NATIONAL FIRE PROTECTION ASSOCIATION
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M E M O R A N D U M

TO: Correlating Committee on Automatic Sprinkler Systems

FROM: David Hague, *Staff Liaison*

DATE: November 6, 2017

SUBJECT: **AUT-AAC AGENDA PACKAGE – A2019 Second Draft Meeting**

Enclosed is the agenda for the Second Draft meeting for NFPA 13, *Standard for the Installation of Sprinkler Systems, NFPA 13R Standard for the Installation of Sprinkler Systems in Low-Rise Residential Occupancies, NFPA 13D Standard for the Installation of Sprinkler Systems in One and Two-Family Dwellings and Manufactured Homes, NFPA 24 Standard for the Installation of Private Fire Service Mains and Their Appurtenances,* and *NFPA 291Recommended Practice for Fire Flow Testing and Marking of Hydrants*. The meeting will be held via conference call on Wednesday November 15, 2017 at 11:00 AM ET.

Conference Number(s):

US (Toll): 1-719-234-7872
US (Toll Free): 1-866-546-3377
Canada, Montreal (Local): +1 514 669 5926
Canada, Toronto (Local): +1 647 426 9175

To join the meeting:
https://nfpa.adobeconnect.com/rh2o10conl3l/

Included in this agenda package are the Second Revisions created by the respective Technical Committee. These SRs are currently being balloted by the committees, however once the ballots are complete, we will provide you with access to the Second Draft, as well as all of the components which will make up the Second Draft report, including Public Comment, Committee Comment, and all Second Revisions. These reports may also be found on the Document Information Pages for the respective standards:
www.nfpa.org/13next
www.nfpa.org/13Rnext
www.nfpa.org/13Dnext
www.nfpa.org/24next
www.nfpa.org/291next

If you have suggestions for actions that the CC should take at this meeting, please come prepared with proposed language. Allowable CC actions are provided on the following page.

For administrative questions, please feel free to contact Elena Carroll at (617) 984-7952. For technical questions, please feel free to contact Dave Hague at (617) 984-7273. You can also reach either of us via e-mail at ecarroll@nfpa.org or dhague@nfpa.org.

Correlating Committee on Automatic Sprinkler Systems
Second Draft Meeting November 15, 2017
AGENDA

1. Call to Order – 8:00 AM (Linder)
2. Introductions of Members and Staff
3. Review and Approval of A2019 First Draft Meeting Minutes
4. Review of A2018 Revision Cycle and Meeting Schedule
5. Review of Distributed Material and Workload
    a. Overview of Public Comment/SRs
    b. Overview of Technical Committee Work
6. Technical Committee Chair Reports (order of reports subject to change):
    a. Technical Committee on Private Water Supply Piping Systems (Wagoner)
    b. Technical Committee on Hanging and Bracing of Water-Based Fire protection Systems (Biggins)
    c. Technical Committee on Sprinkler System Installation Criteria (Grill)
    d. Technical Committee on Sprinkler System Discharge Criteria (Leavitt)
    e. Technical Committee on Residential Sprinkler Systems (Isman)
7. New Materials
    a. Discuss Potential Correlating Items from CC Members
        1. Annex text related to future editions
        2. Metric conversions

ATTACHMENT A

Address List No Phone

11/06/2017
David R. Hague
AUT-AAC

Automatic Sprinkler Systems

Kenneth W. Linder **I** 10/10/1997
Chair **AUT-AAC**
Swiss Re
2 Waterside Crossing, Suite 200
Windsor, CT 06095-1588

Jose R. Baz **M** 11/14/1997
Principal **AUT-AAC**
JRB Associates Group Inc.
555 NE 34th Street
Apt. 2603
Miami, FL 33137-4060
NFPA Latin American Section
Alternate: Donato A. Pirro

Kerry M. Bell **RT** 10/10/1997
Principal **AUT-AAC**
UL LLC
333 Pfingsten Road
Northbrook, IL 60062-2096
Alternate: Jeff Hebenstreit

Tracey D. Bellamy **U** 10/29/2012
Principal **AUT-AAC**
Telgian Corporation
900 Circle 75 Parkway, Suite 680
Atlanta, GA 30339-3084
The Home Depot
Alternate: Ralph E. Bless, Jr.

Scott T. Franson **M** 1/18/2001
Principal **AUT-AAC**
The Viking Corporation
210 North Industrial Park Road
Hastings, MI 49058
Alternate: Scott T. Martorano

Michael J. Friedman **SE** 3/21/2006
Principal **AUT-AAC**
Friedman Consulting, Inc.
1 Bluestone Road
Lutherville, MD 21093-4512
Alternate: Russell P. Fleming

Luke Hilton **I** 4/16/1999
Principal **AUT-AAC**
Liberty Mutual Property
13830 Ballantyne Corporate Place, Suite 525
Charlotte, NC 20277-2711
Alternate: James P. Carroll

Alex Hoffman **IM** 9/30/2004
Principal **AUT-AAC**
Viking Fire Protection Inc.
7885 North Fraser Way, Unit 140
Burnaby, BC V5J 5M7 Canada
Canadian Automatic Sprinkler Association
Alternate: Jason W. Ryckman

Mark Hopkins **M** 11/30/2016
Principal **AUT-AAC**
National Fire Sprinkler Association
514 Progress Drive, Suite A
Linthicum Heights, MD 21090
National Fire Sprinkler Association
Alternate: Roland A. Asp

Roland J. Huggins **IM** 10/10/1997
Principal **AUT-AAC**
American Fire Sprinkler Association, Inc.
12750 Merit Drive, Suite 350
Dallas, TX 75251-1273
Alternate: Jack A. Medovich

Sultan M. Javeri **IM** 10/10/1997
Principal **AUT-AAC**
SC Engineering
2 Impasse Du Guernehlue
La Trinite, Surzur, 56190 France

Charles W. Ketner **L** 1/10/2008
Principal **AUT-AAC**
National Automatic Sprinkler Fitters LU 669
Joint Apprenticeship & Training Committee
7050 Oakland Mills Road
Columbia, MD 20732
United Assn. of Journeymen & Apprentices of the Plumbing & Pipe Fitting Industry

Address List No Phone

11/06/2017
David R. Hague
AUT-AAC

Automatic Sprinkler Systems

John A. LeBlanc — **I** 07/29/2013
Principal — **AUT-AAC**
FM Global
1151 Boston-Providence Turnpike
PO Box 9102
Norwood, MA 02062-9102
Alternate: David B. Fuller

David O. Lowrey — **E** 10/29/2012
Principal — **AUT-AAC**
City of Boulder Fire Rescue
3065 Center Green Drive
Boulder, CO 80301

Brock Mitchell — **U** 10/29/2012
Principal — **AUT-AAC**
Extended Stay Hotels
11525 N Community House Rd
Suite 100
Charlotte, NC 28277

Garner A. Palenske — **SE** 4/17/2002
Principal — **AUT-AAC**
Jensen Hughes/AON Fire Protection Engineering
11770 Bernardo Plaza Court, Suite 116
San Diego, CA 92128
JENSEN HUGHES
Alternate: Jeffrey E. Harper

Adam Seghi — **I** 10/29/2012
Principal — **AUT-AAC**
Coda Risk Analysis
9624 Vista View Drive
Austin, TX 78750
Alternate: Bruce H. Clarke

Douglas Paul Stultz — **E** 3/15/2007
Principal — **AUT-AAC**
US Department of the Navy
NAVFAC MIDLANT, Code CI45
9742 Maryland Avenue
Building Z-140, Room 126
Norfolk, VA 23508
Alternate: Lawrence Richard Phillips

J. Michael Thompson — **SE** 4/17/2002
Principal — **AUT-AAC**
GHD/The Protection Engineering Group, PC
14585 Avion Parkway, Suite 150
Chantilly, VA 20151
Alternate: John G. O'Neill

Joseph Su — **RT** 10/29/2012
Voting Alternate — **AUT-AAC**
National Research Council of Canada
1200 Montreal Road, M-59
Ottawa, ON K1A 0R6 Canada

Roland A. Asp — **M** 11/30/2016
Alternate — **AUT-AAC**
National Fire Sprinkler Association, Inc.
514 Progress Drive, Suite A
Linthicum, MD 21090
National Fire Sprinkler Association
Principal: Mark Hopkins

Ralph E. Bless, Jr. — **U** 10/29/2012
Alternate — **AUT-AAC**
Telgian Corporation
900 Circle 75 Parkway, Suite 680
Atlanta, GA 30339-3084
The Home Depot
Principal: Tracey D. Bellamy

James P. Carroll — **I** 08/11/2014
Alternate — **AUT-AAC**
Liberty Mutual Insurance
18018 Java Isle Drive
Tampa, FL 33647-2708
Principal: Luke Hilton

Bruce H. Clarke — **I** 04/04/2017
Alternate — **AUT-AAC**
American International Group, Inc. (AIG)
8606 Driscoll Court
Charlotte, NC 28269-6105
Principal: Adam Seghi

Address List No Phone

11/06/2017
David R. Hague
AUT-AAC

Automatic Sprinkler Systems

Russell P. Fleming **SE** 10/10/1997
Alternate **AUT-AAC**
Northeast Fire Suppression Associates, LLC
157 School Street
PO Box 435
Keene, NH 03431
Principal: Michael J. Friedman

David B. Fuller **I** 7/26/2007
Alternate **AUT-AAC**
FM Approvals
743 Reynolds Road
West Glocester, RI 02814
Principal: John A. LeBlanc

Jeffrey E. Harper **SE** 08/11/2014
Alternate **AUT-AAC**
JENSEN HUGHES
210 Salford Drive
Algonquin, IL 60102-5610
JENSEN HUGHES
Principal: Garner A. Palenske

Jeff Hebenstreit **RT** 08/11/2014
Alternate **AUT-AAC**
UL LLC
484 Tamarach Drive
Edwardsville, IL 62025-5246
UL LLC
Principal: Kerry M. Bell

Scott T. Martorano **M** 3/1/2011
Alternate **AUT-AAC**
The Viking Corporation
210 North Industrial Park Road
Hastings, MI 49058
Principal: Scott T. Franson

Jack A. Medovich **IM** 08/17/2017
Alternate **AUT-AAC**
Fire & Life Safety America
1340 Charwood Road, Suite P
Hanover, MD 21076-3117
American Fire Sprinkler Association
Principal: Roland J. Huggins

John G. O'Neill **SE** 1/1/1977
Alternate **AUT-AAC**
GHD/The Protection Engineering Group, PC
14585 Avion Parkway, Suite 150
Chantilly, VA 20151
Principal: J. Michael Thompson

Lawrence Richard Phillips **E** 12/08/2015
Alternate **AUT-AAC**
US Department of the Navy
NAVFAC MIDLANT CI45
9324 Virginia Avenue
Building Z-140, Room 126
Norfolk, VA 23511-3624
Principal: Douglas Paul Stultz

Donato A. Pirro **M** 11/14/1997
Alternate **AUT-AAC**
Electro Sistemas De Panama, S.A.
Ave. Ernesto T. Lefevre
Parque Lefevre
Panama City, Panama
NFPA Latin American Section
Principal: Jose R. Baz

Jason W. Ryckman **IM** 10/28/2014
Alternate **AUT-AAC**
Canadian Automatic Sprinkler Association
335 Renfrew Drive, Suite 302
Markham, ON L3R 9S9 Canada
Principal: Alex Hoffman

James B. Biggins **SE** 7/28/2006
Nonvoting Member **AUT-AAC**
TUV SUD America Inc./Global Risk Consultants Corporation
15732 West Barr Road
Manhattan, IL 60442-9012
TC on Hanging & Bracing of Water-Based Systems

Robert G. Caputo **M** 11/30/2016
Nonvoting Member **AUT-AAC**
Fire & Life Safety America
21992 East Camacho Road
Queen Creek, AZ 85142
TC on Foam-Water Sprinklers

Address List No Phone

11/06/2017
David R. Hague
AUT-AAC

Automatic Sprinkler Systems

Raymond A. Grill **SE** 12/08/2015
Nonvoting Member **AUT-AAC**
Arup
1120 Connecticut Avenue, NW, Suite 1110
Washington, DC 20036
TC on Sprinkler System Installation Criteria

Kenneth E. Isman **SE** 12/08/2015
Nonvoting Member **AUT-AAC**
University of Maryland
7402 Forests Edge Court
Laurel, MD 20707
TC on Residential Sprinkler Systems

William E. Koffel **SE** 10/10/1997
Nonvoting Member **AUT-AAC**
Koffel Associates, Inc.
8815 Centre Park Drive, Suite 200
Columbia, MD 21045-2107
Safety to Life Correlating Committee

Russell B. Leavitt **U** 10/28/2008
Nonvoting Member **AUT-AAC**
Telgian Corporation
10230 S. 50th Place
Phoenix, AZ 85044
TC on Sprinkler System Discharge Criteria

Kenneth W. Wagoner **SE** 03/02/2010
Nonvoting Member **AUT-AAC**
Parsley Consulting Engineers
350 West 9th Avenue, Suite 206
Escondido, CA 92025-5053
TC on Private Water Supply Piping Systems

John J. Walsh **SE** 1/1/1974
Member Emeritus **AUT-AAC**
UA Joint Apprenticeship Committee Local 669
502 Kings Farm Blvd., #302
Rockville, MD 20850
United Assn. of Journeymen & Apprentices of the Plumbing & Pipe Fitting Industry

David R. Hague 3/18/2016
Staff Liaison **AUT-AAC**
National Fire Protection Association
1 Batterymarch Park
Quincy, MA 02169-7471

Chad Duffy 4/20/2017
Co-Staff Liaison **AUT-AAC**
National Fire Protection Association
1 Batterymarch Park
Quincy, MA 02169-7471

ATTACHMENT B

Correlating Committee on Automatic Sprinklers

First Draft Correlating Committee Meeting

December 6, 2016

MEETING MINUTES

1. **Call to Order**. CC Chair Ken Linder called the meeting to order at 8AM.

2. **Self-Introductions of members and guests.**
   a. Self-introductions of CC Members and guests were made. Attendance list is attached

3. **Approval of Minutes of Previous Meeting.**
   a. The minutes of the A15 Second Draft Meeting were reviewed and approved without modification.

4. **Review of Meeting Procedures and Revision Process.**
   a. Dave Hague gave a presentation on the overall meeting guidelines and the NFPA Regulations Governing CC operations

5. **Committee Chair Reports.**
   a. The Chairs of each of the Technical Committee presented an overview of First Draft committee actions for the CC to consider and act on.

6. **Correlating Issues**
   a. Correlating issues were acted on and Correlating Notes (CN) were developed.
   b. The CC voted to recommend to the Standards Council that NFPA 13D and 13R, following the A2019 revision cycle, move to a four year cycle on a one-time basis in order for the standards to be processed immediately following NFPA 13. This is intended to avoid multiple meetings in one revision cycle.

7. **Dates for Second Draft Meetings**
   a. Staff outlined the dates for the Second Draft Meetings as follows:
      i. June 19, 2017 PRI
      ii. June 20, 2017 HBS
      iii. June 21-23, 2017 RES
      iv. June 25-27, 2017 SSI
      v. June 27-29, 2017 SSD
      vi. November 8, 2017 AAC – location TBD.

8. **New Business**

a. CC was presented with a template for Chair Reports (see attached). The template is not mandatory but is intended to assist in preparation of Chair Reports.

9. Adjournment

a. The meeting was adjourned at 2:56pm on 12-6-16

Sign-In Sheet
Automatic Sprinkler Systems

NFPA 13, 13D, 13R, 24, 291 CC FD Meeting
December 6-7, 2016
Lake Buena Vista, FL

Name	Office	Organization
Linder, Kenneth	Chair	Swiss Re
Bell, Kerry	Principal	UL LLC
Bellamy, Tracey	Principal	The Home Depot
Friedman, Michael	Principal	Friedman Consulting, Inc.
Hilton, Luke	Principal	Liberty Mutual Property
Hoffman, Alex	Principal	Canadian Automatic Sprinkler Association
Hopkins, Mark	Principal	National Fire Sprinkler Association
Huggins, Roland	Principal	American Fire Sprinkler Association
Lowrey, David	Principal	City of Boulder Fire Rescue
Palenske, Garner	Principal	JENSEN HUGHES
Seghi, Adam	Principal	Coda Risk Analysis
Stultz, Douglas	Principal	US Department of the Navy
Thompson, J. Michael	Principal	GHD/The Protection Engineering Group,
Asp, Roland	Alternate	National Fire Sprinkler Association

Sign-In Sheet
Automatic Sprinkler Systems

NFPA 13, 13D, 13R, 24, 291 CC FD Meeting
December 6-7, 2016
Lake Buena Vista, FL

Name	Office	Organization
Fleming, Russell	Alternate	
Fuller, David	Alternate	FM Global
Phillips, Lawrence	Alternate	US Department of the Navy
Pirro, Donato	Alternate	NFPA Latin American Section
Biggins, James	Nonvoting Member	TC on Hanging & Bracing of Water-Based
Grill, Raymond	Nonvoting Member	TC on Sprinkler System Installation
Koffel, William	Nonvoting Member	Safety to Life Correlating Committee
Leavitt, Russell	Nonvoting Member	TC on Sprinkler System Discharge Criteria

Sign-In Sheet
Automatic Sprinkler Systems

NFPA 13, 13D, 13R, 24, 291 CC FD Meeting
December 6-7, 2016
Lake Buena Vista, FL

	Office	Organization
Hague, David	Staff Liaison	National Fire Protection Assocation

Guests:

Mark Hopkins
Ken Schneider
Mark Fessenden
William Roberts

Chairman' s Report for “” Technical Committee

Name: _____ **Date:** _____

1. **List date(s) and location of meeting:**
2. **List names of guests in attendance:**
3. **List names of guests addressing the Committee, the subject of their address, and the length of time they spoke:**
4. **Number of Public Inputs/Public Comments acted upon:**
5. **Number of First Revisions/Second Revisions created:**
6. **Number of Committee Inputs created:**
7. **Appointment of any Task Groups including TG Name, Purpose and members:**
8. **List any request contained in a Statement that requires Correlating Committee attention:**
9. **List any Committee actions that, in your opinion, need to be referred to another Committee for correlation:**
10. **List any general Committee requests for information or assistance from the Correlating Committee:**
11. **List any additional information that you feel would be helpful to the Correlating Committee, staff, or to the process in general:**
12. **Were any units of measure "Accepted" by the Committee that are not listed in the Manual of Style? If so, please list the section number(s) and PI/comment number(s) below.**
13. **Identify any issues that should be brought to the attention of the NFPA Research Foundation for their input and assistance.**

ATTACHMENT C

2018 ANNUAL REVISION CYCLE

* Public Input Closing Dates may vary according to standards and schedules for Revision Cycles may change. Please check the NFPA Website for the most up-to-date information on Public Input Closing Dates and schedules at www.nfpa.org/document # (i.e. www.nfpa.org/101) and click on Next Edition tab.

Process Stage	Process Step	Dates for TC	Dates for TC with CC
Public Input Stage (First Draft)	**Public Input Closing Date**	6/29/2016	6/29/2016
	Final date for TC First Draft Meeting	12/7/2016	9/7/2016
	Posting of First Draft and TC Ballot	1/25/2017	10/19/2016
	Final date for Receipt of TC First Draft ballot	2/15/2017	11/9/2016
	Final date for Receipt of TC First Draft ballot - recirc	2/22/2017	11/16/2016
	Posting of First Draft for CC Meeting		11/23/2016
	Final date for CC First Draft Meeting		1/4/2017
	Posting of First Draft and CC Ballot		1/25/2017
	Final date for Receipt of CC First Draft ballot		2/15/2017
	Final date for Receipt of CC First Draft ballot - recirc		2/22/2017
	Post First Draft Report for Public Comment	3/1/2017	3/1/2017
Comment Stage (Second Draft)	**Public Comment closing date**	5/10/2017	5/10/2017
	Notice published on Consent Standards (Standards that receive No Comments). Note: Date varies and determined via TC ballot.	–	–
	Appeal Closing Date for Consent Standards (15 Days) (Standards That Received No Comments)	–	–
	Final date for TC Second Draft Meeting	11/8/2017	8/2/2017
	Posting of Second Draft and TC Ballot	12/20/2017	9/13/2017
	Final date for Receipt of TC Second Draft Ballot	1/10/2018	10/4/2017
	Final date for receipt of TC Second Draft ballot - recirc	1/17/2018	10/11/2017
	Posting of Second Draft for CC Mtg		10/18/2017
	Final date for CC Second Draft Meeting		11/29/2017
	Posting of Second Draft for CC Ballot		12/20/2017
	Final date for Receipt of CC Second Draft ballot		1/10/2018
	Final date for Receipt of CC Second Draft ballot - recirc		1/17/2018
	Post Second Draft Report for NITMAM Review	1/24/2018	1/24/2018
Tech Session Preparation (& Issuance)	**Notice of Intent to Make a Motion (NITMAM) Closing Date**	2/21/2018	2/21/2018
	Posting of Certified Amending Motions (CAMs) and Consent Standards	4/4/2018	4/4/2018
	Appeal Closing Date for Consent Standards (15 Days after posting)	4/19/2018	4/19/2018
	SC Issuance Date for Consent Standards (10 Days)	4/29/2018	4/29/2018
Tech Session	Association Meeting for Standards with CAMs	6/4-7/2018	6/4-7/2018
Appeals and Issuance	Appeal Closing Date for Standards with CAMs (20 Days after ATM)	6/27/2018	6/27/2018
	Council Issuance Date for Standards with CAMs*	8/14/2018	8/14/2018

ATTACHMENT D

Length					
.003”	.08 mm	7.5”	190 mm	26”	650 mm
.0315”	.8 mm	8”	200 mm	27.6”	690 mm
1/32”	0.8 mm	8.5”	215 mm	28”	700 mm
1/16”	1.6 mm	9”	225 mm	29”	725 mm
3/32”	2 mm	9.25”	230 mm	30”	750 mm
1/8”	3 mm	9.5”	240 mm	30.5”	765 mm
3/16”	5 mm	10”	250 mm	31”	775 mm
¼”	6 mm	11”	275 mm	32”	800 mm
5/16”	8 mm	11.5”	290 mm	33”	825 mm
3/8”	10 mm	12”	300 mm	35”	875 mm
½”	13 mm	12.25”	305 mm	35.4”	885 mm
17/32”	13 mm	12.5”	315 mm	36”	900 mm
9/16”	14 mm	12.75”	320 mm	37”	925 mm
5/8”	16 mm	14”	350 mm	38”	950 mm
¾”	19 mm	15”	375 mm	40”	1000 mm
7/8”	22 mm	15.5”	390 mm	42”	1050 mm
1”	25 mm	16”	400 mm	44”	1100 mm
1.5”	40 mm	16.25”	410 mm	47”	1175 mm
1.75”	45 mm	16.5”	415 mm	48”	1200 mm
2”	50 mm	17”	425 mm	54”	1350 mm
2.5”	65 mm	17.5”	440 mm	55”	1375 mm
2.75”	70 mm	18”	450 mm	57”	1425 mm
3”	75 mm	19”	475 mm	58”	1450 mm
3.5”	90 mm	20”	500 mm	66”	1650 mm
4”	100 mm	21”	525 mm	68”	1700 mm
4.5”	115 mm	22”	550 mm	72”	1800 mm
5”	125 mm	22.5”	565 mm	76”	1900 mm
5.5”	140 mm	23”	575 mm	78”	1950 mm
5.75”	145 mm	24”	600 mm	96”	2400 mm
6”	150 mm	25”	625 mm	102”	2550 mm
7”	175 mm	25.5”	640 mm	120”	3000 mm
				148”	3700 mm

Length					
3.5ft	1.1 m	10’-10”	3.3 m	22’-6”	6.9 m
3’-8”	1.1 m	11’-0”	3.4 m	24ft	7.3 m
4ft	1.2 m	11’-3”	3.4 m	25ft	7.6 m
4’-2”	1.3 m	11’-5”	3.5 m	25’-3”	7.7 m
4.5ft	1.4 m	11’-6”	3.5 m	26ft	7.9 m
4’-7”	1.4 m	11’-611/16”	3.5 m	27ft	8.2 m
4’-9”	1.4 m	11’-8”	3.6 m	28ft	8.5 m
5ft	1.5 m	12ft	3.7 m	28’-8”	8.7 m
5’-2”	1.6 m	12’-4”	3.8 m	29’-8”	9 m
5.5ft	1.7 m	13ft	4.0 m	30ft	9.1 m
5’-8”	1.7 m	13’-6”	4.1 m	32ft	10 m
5’-9 5/16”	1.8 m	13’-71/2”	4.2 m	33ft	10 m
6ft	1.8 m	13’-11”	4.2 m	35ft	11 m
6’-3”	1.9 m	14ft	4.3 m	36ft	11 m
6’-4”	1.9 m	14’-6”	4.4 m	40ft	12 m
6.5ft	2 m	15ft	4.6 m	41’-3”	13 m
6’-10”	2.1 m	15’-4”	4.7 m	45ft	14 m
7ft	2.1 m	16ft	4.9 m	50ft	15 m
7.5ft	2.3 m	16’-6”	5.0 m	51’-6”	16 m
7’-7”	2.3 m	16’-8”	5.1 m	55ft	17 m
7’-9”	2.4 m	17ft	5.2 m	60ft	18 m
8ft	2.4 m	18ft	5.5 m	65ft	20 m
8’-2”	2.5 m	18’-6”	5.6 m	70ft	21 m
8’-4”	2.5 m	19’-2”	5.8 m	75ft	23 m
8’-77/8”	2.6 m	19’-10”	6 m	76ft	23 m
9ft	2.7 m	19’-11”	6.1 m	80ft	24 m
9’-5”	2.9 m	20ft	6.1 m	100ft	30 m
9’-6”	2.9 m	20’-8”	6.3 m	200ft	61 m
10ft	3 m	21’-6”	6.6 m	250ft	76 m
10.5ft	3.2 m	21’-10”	6.7 m	300ft	91 m
10’-9”	3.3 m	22 ft	6.7 m	400ft	120 m

Area					
3.5 ft2	0.3 m2	256 ft2	24 m2	2,700 ft2	250 m2
6 ft2	0.6 m2	300 ft2	28 m2	2,734 ft2	255 m2
10 ft2	0.9 m2	306 ft2	28 m2	2,800 ft2	260 m2
12 ft2	1.1 m2	324 ft2	30 m2	3,000 ft2	280 m2
16 ft2	1.5 m2	395 ft2	37 m2	3,250 ft2	300 m2
18 ft2	1.7m2	400 ft2	37 m2	3,300 ft2	305 m2
20 ft2	1.9m2	450 ft2	42 m2	3,450 ft2	320 m2
24 ft2	2.2m2	504 ft2	47 m2	3,500 ft2	325 m2
25 ft2	2.3 m2	585 ft2	54 m2	3,600 ft2	335 m2
32 ft2	3.0 m2	600 ft2	56 m2	3,750 ft2	350 m2
50 ft2	4.6 m2	648 ft2	60 m2	3,900 ft2	360 m2
55 ft2	5.1 m2	700 ft2	65 m2	4,000 ft2	370 m2
64 ft2	5.9 m2	756 ft2	70 m2	4,100 ft2	380 m2
70 ft2	6.5 m2	768 ft2	71 m2	4,500 ft2	420 m2
80 ft2	7.4 m2	800 ft2	74 m2	4,800 ft2	445 m2
90 ft2	8.4 m2	1,000 ft2	93 m2	5,000 ft2	465 m2
100 ft2	9 m2	1,200ft2	112 m2	6,000 ft2	555 m2
110 ft2	10 m2	1,300 ft2	120 m2	6,400 ft2	595 m2
120 ft2	11 m2	1,365 ft2	125 m2	8,000 ft2	740 m2
124 ft2	12 m2	1,400 ft2	130 m2	8,800 ft2	820 m2
130 ft2	12 m2	1,500 ft2	140 m2	10,000 ft2	930 m2
144 ft2	13 m2	1,700 ft2	160 m2	13,100 ft2	1 215 m2
150 ft2	14 m2	1,800 ft2	165 m2	25,000 ft2	2 320 m2
168 ft2	16 m2	1,950 ft2	180 m2	40,000 ft2	3 720 m2
175 ft2	16 m2	2,000 ft2	185 m2	50,000 ft2	4 650 m2
196 ft2	18 m2	2,300 ft2	215 m2	52,000 ft2	4 830 m2
200 ft2	18 m2	2,500 ft2	230m2	100,000 ft2	9 230 m2
225 ft2	20 m2	2,535 ft2	235 m2		
250 ft2	23 m2	2,600 ft2	240 m2		

Volume			
1.76 cuin	28 ml	160 ft3	4.5 m3
15.5 ft3	0.5 m3	400 ft3	11 m3
17.4 ft3	0.5 m3	1,000 ft3	28 m3
17.6 ft3	0.5 m3	1,800 ft3	51 m3
20.7 ft3	0.6 m3	2,100 ft3	59 m3
21.1 ft3	0.6 m3	2,300 ft3	65 m3
22 ft3	0.6 m3	6,500 ft3	184 m3
100 ft3	2.8 m3	2.25M ft3	63,720 m3

Capacity	
16 oz.	0.5 l
32 oz.	1 l
1 gal	4 l
5 gal	20 l
40 gal	150 l
100 gal	380 l
150 gal	570 l
250 gal	950 l
500 gal	1900 l
750 gal	2850 l
300,000 gal	1,135,500 l

Drill Size	
3/32”	2,3 mm
1/8”	3,2 mm
3/8”	10 mm

Density of Cotton Bales	
22.0 lb/ft^3	350 kg/m^3
22.7 lb/ft^3	365 kg/m^3
24.2 lb/ft^3	390 kg/m^3
28.4 lb/ft^3	455 kg/m^3
28.7 lb/ft^3	460 kg/m^3
32.2 lb/ft^3	515 kg/m^3

Flow					
30 gpm	115 lpm	300 gpm	1150 lpm	1000 gpm	3800 lpm
15 gpm	57 lpm	400 gpm	1500 lpm	1500 gpm	5700 lpm
20 gpm	75 lpm	500 gpm	1900 lpm	1992 gpm	7540 lpm
50 gpm	190 lpm	600 gpm	2250 lpm	1993 gpm	7543 lpm
60 gpm	230 lpm	700 gpm	2650 lpm	2156 gpm	8160 lpm
100 gpm	380 lpm	750 gpm	2850 lpm	2575 gpm	9750 lpm
102.8 gpm	390 lpm	800 gpm	3050 lpm	4907 gpm	18,572 lpm
200 gpm	760 lpm	850 gpm	3200 lpm		
215.8 gpm	815 lpm	900 gpm	3400 lpm		
250 gpm	950 lpm				

Pressure			
5 psi	0.3 bar	75	5.2 bar
7	0.5 bar	90	6.2 bar
10	0.7 bar	100	6.9 bar
11	.8 bar	150	10 bar
15	1.0 bar	165	11 bar
20	1.4 bar	175	12 bar
22	15 bar	189	13 bar
25	1.7 bar	200	14 bar
30	2.1 bar	259	17 bar
35	2.4 bar	300	21 bar
50	3.4 bar	400	28 bar
63	4.3 bar		

Gauge	
12	2.8 mm
14	1.98 mm
16	1.57 mm
22	.78 mm
24	.63mm

Weight			
6 lb	2.7 kg	350 lb	160 kg
10 lb	4.5 kg	440 lb	200 kg
20 lb	9.1 kg	520 lb	235 kg
40 lb	18 kg	750 lb	340 kg
61 lb	27 kg	787 lb	355 kg
91 lb	41 kg	1200 lb	544 kg
131 lb	59 kg	1634 lb	740 kg
200 lb	91 kg	2000 lb	907 kg
250 lb	115 kg	2300 lb	1043 kg
		4000 lb	1815 kg

Velocity	
30 mph	49 km/h

Discharge Density			
gpm/ft2	mm/min	gpm/ft2	mm/min
.005	.2	.425	17.3
.05	2.04	.426	17.4
.1	4.1	.44	17.9
.15	6.1	.45	18.3
.16	6.5	.46	18.7
.17	7.0	.49	20
.18	7.3	.5	20.4
.19	7.7	.55	22.4
.2	8.2	.56	22.8
.21	8.6	.57	23.2
.225	9.2	.6	24.5
.24	9.8	.61	24.9
.25	10.2	.65	26.5
.26	10.6	.68	27.7
.28	11.4	.7	28.5
.29	11.8	.74	30.2
.3	12.2	.75	30.6
.31	12.6	.77	31.4
.32	13.0	.8	32.6
.33	13.4	.85	34.6
.34	13.9	.9	36.7
.35	14.3	.92	37.5
.37	15.1	.96	39.1
.375	15.3	1.1	44.8
.39	15.9	1.2	48.9
.4	16.3	6.0	245
.42	17.1	7.5	306

Table 1.6.1.3 Conversion Factors			
	Name of Unit	**Unit Symbol**	**Conversion Factor**
Length	millimeter	mm	1in. = 25 mm
	meter	m	1ft. = .3048 m
Area	square millimeters	mm^2	1 $in.^2$ = 645.2 mm^2
	square Meter	m^2	1 ft^2 = 0.0929 m^2
Volume	cubic Meter	m^3	1 ft^3 = 0.02832 m^3
Fluid Capacity	liter	l	1 fl. oz. = 0.02957 l
	liter	l	1 gal. = 3.785 l
Flow	Liter pre minute	L/min	1 gpm = 3.7848 L/min
Pressure	bar	bar	1 psi = 0.0689 bar
Discharge Density	millimeter/minute	mm/min	1 gpm/ft2 = 40.746 mm/min
	liter/minute/m^2	(L/min)/m^2	1 gpm/ft^2 = 40.746 (L/min)/m^2
k-factor	k-factor	L/min/$(bar)^2$	1gpm/$(psi)^2$ = 14.285 L/min/$(bar)^2$
Weight	kilogram	kg	1 lb = 0.4536 kg
Density	kilogram / cubic meter	kg/m^3	1 lb/ft^3 = 16.02 kg/m^3
Temperature	Farenheit	F°	F° = 9/5 x C° + 32
	Celcius	C°	C° = 5/9(F° - 32)
Velocity	kilometers per hour	km/h	1 mph = 1.609 km/h
Pound Force	Newtons	N	1 lb force = 4.44822 N
Gauge (Sheet Steel)	millimeter	mm	12 gauge = 2.8 mm
			14 gauge = 1.98 mm
			16 gauge - 1.57 mm
			22 gauge = .78 mm
			24 gauge = .63 mm

Table 6.4.6.3.6.2 Positioning of Sprinklers to Avoid Obstructions to Discharge (Residential Upright and Pendent Spray Sprinklers)			
Distance from Sprinkler to side of Obstruction (A)		Maximum Allowable Distance of Deflector Above Bottom of Obstruction (B)	
ft	mm	in	mm
Less than 1 ft	300	0	0
1 ft to less than 1 ft 6 in.	300 to less than 450	0	0
1 ft 6 in. to less than 2 ft	300 to less than 600	1	25
2 ft to less than 2 ft 6 in.	600 to less than 750	1	25
2 ft 6 in. to less than 3 ft	750 to less than 900	1	25
3 ft to less than 3 ft 6 in.	900 to less than 1050	3	75
3 ft 6 in. to less than 4 ft	1050 to less than 1200	3	75
4 ft to less than 4 ft 6 in	1200 to less than 1350	5	125
4 ft 6 in. to less than 5 ft	1350 to less than 1500	7	175
5 ft to less than 5 ft 6 in	1500 to less than 1650	7	175
5 ft 6 in. to less than 6 ft	1650 to less than 1800	7	175
6 ft to less than 6 ft 6 in	1800 to less than 1950	9	225
6 ft 6 in. to less than 7 ft	1950 to less than 2100	11	275
7 ft and greater	2100 and greater	14	350

Table 6.4.6.3.7.2(a) Positioning of Sprinklers to Avoid Obstructions (Residentail Sidewall Sprinklers)			
Distance from Sidewall Sprinkler to Side of Obstruction (A)	Distance from Sidewall Sprinkler to Side of Obstruction (A)	Maximum Allowable Distance of Dseflector Above Bottom of Obstruction (B)	Maximum Allowable Distance of Dseflector Above Bottom of Obstruction (B)
ft	m	ft	mm
Less than 8 ft	2.4	Not allowed	Not allowed
8 ft to less than 10 ft	2.4 to less than 3	1	25
10 ft to less than 11 ft	3 to less than 3.4	2	50
11 ft to less than 12 ft	3.4 to less than 3.7	3	75
12 ft to less than 13 ft	3.7 to less than 4.0	4	100
13 ft to less than 14 ft	4.0 to less than 4.3	6	150
14 ft to less than 15 ft	4.3 to less than 4.6	7	175
15 ft to less than 16 ft	4.6 to less than 4.9	9	225
16 ft to less than 17 ft	4.9 to less than 5.2	11	275
17 ft or greater	5.4 or greater	14	350

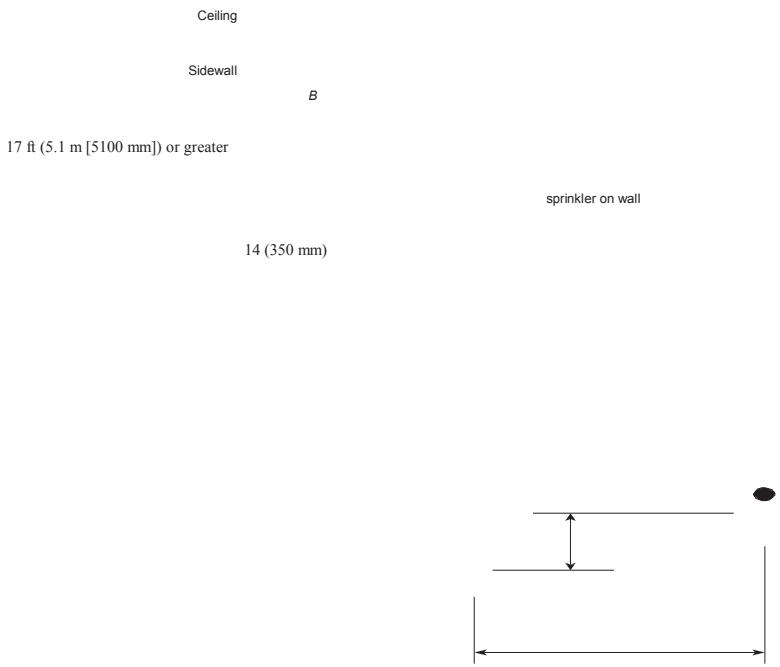


Table 6.4.6.3.7.2(b) Positioning of Sprinklers to Avoid Obstruction Along Wall (Residential Sidewall Sprinklers)			
Distance from Sidewall Sprinkler to Side of Obstruction (a)		**Maximum Allowable Distance of Deflector Above Bottom of Obstruction (B)**	
ft	**mm**	**in**	**mm**
Less than 1 ft 6 in.	Less than 450	0	0
1 ft 6 in. to less than 3 ft	450 to less than 900	1	25
3 ft to less than 4 ft	900 to less than 1200	3	75
4 ft to less than 4 ft 6 in.	1200 to less than 1350	5	125
4 ft 6 in. to less than 6 ft	1350 to less than 1800	7	175
6 ft to less than 6 ft 6 in.	1800 to less than 1950	9	225
6 ft 6 in. to less than 7 ft	1950 to less than 2100	11	275
7 ft to less than 7ft 6 in.	2100 to less than 2250	14	350

ATTACHMENT 9

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Second Revision No. 1039-NFPA 13-2017 [Global Comment]

HBS-AAA

Update metric conversions in NFPA 13 to match that as shown on the attached list and pdf of NFPA 13.

Supplemental Information

File Name	Description	Approved
13-HBS_metrics.pdf	Metric conversions for hanging and bracing	✓
Metric_values_used_in_NFPA_13..docx	List of accepted metric conversions for NFPA 13.	✓

Submitter Information Verification

Submitter Full Name: AUT-HBS
Organization: National Fire Protection Assoc
Street Address:
City:
State:
Zip:
Submittal Date: Fri Oct 06 13:29:50 EDT 2017

Committee Statement and Meeting Notes

Committee Statement: The metric conversions in the attached list are considered to be “soft” or approximate conversions and are intended to consider trade sizes for pipe and other materials and have been appropriately rounded with the number of significant digits taken into account. The intent of this list is to provide for consistent use of metric conversions throughout the standard with the understanding that it is acceptable for an engineer, authority having jurisdiction, designer or, installer to use an exact conversion rather than an approximate conversion as used in the standard when necessary.

The attached list has been reviewed by the NFPA 13 Metric Task Group.

Response Message:

16.15.2.1
In buildings of light or ordinary hazard occupancy, 2½ in. (65 mm) hose valves for fire department use shall be permitted to be attached to wet pipe sprinkler system risers.

16.15.2.2*
The following restrictions shall apply:
(1) Each connection from a standpipe that is part of a combined system to a sprinkler system shall have an individual control valve and check valve of the same size as the connection.

(2) The minimum size of the riser shall be 4 in. (100 mm) unless hydraulic calculations indicate that a smaller size riser will satisfy sprinkler and hose stream allowances.

(3) Each combined sprinkler and standpipe riser shall be equipped with a riser control valve to permit isolating a riser without interrupting the supply to other risers from the same source of supply. *(For fire department connections serving standpipe and sprinkler systems, refer to Section 16.12.)*

16.16 Electrical Bonding and Grounding.

16.16.1
In no case shall sprinkler system piping be used for the grounding of electrical systems.

16.16.2*
The requirement of 16.16.1 shall not preclude the bonding of the sprinkler system piping to the lightning protection grounding system as required by NFPA 780 in those cases where lightning protection is provided for the structure.

16.17* Signs.
(Reserved)

Chapter 17 Installation Requirements for Hanging and Support of System Piping

17.1* General.

17.1.1
Unless the requirements of 17.1.2 are met, types of hangers shall be in accordance with the requirements of Section 9.1.

17.1.2
Hangers certified by a registered professional engineer to include all of the following shall be an acceptable alternative to the requirements of Section 9.1:
(1) Hangers shall be designed to support five times the weight of the water-filled pipe plus 250 lb (115 kg) at each point of piping support.

(2) These points of support shall be adequate to support the system.

(3) The spacing between hangers shall not exceed the value given for the type of pipe as indicated in Table 17.4.2.1(a) or Table 17.4.2.1(b).

(4) Hanger components shall be ferrous.

(5) Detailed calculations shall be submitted, when required by the reviewing authority, showing stresses developed in hangers, piping, and fittings, and safety factors allowed.

17.1.3 Support of Non-System Components.
17.1.3.1*
Sprinkler piping or hangers shall not be used to support non-system components.

17.1.3.2
Sprinkler piping shall be permitted to utilize shared support structures in accordance with 17.1.4.

17.1.4

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Shared support structures shall be certified by a registered professional engineer in accordance with 17.1.2 and 17.1.4.

17.1.4.1*
The design of a shared support structure shall be based on either 17.1.4.1.1 or 17.1.4.1.2.

17.1.4.1.1
Sprinkler pipe and other distribution systems shall be permitted to be supported from a shared support structure designed to support five times the weight of water-filled sprinkler pipe and other supported distribution systems plus 250 lb (115 kg), based on the allowable ultimate stress.

17.1.4.1.2
Sprinkler pipe and other distribution systems shall be permitted to be supported from a shared support structure designed to support five times the weight of the water-filled sprinkler pipe plus 250 lb (115 kg), and one and one-half times the weight of all other supported distribution systems.

17.1.4.1.3
The building structure shall not be considered a shared support structure.

17.1.4.1.4*
The requirements of 17.1.4.1 shall not apply to 17.4.1.3.3.

17.1.4.1.5
Systems that are incompatible with the fire sprinkler systems based on vibration, thermal expansion and contraction, or other factors shall not share support structures.

17.1.5
Where water-based fire protection systems are required to be protected against damage from earthquakes, hangers shall also meet the requirements of 18.7.

17.1.6 Listing.

17.1.6.1*
Unless permitted by 17.1.6.2 or 17.1.6.3, the components of hanger assemblies that directly attach to the pipe, building structure, or racking structure shall be listed.

17.1.6.2*
Mild steel hanger rods and hangers formed from mild steel rods shall be permitted to be not listed.

17.1.6.3*
Fasteners as specified in 17.2.2, 17.2.3, and 17.2.4 shall be permitted to be not listed.

17.1.6.4
Other fasteners shall be permitted as part of a hanger assembly that has been tested, listed, and installed in accordance with the listing requirements.

17.1.7 Component Material.

17.1.7.1
Unless permitted by 17.1.7.2 or 17.1.7.3, hangers and their components shall be ferrous metal.

17.1.7.2
Nonferrous components that have been proven by fire tests to be adequate for the hazard application, that are listed for this purpose, and that are in compliance with the other requirements of this section shall be acceptable.

17.1.7.3
Holes through solid structural members shall be permitted to serve as hangers for the support of system piping, provided such holes are permitted by applicable building codes and the spacing and support provisions for hangers of this standard are satisfied.

17.2 Hanger Components.

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17.2.1 Hanger Rods.

17.2.1.1
Unless the requirements of 17.2.1.2 are met, hanger rod size shall be the same as that approved for use with the hanger assembly, and the size of rods shall not be less than that given in Table 17.2.1.1.

Table 17.2.1.1 Hanger Rod Sizes

Pipe Size		Diameter of Rod	
in.	mm	in.	mm
Up to and including 4	100	⅜	10
5	125	½	12
6	150		
8	200		
10	250	⅝	16
12	300		

17.2.1.2
Rods of smaller diameters than indicated in Table 17.2.1.1 shall be permitted where the hanger assembly has been tested and listed by a testing laboratory and installed within the limits of pipe sizes expressed in individual listings.

17.2.1.3
Where the pitch of the branch line is 6 in 12 or greater, a reduction in the lateral loading on branch line hanger rods shall be done by one of the following:
(1) *Second hanger installed in addition to the required main hangers
(2) Lateral sway brace assemblies on the mains
(3) Branch line hangers utilizing an articulating structural attachment
(4) Equivalent means providing support to the branch line hanger rods

17.2.1.4 U-Hooks.
The size of the rod material of U-hooks shall not be less than that given in Table 17.2.1.4.

Table 17.2.1.4 U-Hook Rod Sizes

Pipe Size		Hook Material Diameter	
in.	mm	in.	mm
Up to and including 2	50	5/16	8
2½ to 6	65 to 150	⅜	10
8	200	½	12

17.2.1.5 Eye Rods.

17.2.1.5.1
The size of the rod material for eye rods shall not be less than specified in Table 17.2.1.5.1.

Table 17.2.1.5.1 Eye Rod Sizes

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Pipe Size		Diameter of Rod			
		With Bent Eye		With Welded Eye	
in.	mm	in.	mm	in.	mm
Up to and including 4	100	⅜	10	⅜	10
5	125	½	12	½	12
6	150	½	12	½	12
8	200	¾	20	½	12

17.2.1.5.2
Eye rods shall be secured with lock washers to prevent lateral motion.

17.2.1.5.3
Where eye rods are fastened to wood structural members, the eye rod shall be backed with a large flat washer bearing directly against the structural member, in addition to the lock washer.

17.2.1.6 Threaded Sections of Rods.
Threaded sections of rods shall not be formed or bent.

17.2.2* Fasteners in Concrete.

17.2.2.1
Unless prohibited by 17.2.2.2 or 17.2.2.3, the use of listed inserts set in concrete and listed post-installed anchors to support hangers shall be permitted for mains and branch lines.

17.2.2.2
Post-installed anchors shall not be used in cinder concrete, except for branch lines where the post-installed anchors are alternated with through-bolts or hangers attached to beams.

17.2.2.3
Post-installed anchors shall not be used in ceilings of gypsum or other similar soft material.

17.2.2.4
Unless the requirements of 17.2.2.5 are met, post-installed anchors shall be installed in a horizontal position in the sides of concrete beams.

17.2.2.5
Post-installed anchors shall be permitted to be installed in the vertical position under any of the following conditions:
(1) When used in concrete having gravel or crushed stone aggregate to support pipes 4 in. (100 mm) or less in diameter

(2) When post-installed anchors are alternated with hangers connected directly to the structural members, such as trusses and girders, or to the sides of concrete beams [to support pipe 5 in. (125 mm) or larger]

(3) When post-installed anchors are spaced not over 10 ft (3 m) apart [to support pipe 4 in. (100 mm) or larger]

17.2.2.6
Holes for post-installed anchors in the side of beams shall be above the centerline of the beam or above the bottom reinforcement steel rods.

17.2.2.7
Holes for post-installed anchors used in the vertical position shall be drilled to provide uniform contact with the shield over its entire circumference.

17.2.2.8
The depth of the post-installed anchor hole shall not be less than specified for the type of shield used.

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17.2.2.9 Powder-Driven Studs.

17.2.2.9.1
Powder-driven studs, welding studs, and the tools used for installing these devices shall be listed.

17.2.2.9.2
Pipe size, installation position, and construction material into which they are installed shall be in accordance with individual listings.

17.2.2.9.3*
Representative samples of concrete into which studs are to be driven shall be tested to determine that the studs will hold a minimum load of 750 lb (340 kg) for 2 in. (50 mm) or smaller pipe; 1000 lb (454 kg) for 2½ in., 3 in., or 3½ in. (65 mm, 80 mm, or 90 mm) pipe; and 1200 lb (544 kg) for 4 in. or 5 in. (100 mm or 125 mm) pipe.

17.2.2.9.4
Increaser couplings shall be attached directly to the powder-driven studs.

17.2.2.10 Minimum Bolt or Rod Size for Concrete.

17.2.2.10.1
The size of a bolt or rod used with a hanger and installed through concrete shall not be less than specified in Table 17.2.2.10.1.

Table 17.2.2.10.1 Minimum Bolt or Rod Size for Concrete

Pipe Size		Size of Bolt or Rod	
in.	mm	in.	mm
Up to and including 4	100	⅜	10
5	125	½	12
6	150		
8	200		
10	250	⅝	16
12	300	¾	20

17.2.2.10.2
Holes for bolts or rods shall not exceed 1/16 in. (1.6 mm) greater than the diameter of the bolt or rod.

17.2.2.10.3
Bolts and rods shall be provided with flat washers and nuts.

17.2.3 Fasteners in Steel.

17.2.3.1*
Powder-driven studs, welding studs, and the tools used for installing these devices shall be listed.

17.2.3.2
Pipe size, installation position, and construction material into which they are installed shall be in accordance with individual listings.

17.2.3.3
Increaser couplings shall be attached directly to the powder-driven studs or welding studs.

17.2.3.4
Welding studs or other hanger parts shall not be attached by welding to steel less than U.S. Standard, 12 gauge (2.8 mm).

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17.2.3.5 Minimum Bolt or Rod Size for Steel.

17.2.3.5.1
The size of a bolt or rod used with a hanger and installed through steel shall not be less than specified in Table 17.2.3.5.1.

Table 17.2.3.5.1 Minimum Bolt or Rod Size for Steel

Pipe Size		Size of Bolt or Rod	
in.	**mm**	**in.**	**mm**
Up to and including 4	100	⅜	10
5	125	½	12
6	150		
8	200		
10	250	⅝	15
12	300	¾	20

17.2.3.5.2
Holes for bolts or rods shall not exceed 1⁄16 in. (1.6 mm) greater than the diameter of the bolt or rod.

17.2.3.5.3
Bolts and rods shall be provided with flat washers and nuts.

17.2.4 Fasteners in Wood.

17.2.4.1 Drive Screws.

17.2.4.1.1
Drive screws shall be used only in a horizontal position as in the side of a beam and only for 2 in. (50 mm) or smaller pipe.

17.2.4.1.2
Drive screws shall only be used in conjunction with hangers that require two points of attachments.

17.2.4.2 Ceiling Flanges and U-Hooks with Screws.

17.2.4.2.1
Unless the requirements of 17.2.4.2.2 or 17.2.4.2.3 are met, for ceiling flanges and U-hooks, screw dimensions shall not be less than those given in Table 17.2.4.2.1.

Table 17.2.4.2.1 Screw Dimensions for Ceiling Flanges and U-Hooks

Pipe Size		Two Screw Ceiling Flanges
in.	**mm**	
Up to and including 2	50	Wood screw No. 18 × 1½ in. or Lag screw 5⁄16 in. × 1½ in.
		Three Screw Ceiling Flanges
Up to and including 2	50	Wood screw No. 18 × 1½ in.
2½	65	Lag screw ⅜ in. × 2 in.
3	80	

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Pipe Size		Two Screw Ceiling Flanges
in.	mm	
3½	90	
4	100	Lag screw ½ in. × 2 in.
5	125	
6	150	
8	200	Lag screw ⅝ in. × 2 in.
		Four Screw Ceiling Flanges
Up to and including 2	50	Wood screw No. 18 × 1½ in.
2½	65	Lag screw ⅜ in. × 1½ in.
3	80	
3½	90	
4	100	Lag screw ½ in. × 2 in.
5	125	
6	150	
8	200	Lag screw ⅝ in. × 2 in.
		U-Hooks
Up to and including 2	50	Drive screw No. 16 × 2 in.
2½	65	Lag screw ⅜ in. × 2½ in.
3	80	
3½	90	
4	100	Lag screw ½ in. × 3 in.
5	125	
6	150	
8	200	Lag screw ⅝ in. × 3 in.

17.2.4.2.2
When the thickness of planking and thickness of flange do not permit the use of screws 2 in. (50 mm) long, screws 1¾ in. (45 mm) long shall be permitted with hangers spaced not over 10 ft (3 m) apart.

17.2.4.2.3
When the thickness of beams or joists does not permit the use of screws 2½ in. (65 mm) long, screws 2 in. (50 mm) long shall be permitted with hangers spaced not over 10 ft (3 m) apart.

17.2.4.3 Bolts, Rods, or Lag Screws.

17.2.4.3.1
Unless the requirements of 17.2.4.3.2 are met, the size of bolt, rod, or lag screw used with a hanger and installed on the side of the beam shall not be less than specified in Table 17.2.4.3.1.

Table 17.2.4.3.1 Minimum Bolt, Rod, or Lag Screw Sizes for Side of Beam Installation

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Pipe Size		Size of Bolt, Rod or Lag Screw		Length of Lag Screw Used with Wood Beams	
in.	mm	in.	mm	in.	mm
Up to and including 2	50	⅜	10	2½	65
2½ to 6 (inclusive)	65 to 150	½	12	3	75
8	200	⅝	16	3	75

17.2.4.3.2
Where the thickness of beams or joists does not permit the use of screws 2½ in. (65 mm) long, screws 2 in. (50 mm) long shall be permitted with hangers spaced not over 10 ft (3 m) apart.

17.2.4.3.3
All holes for lag screws shall be pre-drilled ⅛ in. (3 mm) less in diameter than the maximum root diameter of the lag screw thread.

17.2.4.3.4
Holes for bolts or rods shall not exceed 1/16 in. (1.6 mm) greater than the diameter of the bolt or rod.

17.2.4.3.5
Bolts and rods shall be provided with flat washers and nuts.

17.2.4.4 Wood Screws.
Wood screws shall be installed with a screwdriver.

17.2.4.5 Nails.
Nails shall not be acceptable for fastening hangers.

17.2.4.6 Screws in Side of Timber or Joists.

17.2.4.6.1
Screws in the side of a timber or joist shall be not less than 2½ in. (65 mm) from the lower edge where supporting pipe is up to and including nominal 2½ in. and not less than 3 in. (75 mm) where supporting pipe is greater than nominal 2½ in.

17.2.4.6.2
The requirements of 17.2.4.6.1 shall not apply to 2 in. (50 mm) or thicker nailing strips resting on top of steel beams.

17.2.4.7 Coach Screw Rods.

17.2.4.7.1 Minimum Coach Screw Rod Size.
The size of coach screw rods shall not be less than the requirements of Table 17.2.4.7.1.

Table 17.2.4.7.1 Minimum Coach Screw Rod Size

Pipe Size		Diameter of Rod		Minimum Penetration	
in.	mm	in.	mm	in.	mm
Up to and including 4	100	⅜	10	3	75
Larger than 4	100	NP	NP	NP	NP

NP: Not permitted.

17.2.4.7.2

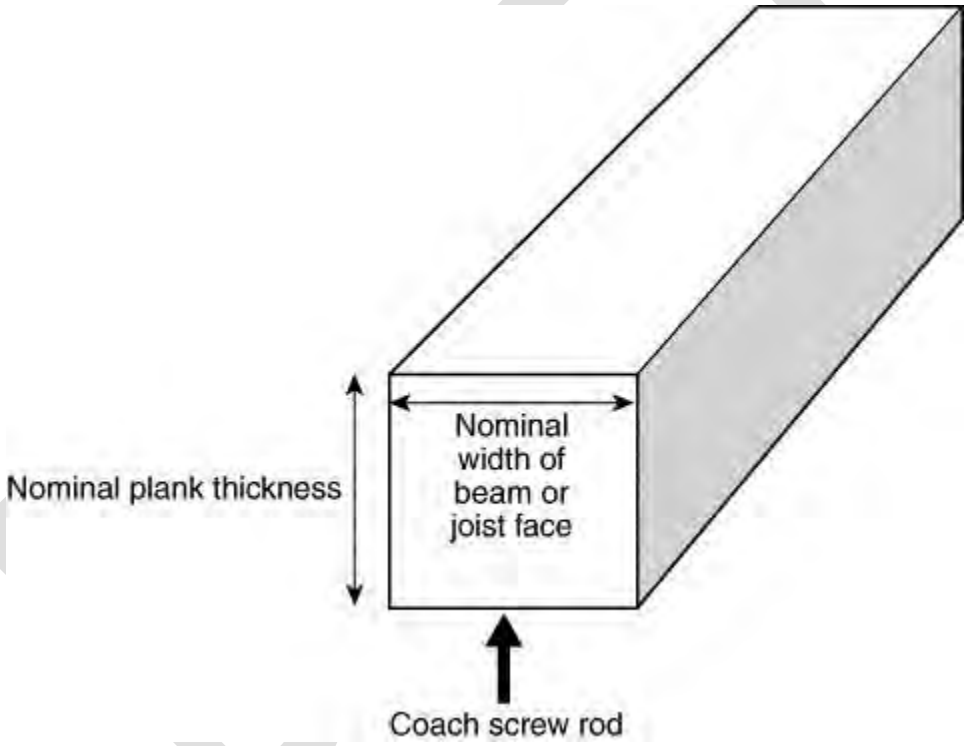
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The minimum plank thickness and the minimum width of the lower face of beams or joists in which coach screw rods are used shall be not less than that specified in Table 17.2.4.7.2 and shown in Figure 17.2.4.7.2.

Table 17.2.4.7.2 Minimum Plank Thicknesses and Beam or Joist Widths

Pipe Size		Nominal Plank Thickness		Nominal Width of Beam or Joist Face	
in.	mm	in.	mm	in.	mm
Up to and including 2	50	3	75	2	50
2½	65	4	100	2	50
3	80				
3½	90				
4	100	4	100	3	75

Figure 17.2.4.7.2 Dimensions for Structural Members with Coach Screw Rods.



17.2.4.7.3
Coach screw rods shall not be used for support of pipes larger than 4 in. (100 mm) in diameter.

17.2.4.7.4
All holes for coach screw rods shall be predrilled ⅛ in. (3 mm) less in diameter than the maximum root diameter of the wood screw thread.

17.3* Trapeze Hangers.

17.3.1
For trapeze hangers, the minimum size of steel angle or pipe span between structural members shall be such that the section modulus required in Table 17.3.1(a**)** does not exceed the available section modulus of the trapeze member from Table 17.3.1(b) or Table 17.3.1(c).

Table 17.3.1(a) Section Modulus Required for Trapeze Members (in.^{3})

Nominal Diameter of Pipe Being Supported – Schedule 10 Steel												
Span (ft)	**1**	**1.25**	**1.5**	**2**	**2.5**	**3**	**3.5**	**4**	**5**	**6**	**8**	**10**
1.5	0.08	0.08	0.09	0.09	0.10	0.11	0.12	0.13	0.15	0.18	0.26	0.34
2.0	0.11	0.11	0.12	0.13	0.14	0.15	0.16	0.17	0.20	0.24	0.34	0.45
2.5	0.14	0.14	0.15	0.16	0.18	0.21	0.23	0.25	0.30	0.36	0.50	0.69
3.0	0.16	0.17	0.18	0.19	0.20	0.22	0.24	0.26	0.31	0.36	0.51	0.67
3.5	0.19	0.20	0.21	0.22	0.24	0.26	0.28	0.30	0.36	0.42	0.60	0.78
4.0	0.22	0.22	0.24	0.25	0.27	0.30	0.32	0.34	0.41	0.48	0.68	0.89
4.5	0.24	0.25	0.27	0.28	0.30	0.33	0.36	0.38	0.46	0.54	0.77	1.01
5.0	0.27	0.28	0.30	0.31	0.34	0.37	0.40	0.43	0.51	0.60	0.85	1.12
5.5	0.30	0.31	0.33	0.34	0.37	0.41	0.44	0.47	0.56	0.66	0.94	1.23
6.0	0.33	0.34	0.35	0.38	0.41	0.44	0.48	0.51	0.61	0.71	1.02	1.34
6.5	0.35	0.36	0.38	0.41	0.44	0.48	0.52	0.56	0.66	0.77	1.11	1.45
7.0	0.38	0.39	0.41	0.44	0.47	0.52	0.56	0.60	0.71	0.83	1.19	1.56
7.5	0.41	0.42	0.44	0.47	0.51	0.55	0.60	0.64	0.76	0.89	1.28	1.68
8.0	0.43	0.45	0.47	0.50	0.54	0.59	0.63	0.68	0.82	0.95	1.36	1.79
8.5	0.46	0.48	0.50	0.53	0.58	0.63	0.67	0.73	0.87	1.01	1.45	1.90
9.0	0.49	0.50	0.53	0.56	0.61	0.66	0.71	0.77	0.92	1.07	1.53	2.01
9.5	0.52	0.53	0.56	0.60	0.64	0.70	0.75	0.81	0.97	1.13	1.62	2.12
10.0	0.54	0.56	0.59	0.63	0.68	0.74	0.79	0.85	1.02	1.19	1.70	2.23
10.5	0.57	0.59	0.62	0.66	0.71	0.78	0.83	0.90	1.07	1.25	1.79	2.35
11.0	0.60	0.62	0.65	0.69	0.74	0.81	0.87	0.94	1.12	1.31	1.87	2.46
11.5	0.63	0.64	0.68	0.72	0.78	0.85	0.91	0.98	1.17	1.37	1.96	2.57
12.0	0.65	0.67	0.71	0.75	0.81	0.89	0.95	1.02	1.22	1.43	2.04	2.68
12.5	0.68	0.70	0.74	0.78	0.85	0.92	0.99	1.07	1.27	1.49	2.13	2.79
13.0	0.71	0.73	0.77	0.81	0.88	0.96	1.03	1.11	1.33	1.55	2.21	2.90
13.5	0.73	0.76	0.80	0.85	0.91	1.00	1.07	1.15	1.38	1.61	2.30	3.02
14.0	0.76	0.78	0.83	0.88	0.95	1.03	1.11	1.20	1.43	1.67	2.38	3.13
14.5	0.79	0.81	0.86	0.91	0.98	1.07	1.15	1.24	1.48	1.73	2.47	3.24
15.0	0.82	0.84	0.89	0.94	1.02	1.11	1.19	1.28	1.53	1.79	2.56	3.35
15.5	0.84	0.87	0.92	0.97	1.05	1.14	1.23	1.32	1.58	1.85	2.64	3.46
16.0	0.87	0.90	0.95	1.00	1.08	1.18	1.27	1.37	1.63	1.91	2.73	3.58
Nominal Diameter of Pipe Being Supported – Schedule 40 Steel												
Span (ft)	**1**	**1.25**	**1.5**	**2**	**2.5**	**3**	**3.5**	**4**	**5**	**6**	**8**	**10**
1.5	0.08	0.09	0.09	0.1	0.11	0.12	0.14	0.15	0.18	0.22	0.30	0.41

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Nominal Diameter of Pipe Being Supported – Schedule 10 Steel												
Span (ft)	**1**	**1.25**	**1.5**	**2**	**2.5**	**3**	**3.5**	**4**	**5**	**6**	**8**	**10**
2.0	0.11	0.11	0.12	0.13	0.15	0.16	0.18	0.20	0.24	0.29	0.40	0.55
2.5	0.14	0.14	0.15	0.16	0.17	0.18	0.20	0.21	0.25	0.30	0.43	0.56
3.0	0.16	0.17	0.18	0.20	0.22	0.25	0.27	0.30	0.36	0.43	0.60	0.82
3.5	0.19	0.20	0.21	0.23	0.26	0.29	0.32	0.35	0.42	0.51	0.70	0.96
4.0	0.22	0.23	0.24	0.26	0.29	0.33	0.36	0.40	0.48	0.58	0.80	1.10
4.5	0.25	0.26	0.27	0.29	0.33	0.37	0.41	0.45	0.54	0.65	0.90	1.23
5.0	0.27	0.29	0.30	0.33	0.37	0.41	0.45	0.49	0.60	0.72	1.00	1.37
5.5	0.30	0.31	0.33	0.36	0.40	0.45	0.50	0.54	0.66	0.79	1.10	1.51
6.0	0.33	0.34	0.36	0.39	0.44	0.49	0.54	0.59	0.72	0.87	1.20	1.64
6.5	0.36	0.37	0.40	0.42	0.48	0.54	0.59	0.64	0.78	0.94	1.31	1.78
7.0	0.38	0.40	0.43	0.46	0.52	0.58	0.63	0.69	0.84	1.01	1.41	1.92
7.5	0.41	0.43	0.46	0.49	0.55	0.62	0.68	0.74	0.90	1.08	1.51	2.06
8.0	0.44	0.46	0.49	0.52	0.59	0.66	0.72	0.79	0.96	1.16	1.61	2.19
8.5	0.47	0.48	0.52	0.56	0.63	0.70	0.77	0.84	1.02	1.23	1.71	2.33
9.0	0.49	0.51	0.55	0.59	0.66	0.74	0.81	0.89	1.08	1.30	1.81	2.47
9.5	0.52	0.54	0.58	0.62	0.70	0.78	0.86	0.94	1.14	1.37	1.91	2.60
10.0	0.55	0.57	0.61	0.65	0.74	0.82	0.90	0.99	1.20	1.45	2.01	2.74
10.5	0.58	0.60	0.64	0.69	0.77	0.86	0.95	1.04	1.26	1.52	2.11	2.88
11.0	0.60	0.63	0.67	0.72	0.81	0.91	0.99	1.09	1.32	1.59	2.21	3.01
11.5	0.63	0.66	0.70	0.75	0.85	0.95	1.04	1.14	1.38	1.66	2.31	3.15
12.0	0.66	0.68	0.73	0.78	0.88	0.99	1.08	1.19	1.44	1.73	2.41	3.29
12.5	0.69	0.71	0.76	0.82	0.92	1.03	1.13	1.24	1.5	1.81	2.51	3.43
13.0	0.71	0.74	0.79	0.85	0.96	1.07	1.17	1.29	1.56	1.88	2.61	3.56
13.5	0.74	0.77	0.82	0.88	0.99	1.11	1.22	1.34	1.62	1.95	2.71	3.70
14.0	0.77	0.80	0.85	0.91	1.03	1.15	1.26	1.39	1.68	2.02	2.81	3.84
14.5	0.80	0.83	0.88	0.95	1.07	1.19	1.31	1.43	1.74	2.1	2.91	3.97
15.0	0.82	0.86	0.91	0.98	1.10	1.24	1.35	1.48	1.8	2.17	3.01	4.11
15.5	0.85	0.88	0.94	1.01	1.14	1.28	1.4	1.53	1.86	2.24	3.11	4.25
16.0	0.88	0.91	0.97	1.05	1.18	1.32	1.44	1.58	1.92	2.31	3.21	4.39

For SI units, 1 in. = 25.4 mm; 1 ft = 0.3048 m.

Note: The table is based on a maximum bending stress of 15 ksi and a midspan concentrated load from 15 ft (4.6 m) of water-filled pipe, plus 250 lb (114 kg).

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Table 17.3.1(b) Available Section Modulus of Common Trapeze Hangers (in.^{3})

Pipe				
in.	mm	Modulus (in.^{3})	Angles (in.)	Modulus (in.^{3})
Schedule 10				
1	25	0.12	1½ × 1½ × 3/16	0.10
1¼	32	0.19	2 × 2 × ⅛	0.13
1½	40	0.26	2 × 1½ × 3/16	0.18
2	50	0.42	2 × 2 × 3/16	0.19
2½	65	0.69	2 × 2 × ¼	0.25
3	80	1.04	2½ × 1½ × 3/16	0.28
3½	90	1.38	2½ × 2 × 3/16	0.29
4	100	1.76	2 × 2 × 5/16	0.30
5	125	3.03	2½ × 2½ × 3/16	0.30
6	150	4.35	2 × 2 × ⅜	0.35
			2½ × 2½ × ¼	0.39
			3 × 2 × 3/16	0.41
Schedule 40				
1	25	0.13	3 × 2½ × 3/16	0.43
1¼	32	0.23	3 × 3 × 3/16	0.44
1½	40	0.33	2½ × 2½ × 5/16	0.48
2	50	0.56	3 × 2 × ¼	0.54
2½	65	1.06	2½ × 2 × ⅜	0.55
3	80	1.72	2½ × 2½ × ⅜	0.57
3½	90	2.39	3 × 3 × ¼	0.58
4	100	3.21	3 × 3 × 5/16	0.71
5	125	5.45	2½ × 2½ × ½	0.72
6	150	8.50	3½ × 2½ × ¼	0.75
			3 × 2½ × ⅜	0.81
			3 × 3 × ⅜	0.83
			3½ × 2½ × 5/16	0.93
			3 × 3 × 7/16	0.95
			4 × 4 × ¼	1.05
			3 × 3 × ½	1.07
			4 × 3 × 5/16	1.23
			4 × 4 × 5/16	1.29
			4 × 3 × ⅜	1.46

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Pipe		Modulus (in.^{3})	Angles (in.)	Modulus (in.^{3})
in.	mm			
			4 ×4 × ⅜	1.52
			5 × 3½ × 5⁄16	1.94
			4 × 4 × ½	1.97
			4 × 4 × ⅝	2.40
			4 × 4 × ¾	2.81
			6 × 4 × ⅜	3.32
			6 × 4 × ½	4.33
			6 × 4 × ¾	6.25
			6 × 6 × 1	8.57

Table 17.3.1(c) Available Section Modulus of Common Trapeze Hangers (cm^3)

Pipe		Modulus (cm^3)	Angles (mm)	Modulus (cm^3)
in.	mm			
Schedule 10				
1	25	1.97	40 × 40 × 5	1.64
1¼	32	3.11	50 × 50 × 3	2.13
1½	40	4.26	50 × 40 × 5	2.95
2	50	6.88	50 × 50 × 5	3.11
2½	65	11.3	50 × 50 × 6	4.10
3	80	17.0	65 × 40 × 5	4.59
3½	90	22.6	65 × 50 × 5	4.75
4	100	28.8	50 × 50 × 8	4.92
5	125	49.7	65 × 65 × 5	4.92
6	150	71.3	50 × 50 × 10	5.74
			65 × 65 × 6	6.39
			80× 50 × 5	6.72
Schedule 40				
1	25	2.1	80 × 65 × 10	7.05
1¼	32	3.8	3 × 3 × 3⁄16	7.21
1½	40	5.4	65 × 65 × 8	7.87
2	50	9.2	3 × 2 × ¼	8.85
2½	65	17.4	65 × 50 × 10	9.01
3	80	28.2	65 × 65 × 10	9.34
3½	90	39.2	80 × 80 × 6	9.50

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Pipe		Modulus (cm^3)	Angles (mm)	Modulus (cm^3)
in.	mm			
Schedule 10				
4	100	52.6	80 × 80 × 8	11.6
5	125	89.3	65 × 65 ×15	11.8
6	150	139.3	90 × 65 ×6	12.3
			80 × 65 × 10	13.3
			80 × 80 × 10	13.6
			90 × 65 × 8	15.2
			80 × 80 × 11	15.6
			100 × 100 × 6	17.2
			80 × 80 × 15	17.5
			100 × 80 × 8	20.2
			100 × 100 × 8	21.1
			100 × 80 × 10	23.9
			100 ×100 × 10	24.9
			125 × 90 × 8	31.8
			100 × 100 × 16	32.3
			100 × 100 × 8	39.3
			100 × 100 × 20	46.0
			150 × 100 × 10	54.4
			150 × 100 × 15	71.0
			150 × 100 × 20	102
			150 × 150 × 25	140

17.3.2
Any other sizes or shapes giving equal or greater section modulus shall be acceptable.

17.3.3
All angles shall be installed with the longer leg vertical.

17.3.4
The trapeze member shall be secured to prevent slippage.

17.3.5*
All components of each hanger assembly that attach to a trapeze member shall conform to **17.1.6** and be sized to support the suspended sprinkler pipe.

17.3.6
The ring, strap, or clevis installed on a pipe trapeze shall be manufactured to fit the pipe size of the trapeze member.

17.3.7
Holes for bolts or rods shall not exceed $\frac{1}{16}$ in. (1.6 mm) greater than the diameter of the bolt or rod.

17.3.8

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Bolts and rods shall be provided with flat washers and nuts.

17.3.9
Where angles are used for trapeze hangers and slotted holes are used, the slotted holes shall meet all of the following:
(1) The length of each slotted hole shall not exceed 3 in. (80 mm)

(2) The width of the slotted hole shall not exceed 1/16 in. (1.6 mm) greater than the bolt or rod diameter.

(3) The minimum distance between slotted holes shall be 3 in. (80 mm) edge to edge.

(4) The minimum distance from the end of the angle to the edge of the slotted hole shall be 3 in. (80 mm)

(5) The number of slots shall be limited to three per section of angle.

(6) The washer(s) required by 17.3.8 shall have a minimum thickness of one-half the thickness of the angle.

(7) Washers and nuts required by 17.3.8 shall be provided on both the top and bottom of the angle.

17.4* Installation of Pipe Hangers.

17.4.1 General.

17.4.1.1 Ceiling Sheathing.

17.4.1.1.1*
Unless the requirements of 17.4.1.1.2 are met, sprinkler piping shall be supported independently of the ceiling sheathing.

17.4.1.1.2
Toggle hangers shall be permitted only for the support of pipe 1½ in. (40 mm) or smaller in size under ceilings of hollow tile or metal lath and plaster.

17.4.1.2 Storage Racks.
Where sprinkler piping is installed in storage racks, piping shall be supported from the storage rack structure or building in accordance with all applicable provisions of Sections 17.4 and 9.3.

17.4.1.3* Building Structure.

17.4.1.3.1
Sprinkler piping shall be substantially supported from the building structure, which must support the added load of the water-filled pipe plus a minimum of 250 lb (115 kg) applied at the point of hanging, except where permitted by 17.4.1.1.2, 17.4.1.3.3, and 17.4.1.4.1.

17.4.1.3.2
Trapeze hangers shall be used where necessary to transfer loads to appropriate structural members.

17.4.1.3.3* Flexible Sprinkler Hose Fittings.

17.4.1.3.3.1
Listed flexible sprinkler hose fittings and their anchoring components intended for use in installations connecting the sprinkler system piping to sprinklers shall be installed in accordance with the requirements of the listing, including any installation instructions.

17.4.1.3.3.2
When installed and supported by suspended ceilings, the ceiling shall meet ASTM C635, *Standard Specification for the Manufacture, Performance, and Testing of Metal Suspension Systems for Acoustical Tile and Lay-In Panel Ceilings*, and shall be installed in accordance with ASTM C636, *Standard Practice for Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-In Panels*.

17.4.1.3.3.3*

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Where flexible sprinkler hose fittings exceed 6 ft (1.8 m) in length and are supported by a suspended ceiling in accordance with 17.4.1.3.3.2, a hanger(s) attached to the structure shall be required to ensure that the maximum unsupported length does not exceed 6 ft (1.8 m).

17.4.1.3.3.4*
Where flexible sprinkler hose fittings are used to connect sprinklers to branch lines in suspended ceilings, a label limiting relocation of the sprinkler shall be provided on the anchoring component.

17.4.1.4 Metal Deck.

17.4.1.4.1*
Branch line hangers attached to metal deck shall be permitted only for the support of pipe 1 in. (25 mm) or smaller in size, by drilling or punching the vertical portion of the metal deck and using through bolts.

17.4.1.4.2
The distance from the bottom of the bolt hole to the bottom of the vertical member shall be not less than ⅜ in. (10 mm).

17.4.1.5
Where sprinkler piping is installed below ductwork, piping shall be supported from the building structure or from the ductwork supports, provided such supports are capable of handling both the load of the ductwork and the load specified in 17.4.1.3.1.

17.4.2* Maximum Distance Between Hangers.

17.4.2.1
The maximum distance between hangers shall not exceed that specified in Table 17.4.2.1(a) or Table 17.4.2.1(b), except where the provisions of 17.4.4 apply.

Table 17.4.2.1(a) Maximum Distance Between Hangers (ft-in.)

	Nominal Pipe Size (in.)											
	¾	1	1¼	1½	2	2½	3	3½	4	5	6	8
Steel pipe except threaded lightwall	NA	12-0	12-0	15-0	15-0	15-0	15-0	15-0	15-0	15-0	15-0	15-0
Threaded lightwall steel pipe	NA	12-0	12-0	12-0	12-0	12-0	12-0	NA	NA	NA	NA	NA
Copper tube	8-0	8-0	10-0	10-0	12-0	12-0	12-0	15-0	15-0	15-0	15-0	15-0
CPVC	5-6	6-0	6-6	7-0	8-0	9-0	10-0	NA	NA	NA	NA	NA
Ductile-iron pipe	NA	NA	NA	NA	NA	NA	15-0	NA	15-0	NA	15-0	15-0

NA: Not applicable.

Table 17.4.2.1(b) Maximum Distance Between Hangers (m)

	Nominal Pipe Size (mm)											
	20	25	32	40	50	65	80	90	100	125	150	200
Steel pipe except threaded lightwall	NA	3.7	3.7	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6
Threaded lightwall steel pipe	NA	3.7	3.7	3.7	3.7	3.7	3.7	NA	NA	NA	NA	NA
Copper tube	2.4	2.4	3.0	3.0	3.7	3.7	3.7	4.6	4.6	4.6	4.6	4.6
CPVC	1.7	1.8	2.0	2.1	2.4	2.7	3.0	NA	NA	NA	NA	NA

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	Nominal Pipe Size (mm)											
	20	**25**	**32**	**40**	**50**	**65**	**80**	**90**	**100**	**125**	**150**	**200**
Ductile-iron pipe	NA	NA	NA	NA	NA	NA	4.6	NA	4.6	NA	4.6	4.6

NA: Not applicable.

17.4.2.2
The maximum distance between hangers for listed nonmetallic pipe shall be modified as specified in the individual product listings.

17.4.3 Location of Hangers on Branch Lines.

17.4.3.1
Subsection 17.4.3 shall apply to the support of steel pipe or copper tube as specified in 7.3.1 and subject to the provisions of 17.4.2.

17.4.3.2* Minimum Number of Hangers.

17.4.3.2.1
Unless the requirements of 17.4.3.2.2 through 17.4.3.2.5 are met, there shall be not less than one hanger for each section of pipe.

17.4.3.2.2*
Unless the requirements of 17.4.3.2.3 are met, where sprinklers are spaced less than 6 ft (1.8 m) apart, hangers spaced up to a maximum of 12 ft (3.7 m) shall be permitted.

17.4.3.2.3
For welded or mechanical outlets on a continuous section of pipe, hanger spacing shall be according to Table 17.4.2.1(a) or Table 17.4.2.1(b).

17.4.3.2.4*
Starter lengths less than 6 ft (1.8 m) shall not require a hanger, unless on the end line of a sidefeed system or where an intermediate cross main hanger has been omitted.

17.4.3.2.5*
A single section of pipe shall not require a hanger when the cumulative distance between hangers on the branch line does not exceed the spacing required by Table 17.4.2.1(a) and Table 17.4.2.1(b).

17.4.3.3 Clearance to Hangers.
The distance between a hanger and the centerline of an upright sprinkler shall not be less than 3 in. (75 mm).

17.4.3.4* Unsupported Lengths.

17.4.3.4.1
For steel pipe, the unsupported horizontal length between the end sprinkler and the last hanger on the line shall not be greater than 36 in. (900 mm) for 1 in. (25 mm) pipe, 48 in. (1.2 m) for 1¼ in. (32 mm) pipe, and 60 in. (1.5 m) for 1½ in. (40 mm) or larger pipe.

17.4.3.4.2
For copper tube, the unsupported horizontal length between the end sprinkler and the last hanger on the line shall not be greater than 18 in. (450 mm) for 1 in. (25 mm) pipe, 24 in. (600 mm) for 1¼ in. (32 mm) pipe, and 30 in. (750 mm) for 1½ in. (40 mm) or larger pipe.

17.4.3.4.3
Where the limits of 17.4.3.4.1 and 17.4.3.4.2 are exceeded, the pipe shall be extended beyond the end sprinkler and shall be supported by an additional hanger.

17.4.3.4.4* Unsupported Length with Maximum Pressure Exceeding 100 psi (6.9 bar) and Branch Line Above Ceiling Supplying Sprinklers in Pendent Position Below Ceiling.

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17.4.3.4.4.1
Where the maximum static or flowing pressure, whichever is greater at the sprinkler, applied other than through the fire department connection, exceeds 100 psi (6.9 bar) and a branch line above a ceiling supplies sprinklers in a pendent position below the ceiling, the hanger assembly supporting the pipe supplying an end sprinkler in a pendent position shall be of a type that restrains upward movement of the pipe.

17.4.3.4.4.2
The unsupported length between the end sprinkler in a pendent position or drop nipple and the last hanger on the branch line shall not be greater than 12 in. (300 mm) for steel pipe or 6 in. (150 mm) for copper pipe.

17.4.3.4.4.3
When the limit of 17.4.3.4.4.2 is exceeded, the pipe shall be extended beyond the end sprinkler and supported by an additional hanger.

17.4.3.4.4.4
Unless flexible sprinkler hose fittings in accordance with 17.4.1.3.3.1 are used, the hanger closest to the sprinkler shall be of a type that restrains the upward movement of the pipe.

17.4.3.5* Unsupported Armover Length.

17.4.3.5.1
The cumulative horizontal length of an unsupported armover to a sprinkler, sprinkler drop, or sprig shall not exceed 24 in. (600 mm) for steel pipe or 12 in. (300 mm) for copper tube.

17.4.3.5.2* Unsupported Armover Length with Maximum Pressure Exceeding 100 psi (6.9 bar) and Branch Line Above Ceiling Supplying Sprinklers in Pendent Position Below Ceiling.

17.4.3.5.2.1
Where the maximum static or flowing pressure, whichever is greater at the sprinkler, applied other than through the fire department connection, exceeds 100 psi (6.9 bar) and a branch line above a ceiling supplies sprinklers in a pendent position below the ceiling, the cumulative horizontal length of an unsupported armover to a sprinkler or sprinkler drop shall not exceed 12 in. (300 mm) for steel pipe and 6 in. (150 mm) for copper tube.

17.4.3.5.2.2
Unless flexible sprinkler hose fittings in accordance with 17.4.1.3.3.1 are used, the hanger closest to the sprinkler shall be of a type that restrains upward movement of the pipe.

17.4.3.5.2.3
Where the armover exceeds the maximum unsupported length of 17.4.3.5.2.1, a hanger shall be installed so that the distance from the end sprinkler or drop nipple to the hanger is not greater than 12 in. (300 mm) for steel or 6 in. (150 mm) for copper, or the pipe shall be extended beyond the end sprinkler and shall be supported by an additional hanger.

17.4.3.6*
Wall-mounted sidewall sprinklers shall be restrained to prevent movement.

17.4.3.7 Sprigs.
Sprigs 4 ft (1.2 m) or longer shall be restrained against lateral movement.

17.4.4 Location of Hangers on Mains.

17.4.4.1
Unless any of the requirements of 17.4.4.2 through 17.4.4.7 are met, hangers for mains shall be in accordance with 17.4.2, between each branch line, or on each section of pipe, whichever is the lesser dimension.

17.4.4.2

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For welded or mechanical outlets on a continuous section of pipe, hanger spacing shall be according to Table 17.4.2.1(a) or Table 17.4.2.1(b).

17.4.4.3
For cross mains in steel pipe systems in bays having two branch lines, the intermediate hanger shall be permitted to be omitted, provided that a hanger attached to a purlin is installed on each branch line located as near to the cross main as the location of the purlin permits.

17.4.4.3.1
The remaining branch line hangers shall be installed in accordance with 17.4.3.

17.4.4.4
For cross mains in steel pipe systems only in bays having three branch lines, either side or center feed, one (only) intermediate hanger shall be permitted to be omitted, provided that a hanger attached to a purlin is installed on each branch line located as near to the cross main as the location of the purlin permits.

17.4.4.4.1
The remaining branch line hangers shall be installed in accordance with 17.4.3.

17.4.4.5
For cross mains in steel pipe systems only in bays having four or more branch lines, either side or center feed, two intermediate hangers shall be permitted to be omitted, provided the maximum distance between hangers does not exceed the distances specified in 17.4.2 and a hanger attached to a purlin on each branch line is located as near to the cross main as the purlin permits.

17.4.4.6
The unsupported length of the end of a main shall be no greater than one half the maximum allowable hanger spacing per Table 17.4.2.1(a) and Table 17.4.2.1(b).

17.4.4.7
At the end of the main, intermediate trapeze hangers shall be installed unless the main is extended to the next framing member with a hanger installed at this point, in which event an intermediate hanger shall be permitted to be omitted in accordance with 17.4.4.3, 17.4.4.4, and 17.4.4.5.

17.4.4.8*
A single section of pipe shall not require a hanger when the cumulative distance between hangers on the main does not exceed the spacing required by Table 17.4.2.1(a) and Table 17.4.2.1(b).

17.4.4.9
The unsupported lengths of mains shall be in accordance with the distances in 9.2.3.4.

17.4.4.10
The unsupported length of the end of a main shall be no greater than one half the maximum allowable hanger spacing per Table 17.4.2.1(a) and Table 17.4.2.1(b).

17.4.5 Support of Risers.

17.4.5.1
Risers shall be supported by riser clamps or by hangers located on the horizontal connections within 24 in. (600 mm) of the centerline of the riser.

17.4.5.2
Riser clamps supporting risers by means of set screws shall not be used.

17.4.5.3*
Riser clamps anchored to walls using hanger rods in the horizontal position shall not be permitted to vertically support risers.

17.4.5.4 Multistory Buildings.

17.4.5.4.1

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In multistory buildings, riser supports shall be provided at the lowest level, at each alternate level above, above and below offsets, and at the top of the riser.

17.4.5.4.2*
Supports above the lowest level shall also restrain the pipe to prevent movement by an upward thrust where flexible fittings are used.

17.4.5.4.3
Where risers are supported from the ground, the ground support shall constitute the first level of riser support.

17.4.5.4.4
Where risers are offset or do not rise from the ground, the first ceiling level above the offset shall constitute the first level of riser support.

17.4.5.5
Distance between supports for risers shall not exceed 25 ft (7.6 m).

17.5* Pipe Stands.

17.5.1 General.

17.5.1.1
Where pipe stands are used to support system piping, the requirements of 17.5 shall apply unless the requirements of 17.5.1.2 are met.

17.5.1.2
Pipe stands certified by a registered professional engineer to include all of the following shall be an acceptable alternative to the requirements of 17.5:
(1) Pipe stands shall be designed to support five times the weight of water-filled pipe plus 250 lb (115 kg) at each point of piping support.

(2) These points of support shall be adequate to support the system.

(3) The spacing between pipe stands shall not exceed the value given for the type of pipe as indicated in Table 17.4.2.1(a) or Table 17.4.2.1(b).

(4) Pipe stand components shall be ferrous.

(5) Detailed calculations shall be submitted, when required by the reviewing authority, showing stresses developed in the pipe stand, the system piping and fittings, and safety factors allowed.

17.5.1.3
Where water-based fire protection systems are required to be protected against damage from earthquakes, pipe stands shall also meet the requirements of 18.8.

17.5.2 Component Material.

17.5.2.1
Pipe stands and their components shall be ferrous unless permitted by 17.5.2.2.

17.5.2.2
Nonferrous components that have been proven by fire tests to be adequate for the hazard application and that are in compliance with the other requirements of this section shall be acceptable.

17.5.3 Sizing.

17.5.3.1*
The maximum heights for pipe stands shall be in accordance with Table 17.5.3.1 unless the requirements of 17.5.3.2 are met.

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Table 17.5.3.1 Maximum Pipe Stand Heights[a]

System Pipe Diameter[c]	Pipe Stand Diameter[b]					
	1½ in.	2 in.	2½ in.	3 in.	4 in.	6 in.
1½ in.	6.6 ft	9.4 ft	11.3 ft	13.8 ft	18.0 ft	26.8 ft
2 in.	4.4 ft	9.4 ft	11.3 ft	13.8 ft	18.0 ft	26.8 ft
2½ in.	—	8.1 ft	11.3 ft	13.8 ft	18.0 ft	26.8 ft
3 in.	—	5.2 ft	11.3 ft	13.8 ft	18.0 ft	26.8 ft
4 in. up to and including 8 in.	—	—	—	—	14.7 ft	26.8 ft

[a]For SI units, 1 in. = 25.4 mm; 1 ft = 0.305 m.

[b]Pipe stands are Schedule 40 pipe.

[c]System piping is assumed to be Schedule 40 (8 in. is Schedule 30).

17.5.3.2*
Pipe diameters up to and including 10 in. (200 mm), Schedule 40 are permitted to be supported by 2 in. (50 mm) diameter pipe stands when all of the following conditions are met:
(1) The maximum height shall be 4 ft (1.2 m), as measured from the base of the pipe stand to the centerline of the pipe being supported.

(2) *The pipe stand shall be axially loaded.

17.5.3.3
The distance between pipe stands shall not exceed the values in Table 17.4.2.1(a) or Table 17.4.2.1(b).

17.5.4 Pipe Stand Base.

17.5.4.1
The pipe stand base shall be secured by an approved method.

17.5.4.2*
Pipe stand base plates shall be threaded malleable iron flanges or welded steel flanges in accordance with Table 7.4.1.

17.5.4.2.1
Pipes stands installed in accordance with 17.5.3.2 shall be permitted to use a welded steel plate.

17.5.4.3*
Pipe stands shall be fastened to a concrete floor or footing using listed concrete anchors or other approved means.

17.5.4.4
A minimum of four anchors shall be used to attach the base plate to the floor.

17.5.4.4.1
Pipe stands installed in accordance with 17.5.3.2 shall be permitted to use a minimum of two anchors to attach the base plate to the floor.

17.5.4.5
The minimum diameter for the anchors shall be ½ in. for pipe stand diameters up to and including 3 in. and ⅝ in. for pipe stands 4 in. diameter and larger.

17.5.4.5.1
Where the pipe stand complies with 17.5.3.2, ⅜ in. anchors shall be permitted.

17.5.5 Attaching to System Piping.

17.5.5.1

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Piping shall be attached to the pipe stand with U-bolts or equivalent attachment.

17.5.5.2*
Where a horizontal bracket is used to attach the system piping to the pipe stand, it shall not be more than 1 ft (0.3 m) as measured horizontally from the centerline of the pipe stand to the centerline of the supported pipe.

17.5.5.3
Horizontal support brackets shall be sized such that the section modulus required in Table 17.5.5.3 does not exceed the available section modulus from Table 17.3.1(b).

Table 17.5.5.3 Required Section Modulus for Pipe Stand Horizontal Support Arms (in.^{3})

Nominal Diameter of Pipe Being Supported (in.)	1	1 ¼	1 ½	2	2 ½	3	3 ½	4	5	6	8
Section Modulus – Schedule 10 Steel	0.22	0.23	0.24	0.25	0.30	0.36	0.42	0.49	0.66	0.85	1.40
Section Modulus – Schedule 40 Steel	0.22	0.24	0.24	0.27	0.36	0.45	0.54	0.63	0.86	1.13	1.64

For SI units, 1 in. = 25.4 mm.

Note: The table is based on the controlling section modulus determined for a concentrated load at a 1 ft (0.3 m) cantilever using: a) a maximum bending stress of 15 ksi (103 MPa) and a concentrated load equal to the weight of 15 ft (4.6 m) of water-filled pipe plus 250 lb (114 kg) b) a maximum bending stress of 28 ksi (193 MPa) and a concentrated load equal to five times the weight of 15 ft (4.6 m) of water-filled pipe plus 250 lb (114 kg)

17.5.6 Thrust.

17.5.6.1*
System piping shall be supported and restrained to restrict movement due to sprinkler/nozzle reaction and water surges.

17.5.6.2*
Where thrust forces are anticipated to be high, a pipe ring or clamp shall secure the system piping to the pipe stand.

17.5.7 Exterior Applications.

17.5.7.1
Where required, pipe stands used in exterior applications shall be made of galvanized steel or other suitable corrosion-resistant materials.

17.5.7.2
A welded, threaded, grooved, or other approved cap shall be securely attached to the top of the pipe stand.

17.6 Protection Criteria for Rack Storage of Group A Plastic Commodities Stored Up to and Including 25 ft (7.6 m) in Height.

17.6.1 Control Mode Density/Area Sprinkler Protection Criteria for Single-, Double-, and Multiple-Row Racks for Group A Plastic Commodities Stored Up to and Including 25 ft (7.6 m) in Height.

17.6.1.1 Storage 5 ft (1.5 m) or Less in Height.
For the storage of Group A plastics stored 5 ft (1.5 m) or less in height, the sprinkler design criteria for miscellaneous storage specified in Chapter 13 shall be used.

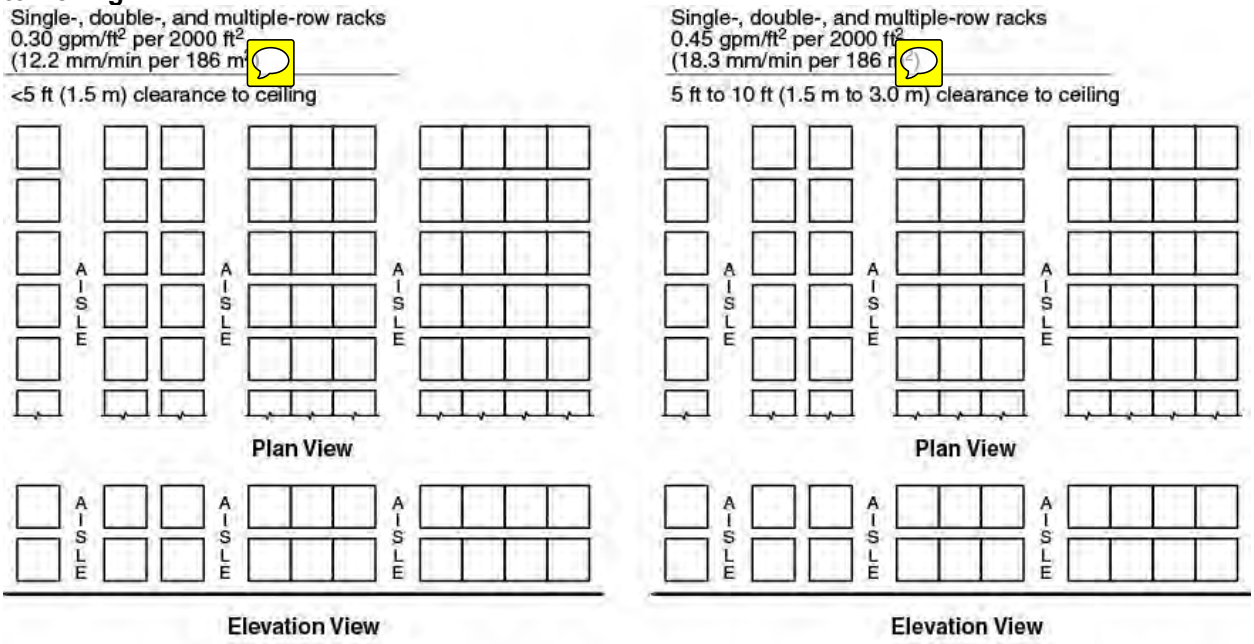
17.6.1.1.1
For storage 5 ft (1.5 m) or less in height that does not meet the definition of *Miscellaneous Storage* that is on solid shelf racks, in-rack sprinklers shall be provided in accordance with 17.1.5, and ceiling sprinkler protection shall be provided in accordance with Chapter 13.

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17.6.1.2 Ceiling Sprinkler Water Demand.
See Section C.22.

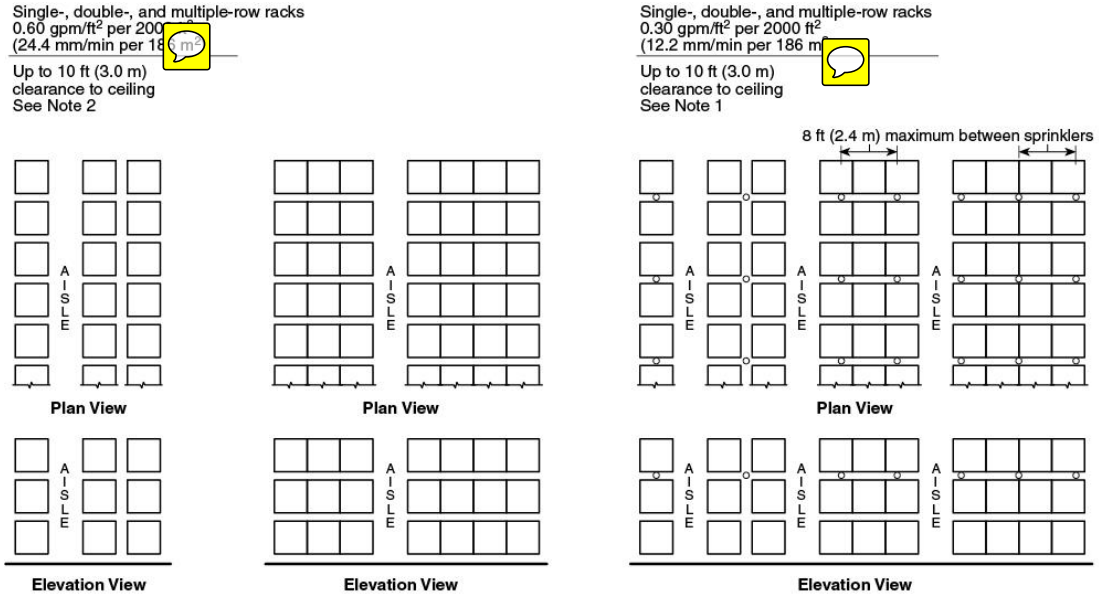
17.6.1.2.1
For Group A plastic commodities in cartons, encapsulated or nonencapsulated in single-, double-, and multiple-row racks and with a clearance to ceiling up to and including 10 ft. (3.0 m), ceiling sprinkler water demand in terms of density [gpm/ft^2 (mm/min)] and area of operation [ft^2 (m^2)] shall be selected from Figure 17.6.1.2.1(a) through Figure 17.6.1.2.1(f).

Figure 17.6.1.2.1(a) Storage 5 ft to 10 ft (1.5 m to 3.0 m) in Height with Up to 10 ft (3.0 m) Clearance to Ceiling.



Note: Each square represents a storage cube measuring 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. (450 mm) up to 10 ft (3.0 m). Therefore, there could be as few as one load or as many as six or seven loads between in-rack sprinklers that are spaced 10 ft (3.0 m) apart vertically.

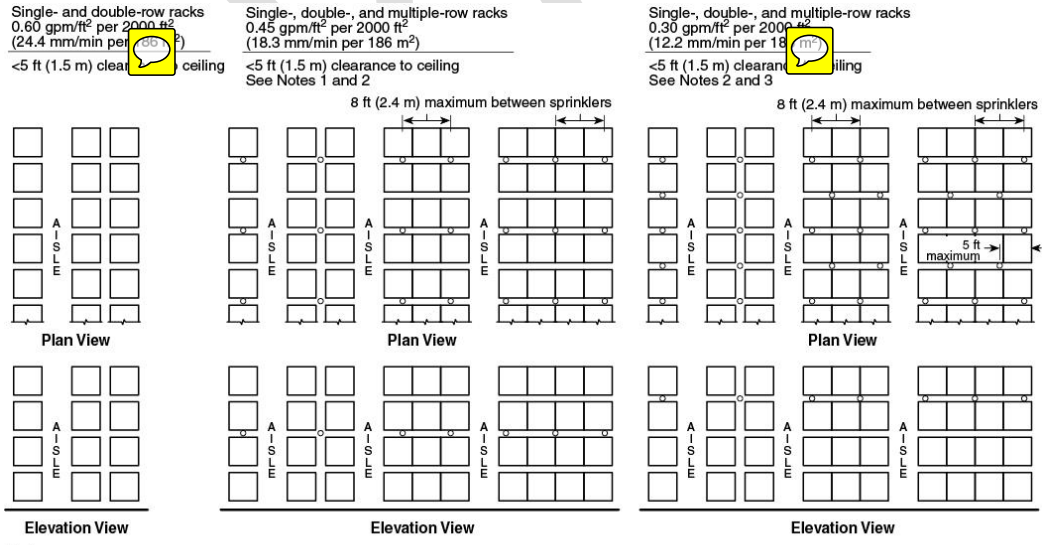
Figure 17.6.1.2.1(b) Storage 15 ft (4.6 m) in Height with Up to 10 ft (3.0 m) Clearance to Ceiling.



Notes:

1. Single level of in-rack sprinklers [K-5.6 (80) or K-8.0 (115) operating at 15 psi (1.0 bar) minimum] installed as indicated in the transverse flue spaces.
2. Where sprinklers listed for storage use are installed at the ceiling only and the ceiling height in the protected area does not exceed 22 ft (6.7 m) and a minimum clearance of 5 ft (1.5 m) and the storage height does not exceed 15 ft (4.6 m), the ceiling sprinkler discharge criteria shall be permitted to be reduced to 0.45 gpm/ft² per 2000 ft² (18.3 mm/min per 186 m²).
3. Each square represents a storage cube measuring 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. (450 mm) up to 10 ft (3.0 m). Therefore, there could be as few as one load or as many as six or seven loads between in-rack sprinklers that are spaced 10 ft (3.0 m) apart vertically.

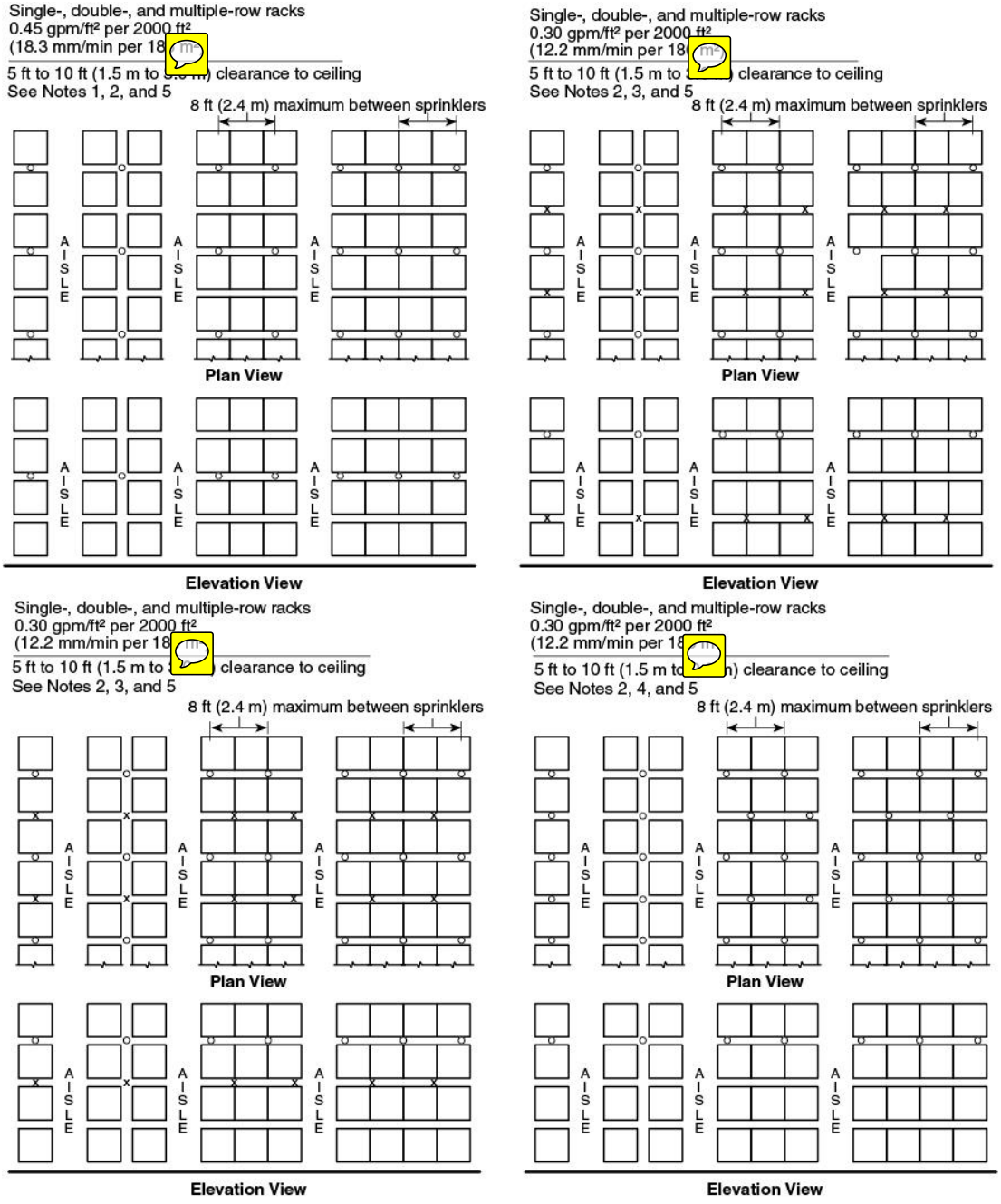
Figure 17.6.1.2.1(c) Storage 20 ft (6.1 m) in Height with <5 ft (1.5 m) Clearance to Ceiling.



Notes:

1. Single level of in-rack sprinklers [K-5.6 (80) or K-8.0 (115) operating at 15 psi (1.0 bar) minimum] installed as indicated in the transverse flue spaces.
2. Ceiling-only protection is not permitted for this storage configuration except where K-11.2 or larger spray sprinklers listed for storage use are installed. In-rack sprinklers are not required, provided the ceiling sprinkler discharge criterion is increased to 0.6 gpm/ft² (24 mm/min) over 2000 ft² (186 m²).
3. Single level of in-rack sprinklers [K-8.0 (115) operating at 15 psi (1.0 bar) minimum or K-5.6 (80) operating at 30 psi (2.1 bar) minimum] installed on 4 ft to 5 ft (1.2 m to 1.5 m) spacings located, as indicated, in the longitudinal flue space at the intersection of every transverse flue space.
4. Each square represents a storage cube measuring 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. (450 mm) up to 10 ft (3.0 m). Therefore, there could be as few as one load or as many as six or seven loads between in-rack sprinklers that are spaced 10 ft (3.0 m) apart vertically.

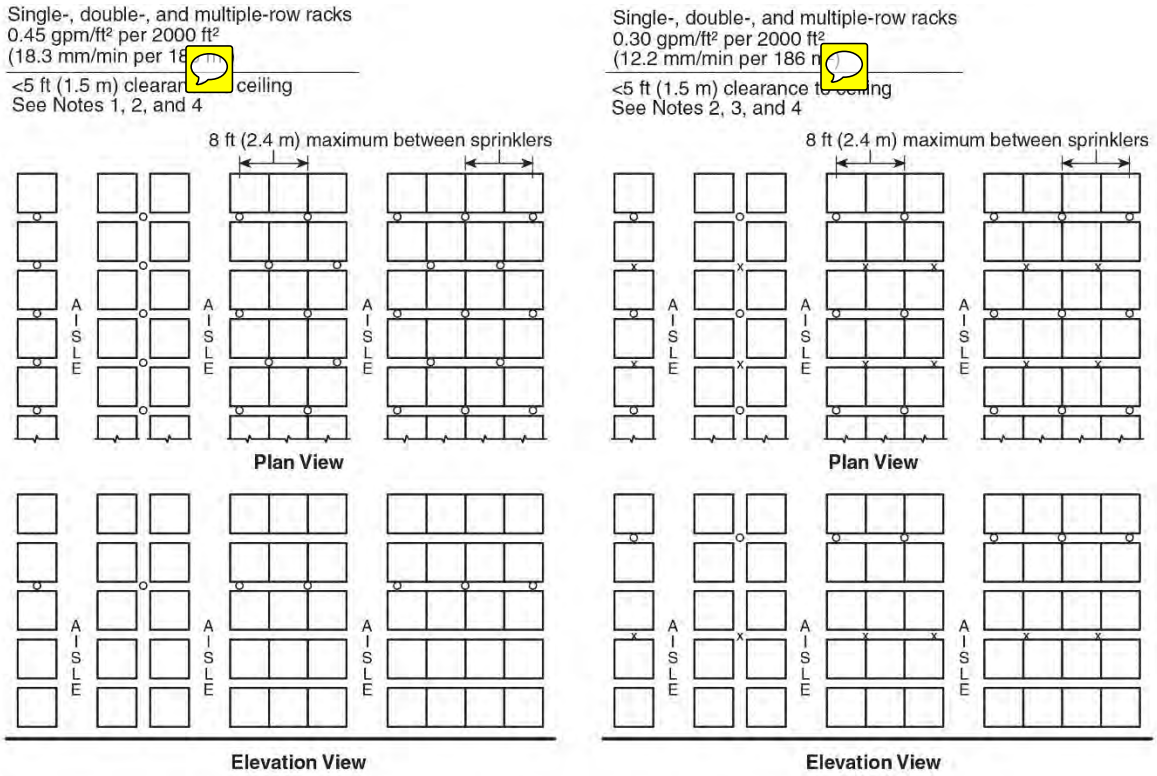
Figure 17.6.1.2.1(d) Storage 20 ft (6.1 m) in Height with 5 ft to 10 ft (1.5 m to 3.0 m) Clearance to Ceiling.



Notes:

1. Single level of in-rack sprinklers [K-5.6 (80) or K-8.0 (115) operating at 15 psi (1.0 bar) minimum] installed as indicated in the transverse flue spaces.
2. Ceiling-only protection shall not be permitted for this storage configuration except where K-11.2 or larger orifice spray sprinklers listed for storage use are installed. In-rack sprinklers shall not be required, provided the ceiling sprinkler discharge criterion is increased to 0.6 gpm/ft² (24.4 mm/min) over 2000 ft² (186 m²) and the ceiling height in the protected area does not exceed 27 ft (8.2 m).
3. Two levels of in-rack sprinklers [K-5.6 (80) or K-8.0 (115) operating at 15 psi (1.0 bar) minimum] installed as indicated and staggered in the transverse flue space.
4. Single level of in-rack sprinklers [K-8 (115) operating at 15 psi (1.0 bar) or K-5.6 (80) operating at 30 psi (2.1 bar) minimum] installed on 4 ft to 5 ft (1.2 m to 1.5 m) spacings located, as indicated, in the longitudinal flue space at the intersection of every transverse flue space.
5. Each square represents a storage cube measuring 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. (450 mm) up to 10 ft (3.0 m). Therefore, there could be as few as one load or as many as six or seven loads between in-rack sprinklers that are spaced 10 ft (3.0 m) apart vertically.

Figure 17.6.1.2.1(e) Storage 25 ft (7.6 m) in Height with <5 ft (1.5 m) Clearance to Ceiling. ***(See Note 2.)***



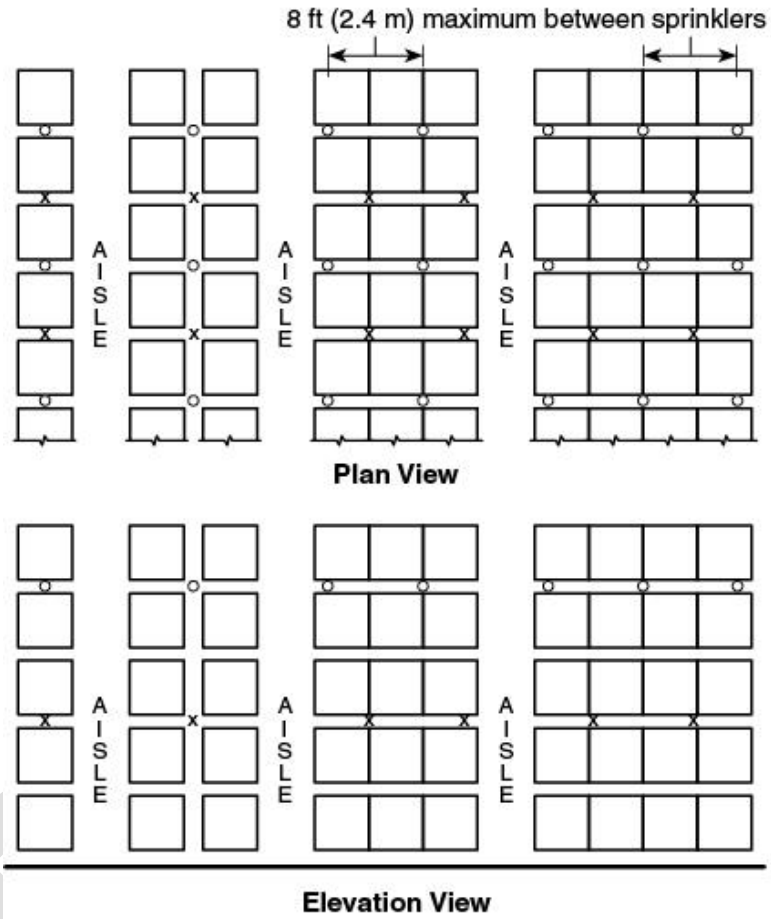
Notes:

1. Single level of in-rack sprinklers [K-8.0 (115) operating at 15 psi (1.0 bar) minimum or K-5.6 (80) operating at 30 psi (2.1 bar) minimum] installed on 4 ft to 5 ft (1.2 m to 1.5 m) spacings located, as indicated, in the longitudinal flue space at the intersection of every transverse flue space.
2. Ceiling-only protection shall not be permitted for this storage configuration except where K-16.8 spray sprinklers listed for storage use are installed. In-rack sprinklers shall not be required, provided the ceiling sprinkler discharge criterion is increased to 0.8 gpm/ft² (32.6 mm/min) over 2000 ft² (186 m²) for wet systems and 4500 ft² (418 m²) for dry systems and the ceiling height in the protected area does not exceed 30 ft (9.1 m).
3. Two levels of in-rack sprinklers [K-5.6 (80) or K-8.0 (115) operating at 15 psi (1.0 bar) minimum] installed as indicated and staggered in the transverse flue space.
4. Each square represents a storage cube measuring 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. (450 mm) up to 10 ft (3.0 m). Therefore, there could be as few as one load or as many as six or seven loads between in-rack sprinklers that are spaced 10 ft (3.0 m) apart vertically.

Figure 17.6.1.2.1(f) Storage 25 ft (7.6 m) in Height with 5 ft to 10 ft (1.5 m to 3.0 m) Clearance to Ceiling. ***(See Note 2.)***

Single-, double-, and multiple-row racks
0.30 gpm/ft² per 2000 ft²
(12.2 mm/min per 186 m²)

5 ft to 10 ft (1.5 m to 3.0 m) clearance to ceiling
See Notes 1, 2, and 3



Notes:

1. Two levels of in-rack sprinklers [K-5.6 (80) or K-8.0 (115) operating at 15 psi (1.0 bar) minimum] installed on 8 ft to 10 ft (2.4 m to 3.0 m) spacings located as indicated and staggered in the transverse flue space.
2. Ceiling-only protection shall not be permitted for this storage configuration except where K-16.8 spray sprinklers listed for storage use are installed. In-rack sprinklers shall not be required, provided the ceiling sprinkler discharge criterion is increased to 0.8 gpm/ft² (32.6 mm/min) over 2000 ft² (186 m²) for wet systems and 4500 ft² (418 m²) for dry systems and the ceiling height in the protected area does not exceed 30 ft (9.1 m).
3. Each square represents a storage cube measuring 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. (450 mm) up to 10 ft (3.0 m). Therefore, there could be as few as one load or as many as six or seven loads between in-rack sprinklers that are spaced 10 ft (3.0 m) apart vertically.

17.6.1.2.2
Linear interpolation of design densities and areas of application shall be permitted between storage heights with the same clearance to ceiling.

17.6.1.2.3
No interpolation between clearance to ceiling shall be permitted.

17.6.1.2.4
An option shall be selected from the appropriate Figure 17.6.1.2.1(a) through Figure 17.6.1.2.1(f) given the storage height and clearance being protected. The density/area criteria at the top of each option shall be applied to the ceiling sprinklers and the in-rack sprinklers shown in the option (if any) shall be provided. Options that do not show multiple-row racks in the figures shall not be permitted to protect multiple-row rack storage. Notes in each figure shall be permitted to clarify options or to present additional options not shown in the figures.

17.6.1.3
For storage of Group A plastics between 5 ft and 12 ft (1.5 m and 3.7 m) in height, the installation requirements for extra hazard systems shall apply.

17.6.1.4*
Exposed unexpanded Group A plastics protected with control mode density/area sprinklers shall be protected in accordance with one of the following:
(1) Maximum 10 ft (3.0 m) storage in a maximum 20 ft (6.1 m) high building with ceiling sprinklers designed for a minimum 0.8 gpm/ft^2 (32.6 mm/min) density over 2500 ft^2 (232 m^2) and no in-rack sprinklers required as shown in Figure 17.6.1.4(a)

(2) Maximum 10 ft (3.0 m) storage in a maximum 20 ft (6.1 m) high building with ceiling sprinklers designed for a minimum 0.45 gpm/ft^2 (18.3 mm/min) density over 2000 ft^2 (186 m^2) and one level of in-rack sprinklers required at alternate transverse flues as shown in Figure 17.6.1.4(b)

(3) Maximum 10 ft (3.0 m) storage in a maximum 20 ft (6.1 m) high building with ceiling sprinklers designed for a minimum 0.3 gpm/ft^2(12.2 mm/min) density over 2000 ft^2(186 m^2) and one level of in-rack sprinklers required in every transverse flue as shown in Figure 17.6.1.4(c)

(4) Maximum 15 ft (4.6 m) storage in a maximum 25 ft (7.6 m) high building with ceiling sprinklers designed for a minimum 0.45 gpm/ft^2(18.3 mm/min) density over 2000 ft^2(186 m^2) and one level of in-rack sprinklers required at alternate transverse flues as shown in Figure 17.6.1.4(d)

(5) Maximum 15 ft (4.6 m) storage in a maximum 25 ft (7.6 m) high building with ceiling sprinklers designed for a minimum 0.3 gpm/ft^2(12.2 mm/min) density over 2000 ft^2 (186 m^2) and one level of in-rack sprinklers required in every transverse flue as shown in Figure 17.6.1.4(e)

(6) Maximum 20 ft (6.1 m) storage in a maximum 25 ft (7.6 m) high building with ceiling sprinklers designed for a minimum 0.6 gpm/ft^2(24.4 mm/min) density over 2000 ft^2(186 m^2) and one level of in-rack sprinklers required at alternate transverse flues as shown in Figure 17.6.1.4(f)

(7) Maximum 20 ft (6.1 m) storage in a maximum 25 ft (7.6 m) high building with ceiling sprinklers designed for a minimum 0.45 gpm/ft^2(18.3 mm/min) density over 2000 ft^2(186 m^2) and one level of in-rack sprinklers required in every transverse flue as shown in Figure 17.6.1.4(g)

(8) Maximum 20 ft (6.1 m) storage in a maximum 30 ft (9.1 m) high building with ceiling sprinklers designed for a minimum 0.8 gpm/ft^2(32.6 mm/min) density over 1500 ft^2 (139 m^2) and one level of in-rack sprinklers required at alternate transverse flues as shown in Figure 17.6.1.4(h)

(9) Maximum 20 ft (6.1 m) storage in a maximum 30 ft (9.1 m) high building with ceiling sprinklers designed for a minimum 0.6 gpm/ft^2 (24.4 mm/min^2) density over 1500 ft^2 (139 m^2) and one level of in-rack sprinklers required in every transverse flue as shown in Figure 17.6.1.4(i)

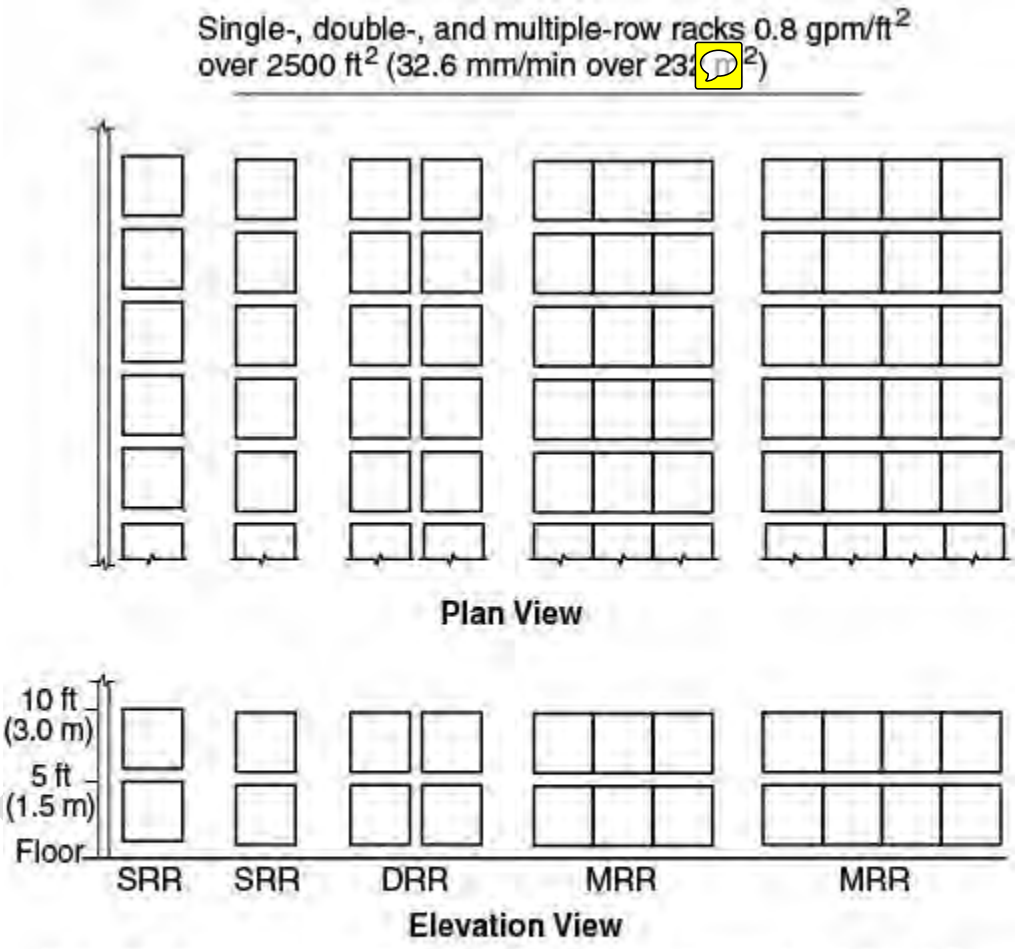
(10) Maximum 20 ft (6.1 m) storage in a maximum 30 ft (9.1 m) high building with ceiling sprinklers designed for a minimum 0.3 gpm/ft^2(12.2 mm/min) density over 2000 ft^2 (186 m^2) and two levels of in-rack sprinklers required in every transverse flue as shown in Figure 17.6.1.4(j)

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(11) Maximum 25 ft (7.6 m) storage in a maximum 35 ft (11 m) high building with ceiling sprinklers designed for a minimum 0.8 gpm/ft^2 (32.6 mm/min) density over 1500 ft^2 (139 m^2) and one level of in-rack sprinklers required in every transverse flue as shown in Figure 17.6.1.4(k)

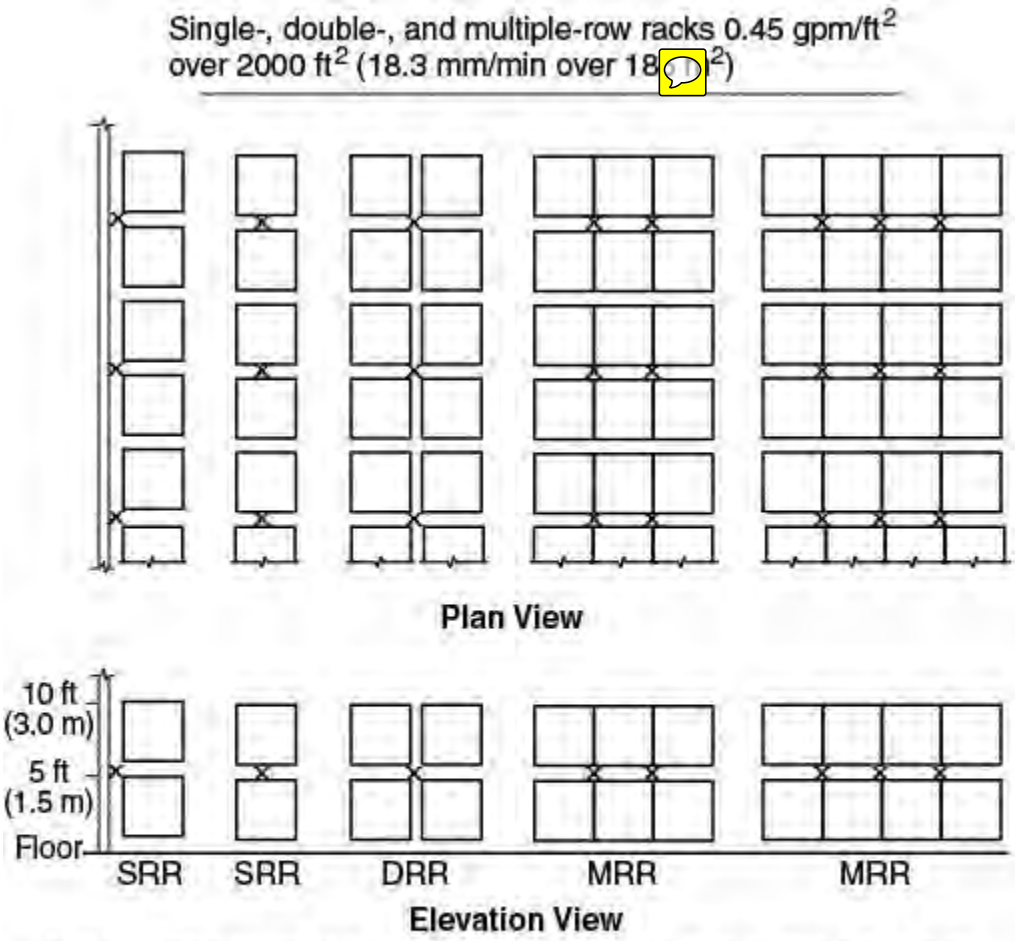
(12) Maximum 25 ft (7.6 m) storage in a maximum 35 ft (11 m) high building with ceiling sprinklers designed for a minimum 0.3 gpm/ft^2(12.2 mm/min) density over 2000 ft^2 (186 m^2) and two levels of in-rack sprinklers required in every transverse flue as shown in Figure 17.6.1.4(l)

Figure 17.6.1.4(a) Exposed Nonexpanded Group A Plastic Up to 10 ft (3.0 m) in Height in Up to a 20 ft (6.1 m) High Building with No In-Rack Sprinklers.



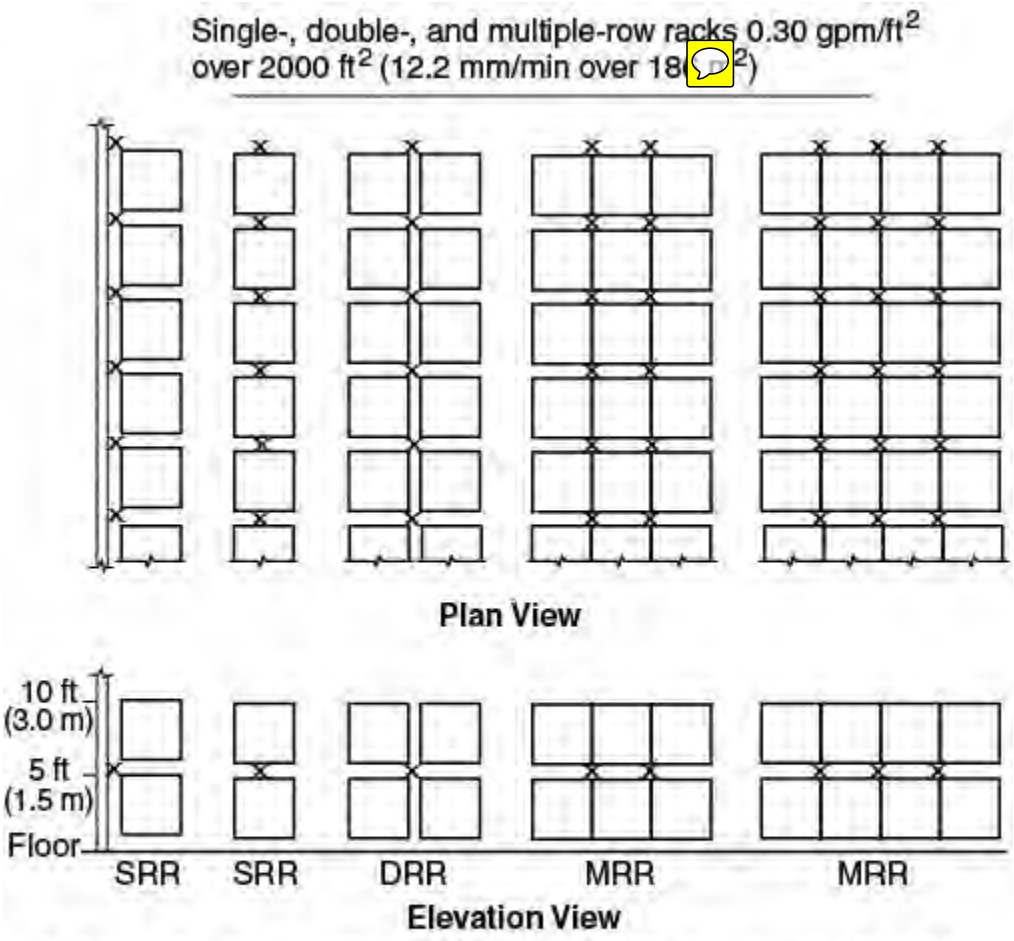
Note: Each square represents a storage cube measuring 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. to 10 ft (450 mm to 3.0 m). Therefore, there could be as few as one load or as many as six or seven loads between in-rack sprinklers that are spaced 10 ft (3.0 m) apart vertically.

Figure 17.6.1.4(b) Exposed Nonexpanded Group A Plastic Up to 10 ft (3.0 m) in Height in Up to a 20 ft (6.1 m) High Building with One Level of In-Rack Sprinklers.



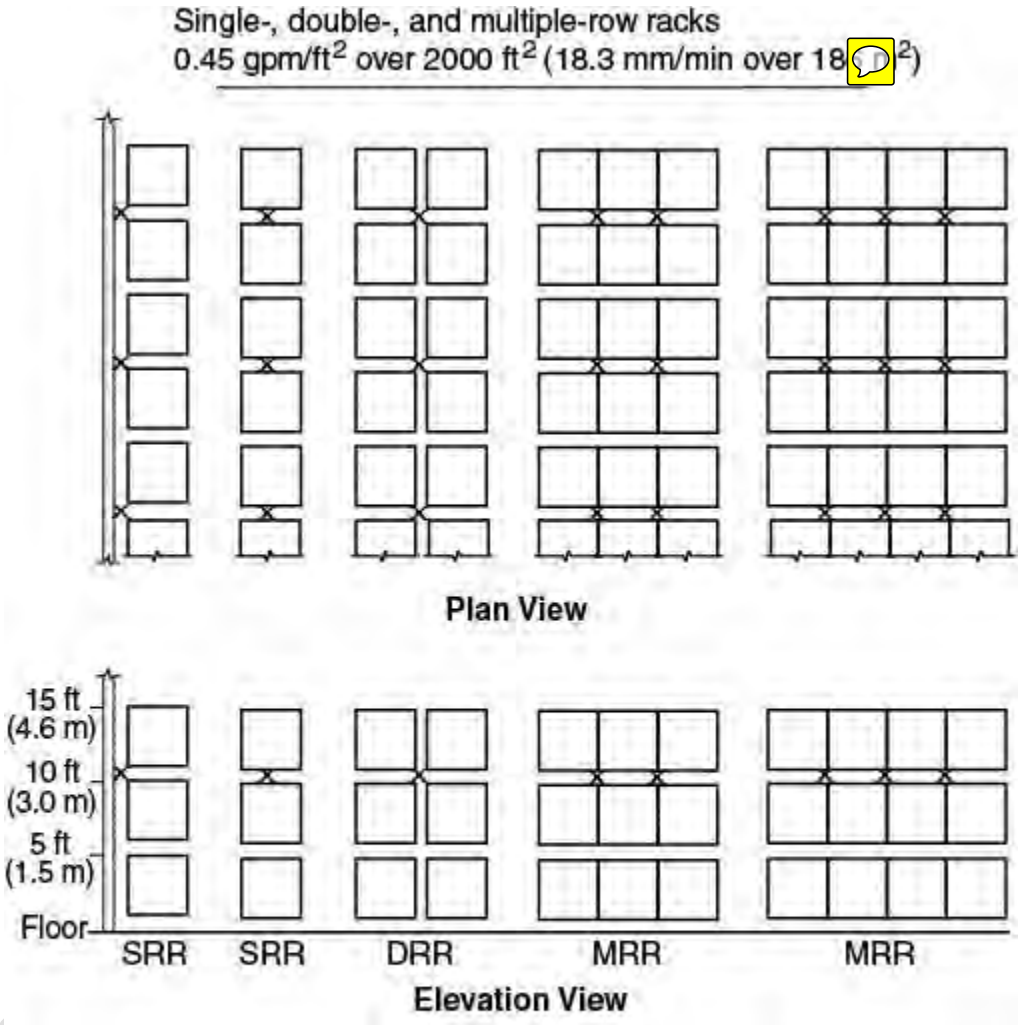
Note: Each square represents a storage cube measuring 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. to 10 ft (450 mm to 3.0 m). Therefore, there could be as few as one load or as many as six or seven loads between in-rack sprinklers that are spaced 10 ft (3.0 m) apart vertically.

Figure 17.6.1.4(c) Exposed Nonexpanded Group A Plastics Up to 10 ft (3.0 m) in Height in Up to a 20 ft (6.1 m) High Building with One Level of Closely Spaced In-Rack Sprinklers.



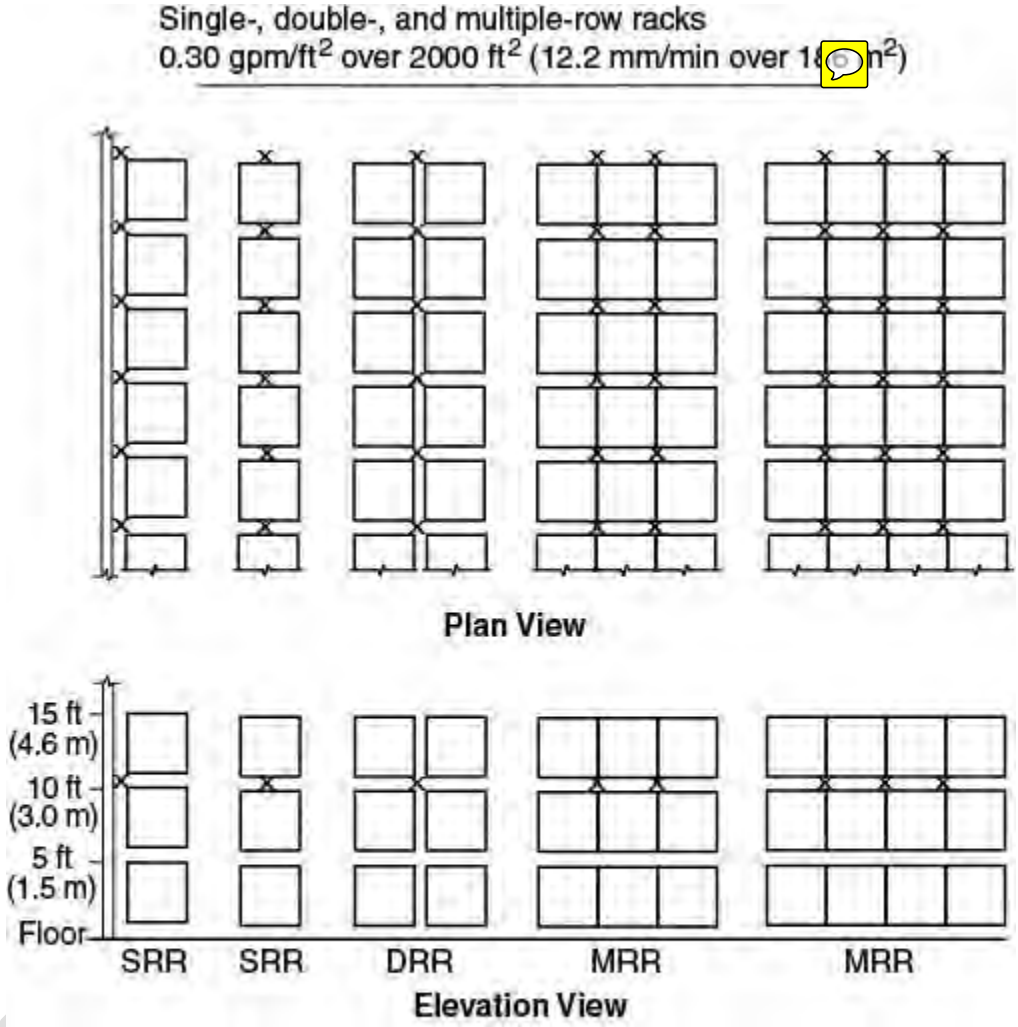
Note: Each square represents a storage cube measuring 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. to 10 ft (450 mm to 3.0 m). Therefore, there could be as few as one load or as many as six or seven loads between in-rack sprinklers that are spaced 10 ft (3.0 m) apart vertically.

Figure 17.6.1.4(d) Exposed Nonexpanded Group A Plastics Up to 15 ft (4.6 m) in Height in Up to a 25 ft (7.6 m) High Building with One Level of In-Rack Sprinklers.



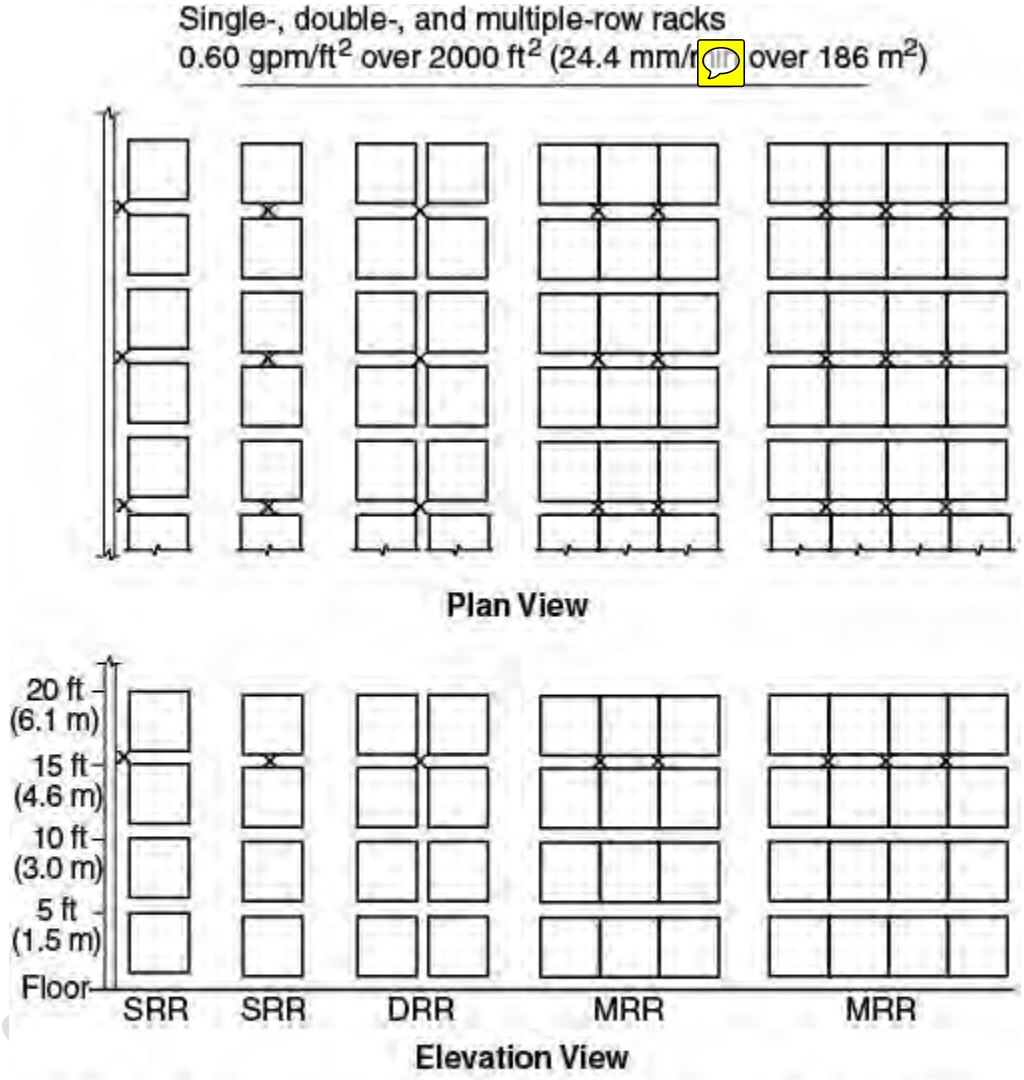
Note: Each square represents a storage cube measuring 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. to 10 ft (450 mm to 3.0 m). Therefore, there could be as few as one load or as many as six or seven loads between in-rack sprinklers that are spaced 10 ft (3.0 m) apart vertically.

Figure 17.6.1.4(e) Exposed Nonexpanded Group A Plastics Up to 15 ft (4.6 m) in Height in Up to a 25 ft (7.6 m) High Building with One Level of Closely Spaced In-Rack Sprinklers.



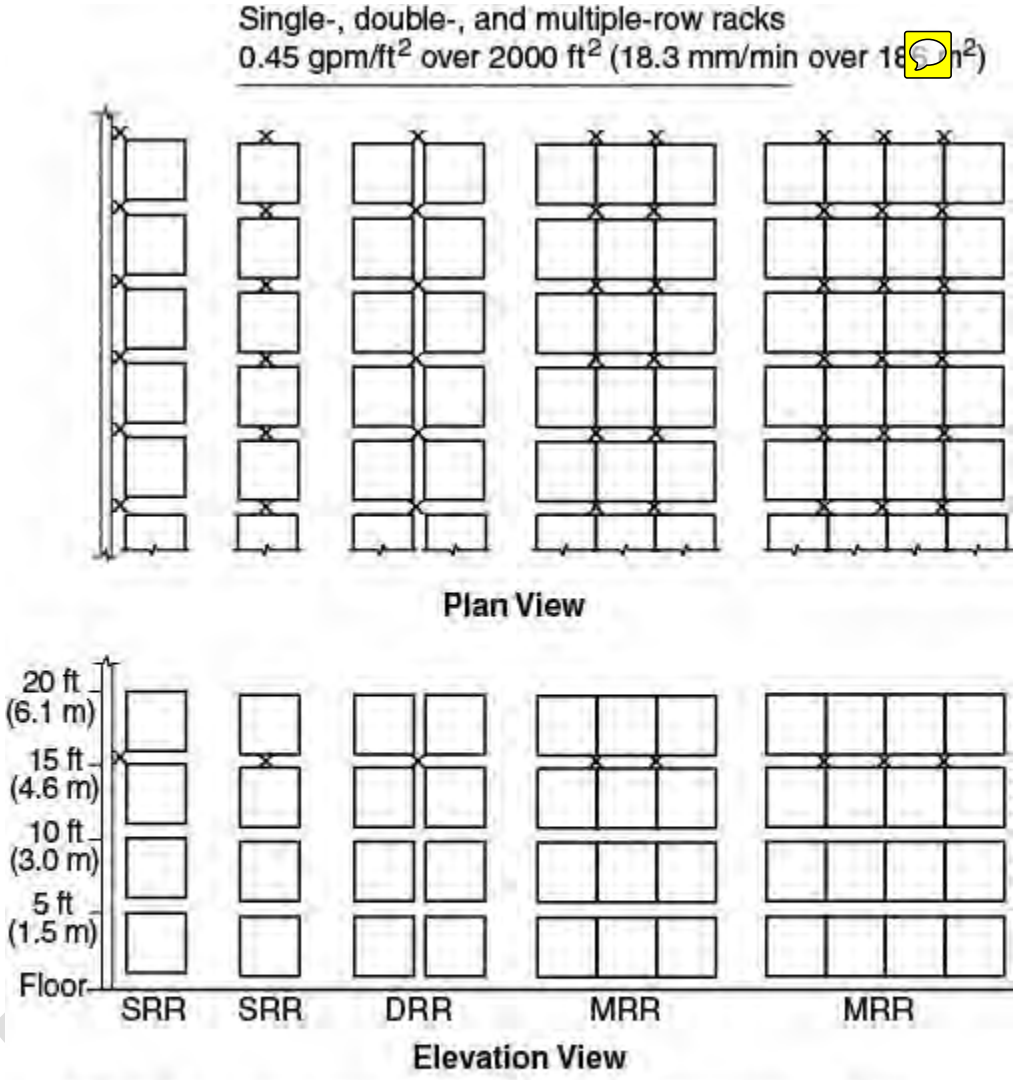
Note: Each square represents a storage cube measuring 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. to 10 ft (450 mm to 3.0 m). Therefore, there could be as few as one load or as many as six or seven loads between in-rack sprinklers that are spaced 10 ft (3.0 m) apart vertically.

Figure 17.6.1.4(f) Exposed Nonexpanded Group A Plastics Up to 20 ft (6.1 m) in Height in Up to a 25 ft (7.6 m) High Building with One Level of In-Rack Sprinklers.



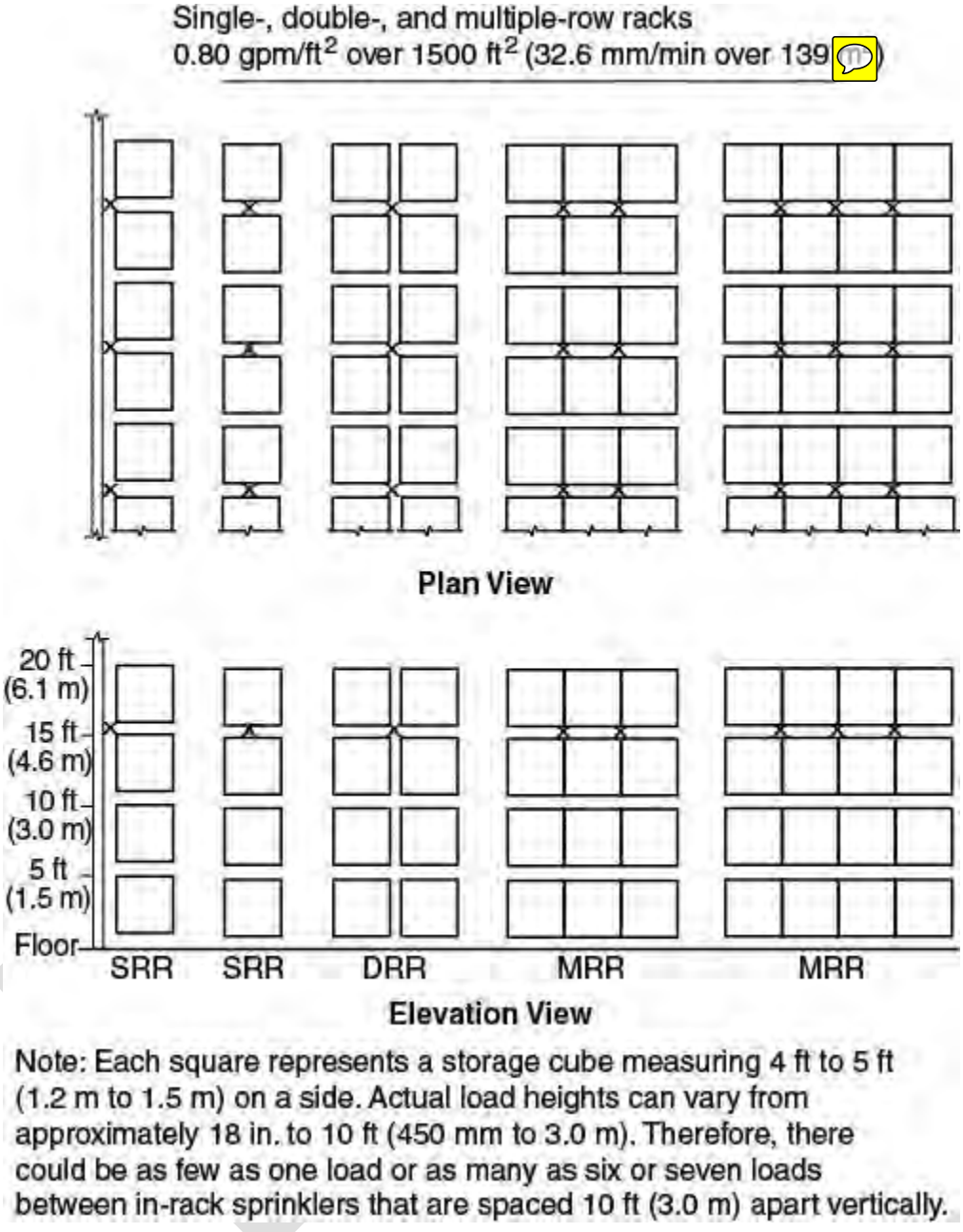
Note: Each square represents a storage cube measuring 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. to 10 ft (450 mm to 3.0 m). Therefore, there could be as few as one load or as many as six or seven loads between in-rack sprinklers that are spaced 10 ft (3.0 m) apart vertically.

Figure 17.6.1.4(g) Exposed Nonexpanded Group A Plastics Up to 20 ft (6.1 m) in Height in Up to a 25 ft (7.6 m) High Building with One Level of Closely Spaced In-Rack Sprinklers.



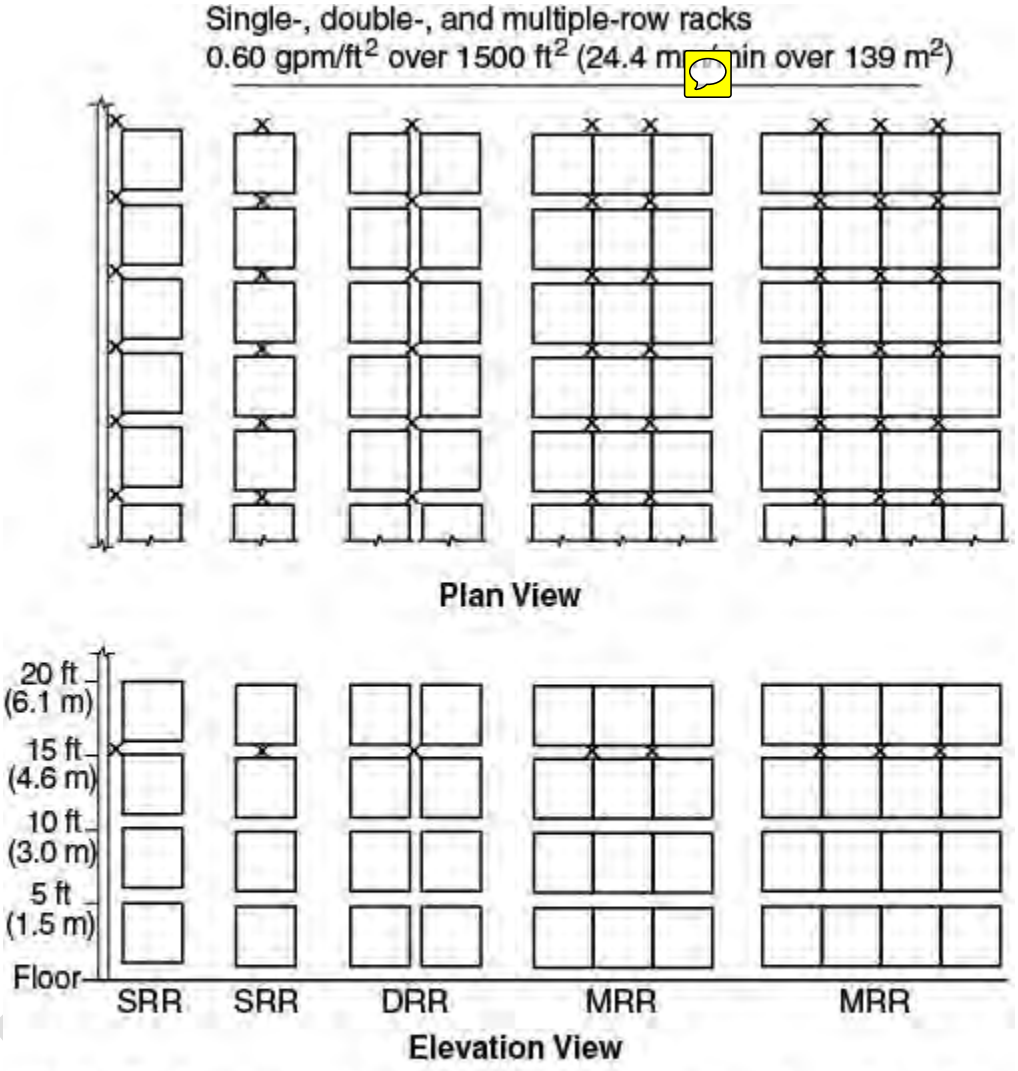
Note: Each square represents a storage cube measuring 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. to 10 ft (450 mm to 3.0 m). Therefore, there could be as few as one load or as many as six or seven loads between in-rack sprinklers that are spaced 10 ft (3.0 m) apart vertically.

Figure 17.6.1.4(h) Exposed Nonexpanded Group A Plastics Up to 20 ft (6.1 m) in Height in Up to a 30 ft (9.1 m) High Building with One Level of In-Rack Sprinklers.



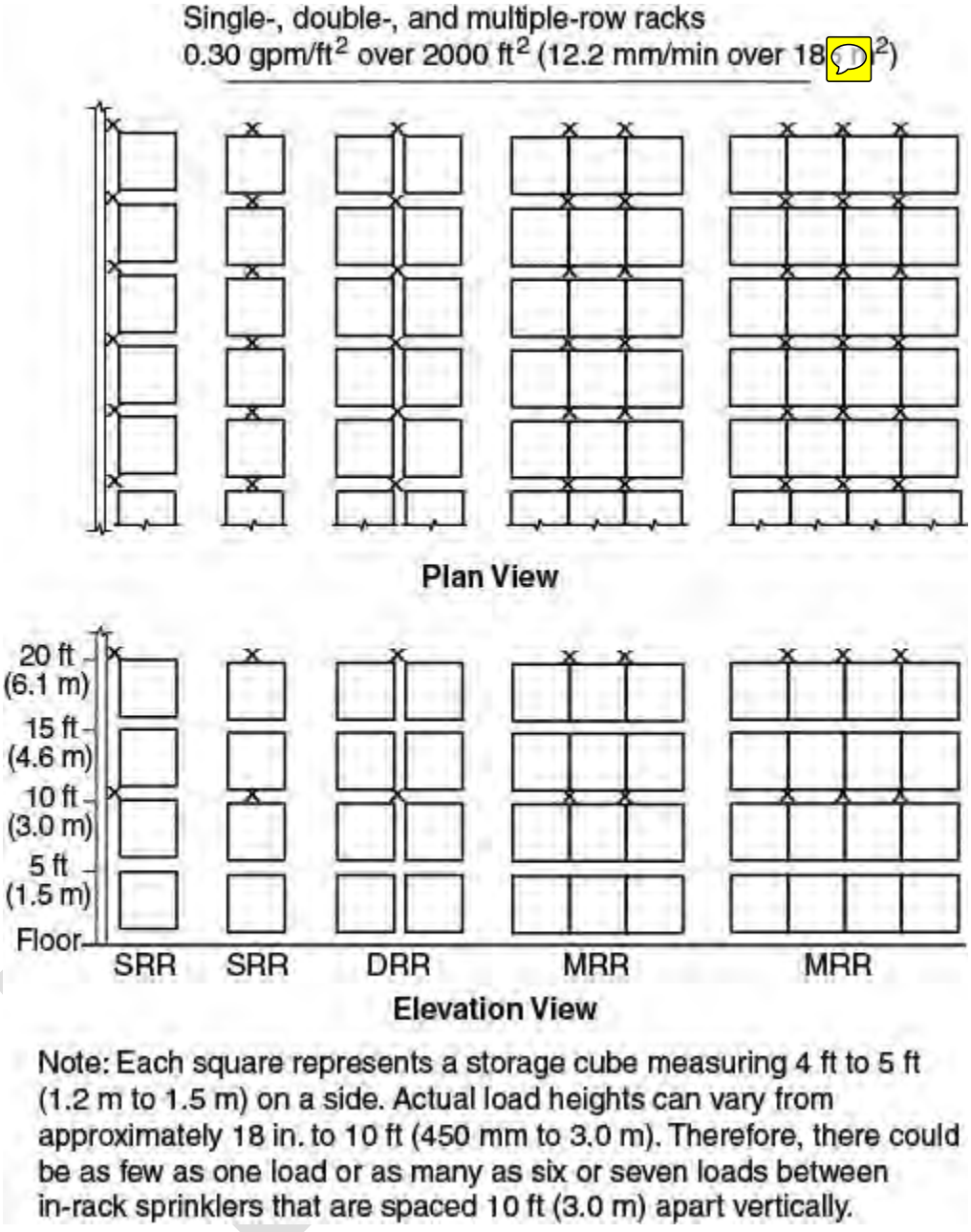
Note: Each square represents a storage cube measuring 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. to 10 ft (450 mm to 3.0 m). Therefore, there could be as few as one load or as many as six or seven loads between in-rack sprinklers that are spaced 10 ft (3.0 m) apart vertically.

Figure 17.6.1.4(i) Exposed Nonexpanded Group A Plastics Up to 20 ft in (6.1 m) Height in Up to a 30 ft (9.1 m) High Building with One Level of Closely Spaced In-Rack Sprinklers.



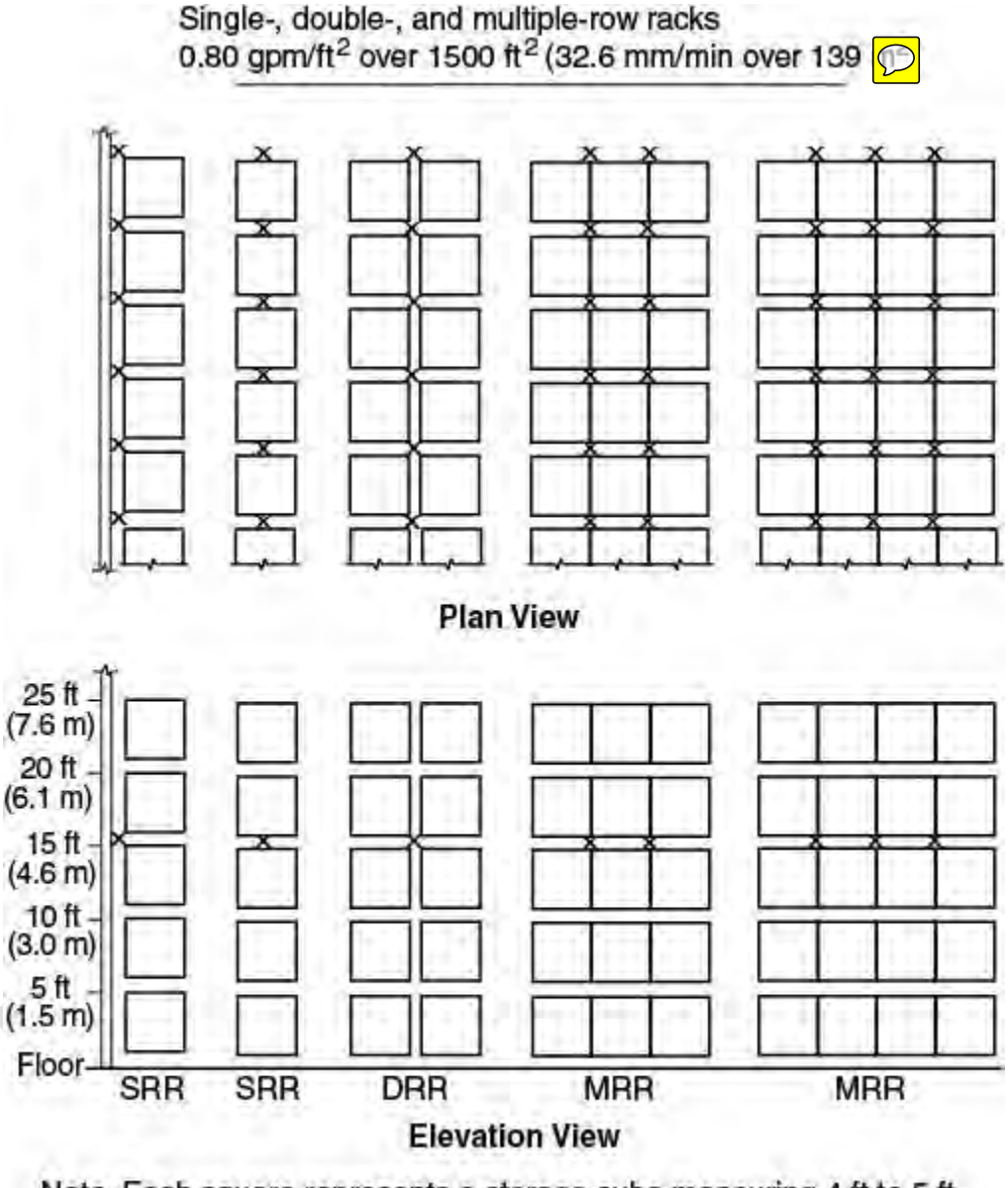
Note: Each square represents a storage cube measuring 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. to 10 ft (450 mm to 3.0 m). Therefore, there could be as few as one load or as many as six or seven loads between in-rack sprinklers that are spaced 10 ft (3.0 m) apart vertically.

Figure 17.6.1.4(j) Exposed Nonexpanded Group A Plastics Up to 20 ft (6.1 m) in Height in Up to a 30 ft (9.1 m) High Building with Two Levels of Closely Spaced In-Rack Sprinklers.



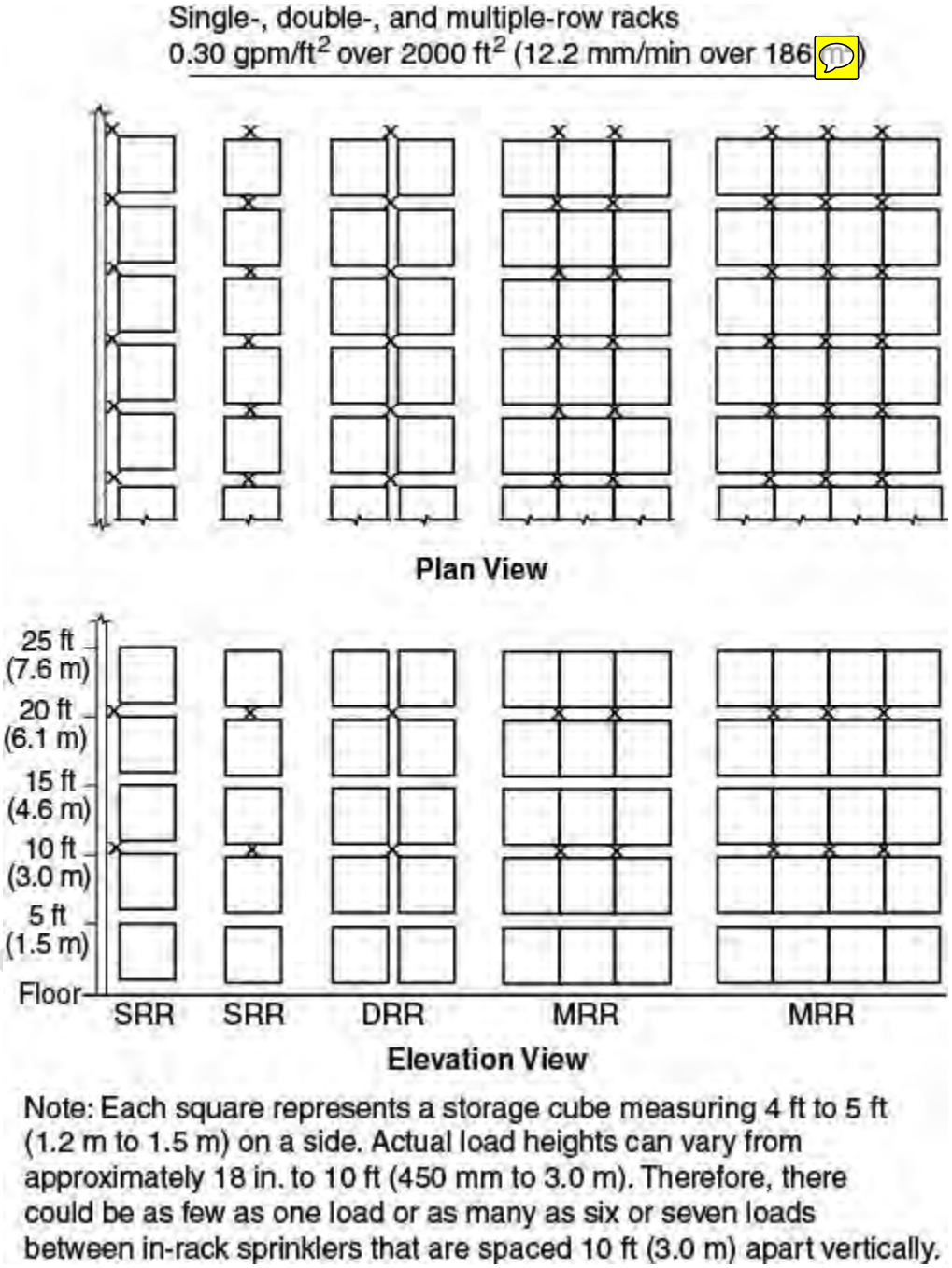
Note: Each square represents a storage cube measuring 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. to 10 ft (450 mm to 3.0 m). Therefore, there could be as few as one load or as many as six or seven loads between in-rack sprinklers that are spaced 10 ft (3.0 m) apart vertically.

Figure 17.6.1.4(k) Exposed Nonexpanded Group A Plastics Up to 25 ft (7.6 m) in Height in Up to a 35 ft (10.7 m) High Building with One Level of Closely Spaced In-Rack Sprinklers.



Note: Each square represents a storage cube measuring 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. to 10 ft (450 mm to 3.0 m). Therefore, there could be as few as one load or as many as six or seven loads between in-rack sprinklers that are spaced 10 ft (3.0 m) apart vertically.

Figure 17.6.1.4(l) Exposed Nonexpanded Group A Plastics Up to 25 ft (7.6 m) in Height in Up to a 35 ft (10.7 m) High Building with Two Levels of Closely Spaced In-Rack Sprinklers.



17.6.1.5 In-Rack Sprinkler Requirements Where Control Mode Density/Area Sprinklers Are Being Used at Ceiling.

17.6.1.5.1 In-Rack Sprinkler Clearance.
The minimum of 6 in. (150 mm) vertical clear space shall be maintained between the sprinkler deflectors and the top of a tier of storage.

(A)
Sprinkler discharge shall not be obstructed by horizontal rack members.

17.6.1.5.2
The spacing of in-rack sprinklers shall be in accordance with Figure 17.6.1.2.1(a) through Figure 17.6.1.2.1(f).

17.6.1.5.3
In-rack sprinklers shall be located at an intersection of transverse and longitudinal flues while not exceeding the maximum spacing rules.

17.6.1.5.4
Where distances between transverse flues exceed the maximum allowable distances, sprinklers shall be installed at the intersection of the transverse and longitudinal flues, and additional sprinklers shall be installed between transverse flues to meet the maximum distance rules.

17.6.1.5.5
Where no transverse flues exist, in-rack sprinklers shall not exceed the maximum spacing rules.

17.6.1.5.6 In-Rack Sprinkler Water Demand.
The water demand for sprinklers installed in racks shall be based on simultaneous operation of the most hydraulically remote sprinklers as follows:
(1) Eight sprinklers where only one level is installed in racks

(2) Fourteen sprinklers (seven on each top two levels) where more than one level is installed in racks

17.6.1.5.7 In-Rack Sprinkler Discharge Pressure.
Sprinklers in racks shall discharge at not less than 15 psi (1.0 bar) for all classes of commodities. *(See Section C.19.)*

17.6.2 CMSA Sprinklers for Rack Storage of Group A Plastic Commodities Stored Up to and Including 25 ft (7.6 m) in Height.

17.6.2.1
Protection of single-, double-, and multiple-row rack storage for nonexpanded Group A plastic commodities shall be in accordance with Table 17.6.2.1.

Table 17.6.2.1 CMSA Sprinkler Design Criteria for Single-, Double-, and Multiple-Row Racks of Group A Plastic Commodities Stored Up and Including 25 ft (7.6 m) in Height

Storage Arrangement	Commodity Class	Maximum Storage Height		Maximum Ceiling/Roof Height		K-Factor/ Orientation	Type of System	Number of Design Sprinklers	Minimum Operating Pressure	
		ft	m	ft	m				psi	bar
Single-, double-, and multiple-row racks (no open-top containers)	Cartoned nonexpanded plastics	20	6.1	25	7.6	11.2 (160) Upright	Wet	15	50	3.4
						16.8 (240) Upright	Wet	15	22	1.5
						19.6 (280) Pendent	Wet	15	16	1.1
				30	9.1	11.2 (160) Upright	Wet	30	50	3.4
							Wet	20	75	5.2
						16.8 (240) Upright	Wet	15*	22	1.5
						19.6 (280) Pendent	Wet	15	16	1.1

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Storage Arrangement	Commodity Class	Maximum Storage Height		Maximum Ceiling/Roof Height		K-Factor/ Orientation	Type of System	Number of Design Sprinklers	Minimum Operating Pressure	
		ft	m	ft	m				psi	bar
		25	7.6	30	9.1	11.2 (160) Upright	Wet	15 + 1 level of in-rack	50	3.4
						16.8 (240) Upright	Wet	15*	22	1.5
						19.6 (280) Pendent	Wet	15	16	1.1
		25	7.6	35	11	11.2 (160) Upright	Wet	30 + 1 level of in-rack	50	3.4
							Wet	20 + 1 level of in-rack	75	5.2
						16.8 (240) Upright	Wet	30 + 1 level of in-rack	22	1.5
							Wet	20 + 1 level of in-rack	35	2.4
						19.6 (280) Pendent	Wet	15	25	1.7
	Exposed nonexpanded plastics	20	6.1	25	7.6	11.2 (160) Upright	Wet	15	50	3.4
						16.8 (240) Upright	Wet	15	22	1.5
		20	6.1	30	9.1	11.2 (160) Upright	Wet	30	50	3.4
							Wet	20	75	5.2
						16.8 (240) Upright	Wet	15*	22	1.5
		25	7.6	30	9.1	11.2 (160) Upright	Wet	15 + 1 level of in-rack	50	3.4
						16.8 (240) Upright	Wet	15*	22	1.5
		25	7.6	35	11	11.2 (160) Upright	Wet	30 + 1 level of in-rack	50	3.4
							Wet	20 + 1 level of in-rack	75	5.2

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Storage Arrangement	Commodity Class	Maximum Storage Height		Maximum Ceiling/Roof Height		K-Factor/ Orientation	Type of System	Number of Design Sprinklers	Minimum Operating Pressure	
		ft	m	ft	m				psi	bar
						16.8 (240) Upright	Wet	30 + 1 level of in-rack	22	1.5
							Wet	20 + 1 level of in-rack	35	2.4

*Minimum 8 ft (2.4 m) aisle.

17.6.2.1.1
CMSA sprinklers shall not be permitted to protect storage on solid shelf racks unless the solid shelf racks are protected with in-rack sprinklers in accordance with 17.1.5.

17.6.2.1.1.1
Where solid shelves are used, in-rack sprinklers shall be installed in every level below the highest solid shelf.

17.6.2.2
Protection shall be provided as specified in Table 17.6.2.1 or appropriate NFPA standards in terms of minimum operating pressure and the number of sprinklers to be included in the design area.

17.6.2.3 Open Wood Joist Construction.

17.6.2.3.1
Where CMSA sprinklers are installed under open wood joist construction, firestopping in accordance with **17.6.2.3.2** shall be provided or the minimum operating pressure of the sprinklers shall be 50 psi (3.4 bar) for a K-11.2 (160) sprinkler or 22 psi (1.5 bar) for a K-16.8 (240) sprinkler.

17.6.2.3.2
Where each joist channel of open wood joist construction is fully firestopped to its full depth at intervals not exceeding 20 ft (6.1 m), the lower pressures specified in Table 17.6.2.1 shall be permitted to be used.

17.6.2.4 Preaction Systems.
For the purpose of using Table 17.6.2.1, preaction systems shall be classified as dry pipe systems.

17.6.2.5
Building steel shall not require special protection where Table 17.6.2.1 is applied as appropriate for the storage configuration.

17.6.2.6 In-Rack Sprinkler Requirements Where CMSA Sprinklers Are Used at Ceiling.

17.6.2.6.1
In-rack sprinklers shall be installed at the first tier level at or above one-half of the storage height.

17.6.2.6.2
The minimum of 6 in. (150 mm) vertical clear space shall be maintained between the sprinkler deflectors and the top of a tier of storage.

(A)
Sprinkler discharge shall not be obstructed by horizontal rack members.

17.6.2.6.3
In-rack sprinklers shall be located at an intersection of transverse and longitudinal flues.

17.6.2.6.4
The maximum horizontal distance between in-rack sprinklers shall be 5 ft (1.5 m).

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17.6.2.6.5
Where distances between transverse flues exceed the maximum allowable distances, sprinklers shall be installed at the intersection of the transverse and longitudinal flues, and additional sprinklers shall be installed between transverse flues to meet the maximum distance rules.

17.6.2.6.6
Where no transverse flues exist, in-rack sprinklers shall not exceed the maximum spacing rules.

17.6.2.6.7 In-Rack Sprinkler Water Demand.
The water demand for sprinklers installed in racks shall be based on simultaneous operation of the most hydraulically remote eight sprinklers.

17.6.2.6.8 In-Rack Sprinkler Discharge Pressure.
Sprinklers in racks shall discharge at not less than 15 psi (1.0 bar) for all classes of commodities. *(See Section C.19.)*

17.6.3 Special Design for Rack Storage of Plastics Commodities Stored Up to and Including 25 ft (7.6 m) in Height.

17.6.3.1 Slatted Shelves.

17.6.3.1.1
Slatted rack shelves shall be considered equivalent to solid rack shelves where the shelving is not considered open rack shelving or where the requirements of 17.6.3.1 are not met. *(See Section C.20.)*

17.6.3.1.2
A wet pipe system that is designed to provide a minimum of 0.6 gpm/ft^2 (24.4 mm/min) density over a minimum area of 2000 ft^2 (186 m^2) or K-14.0 (200) ESFR sprinklers operating at a minimum of 50 psi (3.4 bar), K-16.8 (240) sprinklers operating at a minimum of 32 psi (2.2 bar), or K-25.2 (360) ESFR sprinklers operating at a minimum of 15 psi (1.0 bar) shall be permitted to protect single- and double-row racks with slatted rack shelving racks where all of the following conditions are met:
(1) Sprinklers shall be K-11.2 (160), K-14.0 (200), or K-16.8 (240) orifice spray sprinklers with a temperature rating of ordinary, intermediate, or high and shall be listed for storage occupancies or shall be K-14.0 (200), K-16.8 (240), or K-25.2 (360) ESFR.

(2) The protected commodities shall be limited to Class I through Class IV, Group B plastics, Group C plastics, cartoned (expanded and unexpanded) Group A plastics, and exposed (unexpanded) Group A plastics.

(3) Slats in slatted rack shelving shall be a minimum nominal 2 in. (50 mm) thick by maximum nominal 6 in. (150 mm) wide with the slats held in place by spacers that maintain a minimum 2 in. (50 mm) opening between each slat.

(4) Where K-11.2 (160), K-14.0 (200), or K-16.8 (240) orifice sprinklers are used, there shall be no slatted shelf levels in the rack above 12 ft (3.7 m). Open rack shelving using wire mesh shall be permitted for shelf levels above 12 ft (3.7 m).

(5) Transverse flue spaces at least 3 in. (75 mm) wide shall be provided at least every 10 ft (3.0 m) horizontally.

(6) Longitudinal flue spaces at least 6 in. (150 mm) wide shall be provided for double-row racks. Longitudinal flue spaces shall not be required when ESFR sprinklers are used.

(7) The aisle widths shall be at least 7½ ft (2.3 m).

(8) The maximum roof height shall be 27 ft (8.2 m) or 30 ft (9.1 m) where ESFR sprinklers are used.

(9) The maximum storage height shall be 20 ft (6.1 m).

(10) Solid plywood or similar materials shall not be placed on the slatted shelves so that they block the 2 in. (50 mm) spaces between slats, nor shall they be placed on the wire mesh shelves.

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Chapter 18 Installation Requirements for Seismic Protection

18.1 Protection of Piping Against Damage Where Subject to Earthquakes.

18.1.1
Where water-based fire protection systems are required to be protected against damage from earthquakes, the requirements of Section 18.1 shall apply, unless the requirements of 18.1.2 are met.

18.1.2
Alternative methods of providing earthquake protection of sprinkler systems based on a seismic analysis certified by a registered professional engineer such that system performance will be at least equal to that of the building structure under expected seismic forces shall be permitted.

18.1.3 Obstructions to Sprinklers.
Braces and restraints shall not obstruct sprinklers and shall comply with the obstruction rules of Chapter 8.

18.2* Flexible Couplings.

18.2.1
Flexible couplings joining grooved end pipe shall be provided as flexure joints to allow individual sections of piping 2½ in. (65 mm) or larger to move differentially with the individual sections of the building to which it is attached.

18.2.2
Flexible couplings shall be arranged to coincide with structural separations within a building.

18.2.3
Systems having more flexible couplings than required by this section shall be provided with additional sway bracing as required in 18.5.5.9.

18.2.3.1
The flexible couplings shall be installed as follows:
(1) *Within 24 in. (600 mm) of the top and bottom of all risers, unless the following provisions are met:
(a) In risers less than 3 ft (900 mm) in length, flexible couplings shall be permitted to be omitted.

(b) In risers 3 ft to 7 ft (900 mm to 2.1 m) length, one flexible coupling shall be adequate.

(2) Within 12 in. (300 mm) above and within 24 in. (600 mm) below the floor in multistory buildings
(a) In risers up to 7 ft in length terminating above the roof assembly or top landing, the flexible coupling shall not be required above the assembly.

(3) On both sides of concrete or masonry walls within 1 ft (300 mm) of the wall surface, unless clearance is provided in accordance with 18.4

(4) *Within 24 in. (600 mm) of building expansion joints

(5) Within 24 in. (600 mm) of the top of drops exceeding 15 ft (4.6 m) in length to portions of systems supplying more than one sprinkler, regardless of pipe size

(6) Within 24 in. (600 mm) above and 24 in. (600 mm) below any intermediate points of support for a riser or other vertical pipe

18.2.3.2
When the flexible coupling below the floor is above the tie-in main to the main supplying that floor, a flexible coupling shall be provided in accordance with one of the following:
(1) *On the horizontal portion within 24 in. (600 mm) of the tie-in where the tie-in is horizontal

(2) *On the vertical portion of the tie-in where the tie-in incorporates a riser

18.2.4* Flexible Couplings for Drops.
Flexible couplings for drops to hose lines, rack sprinklers, mezzanines, and free-standing structures shall be installed regardless of pipe sizes as follows:

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(1) Within 24 in. (600 mm) of the top of the drop

(2) Within 24 in. (600 mm) above the uppermost drop support attachment, where drop supports are provided to the structure, rack, or mezzanine

(3) Within 24 in. (600 mm) above the bottom of the drop where no additional drop support is provided

18.3* Seismic Separation Assembly.

18.3.1
An approved seismic separation assembly shall be installed where sprinkler piping, regardless of size, crosses building seismic separation joints at ground level and above.

18.3.2
Seismic separation assemblies shall consist of flexible fittings or flexible piping so as to allow movement sufficient to accommodate closing of the separation, opening of the separation to twice its normal size, and movement relative to the separation in the other two dimensions in an amount equal to the separation distance.

18.3.3*
The seismic separation assembly shall include a four-way brace upstream and downstream within 6 ft (1.8 m) of the seismic separation assembly.

18.3.4
Bracing shall not be attached to the seismic separation assembly.

18.4* Clearance.

18.4.1
Clearance shall be provided around all piping extending through walls, floors, platforms, and foundations, including drains, fire department connections, and other auxiliary piping.

18.4.2
Unless any of the requirements of 18.4.3 through 18.4.7 or 18.4.10 are met, where pipe passes through holes in platforms, foundations, walls, or floors, the holes shall be sized such that the diameter of the holes is nominally 2 in. (50 mm) larger than the pipe for pipe 1 in. (25 mm) nominal to 3½ in. (90 mm) nominal and 4 in. (100 mm) larger than the pipe for pipe 4 in. (100 mm) nominal and larger.

18.4.3
Where clearance is provided by a pipe sleeve, a nominal diameter 2 in. (50 mm) larger than the nominal diameter of the pipe shall be acceptable for pipe sizes 1 in. (25 mm) through 3½ in. (90 mm), and the clearance provided by a pipe sleeve of nominal diameter 4 in. (100 mm) larger than the nominal diameter of the pipe shall be acceptable for pipe sizes 4 in. (100 mm) and larger.

18.4.4
No clearance shall be required for piping passing through gypsum board or equally frangible construction.

18.4.5
No clearance shall be required if flexible couplings are located within 1 ft (300 mm) of each side of a wall or if the requirements of 18.2.3.1(2) are met.

18.4.6
No clearance shall be required where horizontal piping passes perpendicularly through successive studs or joists that form a wall or floor/ceiling assembly.

18.4.7
No clearance shall be required where nonmetallic pipe has been demonstrated to have inherent flexibility equal to or greater than the minimum provided by flexible couplings located within 1 ft (300 mm) of each side of a wall, floor, platform, or foundation.

18.4.8
Where required, the clearance shall be filled with a flexible material that is compatible with the piping material.

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18.4.9
The installed horizontal and upward vertical clearance between horizontal sprinkler piping and structural members not penetrated or used, collectively or independently, to support the piping shall be at least 2 in. (50 mm).

18.4.10*
No clearance shall be required where piping is supported by holes through structural members as permitted by 17.1.7.3.

18.4.11*
The installed clearance between a sprinkler and structural elements not used collectively or independently to support the sprinklers shall be at least 3 in. (75 mm).

18.4.11.1
Where sprinklers are installed using flexible sprinkler hose, clearance for the sprinkler shall not be required.

18.4.12
Clearance shall not be required for piping that is vertically supported by the bottom edge of holes through structural members as permitted by 17.1.7.3.

18.4.13
No horizontal clearance (tight fit) shall be provided for piping that is laterally supported by the side edges of holes through structural members.

18.4.13.1
Clearance shall be permitted where piping is secured to the structural member with an approved hanger or restraint.

18.5* Sway Bracing.

18.5.1 General.

18.5.1.1
The system piping shall be braced to resist both lateral and longitudinal horizontal seismic loads and to prevent vertical motion resulting from seismic loads.

18.5.1.2
The structural components to which bracing is attached shall be determined to be capable of resisting the added applied seismic loads.

18.5.1.3*
Horizontal loads on system piping shall be determined in accordance with 18.5.9.

18.5.1.4*
A shared support structure shall be permitted to support both the gravity loads addressed in 17.1.4.1 and the seismic loads addressed in 18.5.9.

18.5.1.4.1
When a shared support structure is used to support gravity and seismic loads, the structure shall be designed to support these loads for all pipe and distribution systems on the structure using either 18.5.9.3 or 18.5.9.4 with an importance factor, *Ip*, of 1.5 being applied to all of the distribution systems.

18.5.1.5*
If a shared support structure is used to support sprinkler pipe and other distribution systems per 17.1.4.1 and that structure does not provide seismic resistance as required in 18.5.1.4, the following shall be met:
(1) The sprinkler pipe shall be braced using the method in 18.5.6 with the zone of influence including the water-filled sprinkler pipe and all other distribution systems that are not independently equipped with seismic protection and attached to the shared support structure.

(2) The sprinkler sway bracing attachment shall be connected to the same building or structure as the shared support structure.

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18.5.1.6
Bracing requirements of 18.5 shall not apply to drain piping downstream of the drain valve.

18.5.2 Listing.

18.5.2.1
Sway bracing assemblies shall be listed for a maximum load rating, unless the requirements of 18.5.2.2 are met.

18.5.2.2
Where sway bracing utilizing pipe, angles, flats, or rods as shown in Table 18.5.11.8(a), Table 18.5.11.8(b), and Table 18.5.11.8(c) is used, the components shall not require listing.

18.5.2.2.1
Bracing fittings and connections used with those specific materials shall be listed.

18.5.2.3*
The listed load rating shall be reduced as shown in Table 18.5.2.3 to determine the allowable load for installations where the brace is less than 90 degrees from vertical.

Table 18.5.2.3 Listed Horizontal Load Adjustment

Brace Angle Degrees from Vertical	Allowable Horizontal Load
30 to 44	Listed load rating divided by 2.000
45 to 59	Listed load rating divided by 1.414
60 to 89	Listed load rating divided by 1.155
90	Listed load rating

18.5.2.3.1*
Maximum allowable horizontal loads shall be determined by testing at angles of 30, 45, 60, and 90 degrees from vertical and confirmed to be equal to or greater than those calculated using 18.5.2.3.

18.5.2.3.2
For attachments to structures, additional tests shall be performed at 0 degrees.

18.5.3 Component Material.

18.5.3.1
Unless permitted by 18.5.3.2, components of sway brace assemblies shall be ferrous.

18.5.3.2
Nonferrous components that have been proven by fire tests to be adequate for the hazard application, that are listed for this purpose, and that are in compliance with the other requirements of this section shall be acceptable.

18.5.4 Sway Bracing Design.

18.5.4.1
Sway braces shall be designed to withstand forces in tension and compression, unless the requirements of 18.5.4.2 are met.

18.5.4.2*
Tension-only bracing systems shall be permitted for use where listed for this service and where installed in accordance with their listing limitations, including installation instructions.

18.5.4.3
For all braces, whether or not listed, the maximum allowable load shall be based on the weakest component of the brace with safety factors.

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18.5.5 Lateral Sway Bracing.

18.5.5.1*
Lateral sway bracing shall be provided on all feed and cross mains regardless of size and all branch lines and other piping with a diameter of 2½ in. (65 mm) and larger.

18.5.5.1.1
Where branch lines are not provided with lateral sway bracing, they shall be provided with restraint in accordance with 18.6.

18.5.5.2*
The spacing between lateral sway braces shall be in accordance with either Table 18.5.5.2(a) through Table 18.5.5.2(l) or 18.5.5.3, based on the piping material of the sprinkler system.

Table 18.5.5.2(a) Maximum Load (F_{pw}) in Zone of Influence (lb), (F_y = 30 ksi) Schedule 10 Steel Pipe

Diameter of Pipe (in.) Being Braced	Lateral Sway Brace Spacing (ft)				
	20	25	30	35	40
1	111	89	73	63	52
1¼	176	141	116	99	83
1½	241	193	158	136	114
2	390	312	256	219	183
2½	641	513	420	360	301
3	966	773	633	543	454
3½	1281	1025	840	720	603
4	1634	1307	1071	918	769
5	2814	2251	1844	1581	1324
6 and larger*	4039	3231	2647	2269	1900

Note: ASTM A106 Grade B or ASTM A53 Grade B has an F_y = 35 ksi. An F_y = 30 ksi was used as a conservative value to account for differences in material properties as well as other operational stresses.

*Larger diameter pipe can be used when justified by engineering analysis.

Table 18.5.5.2(b) Maximum Load (F_{pw}) in Zone of Influence (kg), (F_y = 207 N/mm^2) Schedule 10 Steel Pipe

Diameter of Pipe (mm) Being Braced	Lateral Sway Brace Spacing (m)				
	6.1	7.6	9.1	10.7	12.2
25	50	40	33	29	24
32	80	64	53	45	38
40	109	88	72	62	52
50	177	142	116	99	83
65	291	233	191	163	137
80	438	351	287	246	206
90	581	465	381	327	273
100	741	593	486	416	349
125	1276	1021	836	717	601

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Diameter of Pipe (mm) Being Braced	Lateral Sway Brace Spacing (m)				
	6.1	7.6	9.1	10.7	12.2
150*	1832	1466	1201	1029	862

Note: ASTM A106 Grade B or ASTM A53 Grade B has an F_y = 241 N/mm^2. An F_y = 207 N/mm^2 was used also as a conservative value to account for differences in material properties as well as other operational stresses.

*Larger diameter pipe can be used when justified by engineering analysis.

Table 18.5.5.2(c) Maximum Load (F_{pw}) in Zone of Influence (lb), (F_y= 30 ksi) Schedule 40 Steel Pipe

Diameter of Pipe (in.) Being Braced	Lateral Sway Brace Spacing (ft)				
	20	25	30	35	40
1	121	97	79	68	57
1¼	214	171	140	120	100
1½	306	245	201	172	144
2	520	416	341	292	245
2½	984	787	645	553	463
3	1597	1278	1047	897	751
3½	2219	1775	1455	1247	1044
4	2981	2385	1954	1675	1402
5	5061	4049	3317	2843	2381
6 and larger*	7893	6314	5173	4434	3713

Note: ASTM A106 Grade B or ASTM A53 Grade B has an F_y = 35 ksi. An F_y = 30 ksi was used as a conservative value to account for differences in material properties as well as other operational stresses.

*Larger diameter pipe can be used when justified by engineering analysis.

Table 18.5.5.2(d) Maximum Load (F_{pw}) in Zone of Influence (kg), (F_y = 207 N/mm^2) Schedule 40 Steel Pipe

Diameter of Pipe (in.) Being Braced	Lateral Sway Brace Spacing (m)				
	6.1	7.6	9.1	10.7	12.2
25	55	44	36	31	26
32	97	78	63	54	45
40	139	111	91	78	65
50	236	189	155	132	111
65	446	357	293	251	210
80	724	580	475	407	341
90	1007	805	660	566	474
100	1352	1082	886	760	636
125	2296	1837	1505	1290	1080
150*	3580	2864	2346	2011	1684

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Note: ASTM A106 Grade B or ASTM A53 Grade B has an F_y = 241 N/mm^2. An F_y = 207 N/mm^2 was used also as a conservative value to account for differences in material properties as well as other operational stresses.

*Larger diameter pipe can be used when justified by engineering analysis.

Table 18.5.5.2(e) Maximum Load (F_{pw}) in Zone of Influence (lb), (F_y = 30 ksi) Schedule 5 Steel Pipe

Diameter of Pipe (in.) Being Braced	Lateral Sway Brace Spacing (ft)				
	20	25	30	35	40
1	71	56	46	40	33
1¼	116	93	76	65	55
1½	154	124	101	87	73
2	246	197	161	138	116
2½	459	367	301	258	216
3	691	552	453	388	325
3½	910	728	597	511	428
4*	1160	928	760	652	546

Note: ASTM A106 Grade B or ASTM A53 Grade B has an F_y = 35 ksi. An F_y = 30 ksi was used as a conservative value to account for differences in material properties as well as other operational stresses.

*Larger diameter pipe can be used when justified by engineering analysis.

Table 18.5.5.2(f) Maximum Load (F_{pw}) in Zone of Influence (kg), (F_y = 207 N/mm^2) Schedule 5 Steel Pipe

Diameter of Pipe (mm) Being Braced	Lateral Sway Brace Spacing (m)				
	6.1	7.6	9.1	10.7	12.2
25	32	25	21	18	15
32	53	42	34	29	25
40	70	56	46	39	33
50	112	89	73	63	53
65	208	166	137	117	98
80	313	250	205	176	147
90	413	330	271	232	194
100*	526	421	345	296	248

Note: ASTM A106 Grade B or ASTM A53 Grade B has an F_y = 241 N/mm^2. An F_y = 207 N/mm^2 was used also as a conservative value to account for differences in material properties as well as other operational stresses.

*Larger diameter pipe can be used when justified by engineering analysis.

Table 18.5.5.2(g) Maximum Load (F_{pw}) in Zone of Influence (lb), (F_y = 8 ksi) CPVC Pipe

Diameter of Pipe (in.) Being Braced	Lateral Sway Brace Spacing (ft)				
	20	25	30	35	40
¾	15	12	10	8	7

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Diameter of Pipe (in.) Being Braced	Lateral Sway Brace Spacing (ft)				
	20	25	30	35	40
1	28	22	18	15	13
1¼	56	45	37	30	26
1½	83	67	55	45	39
2	161	129	105	87	76
2½	286	229	188	154	135
3	516	413	338	278	243

Table 18.5.5.2(h) Maximum Load (F_{pw}) in Zone of Influence (kg), (F_y = 55 N/mm^2) CPVC Pipe

Diameter of Pipe (in.) Being Braced	Lateral Sway Brace Spacing (m)				
	6.1	7.6	9.1	10.7	12.2
20	7	5	5	4	3
25	13	10	8	7	6
32	25	20	17	14	12
40	38	30	25	20	18
50	73	59	48	39	34
65	130	104	85	70	61
80	234	187	153	126	110

Table 18.5.5.2(i) Maximum Load (F_{pw}) in Zone of Influence (lb), (F_y = 30 ksi) Type M Copper Tube (with Soldered Joints)

Diameter of Pipe (in.) Being Braced	Lateral Sway Brace Spacing (ft)				
	20	25	30	35	40
¾	16	13	10	9	8
1	29	24	19	16	14
1¼	53	42	35	28	25
1½	86	69	56	46	41
2*	180	144	118	97	85

*Larger diameter pipe can be used when justified by engineering analysis.

Table 18.5.5.2(j) Maximum Load (F_{pw}) in Zone of Influence (kg), (F_y = 3207 N/mm^2) Type M Copper Tube (with Soldered Joints)

Diameter of Pipe (in.) Being Braced	Lateral Sway Brace Spacing (m)				
	6.1	7.6	9.1	10.7	12.2
20	7.3	5.9	5	4.1	3.6
25	13.2	10.9	8.6	7.3	6.4
32	24	19.1	15.9	12.7	11.3
40	39	31.3	25.4	20.9	18.6
50*	81.6	65.3	53	44	38.6

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*Larger diameter pipe can be used when justified by engineering analysis.

Table 18.5.5.2(k) Maximum Load (F_{pw}) in Zone of Influence (lb), (F_y = 9 ksi) Type M Copper Tube (with Brazed Joints)

	Lateral Sway Spacing (ft)				
Diameter of Pipe (in.) Being Braced	**20**	**25**	**30**	**35**	**40**
¾	6	5	4	3	3
1	11	9	7	6	5
1¼	20	16	13	12	10
1½	33	27	22	19	16
2*	70	56	46	39	33

*Larger diameter pipe can be used when justified by engineering analysis.

Table 18.5.5.2(l) Maximum Load (F_{pw}) in Zone of Influence (lb), (F_y = 9 ksi) Red Brass Pipe (with Brazed Joints)

	Lateral Sway Spacing (ft)				
Diameter of Pipe (in.) Being Braced	**20**	**25**	**30**	**35**	**40**
¾	34	27	22	19	16
1	61	49	40	35	29
1¼	116	93	76	65	55
1½	161	129	105	90	76
2*	272	218	178	153	128

*Larger diameter pipe can be used when justified by engineering analysis.

18.5.5.2.1
Specially listed nonstandard pipe shall be permitted using the values in Table 18.5.5.2(e) and Table 18.5.5.2(f) or with values provided by the manufacturer.

18.5.5.2.2
Spacing shall not exceed a maximum interval of 40 ft (12 m) on center.

18.5.5.2.3
The maximum permissible load in the zone of influence of a sway brace shall not exceed the values given in Table 18.5.5.2(a) through Table 18.5.5.2(l) or the values calculated in accordance with 18.5.5.3.

18.5.5.2.4
When determining permissible loads in accordance with 18.5.5.2 or 18.5.5.2.1 on a main with varying sizes, the allowable load shall be based on the smallest pipe size within the zone of influence.

18.5.5.3
The maximum load (F_{pw}) in the zone of influence for specially listed pipe shall be calculated. *(See Annex **E**.)*

18.5.5.4
The requirements of 18.5.5.1 shall not apply to 2½ in. (65 mm) starter pieces that do not exceed 12 ft (3.7 m) in length.

18.5.5.5
The distance between the last brace and the end of the pipe shall not exceed 6 ft (1.8 m).

18.5.5.6

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Where there is a change in direction of the piping, the cumulative distance between consecutive lateral sway braces shall not exceed the maximum permitted distance in accordance with 18.5.5.2.2.

18.5.5.7
The last length of pipe at the end of a feed or cross main shall be provided with a lateral brace.

18.5.5.8
Lateral braces shall be allowed to act as longitudinal braces if they are within 24 in. (600 mm) of the centerline of the piping braced longitudinally and the lateral brace is on a pipe of equal or greater size than the pipe being braced longitudinally.

18.5.5.9
Where flexible couplings are installed on mains other than as required in 18.2, a lateral brace shall be provided within 24 in. (600 mm) of every other coupling, including flexible couplings at grooved fittings, but not more than 40 ft (12 m) on center.

18.5.5.10*
The lateral sway bracing required by 18.5.5 shall be permitted to be omitted when 18.5.5.10.1 for branch lines or 18.5.5.10.2 for mains is met.

18.5.5.10.1
Branch lines shall comply with the following:
(1) *The branch lines shall be individually supported within 6 in. (150 mm) of the structure, measured between the top of the pipe and the point of attachment to the building structure.

(2) At least 75 percent of all the hangers on the branch line shall meet the requirements of 18.5.5.10.1(1).

(3) Consecutive hangers on the branch line shall not be permitted to exceed the limitation in 18.5.5.10.1(1).

18.5.5.10.2
Mains shall comply with all the following:
(1) *The main piping shall be individually supported within 6 in. (150 mm) of the structure, measured between the top of the pipe and the point of attachment to the building structure.

(2) At least 75 percent of all the hangers on the main shall meet the requirements of 18.5.5.10.2(1).

(3) Consecutive hangers on the main shall not be permitted to exceed the limitation in 18.5.5.10.2(1)

(4) The seismic coefficient (C_p) shall not exceed 0.5.

(5) The nominal pipe diameter shall not exceed 6 in. (152 mm) for feed mains and 4 in. (102 mm) cross mains.

(6) Hangers shall not be omitted in accordance with 17.4.4.3, 17.4.4.4, or 17.4.4.5.

18.5.5.10.3
Branch lines permitted to omit lateral sway bracing by 18.5.5.10 shall not be omitted from load calculations for the mains serving them in 18.5.9.6.

18.5.5.11
The lateral sway bracing required by18.5.5 shall be permitted to be omitted when 18.5.5.11.1 for branch lines or 18.5.5.11.2 for mains is met.

18.5.5.11.1
Branch lines shall comply with the following:
(1) The branch lines shall be individually supported by wraparound u-hooks or u-hooks arranged to keep pipe tight to the underside of the structural element provided the legs are bent out at least 30 degrees from the vertical and the maximum length of each leg and the rod size satisfies the conditions of Table 18.5.11.8(a), Table 18.5.11.8(b), and Table 18.5.11.8(c).

(2) At least 75 percent of all the hangers on the branch line shall meet the requirements of 18.5.5.11.2(1).

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(3) Consecutive hangers on the branch line shall not be permitted to exceed the limitation in 18.5.5.11.2(1).

18.5.5.11.2
Mains shall comply with all the following:
(1) The main piping shall be individually supported by wraparound u-hooks or u-hooks arranged to keep pipe tight to the underside of the structural element provided the legs are bent out at least 30 degrees from the vertical and the maximum length of each leg and rod size satisfies the conditions of Table 18.5.11.8(a), Table 18.5.11.8(b), and Table 18.5.11.8(c).

(2) At least 75 percent of all the hangers on the main shall meet the requirements of 18.5.5.11.2(1).

(3) Consecutive hangers on the main shall not be permitted to exceed the limitation in 18.5.5.11.2(1).

(4) The seismic coefficient (C_p) shall not exceed 0.5.

(5) The nominal pipe diameter shall not exceed 6 in. (152 mm) for feed mains and 4 in. (102 mm) for cross mains.

(6) Hangers shall not be omitted in accordance with 17.4.4.3, 17.4.4.4, or 17.4.4.5.

18.5.6 Longitudinal Sway Bracing.

18.5.6.1
Longitudinal sway bracing spaced at a maximum of 80 ft (24 m) on center shall be provided for feed and cross mains.

18.5.6.2
Longitudinal braces shall be allowed to act as lateral braces if they are within 24 in. (600 mm) of the centerline of the piping braced laterally.

18.5.6.3
The distance between the last brace and the end of the pipe or a change in direction shall not exceed 40 ft (12 m).

18.5.7 Pipe with Change(s) in Direction.

18.5.7.1
Each run of pipe between changes in direction shall be provided with both lateral and longitudinal bracing, unless the requirements of 18.5.7.2 are met.

18.5.7.2*
Pipe runs less than 12 ft (3.7 m) in length shall be permitted to be supported by the braces on adjacent runs of pipe.

18.5.8 Sway Bracing of Risers.

18.5.8.1*
Tops of risers exceeding 3 ft (900 mm) in length shall be provided with a four-way brace.

18.5.8.2
Riser nipples shall be permitted to omit the four-way brace required by 18.5.8.1.

18.5.8.3
When a four-way brace at the top of a riser is attached on the horizontal piping, it shall be within 24 in. (600 mm) of the centerline of the riser and the loads for that brace shall include both the vertical and horizontal pipe.

18.5.8.4
Distance between four-way braces for risers shall not exceed 25 ft (7.6 m).

18.5.8.5
Four-way bracing shall not be required where risers penetrate intermediate floors in multistory buildings where the clearance does not exceed the limits of 18.4.

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18.5.9* Horizontal Seismic Loads.

18.5.9.1*
The horizontal seismic load for the braces shall be as determined in 18.5.9.6 or 18.5.9.7, or as required by the authority having jurisdiction.

18.5.9.2
The weight of the system being braced (W_p) shall be taken as 1.15 times the weight of the water-filled piping. *(See A.18.5.9.1.)*

18.5.9.3
The horizontal force, F_{pw}, acting on the brace shall be taken as $F_{pw} = C_p W_p$, where C_p is the seismic coefficient selected in Table 18.5.9.3 utilizing the short period response parameter, S_s.

Table 18.5.9.3 Seismic Coefficient Table

S_S	C_p	S_S	C_p
0.33 or less	0.35	2.2	1.03
0.4	0.38	2.3	1.07
0.5	0.4	2.4	1.12
0.6	0.42	2.5	1.17
0.7	0.42	2.6	1.21
0.8	0.44	2.7	1.26
0.9	0.48	2.8	1.31
1	0.51	2.9	1.35
1.1	0.54	3	1.4
1.2	0.57	3.1	1.45
1.3	0.61	3.2	1.49
1.4	0.65	3.3	1.54
1.5	0.7	3.4	1.59
1.6	0.75	3.5	1.63
1.7	0.79	3.6	1.68
1.8	0.84	3.7	1.73
1.9	0.89	3.8	1.77
2	0.93	3.9	1.82
2.1	0.98	4	1.87

18.5.9.3.1
The value of S_s used in Table 18.5.9.3 shall be obtained from the authority having jurisdiction or from seismic hazard maps.

18.5.9.3.2*
Linear interpolation shall be permitted to be used for intermediate values of S_s.

18.5.9.4*
The horizontal force, F_{pw}, acting on the brace shall be permitted to be determined in accordance with Section 13.3.1 of SEI/ASCE 7, *Minimum Design Loads of Buildings and Other Structures*, multiplied by 0.7 to convert to allowable stress design (ASD).

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18.5.9.5*
Where data for determining C_p are not available, the horizontal seismic force acting on the braces shall be determined as specified in 18.5.9.3 with C_p = 0.5.

18.5.9.6*
The zone of influence for lateral braces shall include all branch lines, drops, sprigs, and mains tributary to the brace, except branch lines that are provided with longitudinal bracing or as prohibited by 18.5.9.6.1.

18.5.9.6.1*
When riser nipples are provided in systems requiring seismic protection, they shall satisfy the following equation, unless one of the following conditions is met:
(1) Where riser nipples are 4 ft (1.2 m) or less in length and C_p is 0.50 or less

(2) Where riser nipples are 3 ft (900 mm) or less in length and C_p is less than 0.67

(3) Where riser nipples are 2 ft (600 mm) in length or less and C_p is less than is 1.0

$$\frac{\left(H_r \cdot W_p \cdot C_p\right)}{S} \geq F_y$$

[18.3.5.9.6.1]

where:

H_r = length of riser nipple piping (in inches)

W_p = tributary weight (in pounds) for the branch line or portion of branch line within the zone of influence including the riser nipple

C_p = seismic coefficient

S = sectional modulus of the riser nipple pipe

F_y = allowable yield strength of 30,000 psi (2070 bar) for steel, 30,000 psi for copper (soldered), 8000 psi (550 bar) for CPVC

18.5.9.6.2
If the calculated value is equal to or greater than the yield strength of the riser nipple, the longitudinal seismic load of each line shall be evaluated individually, and branch lines shall be provided with longitudinal sway bracing per 18.5.6.

18.5.9.7
The zone of influence for longitudinal braces shall include all mains tributary to the brace.

18.5.10 Net Vertical Reaction Forces.
Where the horizontal seismic loads used exceed 0.5 W_p and the brace angle is less than 45 degrees from vertical or where the horizontal seismic load exceeds 1.0 W_p and the brace angle is less than 60 degrees from vertical, the braces shall be arranged to resist the net vertical reaction produced by the horizontal load.

18.5.11* Sway Brace Installation.

18.5.11.1*
Bracing shall be attached directly to the system pipe.

18.5.11.2
Sway bracing shall be tight.

18.5.11.3
For individual braces, the slenderness ratio *(l/r)* shall not exceed 300, where *l* is the length of the brace and *r* is the least radius of gyration.

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18.5.11.4
Where threaded pipe is used as part of a sway brace assembly, it shall not be less than Schedule 30.

18.5.11.5
All parts and fittings of a brace shall lie in a straight line to avoid eccentric loadings on fittings and fasteners.

18.5.11.6
For longitudinal braces only, the brace shall be permitted to be connected to a tab welded to the pipe in conformance to 7.5.2.

18.5.11.7
For tension-only braces, two tension-only brace components opposing each other must be installed at each lateral or longitudinal brace location.

18.5.11.8
The loads determined in 18.5.9 shall not exceed the lesser of the maximum allowable loads provided in Table 18.5.11.8(a), Table 18.5.11.8(b), and Table 18.5.11.8(c)and the manufacturer's certified maximum allowable horizontal loads for brace angles of 30 to 44 degrees, 45 to 59 degrees, 60 to 89 degrees, or 90 degrees.

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Table 18.5.11.8(a) Maximum Horizontal Loads for Sway Braces with *l/r* = 100 for Steel Braces with F_y = 36 ksi

Brace Shape and Size (in.)		Area (in.^{2})	Least Radius of Gyration *(r)* (in.)	Maximum Length for *l/r* = 100		Maximum Horizontal Load (lb)		
						Brace Angle		
				ft	in.	30° to 44° Angle from Vertical	45° to 59° Angle from Vertical	60° to 90° Angle from Vertical
Pipe Schedule 40	1	0.494	0.421	3	6	3,150	4,455	5,456
	1¼	0.669	0.540	4	6	4,266	6,033	7,389
	1½	0.799	0.623	5	2	5,095	7,206	8,825
	2	1.07	0.787	6	6	6,823	9,650	11,818

Brace Shape and Size (in.)		Area (in.^{2})	Least Radius of Gyration *(r)* (in.)	Maximum Length for *l*/*r* = 100		Maximum Horizontal Load (lb)		
						Brace Angle		
				ft	in.	30° to 44° Angle from Vertical	45° to 59° Angle from Vertical	60° to 90° Angle from Vertical
Angles	1½ × 1½ × ¼	0.688	0.292	2	5	4,387	6,205	7,599
	2 × 2 × ¼	0.938	0.391	3	3	5,982	8,459	10,360
	2½ × 2 × ¼	1.06	0.424	3	6	6,760	9,560	11,708
	2½ × 2½ × ¼	1.19	0.491	4	1	7,589	10,732	13,144
	3 × 2½ × ¼	1.31	0.528	4	4	8,354	11,814	14,469
	3 × 3 × ¼	1.44	0.592	4	11	9,183	12,987	15,905
Rods (all thread)	⅜	0.07	0.075	0	7	446	631	773
	½	0.129	0.101	0	10	823	1,163	1,425
	⅝	0.207	0.128	1	0	1,320	1,867	2,286
	¾	0.309	0.157	1	3	1,970	2,787	3,413
	⅞	0.429	0.185	1	6	2,736	3,869	4,738
Rods (threaded at ends only)	⅜	0.11	0.094	0	9	701	992	1,215
	½	0.196	0.125	1	0	1,250	1,768	2,165
	⅝	0.307	0.156	1	3	1,958	2,769	3,391
	¾	0.442	0.188	1	6	2,819	3,986	4,882
	⅞	0.601	0.219	1	9	3,833	5,420	6,638
Flats	1½ × ¼	0.375	0.0722	0	7	2,391	3,382	4,142
	2 × ¼	0.5	0.0722	0	7	3,189	4,509	5,523
	2 × ⅜	0.75	0.1082	0	10	4,783	6,764	8,284

Table 18.5.11.8(b) Maximum Horizontal Loads for Sway Braces with *l*/*r* = 200 for Steel Braces with F_y = 36 ksi

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Brace Shape and Size (in.)		Area (in.^{2})	Least Radius of Gyration *(r)* (in.)	Maximum Length for *l*/*r* = 200		Maximum Horizontal Load (lb)		
						Brace Angle		
				ft	in.	30° to 44° Angle from Vertical	45° to 59° Angle from Vertical	60° to 90° Angle from Vertical
Pipe Schedule 40	1	0.494	0.421	7	0	926	1310	1604
	1¼	0.669	0.540	9	0	1254	1774	2173
	1½	0.799	0.623	10	4	1498	2119	2595
	2	1.07	0.787	13	1	2006	2837	3475
Angles	1½ × 1½ × ¼	0.688	0.292	4	10	1290	1824	2234
	2 × 2 × ¼	0.938	0.391	6	6	1759	2487	3046
	2½ × 2 × ¼	1.06	0.424	7	0	1988	2811	3442
	2½ × 2½ × ¼	1.19	0.491	8	2	2231	3155	3865
	3 × 2½ × ¼	1.31	0.528	8	9	2456	3474	4254
	3 × 3 × ¼	1.44	0.592	9	10	2700	3818	4677
Rods (all thread)	⅜	0.07	0.075	1	2	131	186	227
	½	0.129	0.101	1	8	242	342	419
	⅝	0.207	0.128	2	1	388	549	672
	¾	0.309	0.157	2	7	579	819	1004
	⅞	0.429	0.185	3	0	804	1138	1393
Rods (threaded at ends only)	⅜	0.11	0.094	1	6	206	292	357
	½	0.196	0.125	2	0	368	520	637
	⅝	0.307	0.156	2	7	576	814	997
	¾	0.442	0.188	3	1	829	1172	1435
	⅞	0.601	0.219	3	7	1127	1594	1952
Flats	1½ × ¼	0.375	0.0722	1	2	703	994	1218
	2 × ¼	0.5	0.0722	1	2	938	1326	1624
	2 × ⅜	0.75	0.1082	1	9	1406	1989	2436

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Table 18.5.11.8(c) Maximum Horizontal Loads for Sway Braces with *l/r* = 300 for Steel Braces with F_y = 36 ksi

Brace Shape and Size (in.)		Area (in.^{2})	Least Radius of Gyration *(r)* (in.)	Maximum Length for *l/r* = 300		Maximum Horizontal Load (lb)		
						Brace Angle		
				ft	in.	30° to 44° Angle from Vertical	45° to 59° Angle from Vertical	60° to 90° Angle from Vertical
Pipe Schedule 40	1	0.494	0.421	10	6	412	582	713
	1¼	0.669	0.540	13	6	558	788	966
	1½	0.799	0.623	15	6	666	942	1153
	2	1.07	0.787	19	8	892	1261	1544
Angles	1½ × 1½ × ¼	0.688	0.292	7	3	573	811	993
	2 × 2 × ¼	0.938	0.391	9	9	782	1105	1354
	2½ × 2 × ¼	1.06	0.424	10	7	883	1249	1530
	2½ × 2½ × ¼	1.19	0.491	12	3	992	1402	1718
	3 × 2½ × ¼	1.31	0.528	13	2	1092	1544	1891
	3 × 3 × ¼	1.44	0.592	14	9	1200	1697	2078
Rods (all thread)	⅜	0.07	0.075	1	10	58	82	101
	½	0.129	0.101	2	6	108	152	186
	⅝	0.207	0.128	3	2	173	244	299
	¾	0.309	0.157	3	11	258	364	446
	⅞	0.429	0.185	4	7	358	506	619
Rods (threaded at ends only)	⅜	0.11	0.094	2	4	92	130	159
	½	0.196	0.125	3	1	163	231	283
	⅝	0.307	0.156	3	10	256	362	443
	¾	0.442	0.188	4	8	368	521	638
	⅞	0.601	0.219	5	5	501	708	867
Flats	1½ × ¼	0.375	0.0722	1	9	313	442	541
	2 × ¼	0.5	0.0722	1	9	417	589	722

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Brace Shape and Size (in.)	Area (in.^{2})	Least Radius of Gyration *(r)* (in.)	Maximum Length for *l*/*r* = 300		Maximum Horizontal Load (lb)		
					Brace Angle		
			ft	in.	30° to 44° Angle from Vertical	45° to 59° Angle from Vertical	60° to 90° Angle from Vertical
2 × ⅜	0.75	0.1082	2	8	625	884	1083

Table 18.5.11.8(d) Maximum Horizontal Loads for Sway Braces with *l*/*r* = 100 for Steel Braces with F_y = 248 N/mm^2

Brace Shape and Size (mm)		Area (mm^2)	Least Radius of Gyration *(r)* mm)	Maximum Length for *l*/*r* = 100		Maximum Horizontal Load (kg)		
						Brace Angle		
				meters	mm	30° to 44° Angle from Vertical	45° to 59° Angle from Vertical	60° to 90° Angle from Vertical
Pipe Schedule 40	25	318.7	11	1.0	150	1,429	2,021	2,475
	32	431.6	14	1.2	150	1.935	2,737	3,352
	40	515.5	16	1.5	50	2,311	3,269	4,003
	50	690.3	20	1.8	150	3,095	4,377	5,361
Angles	40 × 40 × 6	443.9	7	0.6	125	1,990	2,815	3,447
	50 × 50 × 6	605.2	10	1.0	75	2,713	3,837	4,699
	65 × 50 × 6	683.9	11	1.0	150	3,066	4,336	5,311
	65 × 65 × 6	767.7	12	1.2	25	3,442	4,868	5,962

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Brace Shape and Size (mm)		Area (mm^2)	Least Radius of Gyration *(r)* mm)	Maximum Length for *l/r* = 100		Maximum Horizontal Load (kg)		
						Brace Angle		
				meters	mm	30° to 44° Angle from Vertical	45° to 59° Angle from Vertical	60° to 90° Angle from Vertical
	80 × 65 × 6	845.2	13	1.2	100	3,789	5,359	6,563
	80 × 80 × 6	929.0	15	1.2	275	4,165	5,891	7,214
Rods (all thread)	10	45.2	2	0.0	175	202	286	351
	15	83.2	3	0.0	250	373	528	646
	16	133.5	3	0.3	0	599	847	1,037
	20	199.4	4	0.3	75	894	1,264	1,548
	22	276.8	5	0.3	150	1,241	1,755	2,149
Rods (threaded at ends only)	10	71.0	2	0.0	225	318	450	551
	15	126.5	3	0.3	0	567	802	982
	16	198.1	4	0.3	75	888	1,256	1,538
	20	285.2	5	0.3	150	1,279	1,808	2,214
	22	387.7	5	0.3	225	1,739	2,458	3,011
Flats	40 × 6	241.9	2	0.0	175	1,085	1,534	1,879
	50 × 6	322.6	2	0.0	175	1,447	2,045	2,505
	50 × 10	483.9	3	0.0	250	2,170	3,068	3,758

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Table 18.5.11.8(e) Maximum Horizontal Loads for Sway Braces with *l/r* = 200 for Steel Braces with F_y = 248 N/mm^2

Brace Shape and Size (mm)		Area (mm^2)	Least Radius of Gyration *(r)* mm)	Maximum Length for *l/r* = 200		Maximum Horizontal Load (kg)		
						Brace Angle		
				meters	mm	30° to 44° Angle from Vertical	45° to 59° Angle from Vertical	60° to 90° Angle from Vertical
Pipe Schedule 40	25	318.7	11	2.1	0	420	594	728
	32	431.6	14	2.7	0	569	805	986
	40	515.5	16	3	100	679	961	1177
	50	690.3	20	4.0	25	910	1287	1576
Angles	40 × 40 × 6	443.9	7	1.2	250	585	827	1013
	50 × 50 × 6	605.2	10	1.8	150	798	1128	1382
	65 × 50 × 6	683.9	11	2.1	0	902	1275	1561
	65 × 65 × 6	767.7	12	2.4	50	1012	1431	1753
	80 × 65 × 6	845.2	13	2.4	225	1114	1576	1930
	80 × 80 × 6	929.0	15	2.7	250	1225	1732	2121
Rods (all thread)	10	45.2	2	0.3	50	59	84	103
	15	83.2	3	0.3	200	110	155	190
	16	133.5	3	0.6	25	176	249	305
	20	199.4	4	0.6	175	263	371	455
	22	276.8	5	0.9	0	365	516	632
Rods (threaded at ends only)	10	71.0	2	0.3	150	93	132	162
	15	126.5	3	0.6	0	167	236	289
	16	198.1	4	0.6	175	261	369	452
	20	285.2	5	0.9	25	376	532	651
	22	387.7	5	0.9	175	511	723	885
Flats	40 × 6	241.9	2	0.3	50	319	451	552

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Brace Shape and Size (mm)		Area (mm^2)	Least Radius of Gyration *(r)* mm)	Maximum Length for *l/r* = 200		Maximum Horizontal Load (kg)		
						Brace Angle		
				meters	mm	30° to 44° Angle from Vertical	45° to 59° Angle from Vertical	60° to 90° Angle from Vertical
	50 × 6	322.6	2	0.3	50	425	601	737
	50 × 10	483.9	3	0.3	225	638	902	1105

Table 18.5.11.8(f) Maximum Horizontal Loads for Sway Braces with *l/r* = 300 for Steel Braces with F_y = 248 N/mm^2

Brace Shape and Size (mm)		Area (mm^2)	Least Radius of Gyration *(r)* mm)	Maximum Length for *l/r* = 300		Maximum Horizontal Load (kg)		
						Brace Angle		
				meters	mm	30° to 44° Angle from Vertical	45° to 59° Angle from Vertical	60° to 90° Angle from Vertical
Pipe Schedule 40	25	318.7	10.5	3	150	187	264	323
	32	431.6	13.5	4	150	253	357	438
	40	515.5	15.6	4.6	150	302	427	523
	50	690.3	19.7	5.8	200	405	572	700
Angles	40 × 40 × 6	443.9	7.3	2.1	75	260	368	450
	50 × 50 × 6	605.2	9.8	2.7	225	355	501	614
	65 × 50 × 6	683.9	10.6	3	175	401	567	694
	65 × 65 × 6	767.7	12.3	3.7	75	450	636	779
	80 × 65 × 6	845.2	13.2	4	50	495	700	858
	80 × 80 × 6	929.0	14.8	4.3	225	544	770	943

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Brace Shape and Size (mm)		Area (mm^2)	Least Radius of Gyration *(r)* mm)	Maximum Length for *l/r* = 300		Maximum Horizontal Load (kg)		
						Brace Angle		
				meters	mm	30° to 44° Angle from Vertical	45° to 59° Angle from Vertical	60° to 90° Angle from Vertical
Rods (all thread)	10	45.2	1.9	0.3	250	26	37	46
	15	83.2	2.5	0.6	150	49	69	84
	16	133.5	3.2	0.9	50	79	111	136
	20	199.4	3.9	0.9	275	117	165	202
	22	276.8	4.6	1.2	175	162	230	281
Rods (threaded at ends only)	10	71.0	2.4	0.6	100	42	59	72
	15	126.5	3.1	0.9	25	74	105	128
	16	198.1	3.9	0.9	250	116	164	201
	20	285.2	4.7	1.2	200	167	236	289
	22	387.7	5.5	1.5	125	227	321	393
Flats	40 × 6	241.9	1.8	0.3	225	142	200	245
	50 × 6	322.6	1.8	0.3	225	189	267	327
	50 × 10	483.9	2.7	0.6	200	283	401	491

18.5.11.9*
Other pipe schedules and materials not specifically included in Table 18.5.11.8(a), Table 18.5.11.8(b), and Table 18.5.11.8(c) shall be permitted to be used if certified by a registered professional engineer to support the loads determined in accordance with the criteria in the tables.

18.5.11.9.1
Calculations shall be submitted where required by the authority having jurisdiction.

18.5.11.10
C-type clamps including beam and large flange clamps, with or without restraining straps, shall not be used to attach braces to the building structure.

18.5.11.11
Powder-driven fasteners shall not be used to attach braces to the building structure, unless they are specifically listed for service in resisting lateral loads in areas subject to earthquakes.

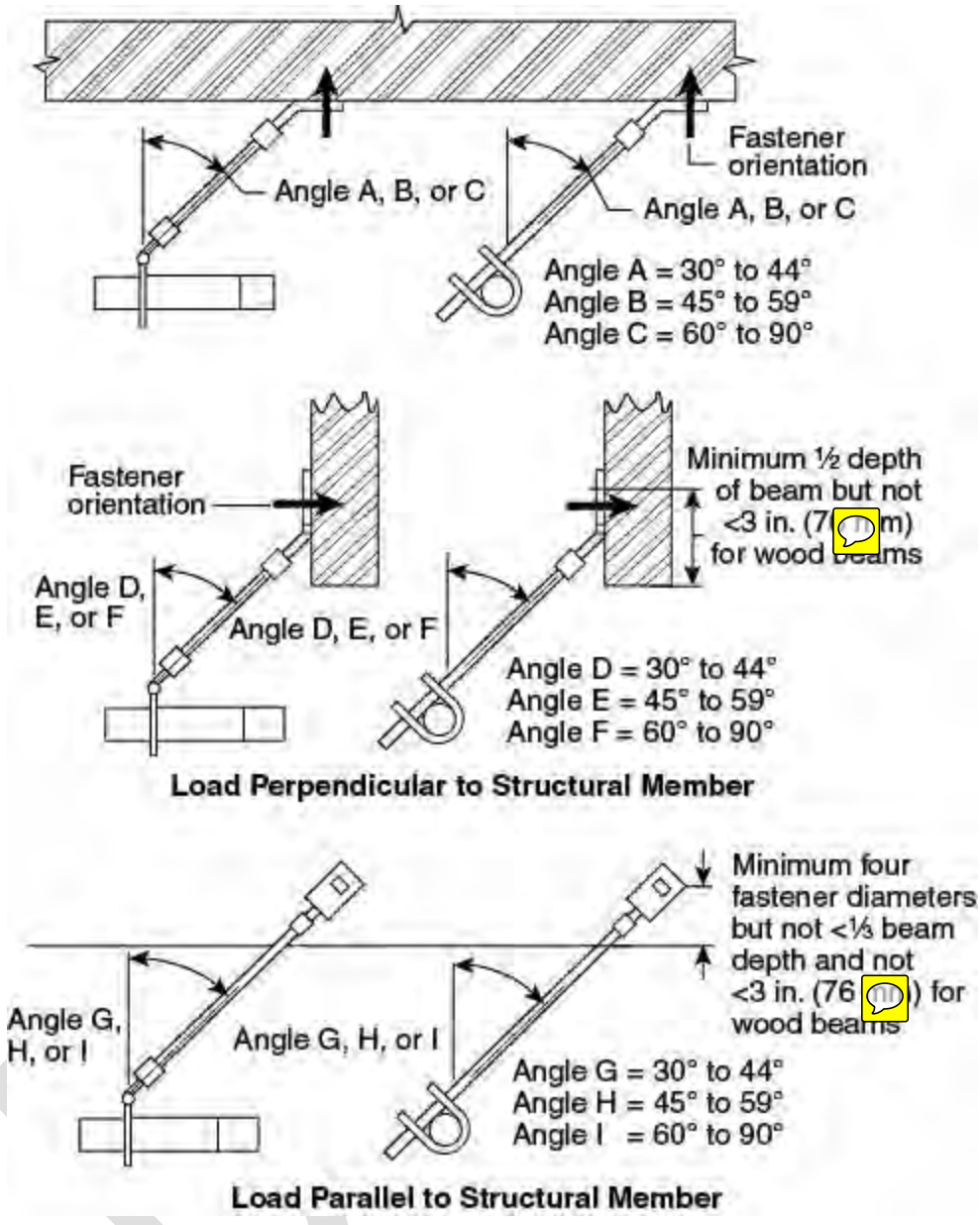
18.5.12* Fasteners.

18.5.12.1
The designated angle category for the fastener(s) used in the sway brace installation shall be determined in accordance with Figure 18.5.12.1.

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Figure 18.5.12.1 Designation of Angle Category Based on Angle of Sway Brace and Fastener Orientation.

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18.5.12.2*

For individual fasteners, unless alternative allowable loads are determined and certified by a registered professional engineer, the loads determined in **18.5.9** shall not exceed the allowable loads provided in Table 18.5.12.2(a) through Table 18.5.12.2(i) or 18.5.12.7.

Table 18.5.12.2(a) Maximum Load for Wedge Anchors in 3000 psi (207 bar) Lightweight Cracked Concrete on Metal Deck

Wedge Anchors in 3000 psi Lightweight Cracked Concrete on Metal Deck (lb)										
		A	B	C	D	E	F	G	H	I
Diameter (in.)	Embedment (in.)	*Pr** ≤2.0	*Pr* ≤1.1	*Pr* ≤0.7	*Pr* ≤1.2	*Pr* ≤1.1	*Pr* ≤1.1	*Pr* ≤1.4	*Pr* ≤0.9	*Pr* ≤0.8
⅜	2	117	184	246	—	—	—	—	—	—

Wedge Anchors in 3000 psi Lightweight Cracked Concrete on Metal Deck (lb)										
½	2⅜	164	257	344	—	—	—	—	—	—
⅝	3⅛	214	326	424	—	—	—	—	—	—
Diameter (in.)	**Embedment (in.)**	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**
		Pr	***Pr***	***Pr***	***Pr***	***Pr***	***Pr***	***Pr***	***Pr***	***Pr***
		2.1–3.5	**1.2–1.8**	**0.8–1.0**	**1.3–1.7**	**1.2–1.8**	**1.2–2.0**	**1.5–1.9**	**1.0–1.3**	**0.9–1.1**
⅜	2	69	127	196	—	—	—	—	—	—
½	2⅜	97	178	274	—	—	—	—	—	—
⅝	3⅛	133	232	346	—	—	—	—	—	—
Diameter (in.)	**Embedment (in.)**	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**
		Pr	***Pr***	***Pr***	***Pr***	***Pr***	***Pr***	***Pr***	***Pr***	***Pr***
		3.6–5.0	**1.9–2.5**	**1.1–1.3**	**1.8–2.2**	**1.9–2.5**	**2.1–2.9**	**2.0–2.4**	**1.4–1.7**	**1.2–1.4**
⅜	2	48	97	163	—	—	—	—	—	—
½	2⅜	67	136	228	—	—	—	—	—	—
⅝	3⅛	93	179	292	—	—	—	—	—	—
Diameter (in.)	**Embedment (in.)**	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**
		Pr	***Pr***	***Pr***	***Pr***	***Pr***	***Pr***	***Pr***	***Pr***	***Pr***
		5.1–6.5	**2.6–3.2**	**1.4–1.6**	**2.3–2.7**	**2.6–3.2**	**3.0–3.8**	**2.5–2.9**	**1.8–2.1**	**1.5–1.7**
⅜	2	36	75	139	—	—	—	—	—	—
½	2⅜	51	106	196	—	—	—	—	—	—
⅝	3⅛	71	146	252	—	—	—	—	—	—

**Pr* = Prying Factor Range. (Refer to Annex for additional information.)

1 lb = 0.45 kg

Table 18.5.12.2(b) Maximum Load for Wedge Anchors in 3000 psi (207 bar) Lightweight Cracked Concrete

Wedge Anchors in 3000 psi Lightweight Cracked Concrete (lb)										
Diameter (in.)	**Embedment (in.)**	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**
		Pr*	***Pr***	***Pr***	***Pr***	***Pr***	***Pr***	***Pr***	***Pr***	***Pr***
		≤2.0	**≤1.1**	**≤0.7**	**≤1.2**	**≤1.1**	**≤1.1**	**≤1.4**	**≤0.9**	**≤0.8**
⅜	2	102	144	175	101	144	184	87	128	152
½	2⅜	140	196	238	137	196	251	118	174	207
⅝	3¼	222	308	372	215	308	397	220	272	323
¾	4⅛	327	469	580	336	469	586	289	426	504
Diameter (in.)	**Embedment (in.)**	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**
		Pr	***Pr***	***Pr***	***Pr***	***Pr***	***Pr***	***Pr***	***Pr***	***Pr***
		2.1–3.5	**1.2–1.8**	**0.8–1.0**	**1.3–1.7**	**1.2–1.8**	**1.2–2.0**	**1.5–1.9**	**1.0–1.3**	**0.9–1.1**
⅜	2	69	109	150	87	109	121	76	110	133

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Wedge Anchors in 3000 psi Lightweight Cracked Concrete (lb)										
½	2⅜	94	149	205	119	149	166	104	150	181
⅝	3¼	151	237	322	187	237	265	201	236	285
¾	4⅛	217	351	492	286	351	380	252	362	436
Diameter (in.)	**Embedment (in.)**	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**
		Pr	***Pr***	***Pr***	***Pr***	***Pr***	***Pr***	***Pr***	***Pr***	***Pr***
		3.6–5.0	**1.9–2.5**	**1.1–1.3**	**1.8–2.2**	**1.9–2.5**	**2.1–2.9**	**2.0–2.4**	**1.4–1.7**	**1.2–1.4**
⅜	2	52	88	132	76	88	90	68	97	118
½	2⅜	71	121	180	104	121	124	93	132	161
⅝	3¼	114	192	284	165	192	198	185	208	254
¾	4⅛	162	280	427	249	280	281	223	315	385
Diameter (in.)	**Embedment (in.)**	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**
		Pr	***Pr***	***Pr***	***Pr***	***Pr***	***Pr***	***Pr***	***Pr***	***Pr***
		5.1–6.5	**2.6–3.2**	**1.4–1.6**	**2.3–2.7**	**2.6–3.2**	**3.0–3.8**	**2.5–2.9**	**1.8–2.1**	**1.5–1.7**
⅜	2	41	74	117	68	74	70	61	86	106
½	2⅜	56	101	160	93	101	97	84	118	145
⅝	3¼	91	161	253	148	161	157	172	186	230
¾	4⅛	124	233	378	221	233	214	200	279	344

**Pr* = Prying Factor Range. (Refer to Annex for additional information.)

1 lb = 0.45 kg

Table 18.5.12.2(c) Maximum Load for Wedge Anchors in 3000 psi (207 bar) Normal Weight Cracked Concrete

Wedge Anchors in 3000 psi Normal Weight Cracked Concrete (lb)										
Diameter (in.)	**Embedment (in.)**	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**
		Pr*	***Pr***	***Pr***	***Pr***	***Pr***	***Pr***	***Pr***	***Pr***	***Pr***
		≤2.0	**≤1.1**	**≤0.7**	**≤1.2**	**≤1.1**	**≤1.1**	**≤1.4**	**≤0.9**	**≤0.8**
⅜	2	171	240	292	169	240	307	145	214	254
½	3⅝	412	567	682	394	567	735	340	498	592
⅝	3⅞	480	668	809	468	668	859	479	591	703
¾	4⅛	545	780	965	559	780	976	482	709	839
Diameter (in.)	**Embedment (in.)**	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**
		Pr	***Pr***	***Pr***	***Pr***	***Pr***	***Pr***	***Pr***	***Pr***	***Pr***
		2.1–3.5	**1.2–1.8**	**0.8–1.0**	**1.3–1.7**	**1.2–1.8**	**1.2–2.0**	**1.5–1.9**	**1.0–1.3**	**0.9–1.1**
⅜	2	116	183	252	146	183	203	128	184	223
½	3⅝	282	438	592	344	438	493	302	434	523
⅝	3⅞	327	512	699	406	512	571	438	512	618
¾	4⅛	363	584	819	477	584	634	420	604	727

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Wedge Anchors in 3000 psi Normal Weight Cracked Concrete (lb)										
Diameter (in.)	Embedment (in.)	A	B	C	D	E	F	G	H	I
		Pr	*Pr*	*Pr*	*Pr*	*Pr*	*Pr*	*Pr*	*Pr*	*Pr*
		3.6–5.0	1.9–2.5	1.1–1.3	1.8–2.2	1.9–2.5	2.1–2.9	2.0–2.4	1.4–1.7	1.2–1.4
⅜	2	87	148	221	128	148	152	114	162	198
½	3⅝	214	357	523	305	357	371	271	384	469
⅝	3⅞	247	415	615	359	415	428	404	452	551
¾	4⅛	271	467	712	416	467	468	371	526	641
Diameter (in.)	Embedment (in.)	A	B	C	D	E	F	G	H	I
		Pr	*Pr*	*Pr*	*Pr*	*Pr*	*Pr*	*Pr*	*Pr*	*Pr*
		5.1–6.5	2.6–3.2	1.4–1.6	2.3–2.7	2.6–3.2	3.0–3.8	2.5–2.9	1.8–2.1	1.5–1.7
⅜	2	69	124	197	115	124	118	103	145	178
½	3⅝	173	301	469	274	301	296	247	345	425
⅝	3⅞	197	349	549	321	349	337	374	404	498
¾	4⅛	208	389	629	369	389	357	333	465	573

**Pr* = Prying Factor Range. (Refer to Annex for additional information.)

1 lb = 0.45 kg

Table 18.5.12.2(d) Maximum Load for Wedge Anchors in 4000 psi (276 bar) Normal Weight Cracked Concrete

Wedge Anchors in 4000 psi Normal Weight Cracked Concrete (lb)										
Diameter (in.)	Embedment (in.)	A	B	C	D	E	F	G	H	I
		*Pr**	*Pr*	*Pr*	*Pr*	*Pr*	*Pr*	*Pr*	*Pr*	*Pr*
		≤2.0	≤1.1	≤0.7	≤1.2	≤1.1	≤1.1	≤1.4	≤0.9	≤0.8
⅜	2	200	282	344	199	282	359	171	251	299
½	3⅝	430	607	742	430	607	770	370	544	645
⅝	3⅞	532	729	872	505	729	950	511	636	758
¾	4⅛	630	903	1117	647	903	1129	558	821	971
Diameter (in.)	Embedment (in.)	A	B	C	D	E	F	G	H	I
		Pr	*Pr*	*Pr*	*Pr*	*Pr*	*Pr*	*Pr*	*Pr*	*Pr*
		2.1–3.5	1.2–1.8	0.8–1.0	1.3–1.7	1.2–1.8	1.2–2.0	1.5–1.9	1.0–1.3	0.9–1.1
⅜	2	135	214	295	171	214	236	150	216	261
½	3⅝	289	460	636	370	460	506	325	467	563
⅝	3⅞	367	566	760	442	566	642	470	557	672
¾	4⅛	419	676	948	552	676	733	486	699	841
Diameter (in.)	Embedment (in.)	A	B	C	D	E	F	G	H	I
		Pr	*Pr*	*Pr*	*Pr*	*Pr*	*Pr*	*Pr*	*Pr*	*Pr*
		3.6–5.0	1.9–2.5	1.1–1.3	1.8–2.2	1.9–2.5	2.1–2.9	2.0–2.4	1.4–1.7	1.2–1.4

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Wedge Anchors in 4000 psi Normal Weight Cracked Concrete (lb)										
⅜	2	101	172	258	150	172	176	134	190	232
½	3⅝	218	370	556	325	370	377	290	410	500
⅝	3⅞	280	463	674	393	463	484	435	494	603
¾	4⅛	313	540	824	481	540	541	430	608	741
Diameter (in.)	**Embedment (in.)**	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**
		Pr	***Pr***	***Pr***	***Pr***	***Pr***	***Pr***	***Pr***	***Pr***	***Pr***
		5.1–6.5	**2.6–3.2**	**1.4–1.6**	**2.3–2.7**	**2.6–3.2**	**3.0–3.8**	**2.5–2.9**	**1.8–2.1**	**1.5–1.7**
⅜	2	79	144	230	134	144	137	121	169	209
½	3⅝	170	310	494	289	310	292	261	365	449
⅝	3⅞	226	391	605	354	391	389	406	445	547
¾	4⅛	241	449	728	427	449	413	386	538	663

**Pr* = Prying Factor Range. (Refer to Annex for additional information.)

1 lb = 0.45 kg

Table 18.5.12.2(e) Maximum Load for Wedge Anchors in 6000 psi (414 bar) Normal Weight Cracked Concrete

Wedge Anchors in 6000 psi Normal Weight Cracked Concrete (lb)										
Diameter (in.)	**Embedment (in.)**	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**
		Pr*	***Pr***	***Pr***	***Pr***	***Pr***	***Pr***	***Pr***	***Pr***	***Pr***
		≤2.0	**≤1.1**	**≤0.7**	**≤1.2**	**≤1.1**	**≤1.1**	**≤1.4**	**≤0.9**	**≤0.8**
⅜	2¼	254	354	428	199	354	585	213	313	372
½	3⅝	527	744	910	418	744	1227	454	667	791
⅝	3⅞	652	893	1069	504	893	1481	626	780	928
¾	4⅛	772	1106	1369	622	1106	1819	684	1005	1190
Diameter (in.)	**Embedment (in.)**	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**
		Pr	***Pr***	***Pr***	***Pr***	***Pr***	***Pr***	***Pr***	***Pr***	***Pr***
		2.1–3.5	**1.2–1.8**	**0.8–1.0**	**1.3–1.7**	**1.2–1.8**	**1.2–2.0**	**1.5–1.9**	**1.0–1.3**	**0.9–1.1**
⅜	2¼	172	271	370	215	271	302	188	271	327
½	3⅝	355	564	780	453	564	621	399	573	690
⅝	3⅞	450	694	932	542	694	786	576	682	823
¾	4⅛	514	828	1162	676	828	898	595	856	1030
Diameter (in.)	**Embedment (in.)**	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**
		Pr	***Pr***	***Pr***	***Pr***	***Pr***	***Pr***	***Pr***	***Pr***	***Pr***
		3.6–5.0	**1.9–2.5**	**1.1–1.3**	**1.8–2.2**	**1.9–2.5**	**2.1–2.9**	**2.0–2.4**	**1.4–1.7**	**1.2–1.4**
⅜	2¼	130	219	325	189	219	226	169	239	292
½	3⅝	267	454	682	398	454	462	355	502	613
⅝	3⅞	343	567	826	481	567	593	534	606	739

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Wedge Anchors in 6000 psi Normal Weight Cracked Concrete (lb)										
¾	4⅛	384	662	1009	590	662	663	527	745	909
Diameter (in.)	**Embedment (in.)**	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**
		Pr	***Pr***	***Pr***	***Pr***	***Pr***	***Pr***	***Pr***	***Pr***	***Pr***
		5.1–6.5	**2.6–3.2**	**1.4–1.6**	**2.3–2.7**	**2.6–3.2**	**3.0–3.8**	**2.5–2.9**	**1.8–2.1**	**1.5–1.7**
⅜	2¼	103	184	290	170	184	178	153	214	263
½	3⅝	209	380	606	355	380	358	320	447	551
⅝	3⅞	277	480	741	433	480	476	497	545	671
¾	4⅛	295	551	892	523	551	506	473	660	813

**Pr* = Prying Factor Range. (Refer to Annex for additional information.)

1 lb = 0.45 kg

Table 18.5.12.2(f) Maximum Load for Undercut Anchors in 3000 psi (207 bar) Normal Weight Cracked Concrete

Undercut Anchors in 3000 psi Normal Weight Cracked Concrete (lb)										
Diameter (in.)	**Embedment (in.)**	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**
		Pr*	***Pr***	***Pr***	***Pr***	***Pr***	***Pr***	***Pr***	***Pr***	***Pr***
		≤2.0	**≤1.1**	**≤0.7**	**≤1.2**	**≤1.1**	**≤1.1**	**≤1.4**	**≤0.9**	**≤0.8**
⅜	4⅜	501	638	726	420	638	889	362	525	630
½	7	700	911	1051	608	911	1245	525	761	912
⅝	9½	1106	1535	1855	1074	1535	1975	1098	1356	1612
¾	12	1701	2404	2946	1707	2404	3041	1472	2161	2561
Diameter (in.)	**Embedment (in.)**	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**
		Pr	***Pr***	***Pr***	***Pr***	***Pr***	***Pr***	***Pr***	***Pr***	***Pr***
		2.1–3.5	**1.2–1.8**	**0.8–1.0**	**1.3–1.7**	**1.2–1.8**	**1.2–2.0**	**1.5–1.9**	**1.0–1.3**	**0.9–1.1**
⅜	4⅜	368	526	658	381	526	643	333	477	578
½	7	505	738	942	547	738	882	479	685	829
⅝	9½	754	1179	1604	933	1179	1318	1005	1177	1419
¾	12	1143	1819	2520	1468	1819	1996	1291	1854	2233
Diameter (in.)	**Embedment (in.)**	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**
		Pr	***Pr***	***Pr***	***Pr***	***Pr***	***Pr***	***Pr***	***Pr***	***Pr***
		3.6–5.0	**1.9–2.5**	**1.1–1.3**	**1.8–2.2**	**1.9–2.5**	**2.1–2.9**	**2.0–2.4**	**1.4–1.7**	**1.2–1.4**
⅜	4⅜	291	447	601	350	447	504	309	437	534
½	7	395	620	854	497	620	683	440	622	760
⅝	9½	572	957	1413	825	957	989	927	1039	1268
¾	12	860	1463	2202	1287	1463	1486	1149	1624	1980
Diameter (in.)	**Embedment (in.)**	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**
		Pr	***Pr***	***Pr***	***Pr***	***Pr***	***Pr***	***Pr***	***Pr***	***Pr***

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Undercut Anchors in 3000 psi Normal Weight Cracked Concrete (lb)										
		5.1–6.5	**2.6–3.2**	**1.4–1.6**	**2.3–2.7**	**2.6–3.2**	**3.0–3.8**	**2.5–2.9**	**1.8–2.1**	**1.5–1.7**
⅜	4⅜	241	389	554	323	389	414	287	403	496
½	7	324	535	780	455	535	557	407	570	701
⅝	9½	456	806	1263	739	806	781	859	931	1145
¾	12	670	1223	1955	1146	1223	1147	1035	1444	1778

**Pr* = Prying Factor Range. (Refer to Annex for additional information.)

1 lb = 0.45 kg

Table 18.5.12.2(g) Maximum Load for Connections to Steel Using Unfinished Steel Bolts

Connections to Steel (Values Assume Bolt Perpendicular to Mounting Surface																		
Diameter of Unfinished Steel Bolt (in.)																		
¼									⅜									
A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**
400	500	600	300	500	650	325	458	565	900	1200	1400	800	1200	1550	735	1035	1278
Diameter of Unfinished Steel Bolt (in.)																		
½									⅝									
A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**
1600	2050	2550	1450	2050	2850	1300	1830	2260	2500	3300	3950	2250	3300	4400	2045	2880	3557

Table 18.5.12.2(h) Maximum Load for Through-Bolts in Sawn Lumber or Glue-Laminated Timbers

Through-Bolts in Sawn Lumber or Glue-Laminated Timbers (Load Perpendicular to Grain)																												
		Bolt Diameter (in.)																										
		½									⅝										¾							
		A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**
Length of Bolt in Timber (in.)	1½	115	165	200	135	230	395	130	215	310	135	190	235	155	270	460	155	255	380	155	220	270	180	310	530	170	300	450
	2½	140	200	240	160	280	480	165	275	410	160	225	280	185	320	550	190	320	495	180	255	310	205	360	615	215	365	575
	3½	175	250	305	200	350	600	200	330	485	200	285	345	230	400	685	235	405	635	220	310	380	255	440	755	260	455	730
	5½	—	—	—	—	—	—	—	—	—	280	395	485	325	560	960	315	515	735	310	440	535	360	620	1065	360	610	925

Note: Wood fastener maximum capacity values are based on the 2001 National Design Specifications (NDS) for wood with a specific gravity of 0.35. Values for other types of wood can be obtained by multiplying the above values by the factors in Table 9.3.5.12.2(j).

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Table 18.5.12.2(i) Maximum Load for Lag Screws and Lag Bolts in Wood

Lag Screws and Lag Bolts in Wood (Load Perpendicular to Grain — Holes Predrilled Using Good Practice)																											
		Lag Bolt Diameter (in.)																									
		½									⅝									¾							
		A	B	C	D	E	F	G	H	I	A	B	C	D	E	F	G	H	I	A	B	C	D	E	F	G	H	I
Length of Bolt in Timber (in.)	3½	165	190	200	170	220	310	80	120	170	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	4½	180	200	200	175	235	350	80	120	170	300	355	380	315	400	550	145	230	325	—	—	—	—	—	—	—	—
	5½	190	200	200	175	245	380	80	120	170	320	370	380	320	420	610	145	230	325	435	525	555	425	550	775	195	320	460
	6½	195	205	200	175	250	400	80	120	170	340	375	380	325	435	650	145	230	325	465	540	555	430	570	840	195	320	460

Note: Wood fastener maximum capacity values are based on the 2001 National Design Specifications (NDS) for wood with a specific gravity of 0.35. Values for other types of wood can be obtained by multiplying the above values by the factors in Table 9.3.5.12.2(j).

Table 18.5.12.2(j) Factors for Wood Based on Specific Gravity

Specific Gravity of Wood	Multiplier
0.36 thru 0.49	1.17
0.50 thru 0.65	1.25
0.66 thru 0.73	1.50

18.5.12.3*
The type of fasteners used to secure the bracing assembly to the structure shall be limited to those shown in Table 18.5.12.2(a) through Table 18.5.12.2(i) or to listed devices.

18.5.12.4*
For connections to wood, through-bolts with washers on each end shall be used, unless the requirements of 18.5.12.5 are met.

18.5.12.5
Where it is not practical to install through-bolts due to the thickness of the wood member in excess of 12 in. (300 mm) or inaccessibility, lag screws shall be permitted and holes shall be pre-drilled ⅛ in. (3 mm) smaller than the maximum root diameter of the lag screw.

18.5.12.6
Holes for through-bolts and similar listed attachments shall be 1/16 in. (1.6 mm) greater than the diameter of the bolt.

18.5.12.6.1
The requirements of 18.5.12 shall not apply to other fastening methods, which shall be acceptable for use if certified by a registered professional engineer to support the loads determined in accordance with the criteria in 18.5.9.

18.5.12.6.2

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Calculations shall be submitted where required by the authority having jurisdiction.

18.5.12.7 Concrete Anchors.

18.5.12.7.1*
Concrete anchors shall be prequalified for seismic applications in accordance with ACI 355.2, *Qualification of Post-Installed Mechanical Anchors in Concrete and Commentary*, and installed in accordance with the manufacturer's instructions.

18.5.12.7.2
Unless the requirements of 18.5.12.7.3 are met, concrete anchors shall be based on concrete strength, anchor type, designated angle category A through I, prying factor (*Pr*) range, and allowable maximum load.

(A)
Sway brace manufacturers shall provide prying factors (*Pr*) based on geometry of the structure attachment fitting and the designated angle category A through I as shown in Figure 18.5.12.1.

(B)
Where the prying factor for the fitting is unknown, the largest prying factor range in Table 18.5.12.2(a) through Table 18.5.12.2(f) for the concrete strength and designated angle category A through I shall be used.

18.5.12.7.3
The allowable maximum load shall be permitted to be calculated.

(A)
Allowable concrete anchor loads shall be permitted to be determined using approved software that considers the effects of prying for concrete anchors.

(B)
Anchors shall be seismically prequalified per 18.5.12.7.1.

(C)
Allowable maximum loads shall be based on the anchor capacities given in approved evaluation service reports, where the calculation of ASD allowable shear and tension values are determined in accordance with Chapter 17 of ACI 318, *Building Code Requirements for Structural Concrete and Commentary,* and include the effects of prying, brace angle, and the over strength factor (Ω=2.0).

(D)*
The shear and tension values determined in 18.5.12.7.3(C) using Chapter 17 of ACI 318, *Building Code Requirements for Structural Concrete and Commentary,* shall be multiplied by 0.43.

18.5.12.7.4
Concrete anchors shall be acceptable for use where designed in accordance with the requirements of the building code and certified by a registered professional engineer.

18.5.13 Braces to Buildings with Differential Movement.
A length of pipe shall not be braced to sections of the building that will move differentially.

18.6 Restraint of Branch Lines.

18.6.1*
Restraint is considered a lesser degree of resisting loads than bracing and shall be provided by use of one of the following:
(1) Listed sway brace assembly

(2) Wraparound U-hook satisfying the requirements of 18.5.5.11

(3) No. 12, 440 lb (200 kg) wire installed at least 45 degrees from the vertical plane and anchored on both sides of the pipe

(4) CPVC hangers listed to provide restraint

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(5) *Hanger not less than 45 degrees from vertical installed within 6 in. (150 mm) of the vertical hanger arranged for restraint against upward movement, provided it is utilized such that *l*/*r* does not exceed 400, where the rod extends to the pipe or a surge clip has been installed

(6) Other approved means

18.6.2 Wire Restraint.

18.6.2.1
Wire used for restraint shall be located within 2 ft (600 mm) of a hanger.

18.6.2.2
The hanger closest to a wire restraint shall be of a type that resists upward movement of a branch line.

18.6.3
The end sprinkler on a branch line shall be restrained.

18.6.3.1
The location of the restraint from end of the line shall not be greater than 36 in. (900 mm) for 1 in. (25 mm) pipe, 48 in. (1219 mm) for 1 ¼ in. (32 mm) pipe, and 60 in. (1.5 m) for 1 ½ in. (40 mm) or larger pipe.

18.6.4*
Branch lines shall be laterally restrained at intervals not exceeding those specified in Table 18.6.4(a) or Table 18.6.4(b) based on branch line diameter and the value of C_p.

Table 18.6.4(a) Maximum Spacing (ft)(m) of Steel Pipe Restraints

Pipe	Seismic Coefficient, C_p			
(in.) (mm)	$C_p \leq 0.50$	$0.5 < C_p \leq 0.71$	$0.71 < C_P \leq 1.40$	$C_P > 1.40$
½ (15)	34 (10.3)	29 (8.8)	20 (6.1)	18 (5.5)
¾ (20)	38 (11.6)	32 (9.7)	23 (7.0)	20 (6.1)
1 (25)	43 (13.1)	36 (11.0)	26 (7.9)	22 (6.7)
1¼ (32)	46 (14.0)	39 (11.9)	27 (8.2)	24 (7.3)
1½ (40)	49 (14.9)	41 (12.5)	29 (8.8)	25 (7.6)
2 (50)	53 (16.1)	45 (13.7)	31 (9.4)	27 (8,2)

Table 18.6.4(b) Maximum Spacing (ft) of CPVC, Copper, and Red Brass Pipe Restraints

Pipe	Seismic Coefficient C_p			
(in.) (mm)	$C_p \leq 0.50$	$0.5 < C_p \leq 0.71$	$0.71 < C_P \leq 1.40$	$C_P > 1.40$
½ (15)	26 (7.9)	22 (6.7)	16 (4.9)	13 (4.0)
¾ (20)	31 (9.4)	26 (7.9)	18 (5.5)	15 (4.6)
1 (25)	34 (10.3)	28 (8.5)	20 (6.1)	17 (5.2)
1¼ (32)	37 (11.3)	31 (9.4)	22 (6.7)	19 (5.8)
1½ (40)	40 (12.2)	34 (10.3)	24 (7.3)	20 (6.1)
2 (50)	45 (13.7)	38 (11.6)	27 (8.2)	23 (7.0)

18.6.5
Where the branch lines are supported by rods less than 6 in. (150 mm) long measured between the top of the pipe and the point of attachment to the building structure, the requirements of 18.6.1 through 18.6.4 shall not apply and additional restraint shall not be required for the branch lines.

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18.6.6*
Sprigs 4 ft (1.2 m) or longer shall be restrained against lateral movement.

18.6.7
Drops and armovers shall not require restraint.

18.7 Hangers and Fasteners Subject to Earthquakes.

18.7.1
Where seismic protection is provided, C-type clamps (including beam and large flange clamps) used to attach hangers to the building structure shall be equipped with a restraining strap unless the provisions of 18.7.1.1 are satisfied.

18.7.1.1
As an alternative to the installation of a required restraining strap, a device investigated and specifically listed to restrain the clamp to the structure is permitted where the intent of the device is to resist the worst-case expected horizontal load.

18.7.2
The restraining strap shall be listed for use with a C-type clamp or shall be a steel strap of not less than 16 gauge (1.57 mm) thickness and not less than 1 in. (25 mm) wide for pipe diameters 8 in. (200 mm) or less and 14 gauge (1.98 mm) thickness and not less than 1¼ in. (32 mm) wide for pipe diameters greater than 8 in. (200 mm).

18.7.3
The restraining strap shall wrap around the beam flange not less than 1 in. (25 mm).

18.7.4
A lock nut on a C-type clamp shall not be used as a method of restraint.

18.7.5
A lip on a “C” or “Z” purlin shall not be used as a method of restraint.

18.7.6
Where purlins or beams do not provide a secure lip to a restraining strap, the strap shall be through-bolted or secured by a self-tapping screw.

18.7.7
In areas where the horizontal force factor exceeds 0.50 W_p, powder-driven studs shall be permitted to attach hangers to the building structure where they are specifically listed for use in areas subject to earthquakes.

18.7.8*
Where seismic protection is provided, concrete anchors used to secure hangers to the building structure shall be in accordance with ACI 355.2, *Qualification of Post-Installed Mechanical Anchors in Concrete and Commentary*, and installed in accordance with manufacturer's instructions.

18.7.9
Where seismic protection is provided, cast-in-place anchors used to secure hangers to the building structure shall be in accordance with ICC-ES AC446, *Acceptance Criteria for Headed Cast-in Specialty Inserts in Concrete,* and installed in accordance with manufacturer’s instructions.

18.8* Pipe Stands Subject to Earthquakes.

18.8.1
In areas where the horizontal force factor exceeds 0.5 W_p, pipe stands over 4 ft (1.2 m) in height shall be certified by a registered professional engineer to be adequate for the seismic forces.

18.8.2
Where seismic protection is provided, concrete anchors used to secure pipe stands to their bases shall be in accordance with ACI 355.2, *Qualification of Post-Installed Mechanical Anchors in Concrete and Commentary*, and shall be installed in accordance with manufacturer’s instructions.

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D.2.24.2 Installation Requirements.

D.2.24.2.1 Protection of Vertical Openings.
Any vertical opening shall be protected in accordance with NFPA *101*, Section 8.6, except under the following conditions:
(1) In Class A or Class B mercantile occupancies protected throughout by an approved, supervised automatic sprinkler system in accordance with NFPA *101*, 9.7.1.1(1), unprotected vertical openings shall be permitted at one of the following locations:
(a) Between any two floors

(b) Among the street floor, the first adjacent floor below, and adjacent floor (or mezzanine) above

(2) In Class C mercantile occupancies, unprotected openings shall be permitted between the street floor and the mezzanine.

(3) The draft stop and closely spaced sprinkler requirements of NFPA 13 shall not be required for unenclosed vertical openings permitted in NFPA *101*, 37.3.1(1) and (2). [*101*:37.3.1]

D.2.24.2.2
Rooms housing building service equipment, janitor closets, and service elevators shall be permitted to open directly onto exit passageways, provided that the following criteria are met:
(1) The required fire resistance rating between such rooms or areas and the exit passageway shall be maintained in accordance with NFPA *101*, 7.1.3.2.

(2) Such rooms or areas shall be protected by an approved, supervised automatic sprinkler system in accordance with NFPA *101*, 9.7.1.1(1), but the exceptions in NFPA 13 allowing the omission of sprinklers from such rooms shall not be permitted. [*101*:37.4.4.6.2]

D.2.25 New Business Occupancies.

D.2.25.1 Design Requirements. (Reserved)

D.2.25.2 Installation Requirements. (Reserved)

D.2.26 Existing Business Occupancies.

D.2.26.1 Design Requirements. (Reserved)

D.2.26.2 Installation Requirements. (Reserved)

D.2.27 Industrial Occupancies. (Reserved)

D.2.27.1 Design Criteria.

D.2.27.1.1 Special Provisions — High-Rise Buildings.
The provisions of NFPA *101*, 11.8.5.2.4(2), for jockey pumps and NFPA *101*, 11.8.5.2.4(3), for air compressors serving dry-pipe and pre-action systems shall not apply to special-purpose industrial occupancies. [***101*:**40.4.1]

D.2.28 Storage Occupancies. (Reserved)

Annex E Development of the Design Approach to Conform with SEI/ASCE 7

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This annex is not a part of the requirements of this NFPA document but is included for informational purposes only.

E.1
Seismic design of nonstructural components is governed by the provisions of Chapter 13 of ASCE/SEI 7, *Minimum Design Loads for Buildings and Other Structures*. In ASCE/SEI 7, fire sprinkler piping is classified as a "Designated Seismic System," due to its critical safety function. Design earthquake forces are multiplied by an Importance Factor, I_p = 1.5, and both the bracing and the piping itself must be designed for seismic forces.

The lateral sway bracing provisions of 18.5.5 were developed to allow the use of the concept of Zone of Influence (ZOI), while providing designs that comply with ASCE/SEI 7. One of the main changes between the current seismic sway bracing design approach adopted in NFPA 13 and the approach used in early editions of NFPA 13 is that the spacing of the sway braces can be constrained by the flexural capacity of the pipe, as well as the capacity of the brace assembly or the capacity of the connection between the brace assembly and the supporting structure. NFPA 13 provides a design that complies with the seismic design requirements of ASCE/SEI 7 for the pipe itself.

The ZOI approach yields the force demand on the bracing element and connections to the structure. Another way to look at a ZOI force is as a reaction in a system of continuous beams (i.e., the multiple spans of a piping system). By using conservative simplifying assumptions, a maximum ZOI force limited by the flexural capacity of the pipe can be developed for a given pipe size and span (spacing between horizontal sway braces). The method used to develop these maximum ZOI forces is described in the following paragraphs, along with a discussion of the assumptions on the geometry of the piping system, the determination of the seismic design force coefficients, and the flexural capacity of the pipe.

In the discussion that follows, the term "main" can be taken to mean a sprinkler main, either a feed main or a cross-main that requires sway bracing.

E.2 Assumptions on System Geometry.
While every fire sprinkler system is uniquely designed for a particular structure, there are general similarities in the layout and geometry that can be used to simplify the design approach for earthquake protection. These similarities were used to develop assumptions on the effects of piping system continuity on the distribution of bending and shear forces in the pipe, and assumptions on spacing of branch lines between sway brace locations.

E.2.1 Continuity in Piping Systems.
For lateral brace design purposes, piping systems can be idealized as a system of continuous beams. The bending moments in the sprinkler mains (the beams) were computed assuming three continuous spans, which generates the largest bending moment in any system of continuous beams. The loads generated by the branch lines are idealized as point loads. The tributary mass of the main is lumped along with the mass of the branch lines as point loads at the assumed branch line locations.

E.2.2 Branch Line Locations.
In many sprinkler system installations, the branch lines constitute a substantial portion of the seismic mass. While there are significant variations in the spacing of the branch lines, their geometry is constrained by the need to provide adequate water coverage, which imposes limits on the spacing of the branches. Defining a "span" of the main as the distance between lateral sway braces, the seismic provisions make the following assumptions:
(1) There is a branch located at the center of the sprinkler main for spans of 25 ft (7.6 m) or less.

(2) There are branches at third-points of the sprinkler main for spans greater than 25 ft (7.6 m) and less than 40 ft (12.2 m).

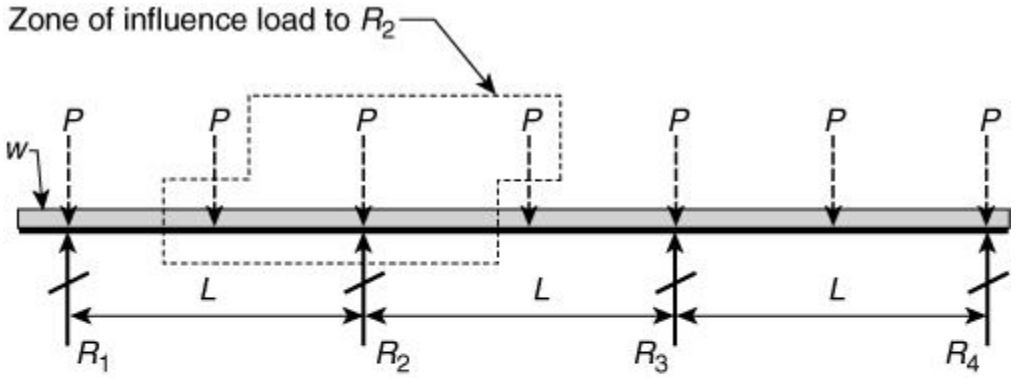
(3) There are branches at quarter-points of the sprinkler main for spans of 40 ft (12.2 m).

It was further assumed that there is a branch line located in close proximity to each sway brace.

The layout of branch lines, maximum bending moment M_{max} in the pipe, and reaction R_{max} (horizontal loads at sway brace locations) for sprinkler mains with spans less than 25 ft (7.6 m) is illustrated in Figure

E.2.2(a). Maximum demands for spans greater than 25 ft (7.6 m) and less than 40 ft (12.2 m) are given in Figure E.2.2(b), and for spans of 40 ft (12.2 m) ... Figure E.2.2(c).

Figure E.2.2(a) Maximum Demands for Spans Less Than 25 ft.

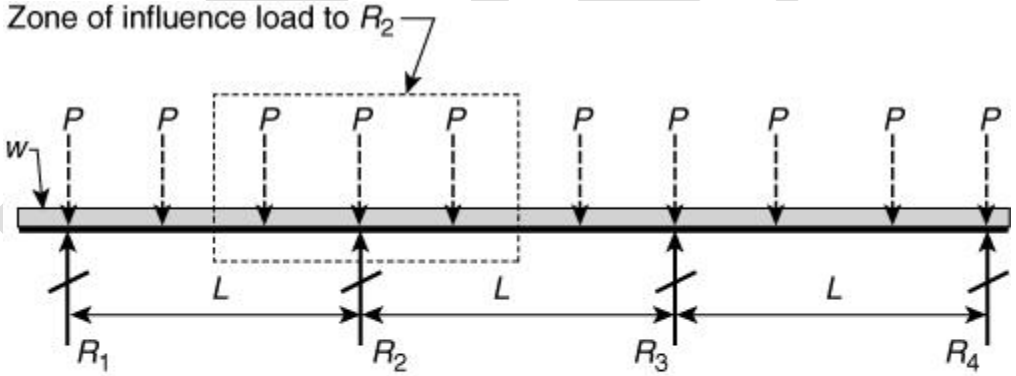


L = distance between sway braces (span)
P = branch line lateral load + tributary lateral load from main
w = lateral load of the main (included in P)
R_1, R_2, R_3, R_4 = zone of influence load (reactions)

$$M_{max} = 0.175PL$$

$$R_{max} \approx 2P$$

Figure E.2.2(b) Maximum Demands for Spans Greater Than 25 ft and Less Than 40 ft.

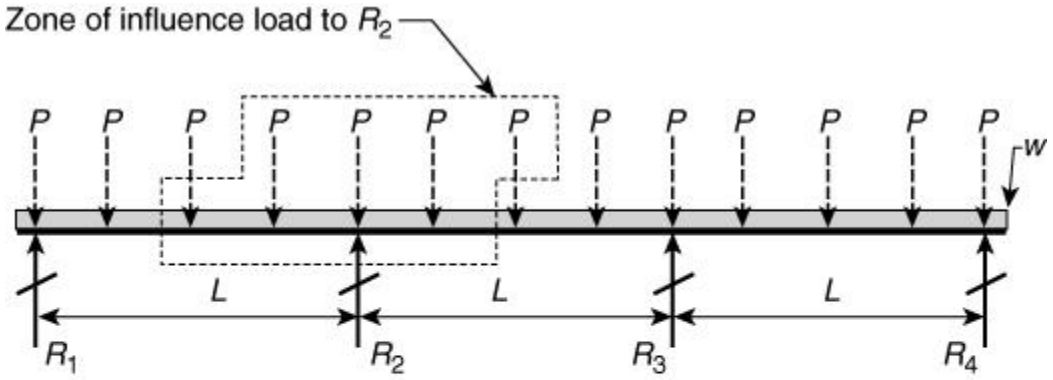


L = distance between sway braces (span)
P = branch line lateral load + tributary lateral load from main
w = lateral load of the main (included in P)
R_1, R_2, R_3, R_4 = zone of influence load (reactions)

$$M_{max} = 0.267PL$$

$$R_{max} \approx 3P$$

Figure E.2.2(c) Maximum Demands for Spans of 40 ft.



L = distance between sway braces (span)
P = branch line lateral load + tributary lateral load from main
w = lateral load of the main (included in P)
R_1, R_2, R_3, R_4 = zone of influence load (reactions)

$$M_{max} = 0.372PL$$

$$R_{max} \approx 4P$$

E.3 Computing the Seismic Demand on Piping Systems.
In ASCE/SEI 7, seismic demands on nonstructural components and systems are a function of the ground shaking intensity, the ductility and dynamic properties of the component or system, and the height of attachment of the component in the structure. Seismic forces are determined at strength design (SD) levels. The horizontal seismic design force is given by

$$F_p = \frac{0.4 a_p S_{DS} W_p}{\left(\frac{R_p}{I_p}\right)}\left(1 + 2\frac{z}{h}\right) \qquad \textbf{[E.3a]}$$

where:

F_p = seismic design force

S_{DS} = short period spectral acceleration, which takes into account soil conditions at the site

a_p = component amplification factor, taken as 2.5 for piping systems

I_p = component importance factor, taken as 1.5 for fire sprinkler systems

z = height of the component attachment to the structure

h = average roof height of the structure

W_p = component operating weight

R_p = component response modification factor as follows:

R_p = 9 for high-deformability piping with joints made by welding or brazing

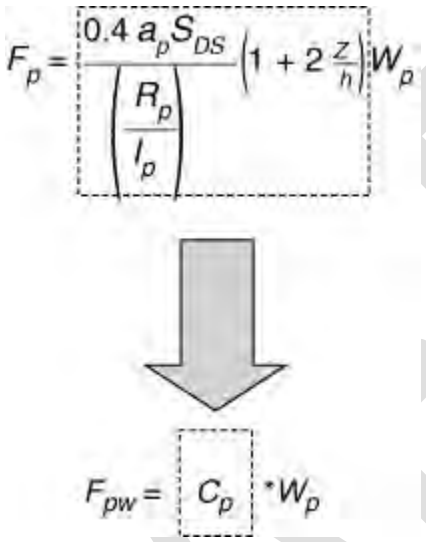
R_p = 4.5 for high- or limited-deformability piping with joints made by threading, bonding, compression couplings, or grooved couplings

R_p = 1.5 for low-deformability piping such as cast iron and nonductile plastics

F_p need not be greater than 1.6 $S_{DS}I_pW_p$ and cannot be less than 0.30 $S_{DS}I_pW_p$.

As illustrated in Figure E.3, NFPA 13 uses a simplified seismic factor, C_p, which combines ground shaking S_{DS}, dynamic amplification a_p, component response R_p/I_p, and location in the building (z/h) into a single variable. Conservative assumptions are made for each variable, so that the only information needed to find C_p is the short-period mapped spectral acceleration for the Maximum Considered Earthquake (MCE), S_s.

Figure E.3 Simplified Seismic Factor, C_p.



The importance factor (I_p) for fire sprinkler systems is specified in ASCE/SEI 7 as 1.5. The amplification factor (a_p) for piping systems is specified as 2.5. Piping systems (even when seismically braced) are considered flexible, since the fundamental period of vibration for the system is greater than 0.06 seconds. A component response factor of R_p = 4.5 was assumed for all piping. Finally, it was assumed that the system is installed at the roof level, h.

Assume the system is laterally braced at the roof, $z = h$ and substitute these values into the lateral force equation

$$F_p = \frac{0.4 a_p S_{DS} W_p}{\left(\frac{R_p}{I_p}\right)}\left(1+2\frac{z}{h}\right) = \frac{0.4(2.5) S_{DS} W_p}{\left(\frac{4.5}{1.5}\right)}\left(1+2\frac{h}{h}\right) = (1.0) S_{DS} W_p \qquad \textbf{[E.3b]}$$

ASCE/SEI 7 forces are determined at the strength design (SD) level. NFPA 13 is based on Allowable Stress Design (ASD). To convert F_p to an ASD load, F_{pw}, the load from ASCE/SEI 7 is multiplied by a 0.7 load factor.

$$F_{pw} = 0.7F_p = 0.7 S_{DS} W_p = C_p W_p \qquad \textbf{[E.3c]}$$

Solving for C_p,

$$C_p = 0.7 S_{DS} \qquad \textbf{[E.3d]}$$

The short-period spectral acceleration, S_{DS}, is obtained by modifying the mapped short-period spectral acceleration, S_S, for the effects of the local soil conditions. In the United States, values for S_S are obtained from seismic hazard maps published by the U.S. Geological Survey (USGS). Free software available from USGS will generate values for S_S based on the latitude and longitude of the project site. The spectral acceleration used for seismic design is determined by

$$-S_{DS} = \frac{2}{3} S_S F_a$$

[E.3e]

F_a is an amplification factor based on soil conditions and the intensity of ground shaking expected (measured by S_S). Soil conditions are defined by site classification, ranging from Site Class A (hard rock) to Site Class F (extremely soft soils and fill). The values of F_a are given in ASCE/SEI 7 Table 11.4-1 and vary from 0.8 to 2.5. For the purposes of the ZOI method, the values of F_a are taken as the maximum tabulated values and are summarized in Table E.3.

Table E.3 Values of F_a

	Mapped Maximum Considered Earthquake Spectral Response Acceleration Parameter at Short Period					
	$S_S \leq 0.33$	**$S_S = 0.5$**	**$S_S = 0.75$**	**$S_S = 0.95$**	**$S_S = 1.0$**	**$S_S \geq 1.25$**
F_a	2.24	1.7	1.2	1.1	1.1	1.0

Note: Use straight-line interpolation for intermediate values of S_S.

$$C_p = 0.7 S_{DS} = \frac{2}{3}(0.7 S_s F_a) = 0.467 S_s F_a$$

[E.3f]

Table 18.5.9.3 was populated by solving for C_p for different values of S_S. For example when S_S = 1.0:

$$C_p = 0.467 S_s F_a = 0.467(1.0)(1.1) = 0.51$$

[E.3g]

E.4 Flexural Capacity of Piping.

The flexural capacity for different diameters and thicknesses of pipe were computed using Allowable Stress Design (ASD). NFPA 13 has traditionally used ASD for design. While ASCE/SEI 7 generally uses the Strength Design (SD) approach, ASD is preferred for the design of piping systems. For example, the ASTM B 31, *Standards of Pressure Piping*, series of piping codes are based on ASD. ASD was chosen for sprinkler piping design to limit the complexity of the analysis. Use of SD would require the use of the plastic modulus, Z, of the pipe rather than the elastic section modulus, S. Use of Z would trigger analysis of local and global buckling behavior of the pipe. SD is most appropriate when used with compact pipe sections that can develop the full limit capacity of the material, including strain hardening. Thin-wall pipes and materials without well defined post-elastic behavior are not easily considered using SD.

Permissible stresses in the pipe for seismic loading are from 13.6.11 of ASCE/SEI 7. Assuming high- or limited-deformability pipe with threaded or grooved couplings, the permissible flexural stress under SD level demands is $0.7F_y$, where F_y is the yield stress of the material. Since seismic design in NFPA 13 is based on ASD, the SD capacity must be reduced to an ASD level.

The permissible flexural stress for ASD is determined by adjusting the SD level flexural capacity. The SD capacity is first reduced by a load factor to ASD levels, and then can be increased by the allowable stress increase for seismic loading. The use of an allowable stress increase for piping systems is typical when determining the strength of the pipe itself.

For fire sprinkler piping, the SD flexural capacity, M_{cap}, is reduced by a load factor of 0.7 to yield the ASD flexural capacity. The duration of load factor for the piping system, taken as 1.33, is then applied. Taking S as the section modulus of pipe, this yields an allowable moment capacity in the pipe.

$$M_{cap} = 0.7(1.33)(0.7 S F_y) = 0.65 S F_y$$

[E.4a]

To populate Table 18.5.5.2(a) through Table 18.5.5.2(i), which give the maximum Zone of Influence loads, the largest reaction (due to branch lines and the tributary mass of the main) limited by flexure for a given pipe size and span between sway braces was computed.

For example, to determine the maximum permissible ZOI for a 4 in. (100 mm) diameter steel Schedule 10 main spanning 30 ft (9.1 m), first compute the flexural capacity of the pipe.

S = 1.76 in.^{3}(28800 mm^3)

F_y = 30,000 psi (2050 bar)

The flexural capacity of the pipe is

$$M_{cap} = (0.65F_y)S = (0.65)(30{,}000)(1.76) \quad \textbf{[E.4b]}$$

= 34,320 in.-lb (3900 kgn) = 2860 ft-lb (395 kgn)

For spans greater than 25 ft (7.6 m) and less than 40 ft (12 m), the branch lines are assumed to be located at ⅓-points in the span. The point load P is associated with the branch line and tributary mass of the main and L is distance between sway braces. From Figure E.2.2(b), the maximum moment in the main, M_{max}, is

M_{max} = 0.267PL

Setting M_{cap} = M_{max} and solving for P,

$$M_{cap} = \left(0.65F_y\right)S = 0.267PL$$

$$P = \frac{M_{cap}}{0.267L}$$

$$= \frac{2860}{0.267(30) = 357 \text{ lb}} \quad \textbf{[E.4c]}$$

The maximum permissible ZOI load = 3P = 1071 lb. (485 kg).

E.5 Sample Seismic Calculation using the ZOI Method.

To illustrate the application of the ZOI method, the approach can be applied to a sample problem based on the sample seismic bracing calculation in Figure A.18.5(b). The sample calculation yielded a total weight of 480 lb (220 kg), which was obtained using a seismic factor of 0.5. To determine our own seismic factor, to get the total weight of the water-filled pipe, divide by the seismic factor of 0.5,

$$W_p = \frac{480}{0.5} = 960 \text{ lb } (435 \text{ kg}) \quad \textbf{[E.5a]}$$

Assume the 4 in. (100 mm) Schedule 10 pipe is the main that will be braced and that distance between sway braces (span) is 20 ft (6.1 m). The installation is in a region of high seismicity, and based on the latitude and longitude of the building site, S_S = 1.75.

To calculate the seismic load, use Table 18.5.9.3 to determine the seismic coefficient, C_p. The value of S_s = 1.75 coordinates to 0.82.

The horizontal force on the brace, from 18.5.6.2 is

$$F_{pw} = C_pW_p = 0.82(960) = 787 \text{ lb} \quad \textbf{[E.5b]}$$

From Table 18.5.5.2(a), the maximum ZOI load, F_{pw}, for a 4 in. Schedule 10 pipe spanning 20 ft (6.1 m) is 1634 lb (740 kg), which is larger than the calculated demand of 787 lb (355 kg). The 4 in. (100 mm) Schedule 10 pipe is adequate for the seismic load and a brace would be selected with a minimum capacity of 787 lb (355 kg).

If the sway brace was attached to the 2 in. (50 mm) Schedule 40 pipe, the ZOI demand F_{pw} of 787 lb (355 kg) would be compared to the maximum capacity for a 2 in. (50 mm) Schedule 40 pipe found in Table 18.5.5.2(a)(b). For a 20 ft (6.1 m) span, this is 520 lb (235 kg), less than the demand of 787 lb (355 kg). A 2 in. (50 mm) pipe would be inadequate, and a sway brace would have to be added to reduce the ZOI demand, or the system pipe size increased.

E.6 Limitations of the ZOI Method.

The ZOI approach can be used for a variety of piping materials. There are, however, important limitations of which the designer should be aware. The first is that the appropriate component response factor, R_p, must be used. To select the proper value, the piping systems must be classified as high-, limited-, or low-deformability. Definitions of these terms are given in Section 11.2 of ASCE/SEI 7. The second major assumption is that the flexural behavior of the pipe is not governed by local buckling of the pipe wall. For steel pipe, this can be achieved by observing the thickness to diameter limits given in the *AISC Specifications for the Design, Fabrication, and Erection of Structural Steel Buildings*. Establishing the local buckling characteristics of pipe fabricated from other materials can require testing.

The tables for the maximum load, F_{pw}, in zone of influence are based on common configurations of mains and branch lines. There can be cases where the actual configuration of the piping system could generate higher stresses in the piping than assumed in the tables. For example, a main braced at 40 ft intervals, with a single branch line in the center of the span, can have a smaller maximum load capacity, F_{pw}, than the tabulated value. Where the configuration of the mains and branch lines vary significantly from the assumed layout, the pipe stresses should be checked by engineering analysis.

E.7 Allowable Loads for Concrete Anchors.

This section provides step-by-step examples of the procedures for determining the allowable loads for concrete anchors as they are found in Table 18.5.12.2(a) through Table 18.5.12.2(f). Table 18.5.12.2(a) through Table 18.5.12.2(f) were developed using the prying factors found in Table E.7(a) and the representative strength design seismic shear and tension values for concrete anchors found in Table E.7(b).

Table E.7(a) Prying Factors for Table 9.3.5.12.2(a) through Table 9.3.5.12.2(f) Concrete Anchors

Pr Range	Fig. 9.3.5.12.1 Designated Angle Category								
	A	B	C	D	E	F	G	H	I
Lowest	2	1.1	0.7	1.2	1.1	1.1	1.4	0.9	0.8
Low	3.5	1.8	1.0	1.7	1.8	2.0	1.9	1.3	1.1
High	5.0	2.5	1.3	2.2	2.5	2.9	2.4	1.7	1.4
Highest	6.5	3.2	1.6	2.7	3.2	3.8	2.9	2.1	1.7

Table E.7(b) Representative Strength Design Seismic Shear and Tension Values Used for Concrete Anchors

Anchor Dia. (in.)	Nominal Embedment (in.)	LRFD Tension (lb)	LRFD Shear (lb)
Wedge Anchors in 3000 psi LW Sand Concrete on Metal Deck			
⅜	2	573	1172
½	2.375	804	1616
⅝	3.125	1102	1744
Wedge Anchors in 3000 psi LW Sand Concrete			
⅜	2	637	550
½	3.625	871	745
⅝	3.875	1403	1140
¾	4.125	1908	1932
Wedge Anchors in 3000 psi NW Concrete			
⅜	2	1063	917

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Anchor Dia. (in.)	Nominal Embedment (in.)	LRFD Tension (lb)	LRFD Shear (lb)
½	3.625	2639	2052
⅝	3.875	3004	2489
¾	4.125	3179	3206
Wedge Anchors in 4000 psi NW Concrete			
⅜	2	1226	1088
½	3.625	2601	2369
⅝	3.875	3469	2586
¾	4.125	3671	3717
Wedge Anchors in 6000 psi NW Concrete			
⅜	2.25	1592	1322
½	3.625	3186	2902
⅝	3.875	4249	3167
¾	4.125	4497	4553
Undercut Anchors in 3000 psi NW Concrete			
⅜	5	4096	1867
½	7	5322	2800
⅝	9.5	6942	5675
¾	12	10182	9460

E.7.1 Selecting a Wedge Anchor Using Table 9.3.5.12.2(a) through Table 9.3.5.12.2(f).

E.7.1.1 Procedure.
Step 1. Determine the ASD horizontal earthquake load F_{pw}.

Step 1a. Calculate the weight of the water-filled pipe within the zone of influence of the brace.

Step 1b. Find the applicable seismic coefficient C_p in Table 18.5.9.3

Step 1c. Multiply the zone of influence weight by C_p to determine the ASD horizontal earthquake load F_{pw}.

Step 2. Select a concrete anchor from Table 18.5.12.2(a) through Table 18.5.12.2(f) with a maximum load capacity that is greater than the calculated horizontal earthquake load F_{pw} from Step 1.

Step 2a. Locate the table for the applicable concrete strength.

Step 2b. Find the column in the selected table for the applicable designated angle category (A thru I) and the appropriate prying factor *Pr* range.

Step 2c. Scan down the category column to find a concrete anchor diameter, embedment depth, and maximum load capacity that is greater than the calculated horizontal earthquake load F_{pw} from Step 1.

(ALTERNATIVE) Step 2. As an alternative to using the maximum load values in Table 18.5.12.2(a) through Table 18.5.12.2(f), select an AC355.2 seismically pre-qualified concrete anchor with a load-carrying capacity that exceeds the calculated F_{pw}, with calculations, including the effects of prying, based on seismic shear and tension values taken from an ICC-ES Report and calculated in accordance with ACI 318, Chapter 17, and adjusted to ASD values by multiplying by 0.43 per 18.5.12.7.3(D).

E.7.1.2 Example.

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Step 1. Zone of influence F_{pw}.

Step 1a. 40 ft of 2½ in. Sch. 10 pipe plus 15% fitting allowance

40 × 5.89 lb/ft × 1.15 = 270.94 lb

Step 1b. Seismic coefficient C_p from Table 18.5.9.3

C_p = 0.35

Step 1c. F_{pw} = 0.35 × 270.94 = 94.8 lb

Step 2. Select a concrete anchor from Table 18.5.12.2(a) through Table 18.5.12.2(f).

Step 2a. Use the table for 4000 psi Normal Weight Concrete.

Step 2b. Fastener orientation "A" – assume the manufacturer's prying factor is 3.0 for the fitting. Use the *Pr* range of 2.1–3.5.

Step 2c. Allowable F_{pw} on ⅜ in. dia. with 2 in. embedment = 135 lb and is greater than the calculated F_{pw} of 94.8 lb.

E.7.2 Calculation for Maximum Load Capacity of Concrete Anchors.
This example shows how the effects of prying and brace angle are calculated.

E.7.2.1 Procedure.
Step 1. Determine the allowable seismic tension value (T_{allow}) and the allowable seismic shear value (V_{allow}) for the anchor, based on data found in the anchor manufacturer's approved evaluation report. Note that, in this example, it is assumed the evaluation report provides the allowable tension and shear capacities. If this is not the case, the strength design anchor capacities must be determined using the procedures in ACI 318, Chapter 17, which are then converted to ASD values by dividing by a factor of 1.4. As an alternative to calculating the allowable seismic tension value (T_{allow}) and the allowable seismic shear value (V_{allow}) for the anchor, the seismic tension and shear values that were used to calculate the Figure 18.5.12.1 for anchor allowable load tables can be used.

Step 1a. Find the ASD seismic tension capacity (T_{allow}) for the anchor according to the strength of concrete, diameter of the anchor, and embedment depth of the anchor. Divide the ASD tension value by 2.0 and then multiply by 1.2.

Step 1b. Find the ASD seismic shear capacity (V_{allow}) for the anchor according to the strength of concrete, diameter of the anchor, and embedment depth of the anchor. Divide the ASD shear value by 2.0 and then multiply by 1.2.

Step 2. Calculate the applied seismic tension (T) and the applied seismic shear (V) based on the calculated horizontal earthquake load F_{pw}.

Step 2a. Calculate the designated angle category applied tension factor, including the effects of prying (Pr), using the following formulas:

Category A, B, and C

$$Pr = \frac{\left(\frac{C + A}{Tan\theta}\right) - D}{A}$$

Category D, E, and F

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$$Pr = \frac{(C+A) - \left(\frac{D}{Tan\theta}\right)}{A}$$

Category G, H, and I

$$Pr = \frac{\left(\frac{D}{B}\right)}{Sin\theta}$$

Step 2b. Calculate the ASD applied seismic tension (*T*) on the anchor, including the effects of prying, and when applied at the applicable brace angle from vertical and the designated angle category (A through I) using the following formula:

$$T = F_{pw} \times Pr$$

Step 2c. Calculate the ASD applied seismic shear (*V*) on the anchor, when applied at the applicable brace angle from vertical and the designated angle category (A through I) using the following formulas:

Category A, B, and C

$$V = F_{pw}$$

Category D, E, and F

$$V = \frac{F_{pw}}{Tan\theta}$$

Category G, H, and I

$$V = \frac{F_{pw}}{Sin\theta}$$

Step 3. Check the anchor for combined tension and shear loads using the formula:

$$\left(\frac{T}{T_{allow}}\right) + \left(\frac{V}{V_{allow}}\right) \leq 1.2$$

Confirm that T/T_{allow} and $V/V_{allow} \leq 1.0$.

E.7.2.2 Example: Sample Calculation, Maximum Load Capacity of Concrete Anchors as Shown in Table 9.3.5.12.2(a) through Table 9.3.5.12.2(f).
In this example, a sample calculation is provided showing how the values in Table 18.5.12.2(a) through Table 18.5.12.2(f) were calculated.

Step 1. Determine the allowable seismic tension value (T_{allow}) and the allowable seismic shear value (V_{allow}) for a concrete anchor in Figure 18.5.12.1.

Step 1a. The Table E.7(b) strength design seismic tension value (T_{allow}) for a ½ in. carbon steel anchor with 3⅝ in. embedment depth in 4000 psi normal weight concrete is 2601 lb. Therefore, the allowable stress design seismic tension value (T_{allow}) is 2601/1.4/2.0 × 1.2 = 1115 lb.

Step 1b. The Table E.7(b) strength design seismic shear value (V_{allow}) for a ½ in. carbon steel anchor with 3⅝ in. embedment is 2369 lb. Therefore, the allowable stress design seismic shear value (V_{allow}) is 2369/1.4/2.0 × 1.2 = 1015 lb.

Step 2. Use the applied seismic tension value (*T*) and the applied seismic shear value (*V*) based on an ASD horizontal earthquake load (F_{pw}) of 170 lb, a 30-degree brace angle from vertical, and designated angle category A.

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Step 2a. Calculate the ASD applied seismic tension value (*T*) on the anchor, including the effects of prying, using the following formula and **Figure E.7.2.2**.

$$T = \frac{F_{pw}\left[\left(\frac{C+A}{Tan\theta}\right)-D\right]}{A}$$

where:

T = applied service tension load, including the effect of prying

F_{pw} = horizontal earthquake load (F_{pw} = 170)

Tan = tangent of brace angle from vertical (*Tan*θ 0°= 0.5774)

A = 0.7500

B = 1.5000

C = 2.6250

$T = F_{pw} \times Pr$

$$T = \frac{\left\{F_{pw}\left[\left(\frac{2.625+0.75}{0.5774}\right)-1.0\right]\right\}}{0.75}$$

$$T = \frac{\left[F_{pw}\left(5.8452-1.0\right)\right]}{0.75}$$

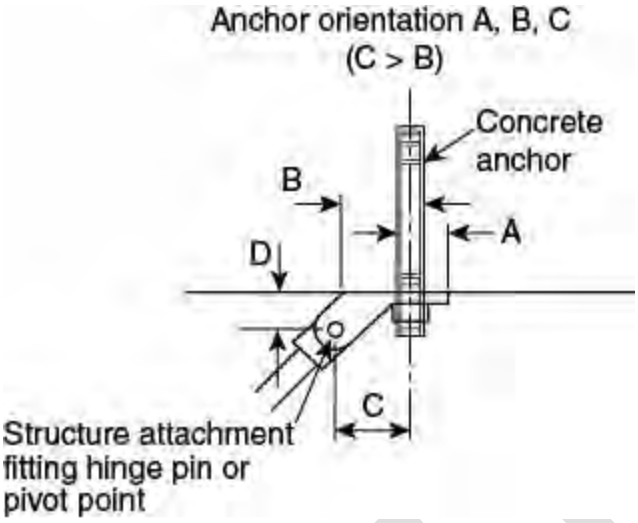
$$T = F_{pw}\left(\frac{4.8451}{0.75}\right)$$

$T = F_{pw} \times 6.46$

T = 170 lb × 6.46=1098.2 lb

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Figure E.7.2.2 Concrete Anchor for Sample Calculation in E.7.2.2.



Step 2b. The ASD applied seismic shear value (*V*)on the anchor for anchor orientations A, B, and C is equal to the ASD horizontal earthquake load F_{pw} = 170 lb.

Step 3. Calculate the maximum allowable horizontal earthquake load F_{pw} using the formula:

$$\left(\frac{T}{T_{allow}}\right)+\left(\frac{V}{V_{allow}}\right)\leq 1.2$$

$$\left(\frac{1098.2}{1115}\right)+\left(\frac{170}{1015}\right)=0.9849+0.1675=1.1524\left(\leq 1.2\right)$$

Annex F Informational References

F.1 Referenced Publications.

The documents or portions thereof listed in this annex are referenced within the informational sections of this standard and are not part of the requirements of this document unless also listed in Chapter **2** for other reasons.

F.1.1 NFPA Publications.

National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA 1, *Fire Code*, 2018 edition.

NFPA 11, *Standard for Low-, Medium-, and High-Expansion Foam*, 2016 edition.

NFPA 12, *Standard on Carbon Dioxide Extinguishing Systems*, 2018 edition.

NFPA 13D, *Standard for the Installation of Sprinkler Systems in One- and Two-Family Dwellings and Manufactured Homes*, 2019 edition.

NFPA 13E, *Recommended Practice for Fire Department Operations in Properties Protected by Sprinkler and Standpipe Systems*, 2015 edition.

NFPA 13R, *Standard for the Installation of Sprinkler Systems in Low-Rise Residential Occupancies*, 2019 edition.

NFPA 14, *Standard for the Installation of Standpipe and Hose Systems*, 2016 edition.

NFPA 15, *Standard for Water Spray Fixed Systems for Fire Protection*, 2017 edition.

NFPA 16, *Standard for the Installation of Foam-Water Sprinkler and Foam-Water Spray Systems*, 2015 edition.

Length					
.003”	.08 mm	7.5”	190 mm	26”	650 mm
.0315”	.8 mm	8”	200 mm	27.6”	690 mm
1/32”	0.8 mm	8.5”	215 mm	28”	700 mm
1/16”	1.6 mm	9”	225 mm	29”	725 mm
3/32”	2 mm	9.25”	230 mm	30”	750 mm
1/8”	3 mm	9.5”	240 mm	30.5”	765 mm
3/16”	5 mm	10”	250 mm	31”	775 mm
¼”	6 mm	11”	275 mm	32”	800 mm
5/16”	8 mm	11.5”	290 mm	33”	825 mm
3/8”	10 mm	12”	300 mm	35”	875 mm
½”	13 mm	12.25”	305 mm	35.4”	885 mm
17/32”	13 mm	12.5”	315 mm	36”	900 mm
9/16”	14 mm	12.75”	320 mm	37”	925 mm
5/8”	16 mm	14”	350 mm	38”	950 mm
¾”	19 mm	15”	375 mm	40”	1000 mm
7/8”	22 mm	15.5”	390 mm	42”	1050 mm
1”	25 mm	16”	400 mm	44”	1100 mm
1.5”	40 mm	16.25”	410 mm	47”	1175 mm
1.75”	45 mm	16.5”	415 mm	48”	1200 mm
2”	50 mm	17”	425 mm	54”	1350 mm
2.5”	65 mm	17.5”	440 mm	55”	1375 mm
2.75”	70 mm	18”	450 mm	57”	1425 mm
3”	75 mm	19”	475 mm	58”	1450 mm
3.5”	90 mm	20”	500 mm	66”	1650 mm
4”	100 mm	21”	525 mm	68”	1700 mm
4.5”	115 mm	22”	550 mm	72”	1800 mm
5”	125 mm	22.5”	565 mm	76”	1900 mm
5.5”	140 mm	23”	575 mm	78”	1950 mm
5.75”	145 mm	24”	600 mm	96”	2400 mm
6”	150 mm	25”	625 mm	102”	2550 mm
7”	175 mm	25.5”	640 mm	120”	3000 mm
				148”	3700 mm

Length					
3.5ft	1.1 m	10’-10”	3.3 m	22’-6”	6.9 m
3’-8”	1.1 m	11’-0”	3.4 m	24ft	7.3 m
4ft	1.2 m	11’-3”	3.4 m	25ft	7.6 m
4’-2”	1.3 m	11’-5”	3.5 m	25’-3”	7.7 m
4.5ft	1.4 m	11’-6”	3.5 m	26ft	7.9 m
4’-7”	1.4 m	11’-611/16”	3.5 m	27ft	8.2 m
4’-9”	1.4 m	11’-8”	3.6 m	28ft	8.5 m
5ft	1.5 m	12ft	3.7 m	28’-8”	8.7 m
5’-2”	1.6 m	12’-4”	3.8 m	29’-8”	9 m
5.5ft	1.7 m	13ft	4.0 m	30ft	9.1 m
5’-8”	1.7 m	13’-6”	4.1 m	32ft	10 m
5’-9 5/16”	1.8 m	13’-71/2”	4.2 m	33ft	10 m
6ft	1.8 m	13’-11”	4.2 m	35ft	11 m
6’-3”	1.9 m	14ft	4.3 m	36ft	11 m
6’-4”	1.9 m	14’-6”	4.4 m	40ft	12 m
6.5ft	2 m	15ft	4.6 m	41’-3”	13 m
6’-10”	2.1 m	15’-4”	4.7 m	45ft	14 m
7ft	2.1 m	16ft	4.9 m	50ft	15 m
7.5ft	2.3 m	16’-6”	5.0 m	51’-6”	16 m
7’-7”	2.3 m	16’-8”	5.1 m	55ft	17 m
7’-9”	2.4 m	17ft	5.2 m	60ft	18 m
8ft	2.4 m	18ft	5.5 m	65ft	20 m
8’-2”	2.5 m	18’-6”	5.6 m	70ft	21 m
8’-4”	2.5 m	19’-2”	5.8 m	75ft	23 m
8’-77/8”	2.6 m	19’-10”	6 m	76ft	23 m
9ft	2.7 m	19’-11”	6.1 m	80ft	24 m
9’-5”	2.9 m	20ft	6.1 m	100ft	30 m
9’-6”	2.9 m	20’-8”	6.3 m	200ft	61 m
10ft	3 m	21’-6”	6.6 m	250ft	76 m
10.5ft	3.2 m	21’-10”	6.7 m	300ft	91 m
10’-9”	3.3 m	22 ft	6.7 m	400ft	120 m

Area					
3.5 ft2	0.3 m2	256 ft2	24 m2	2,700 ft2	250 m2
6 ft2	0.6 m2	300 ft2	28 m2	2,734 ft2	255 m2
10 ft2	0.9 m2	306 ft2	28 m2	2,800 ft2	260 m2
12 ft2	1.1 m2	324 ft2	30 m2	3,000 ft2	280 m2
16 ft2	1.5 m2	395 ft2	37 m2	3,250 ft2	300 m2
18 ft2	1.7m2	400 ft2	37 m2	3,300 ft2	305 m2
20 ft2	1.9m2	450 ft2	42 m2	3,450 ft2	320 m2
24 ft2	2.2m2	504 ft2	47 m2	3,500 ft2	325 m2
25 ft2	2.3 m2	585 ft2	54 m2	3,600 ft2	335 m2
32 ft2	3.0 m2	600 ft2	56 m2	3,750 ft2	350 m2
50 ft2	4.6 m2	648 ft2	60 m2	3,900 ft2	360 m2
55 ft2	5.1 m2	700 ft2	65 m2	4,000 ft2	370 m2
64 ft2	5.9 m2	756 ft2	70 m2	4,100 ft2	380 m2
70 ft2	6.5 m2	768 ft2	71 m2	4,500 ft2	420 m2
80 ft2	7.4 m2	800 ft2	74 m2	4,800 ft2	445 m2
90 ft2	8.4 m2	1,000 ft2	93 m2	5,000 ft2	465 m2
100 ft2	9 m2	1,200ft2	112 m2	6,000 ft2	555 m2
110 ft2	10 m2	1,300 ft2	120 m2	6,400 ft2	595 m2
120 ft2	11 m2	1,365 ft2	125 m2	8,000 ft2	740 m2
124 ft2	12 m2	1,400 ft2	130 m2	8,800 ft2	820 m2
130 ft2	12 m2	1,500 ft2	140 m2	10,000 ft2	930 m2
144 ft2	13 m2	1,700 ft2	160 m2	13,100 ft2	1 215 m2
150 ft2	14 m2	1,800 ft2	165 m2	25,000 ft2	2 320 m2
168 ft2	16 m2	1,950 ft2	180 m2	40,000 ft2	3 720 m2
175 ft2	16 m2	2,000 ft2	185 m2	50,000 ft2	4 650 m2
196 ft2	18 m2	2,300 ft2	215 m2	52,000 ft2	4 830 m2
200 ft2	18 m2	2,500 ft2	230m2	100,000 ft2	9 230 m2
225 ft2	20 m2	2,535 ft2	235 m2		
250 ft2	23 m2	2,600 ft2	240 m2		

Volume			
1.76 cuin	28 ml	160 ft3	4.5 m3
15.5 ft3	0.5 m3	400 ft3	11 m3
17.4 ft3	0.5 m3	1,000 ft3	28 m3
17.6 ft3	0.5 m3	1,800 ft3	51 m3
20.7 ft3	0.6 m3	2,100 ft3	59 m3
21.1 ft3	0.6 m3	2,300 ft3	65 m3
22 ft3	0.6 m3	6,500 ft3	184 m3
100 ft3	2.8 m3	2.25M ft3	63,720 m3

Capacity	
16 oz.	0.5 l
32 oz.	1 l
1 gal	4 l
5 gal	20 l
40 gal	150 l
100 gal	380 l
150 gal	570 l
250 gal	950 l
500 gal	1900 l
750 gal	2850 l
300,000 gal	1,135,500 l

Drill Size	
3/32”	2,3 mm
1/8”	3,2 mm
3/8”	10 mm

Density of Cotton Bales	
22.0 lb/ft^3	350 kg/m^3
22.7 lb/ft^3	365 kg/m^3
24.2 lb/ft^3	390 kg/m^3
28.4 lb/ft^3	455 kg/m^3
28.7 lb/ft^3	460 kg/m^3
32.2 lb/ft^3	515 kg/m^3

Flow					
30 gpm	115 lpm	300 gpm	1150 lpm	1000 gpm	3800 lpm
15 gpm	57 lpm	400 gpm	1500 lpm	1500 gpm	5700 lpm
20 gpm	75 lpm	500 gpm	1900 lpm	1992 gpm	7540 lpm
50 gpm	190 lpm	600 gpm	2250 lpm	1993 gpm	7543 lpm
60 gpm	230 lpm	700 gpm	2650 lpm	2156 gpm	8160 lpm
100 gpm	380 lpm	750 gpm	2850 lpm	2575 gpm	9750 lpm
102.8 gpm	390 lpm	800 gpm	3050 lpm	4907 gpm	18,572 lpm
200 gpm	760 lpm	850 gpm	3200 lpm		
215.8 gpm	815 lpm	900 gpm	3400 lpm		
250 gpm	950 lpm				

Pressure			
5 psi	0.3 bar	75	5.2 bar
7	0.5 bar	90	6.2 bar
10	0.7 bar	100	6.9 bar
11	.8 bar	150	10 bar
15	1.0 bar	165	11 bar
20	1.4 bar	175	12 bar
22	15 bar	189	13 bar
25	1.7 bar	200	14 bar
30	2.1 bar	259	17 bar
35	2.4 bar	300	21 bar
50	3.4 bar	400	28 bar
63	4.3 bar		

Gauge	
12	2.8 mm
14	1.98 mm
16	1.57 mm
22	.78 mm
24	.63mm

Weight			
6 lb	2.7 kg	350 lb	160 kg
10 lb	4.5 kg	440 lb	200 kg
20 lb	9.1 kg	520 lb	235 kg
40 lb	18 kg	750 lb	340 kg
61 lb	27 kg	787 lb	355 kg
91 lb	41 kg	1200 lb	544 kg
131 lb	59 kg	1634 lb	740 kg
200 lb	91 kg	2000 lb	907 kg
250 lb	115 kg	2300 lb	1043 kg
		4000 lb	1815 kg

Velocity	
30 mph	49 km/h

Discharge Density			
gpm/ft2	mm/min	gpm/ft2	mm/min
.005	.2	.425	17.3
.05	2.04	.426	17.4
.1	4.1	.44	17.9
.15	6.1	.45	18.3
.16	6.5	.46	18.7
.17	7.0	.49	20
.18	7.3	.5	20.4
.19	7.7	.55	22.4
.2	8.2	.56	22.8
.21	8.6	.57	23.2
.225	9.2	.6	24.5
.24	9.8	.61	24.9
.25	10.2	.65	26.5
.26	10.6	.68	27.7
.28	11.4	.7	28.5
.29	11.8	.74	30.2
.3	12.2	.75	30.6
.31	12.6	.77	31.4
.32	13.0	.8	32.6
.33	13.4	.85	34.6
.34	13.9	.9	36.7
.35	14.3	.92	37.5
.37	15.1	.96	39.1
.375	15.3	1.1	44.8
.39	15.9	1.2	48.9
.4	16.3	6.0	245
.42	17.1	7.5	306

Second Revision No. 16-NFPA 13-2017 [Section No. 17.2.1.1]

17.2.1.1

Unless the requirements of 17.2.1.2 are met, hanger rod size shall be the same as that approved for use with the hanger assembly, and the size of rods shall not be less than that given in Table 17.2.1.1.

Table 17.2.1.1 Hanger Rod Sizes

Pipe Size		Diameter of Rod	
in.	mm	in.	mm
Up to and including 4	100	⅜	10
5	125	½	12
6	150		
8	200		
10	250	⅝	16
12	300	¾	20

Supplemental Information

File Name	Description	Approved
Table_17.2.1.1_Hanger_Rod_Sizes.docx	Revised Table 17.2.1.1. For staff use.	

Submitter Information Verification

Submitter Full Name: AUT-HBS
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Tue Jul 11 14:37:02 EDT 2017

Committee Statement

Committee Statement: 12 in. pipe must be supported with ¾ in. rod as is identified in Table 17.2.2.10.1.
Response Message:

Second Revision No. 1016-NFPA 13-2017 [Section No. 17.2.4.6.1]

17.2.4.6.1

Screws in the side of a timber or joist shall be not less than 2½ in. (65 mm) from the lower edge where supporting pipe is up to and including nominal 2½ in. (65 mm) and not less than 3 in. (75 mm) where supporting pipe is greater than nominal 2½ in. (65 mm).

Submitter Information Verification

Submitter Full Name: AUT-HBS
Organization: National Fire Protection Assoc
Street Address:
City:
State:
Zip:
Submittal Date: Mon Aug 07 09:12:33 EDT 2017

Committee Statement

Committee Statement: Editorial revision.
Response Message:

Second Revision No. 1017-NFPA 13-2017 [Section No. 17.3.1]

17.3.1

For trapeze hangers, the minimum size of steel angle or pipe span between structural members shall be such that the section modulus required in Table 17.3.1(a) does not exceed the available section modulus of the trapeze member from Table 17.3.1(b) or Table 17.3.1(c).

Table 17.3.1(a) Section Modulus Required for Trapeze Members (in.^{3})

Nominal Diameter of Pipe Being Supported – Schedule 10 Steel												
Span (ft)	**1**	**1.25**	**1.5**	**2**	**2.5**	**3**	**3.5**	**4**	**5**	**6**	**8**	**10**
1.5	0.08	0.08	0.09	0.09	0.10	0.11	0.12	0.13	0.15	0.18	0.26	0.34
2.0	0.11	0.11	0.12	0.13	0.14	0.15	0.16	0.17	0.20	0.24	0.34	0.45
2.5	0.14	0.14	0.15	0.16	0.18	0.21	0.23	0.25	0.30	0.36	0.50	0.69
3.0	0.16	0.17	0.18	0.19	0.20	0.22	0.24	0.26	0.31	0.36	0.51	0.67
3.5	0.19	0.20	0.21	0.22	0.24	0.26	0.28	0.30	0.36	0.42	0.60	0.78
4.0	0.22	0.22	0.24	0.25	0.27	0.30	0.32	0.34	0.41	0.48	0.68	0.89
4.5	0.24	0.25	0.27	0.28	0.30	0.33	0.36	0.38	0.46	0.54	0.77	1.01
5.0	0.27	0.28	0.30	0.31	0.34	0.37	0.40	0.43	0.51	0.60	0.85	1.12
5.5	0.30	0.31	0.33	0.34	0.37	0.41	0.44	0.47	0.56	0.66	0.94	1.23
6.0	0.33	0.34	0.35	0.38	0.41	0.44	0.48	0.51	0.61	0.71	1.02	1.34
6.5	0.35	0.36	0.38	0.41	0.44	0.48	0.52	0.56	0.66	0.77	1.11	1.45
7.0	0.38	0.39	0.41	0.44	0.47	0.52	0.56	0.60	0.71	0.83	1.19	1.56
7.5	0.41	0.42	0.44	0.47	0.51	0.55	0.60	0.64	0.76	0.89	1.28	1.68
8.0	0.43	0.45	0.47	0.50	0.54	0.59	0.63	0.68	0.82	0.95	1.36	1.79
8.5	0.46	0.48	0.50	0.53	0.58	0.63	0.67	0.73	0.87	1.01	1.45	1.90
9.0	0.49	0.50	0.53	0.56	0.61	0.66	0.71	0.77	0.92	1.07	1.53	2.01
9.5	0.52	0.53	0.56	0.60	0.64	0.70	0.75	0.81	0.97	1.13	1.62	2.12
10.0	0.54	0.56	0.59	0.63	0.68	0.74	0.79	0.85	1.02	1.19	1.70	2.23
10.5	0.57	0.59	0.62	0.66	0.71	0.78	0.83	0.90	1.07	1.25	1.79	2.35
11.0	0.60	0.62	0.65	0.69	0.74	0.81	0.87	0.94	1.12	1.31	1.87	2.46
11.5	0.63	0.64	0.68	0.72	0.78	0.85	0.91	0.98	1.17	1.37	1.96	2.57
12.0	0.65	0.67	0.71	0.75	0.81	0.89	0.95	1.02	1.22	1.43	2.04	2.68
12.5	0.68	0.70	0.74	0.78	0.85	0.92	0.99	1.07	1.27	1.49	2.13	2.79
13.0	0.71	0.73	0.77	0.81	0.88	0.96	1.03	1.11	1.33	1.55	2.21	2.90
13.5	0.73	0.76	0.80	0.85	0.91	1.00	1.07	1.15	1.38	1.61	2.30	3.02
14.0	0.76	0.78	0.83	0.88	0.95	1.03	1.11	1.20	1.43	1.67	2.38	3.13
14.5	0.79	0.81	0.86	0.91	0.98	1.07	1.15	1.24	1.48	1.73	2.47	3.24
15.0	0.82	0.84	0.89	0.94	1.02	1.11	1.19	1.28	1.53	1.79	2.56	3.35
15.5	0.84	0.87	0.92	0.97	1.05	1.14	1.23	1.32	1.58	1.85	2.64	3.46
16.0	0.87	0.90	0.95	1.00	1.08	1.18	1.27	1.37	1.63	1.91	2.73	3.58
Nominal Diameter of Pipe Being Supported – Schedule 40 Steel												
Span (ft)	**1**	**1.25**	**1.5**	**2**	**2.5**	**3**	**3.5**	**4**	**5**	**6**	**8**	**10**
1.5	0.08	0.09	0.09	0.1	0.11	0.12	0.14	0.15	0.18	0.22	0.30	0.41
2.0	0.11	0.11	0.12	0.13	0.15	0.16	0.18	0.20	0.24	0.29	0.40	0.55
2.5	0.14	0.14	0.15	0.16	0.17	0.18	0.20	0.21	0.25	0.30	0.43	0.56
3.0	0.16	0.17	0.18	0.20	0.22	0.25	0.27	0.30	0.36	0.43	0.60	0.82
3.5	0.19	0.20	0.21	0.23	0.26	0.29	0.32	0.35	0.42	0.51	0.70	0.96
4.0	0.22	0.23	0.24	0.26	0.29	0.33	0.36	0.40	0.48	0.58	0.80	1.10
4.5	0.25	0.26	0.27	0.29	0.33	0.37	0.41	0.45	0.54	0.65	0.90	1.23

Nominal Diameter of Pipe Being Supported – Schedule 10 Steel

Span (ft)	1	1.25	1.5	2	2.5	3	3.5	4	5	6	8	10
5.0	0.27	0.29	0.30	0.33	0.37	0.41	0.45	0.49	0.60	0.72	1.00	1.37
5.5	0.30	0.31	0.33	0.36	0.40	0.45	0.50	0.54	0.66	0.79	1.10	1.51
6.0	0.33	0.34	0.36	0.39	0.44	0.49	0.54	0.59	0.72	0.87	1.20	1.64
6.5	0.36	0.37	0.40	0.42	0.48	0.54	0.59	0.64	0.78	0.94	1.31	1.78
7.0	0.38	0.40	0.43	0.46	0.52	0.58	0.63	0.69	0.84	1.01	1.41	1.92
7.5	0.41	0.43	0.46	0.49	0.55	0.62	0.68	0.74	0.90	1.08	1.51	2.06
8.0	0.44	0.46	0.49	0.52	0.59	0.66	0.72	0.79	0.96	1.16	1.61	2.19
8.5	0.47	0.48	0.52	0.56	0.63	0.70	0.77	0.84	1.02	1.23	1.71	2.33
9.0	0.49	0.51	0.55	0.59	0.66	0.74	0.81	0.89	1.08	1.30	1.81	2.47
9.5	0.52	0.54	0.58	0.62	0.70	0.78	0.86	0.94	1.14	1.37	1.91	2.60
10.0	0.55	0.57	0.61	0.65	0.74	0.82	0.90	0.99	1.20	1.45	2.01	2.74
10.5	0.58	0.60	0.64	0.69	0.77	0.86	0.95	1.04	1.26	1.52	2.11	2.88
11.0	0.60	0.63	0.67	0.72	0.81	0.91	0.99	1.09	1.32	1.59	2.21	3.01
11.5	0.63	0.66	0.70	0.75	0.85	0.95	1.04	1.14	1.38	1.66	2.31	3.15
12.0	0.66	0.68	0.73	0.78	0.88	0.99	1.08	1.19	1.44	1.73	2.41	3.29
12.5	0.69	0.71	0.76	0.82	0.92	1.03	1.13	1.24	1.5	1.81	2.51	3.43
13.0	0.71	0.74	0.79	0.85	0.96	1.07	1.17	1.29	1.56	1.88	2.61	3.56
13.5	0.74	0.77	0.82	0.88	0.99	1.11	1.22	1.34	1.62	1.95	2.71	3.70
14.0	0.77	0.80	0.85	0.91	1.03	1.15	1.26	1.39	1.68	2.02	2.81	3.84
14.5	0.80	0.83	0.88	0.95	1.07	1.19	1.31	1.43	1.74	2.1	2.91	3.97
15.0	0.82	0.86	0.91	0.98	1.10	1.24	1.35	1.48	1.8	2.17	3.01	4.11
15.5	0.85	0.88	0.94	1.01	1.14	1.28	1.4	1.53	1.86	2.24	3.11	4.25
16.0	0.88	0.91	0.97	1.05	1.18	1.32	1.44	1.58	1.92	2.31	3.21	4.39

For SI units, 1 in. = 25.4 mm; 1 ft = 0.3048 m.

Note: The table is based on a maximum bending stress of 15 ksi (103.4 MPa) and a midspan concentrated load from 15 ft (4.6 m) of water-filled pipe, plus 250 lb (114 kg).

Table 17.3.1(b) Available Section Modulus of Common Trapeze Hangers ($in.^3$)

Pipe				
in.	mm	Modulus ($in.^3$)	Angles (in.)	Modulus ($in.^3$)
Schedule 10				
1	25	0.12	1½ × 1½ × 3/16	0.10
1¼	32	0.19	2 × 2 × ⅛	0.13
1½	40	0.26	2 × 1½ × 3/16	0.18
2	50	0.42	2 × 2 × 3/16	0.19
2½	65	0.69	2 × 2 × ¼	0.25
3	80	1.04	2½ × 1½ × 3/16	0.28
3½	90	1.38	2½ × 2 × 3/16	0.29
4	100	1.76	2 × 2 × 5/16	0.30
5	125	3.03	2½ × 2½ × 3/16	0.30
6	150	4.35	2 × 2 × ⅜	0.35
			2½ × 2½ × ¼	0.39
			3 × 2 × 3/16	0.41
Schedule 40				

Pipe				
in.	mm	Modulus (in.^{3})	Angles (in.)	Modulus (in.^{3})
1	25	0.13	3 × 2½ × 3⁄16	0.43
1¼	32	0.23	3 × 3 × 3⁄16	0.44
1½	40	0.33	2½ × 2½ × 5⁄16	0.48
2	50	0.56	3 × 2 × ¼	0.54
2½	65	1.06	2½ × 2 × ⅜	0.55
3	80	1.72	2½ × 2½ × ⅜	0.57
3½	90	2.39	3 × 3 × ¼	0.58
4	100	3.21	3 × 3 × 5⁄16	0.71
5	125	5.45	2½ × 2½ × ½	0.72
6	150	8.50	3½ × 2½ × ¼	0.75
			3 × 2½ × ⅜	0.81
			3 × 3 × ⅜	0.83
			3½ × 2½ × 5⁄16	0.93
			3 × 3 × 7⁄16	0.95
			4 × 4 × ¼	1.05
			3 × 3 × ½	1.07
			4 × 3 × 5⁄16	1.23
			4 × 4 × 5⁄16	1.29
			4 × 3 × ⅜	1.46
			4 ×4 × ⅜	1.52
			5 × 3½ × 5⁄16	1.94
			4 × 4 × ½	1.97
			4 × 4 × ⅝	2.40
			4 × 4 × ¾	2.81
			6 × 4 × ⅜	3.32
			6 × 4 × ½	4.33
			6 × 4 × ¾	6.25
			6 × 6 × 1	8.57

Table 17.3.1(c) Available Section Modulus of Common Trapeze Hangers (cm^3)

Pipe		-	-	-
in.	mm	Modulus (cm^3)	Angles (mm)	Modulus (cm^3)
Schedule 10		-	-	-
1	25	1.97	40 × 40 × 5	1.64
1¼	32	3.11	50 × 50 × 3	2.13
1½	40	4.26	50 × 40 × 5	2.95
2	50	6.88	50 × 50 × 5	3.11
2½	65	11.3	50 × 50 × 6	4.10
3	80	17.0	65 × 40 × 5	4.59
3½	90	22.6	65 × 50 × 5	4.75
4	100	28.8	50 × 50 × 8	4.92
5	125	49.7	65 × 65 × 5	4.92
6	150	71.3	50 × 50 × 10	5.74
			65 × 65 × 6	6.39

Pipe		-	-	-
in.	mm	Modulus (cm^3)	Angles (mm)	Modulus (cm^3)
Schedule 10		-	-	-
			80× 50 × 5	6.72
Schedule 40				
1	25	2.1	80 × 65 × 10	7.05
1¼	32	3.8	3 × 3 × 3⁄16	7.21
1½	40	5.4	65 × 65 × 8	7.87
2	50	9.2	3 × 2 × ¼	8.85
2½	65	17.4	65 × 50 × 10	9.01
3	80	28.2	65 × 65 × 10	9.34
3½	90	39.2	80 × 80 × 6	9.50
4	100	52.6	80 × 80 × 8	11.6
5	125	89.3	65 × 65 ×15	11.8
6	150	139.3	90 × 65 ×6	12.3
			80 × 65 × 10	13.3
			80 × 80 × 10	13.6
			90 × 65 × 8	15.2
			80 × 80 × 11	15.6
			100 × 100 × 6	17.2
			80 × 80 × 15	17.5
			100 × 80 × 8	20.2
			100 × 100 × 8	21.1
			100 × 80 × 10	23.9
			100 ×100 × 10	24.9
			125 × 90 × 8	31.8
			100 × 100 × 16	32.3
			100 × 100 × 8	39.3
			100 × 100 × 20	46.0
			150 × 100 × 10	54.4
			150 × 100 × 15	71.0
			150 × 100 × 20	102
			150 × 150 × 25	140

Submitter Information Verification

Submitter Full Name: AUT-HBS
Organization: National Fire Protection Assoc
Street Address:
City:
State:
Zip:
Submittal Date: Mon Aug 07 09:16:31 EDT 2017

Committee Statement

Committee Statement: Editorial revision.

Response Message:

Second Revision No. 1-NFPA 13-2017 [Section No. 17.4.1.3.1]

17.4.1.3.1

Sprinkler piping shall be substantially supported from the building structure, which must support the added load of the water-filled pipe plus ~~a minimum of~~ 250 lb (115 kg) applied at the point of hanging, except where permitted by 17.4.1.1.2, 17.4.1.3.3, and 17.4.1.4.1.

Submitter Information Verification

Submitter Full Name: AUT-HBS
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Mon Jun 26 08:42:01 EDT 2017

Committee Statement

Committee Statement: This additional value assigned to the load of the pipe does not vary. It is always just 250 lbs. This is the only paragraph that includes the phrase "a minimum of" with this variable whereas 17.1.2(1), 17.1.4.1.1, 17.1.4.1.2, Table 17.3.1(a), and 17.5.1.2(1) all simply say "plus 250 lbs".

Response Message:

Public Comment No. 66-NFPA 13-2017 [Section No. 17.4.1.3.1]

Second Revision No. 2-NFPA 13-2017 [Section No. 17.4.3.4.4.4]

17.4.3.4.4.4

Unless flexible ~~sprinkler~~ hose fittings in accordance with 17.4.1.3.3.1and ceilings in accordance with 17.4.1.3.3.2 are used, the hanger closest to the sprinkler shall be of a type that restrains the pipe from upward movement ~~of the pipe~~ .

Submitter Information Verification

Submitter Full Name: AUT-HBS
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Mon Jun 26 09:07:24 EDT 2017

Committee Statement

Committee Statement: Note that this issue was resolved in Committee action.

Use of an approved ceiling is important factor when used flexible hose fittings. The ceiling must be strong enough to withstand the induced thrust after fusing of a sprinkler at a pressure above 100 psi. This requirement would require other forms of branch piping to restrain against upward movement. This change distiguishes between prevention and restraint. Prevention is absolute and restraint would acknowledge minor movement while a surge clip is being compressor.

Response Message:

Public Comment No. 149-NFPA 13-2017 [Section No. 17.4.3.4.4.4]

Second Revision No. 3-NFPA 13-2017 [Section No. 17.4.4.9]

~~17.4.4.9~~

~~The unsupported lengths of mains shall be in accordance with the distances in 9.2.3.4.~~

Submitter Information Verification

Submitter Full Name: AUT-HBS
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Mon Jun 26 09:24:52 EDT 2017

Committee Statement

Committee Statement: Delete. This section creates a conflict with the requirements of 17.4.4.10 as revised by FR-610.

Response Message:

Public Comment No. 150-NFPA 13-2017 [Section No. 17.4.4.9]

Second Revision No. 1018-NFPA 13-2017 [Section No. 17.5.4.5 [Excluding any Sub-Sections]]

The minimum diameter for the anchors shall be ½ in. (13 mm) for pipe stand diameters up to and including 3 in. (75 mm) and ⅝ in. (16 mm) for pipe stands 4 in. (100 mm) diameter and larger.

Submitter Information Verification

Submitter Full Name: AUT-HBS
Organization: National Fire Protection Assoc
Street Address:
City:
State:
Zip:
Submittal Date: Mon Aug 07 09:23:36 EDT 2017

Committee Statement

Committee Statement: Editorial revision.
Response Message:

Second Revision No. 1019-NFPA 13-2017 [Section No. 17.5.4.5.1]

17.5.4.5.1

Where the pipe stand complies with 17.5.3.2, ⅜ in. (10 mm) anchors shall be permitted.

Submitter Information Verification

Submitter Full Name: AUT-HBS
Organization: National Fire Protection Assoc
Street Address:
City:
State:
Zip:
Submittal Date: Mon Aug 07 09:25:57 EDT 2017

Committee Statement

Committee Statement: Editorial revision.
Response Message:

Second Revision No. 4-NFPA 13-2017 [Section No. 17.6]

~~**17.6** Protection Criteria for Rack Storage of Group A Plastic Commodities Stored Up to and Including 25 ft (7.6 m) in Height.~~

~~**17.6.1** Control Mode Density/Area Sprinkler Protection Criteria for Single-, Double-, and Multiple-Row Racks for Group A Plastic Commodities Stored Up to and Including 25 ft (7.6 m) in Height.~~

~~**17.6.1.1** Storage 5 ft (1.5 m) or Less in Height.~~

~~For the storage of Group A plastics stored 5 ft (1.5 m) or less in height, the sprinkler design criteria for miscellaneous storage specified in Chapter 13 shall be used.~~

~~**17.6.1.1.1**~~

~~For storage 5 ft (1.5 m) or less in height that does not meet the definition of *Miscellaneous Storage* that is on solid shelf racks, in-rack sprinklers shall be provided in accordance with 17.1.5, and ceiling sprinkler protection shall be provided in accordance with Chapter 13 .~~

~~**17.6.1.2** Ceiling Sprinkler Water Demand.~~

~~See Section C.22 .~~

~~17.6.1.2.1~~

For Group A plastic commodities in cartons, encapsulated or nonencapsulated in single-, double-, and multiple-row racks and with a clearance to ceiling up to and including 10 ft. (3.0 m), ceiling sprinkler water demand in terms of density [gpm/ft^2 (mm/min)] and area of operation [ft^2 (m^2)] shall be selected from Figure 17.6.1.2.1(a) through Figure 17.6.1.2.1(f) .

Figure 17.6.1.2.1(a) Storage 5 ft to 10 ft (1.5 m to 3.0 m) in Height with Up to 10 ft (3.0 m) Clearance to Ceiling.

Figure 17.6.1.2.1(b) Storage 15 ft (4.6 m) in Height with Up to 10 ft (3.0 m) Clearance to Ceiling.

Figure 17.6.1.2.1(c) Storage 20 ft (6.1 m) in Height with <5 ft (1.5 m) Clearance to Ceiling.

Figure 17.6.1.2.1(d) Storage 20 ft (6.1 m) in Height with 5 ft to 10 ft (1.5 m to 3.0 m) Clearance to Ceiling.

~~Figure 17.6.1.2.1(e) Storage 25 ft (7.6 m) in Height with <5 ft (1.5 m) Clearance to Ceiling.~~ ***~~(See Note 2.)~~***

~~Figure 17.6.1.2.1(f) Storage 25 ft (7.6 m) in Height with 5 ft to 10 ft (1.5 m to 3.0 m) Clearance to Ceiling.~~ ***~~(See Note 2.)~~***

~~17.6.1.2.2~~

~~Linear interpolation of design densities and areas of application shall be permitted between storage heights with the same clearance to ceiling.~~

~~17.6.1.2.3~~

~~No interpolation between clearance to ceiling shall be permitted.~~

~~17.6.1.2.4~~

~~An option shall be selected from the appropriate Figure 17.6.1.2.1(a) through Figure 17.6.1.2.1(f) given the storage height and clearance being protected. The density/area criteria at the top of each option shall be applied to the ceiling sprinklers and the in-rack sprinklers shown in the option (if any) shall be provided. Options that do not show multiple-row racks in the figures shall not be permitted to protect multiple-row rack storage. Notes in each figure shall be permitted to clarify options or to present additional options not shown in the figures.~~

~~17.6.1.3~~

~~For storage of Group A plastics between 5 ft and 12 ft (1.5 m and 3.7 m) in height, the installation requirements for extra hazard systems shall apply.~~

~~17.6.1.4~~

~~Exposed unexpanded Group A plastics protected with control mode density/area sprinklers shall be protected in accordance with one of the following:~~

- ~~Maximum 10 ft (3.0 m) storage in a maximum 20 ft (6.1 m) high building with ceiling sprinklers designed for a minimum 0.8 gpm/ft^2 (32.6 mm/min) density over 2500 ft^2 (232 m^2) and no in-rack sprinklers required as shown in Figure 17.6.1.4(a)~~
- ~~Maximum 10 ft (3.0 m) storage in a maximum 20 ft (6.1 m) high building with ceiling sprinklers designed for a minimum 0.45 gpm/ft^2 (18.3 mm/min) density over 2000 ft^2 (186 m^2) and one level of in-rack sprinklers required at alternate transverse flues as shown in Figure 17.6.1.4(b)~~
- ~~Maximum 10 ft (3.0 m) storage in a maximum 20 ft (6.1 m) high building with ceiling sprinklers designed for a minimum 0.3 gpm/ft^2 (12.2 mm/min) density over 2000 ft^2 (186 m^2) and one level of in-rack sprinklers required in every transverse flue as shown in Figure 17.6.1.4(c)~~
- ~~Maximum 15 ft (4.6 m) storage in a maximum 25 ft (7.6 m) high building with ceiling sprinklers designed for a minimum 0.45 gpm/ft^2 (18.3 mm/min) density over 2000 ft^2 (186 m^2) and one level of in-rack sprinklers required at alternate transverse flues as shown in Figure 17.6.1.4(d)~~
- ~~Maximum 15 ft (4.6 m) storage in a maximum 25 ft (7.6 m) high building with ceiling sprinklers designed for a minimum 0.3 gpm/ft^2 (12.2 mm/min) density over 2000 ft^2 (186 m^2) and one level of in-rack sprinklers required in every transverse flue as shown in Figure 17.6.1.4(e)~~
- ~~Maximum 20 ft (6.1 m) storage in a maximum 25 ft (7.6 m) high building with ceiling sprinklers designed for a minimum 0.6 gpm/ft^2 (24.4 mm/min) density over 2000 ft^2 (186 m^2) and one level of in-rack sprinklers required at alternate transverse flues as shown in Figure 17.6.1.4(f)~~
- ~~Maximum 20 ft (6.1 m) storage in a maximum 25 ft (7.6 m) high building with ceiling sprinklers designed for a minimum 0.45 gpm/ft^2 (18.3 mm/min) density over 2000 ft^2 (186 m^2) and one level of in-rack sprinklers required in every transverse flue as shown in Figure 17.6.1.4(g)~~
- ~~Maximum 20 ft (6.1 m) storage in a maximum 30 ft (9.1 m) high building with ceiling sprinklers designed for a minimum 0.8 gpm/ft^2 (32.6 mm/min) density over 1500 ft^2 (139 m^2) and one level of in-rack sprinklers required at alternate transverse flues as shown in Figure 17.6.1.4(h)~~
- ~~Maximum 20 ft (6.1 m) storage in a maximum 30 ft (9.1 m) high building with ceiling sprinklers designed for a minimum 0.6 gpm/ft^2 (24.4 mm/min^2) density over 1500 ft^2 (139 m^2) and one level of in-rack sprinklers required in every transverse flue as shown in Figure 17.6.1.4(i)~~
- ~~Maximum 20 ft (6.1 m) storage in a maximum 30 ft (9.1 m) high building with ceiling sprinklers designed for a minimum 0.3 gpm/ft^2 (12.2 mm/min) density over 2000 ft^2 (186 m^2) and two levels of in-rack sprinklers required in every transverse flue as shown in Figure 17.6.1.4(j)~~
- ~~Maximum 25 ft (7.6 m) storage in a maximum 35 ft (11 m) high building with ceiling sprinklers designed for a minimum 0.8 gpm/ft^2 (32.6 mm/min) density over 1500 ft^2 (139 m^2) and one level of in-rack sprinklers required in every transverse flue as shown in Figure 17.6.1.4(k)~~
- ~~Maximum 25 ft (7.6 m) storage in a maximum 35 ft (11 m) high building with ceiling sprinklers designed for a minimum 0.3 gpm/ft^2 (12.2 mm/min) density over 2000 ft^2 (186 m^2) and two levels of in-rack sprinklers required in every transverse flue as shown in Figure 17.6.1.4(l)~~

~~Figure 17.6.1.4(a) Exposed Nonexpanded Group A Plastic Up to 10 ft (3.0 m) in Height in Up to a 20 ft (6.1 m) High Building with No In-Rack Sprinklers.~~

~~Figure 17.6.1.4(b) Exposed Nonexpanded Group A Plastic Up to 10 ft (3.0 m) in Height in Up to a 20 ft (6.1 m) High Building with One Level of In-Rack Sprinklers.~~

~~Figure 17.6.1.4(c) Exposed Nonexpanded Group A Plastics Up to 10 ft (3.0 m) in Height in Up to a 20 ft (6.1 m) High Building with One Level of Closely Spaced In-Rack Sprinklers.~~

~~Figure 17.6.1.4(d) Exposed Nonexpanded Group A Plastics Up to 15 ft (4.6 m) in Height in Up to a 25 ft (7.6 m) High Building with One Level of In-Rack Sprinklers.~~

~~Figure 17.6.1.4(e) Exposed Nonexpanded Group A Plastics Up to 15 ft (4.6 m) in Height in Up to a 25 ft (7.6 m) High Building with One Level of Closely Spaced In-Rack Sprinklers.~~

~~Figure 17.6.1.4(f) Exposed Nonexpanded Group A Plastics Up to 20 ft (6.1 m) in Height in Up to a 25 ft (7.6 m) High Building with One Level of In-Rack Sprinklers.~~

~~Figure 17.6.1.4(g) Exposed Nonexpanded Group A Plastics Up to 20 ft (6.1 m) in Height in Up to a 25 ft (7.6 m) High Building with One Level of Closely Spaced In-Rack Sprinklers.~~

~~Figure 17.6.1.4(h) Exposed Nonexpanded Group A Plastics Up to 20 ft (6.1 m) in Height in Up to a 30 ft (9.1 m) High Building with One Level of In-Rack Sprinklers.~~

~~Figure 17.6.1.4(i) Exposed Nonexpanded Group A Plastics Up to 20 ft in (6.1 m) Height in Up to a 30 ft (9.1 m) High Building with One Level of Closely Spaced In-Rack Sprinklers.~~

~~Figure 17.6.1.4(j) Exposed Nonexpanded Group A Plastics Up to 20 ft (6.1 m) in Height in Up to a 30 ft (9.1 m) High Building with Two Levels of Closely Spaced In-Rack Sprinklers.~~

~~Figure 17.6.1.4(k) Exposed Nonexpanded Group A Plastics Up to 25 ft (7.6 m) in Height in Up to a 35 ft (10.7 m) High Building with One Level of Closely Spaced In-Rack Sprinklers.~~

~~Figure 17.6.1.4(l) Exposed Nonexpanded Group A Plastics Up to 25 ft (7.6 m) in Height in Up to a 35 ft (10.7 m) High Building with Two Levels of Closely Spaced In-Rack Sprinklers.~~

~~17.6.1.5~~ ~~In-Rack Sprinkler Requirements Where Control Mode Density/Area Sprinklers Are Being Used at Ceiling.~~

~~17.6.1.5.1~~ ~~In-Rack Sprinkler Clearance.~~

~~The minimum of 6 in. (150 mm) vertical clear space shall be maintained between the sprinkler deflectors and the top of a tier of storage.~~

(A)

Sprinkler discharge shall not be obstructed by horizontal rack members.

17.6.1.5.2

The spacing of in-rack sprinklers shall be in accordance with Figure 17.6.1.2.1(a) through Figure 17.6.1.2.1(f) .

17.6.1.5.3

In-rack sprinklers shall be located at an intersection of transverse and longitudinal flues while not exceeding the maximum spacing rules.

17.6.1.5.4

Where distances between transverse flues exceed the maximum allowable distances, sprinklers shall be installed at the intersection of the transverse and longitudinal flues, and additional sprinklers shall be installed between transverse flues to meet the maximum distance rules.

17.6.1.5.5

Where no transverse flues exist, in-rack sprinklers shall not exceed the maximum spacing rules.

17.6.1.5.6 In-Rack Sprinkler Water Demand.

The water demand for sprinklers installed in racks shall be based on simultaneous operation of the most hydraulically remote sprinklers as follows:

Eight sprinklers where only one level is installed in racks

Fourteen sprinklers (seven on each top two levels) where more than one level is installed in racks

17.6.1.5.7 In-Rack Sprinkler Discharge Pressure.

Sprinklers in racks shall discharge at not less than 15 psi (1.0 bar) for all classes of commodities. *(See Section C.19 .)*

17.6.2 CMSA Sprinklers for Rack Storage of Group A Plastic Commodities Stored Up to and Including 25 ft (7.6 m) in Height.

17.6.2.1

Protection of single-, double-, and multiple-row rack storage for nonexpanded Group A plastic commodities shall be in accordance with Table 17.6.2.1 .

Table 17.6.2.1 CMSA Sprinkler Design Criteria for Single-, Double-, and Multiple-Row Racks of Group A Plastic Commodities Stored Up and Including 25 ft (7.6 m) in Height

Storage Arrangement	Commodity Class	Maximum Storage Height		Maximum Ceiling/Roof Height		K-Factor/ Orientation	Type of System	Number of Design Sprinklers	Minimum Operating Pressure	
		ft	m	ft	m				psi	bar
Single-, double-, and multiple-row racks (no open-top containers)	Cartoned nonexpanded plastics	20	6.1	25	7.6	11.2 (160) Upright	Wet	15	50	3.4
						16.8 (240) Upright	Wet	15	22	1.5
						19.6 (280) Pendent	Wet	15	16	1.1
						11.2 (160) Upright	Wet Wet	3020	50 75	3.4 5.2
				30	9.1	16.8 (240) Upright	Wet	15*	22	1.5
		-	-			19.6 (280) Pendent	Wet	15	16	1.1
		25	7.6	30	9.1	11.2 (160) Upright	Wet	15 + 1 level of in-rack	50	3.4
						16.8 (240) Upright	Wet	15*	22	1.5
						19.6 (280) Pendent	Wet	15	16	1.1
		25	7.6	35	11	11.2 (160) Upright	Wet	30 + 1 level of in-rack	50	3.4
							Wet	20 + 1 level of in-rack	75	5.2
						16.8 (240) Upright	Wet	30 + 1 level of in-rack	22	1.5
							Wet	20 + 1 level of in-rack	35	2.4
						19.6 (280) Pendent	Wet	15	25	1.7
	-	20	6.1	25	7.6	11.2 (160) Upright	Wet	15	50	3.4
						16.8 (240) Upright	Wet	15	22	1.5
	Exposed nonexpanded plastics	20	6.1	30	9.1	11.2 (160) Upright	Wet	30	50	3.4
							Wet	20	75	5.2
						16.8 (240) Upright	Wet	15*	22	1.5
		25	7.6	30	9.1	11.2 (160) Upright	Wet	15 + 1 level of in-rack	50	3.4
						16.8 (240) Upright	Wet	15*	22	1.5
		25	7.6	35	11	11.2 (160) Upright	Wet	30 + 1 level of in-rack	50	3.4
							Wet	20 + 1 level of in-rack	75	5.2

Storage Arrangement	Commodity Class	Maximum Storage Height		Maximum Ceiling/Roof Height		K-Factor/ Orientation	Type of System	Number of Design Sprinklers	Minimum Operating Pressure	
		ft	m	ft	m				psi	bar
-						16.8 (240) Upright	Wet	30 + 1 level of in-rack	22	1.5
-							Wet	20 + 1 level of in-rack	35	2.4

*Minimum 8 ft (2.4 m) aisle.

17.6.2.1.1

CMSA sprinklers shall not be permitted to protect storage on solid shelf racks unless the solid shelf racks are protected with in-rack sprinklers in accordance with 17.1.5.

17.6.2.1.1.1

Where solid shelves are used, in-rack sprinklers shall be installed in every level below the highest solid shelf.

17.6.2.2

Protection shall be provided as specified in Table 17.6.2.1 or appropriate NFPA standards in terms of minimum operating pressure and the number of sprinklers to be included in the design area.

17.6.2.3 Open Wood Joist Construction.

17.6.2.3.1

Where CMSA sprinklers are installed under open wood joist construction, firestopping in accordance with 17.6.2.3.2 shall be provided or the minimum operating pressure of the sprinklers shall be 50 psi (3.4 bar) for a K-11.2 (160) sprinkler or 22 psi (1.5 bar) for a K-16.8 (240) sprinkler.

17.6.2.3.2

Where each joist channel of open wood joist construction is fully firestopped to its full depth at intervals not exceeding 20 ft (6.1 m), the lower pressures specified in Table 17.6.2.1 shall be permitted to be used.

17.6.2.4 Preaction Systems.

For the purpose of using Table 17.6.2.1 , preaction systems shall be classified as dry pipe systems.

17.6.2.5

Building steel shall not require special protection where Table 17.6.2.1 is applied as appropriate for the storage configuration.

17.6.2.6 In-Rack Sprinkler Requirements Where CMSA Sprinklers Are Used at Ceiling.

17.6.2.6.1

In-rack sprinklers shall be installed at the first tier level at or above one-half of the storage height.

17.6.2.6.2

The minimum of 6 in. (150 mm) vertical clear space shall be maintained between the sprinkler deflectors and the top of a tier of storage.

(A)

Sprinkler discharge shall not be obstructed by horizontal rack members.

17.6.2.6.3

In-rack sprinklers shall be located at an intersection of transverse and longitudinal flues.

17.6.2.6.4

The maximum horizontal distance between in-rack sprinklers shall be 5 ft (1.5 m).

17.6.2.6.5

Where distances between transverse flues exceed the maximum allowable distances, sprinklers shall be installed at the intersection of the transverse and longitudinal flues, and additional sprinklers shall be installed between transverse flues to meet the maximum distance rules.

17.6.2.6.6

Where no transverse flues exist, in-rack sprinklers shall not exceed the maximum spacing rules.

17.6.2.6.7 In-Rack Sprinkler Water Demand.

The water demand for sprinklers installed in racks shall be based on simultaneous operation of the most hydraulically remote eight sprinklers.

17.6.2.6.8 In-Rack Sprinkler Discharge Pressure.

Sprinklers in racks shall discharge at not less than 15 psi (1.0 bar) for all classes of commodities. *(See Section C.19 .)*

17.6.3 Special Design for Rack Storage of Plastics Commodities Stored Up to and Including 25 ft (7.6 m) in Height.

17.6.3.1 Slatted Shelves.

17.6.3.1.1*

Slatted rack shelves shall be considered equivalent to solid rack shelves where the shelving is not considered open rack shelving or where the requirements of 17.6.3.1 are not met. *(See Section C.20 .)*

A.17.6.3.1.1

Slatting of decks or walkways or the use of open grating as a substitute for automatic sprinkler thereunder is not acceptable.

In addition, where shelving of any type is employed, it is for the basic purpose of providing an intermediate support between the structural members of the rack. As a result, it becomes almost impossible to define and maintain transverse flue spaces across the rack as required.

~~17.6.3.1.2~~

~~A wet pipe system that is designed to provide a minimum of 0.6 gpm/ft^2 (24.4 mm/min) density over a minimum area of 2000 ft^2 (186 m^2) or K-14.0 (200) ESFR sprinklers operating at a minimum of 50 psi (3.4 bar), K-16.8 (240) sprinklers operating at a minimum of 32 psi (2.2 bar), or K-25.2 (360) ESFR sprinklers operating at a minimum of 15 psi (1.0 bar) shall be permitted to protect single- and double-row racks with slatted rack shelving racks where all of the following conditions are met:~~

~~Sprinklers shall be K-11.2 (160), K-14.0 (200), or K-16.8 (240) orifice spray sprinklers with a temperature rating of ordinary, intermediate, or high and shall be listed for storage occupancies or shall be K-14.0 (200), K-16.8 (240), or K-25.2 (360) ESFR.~~

~~The protected commodities shall be limited to Class I through Class IV, Group B plastics, Group C plastics, cartoned (expanded and unexpanded) Group A plastics, and exposed (unexpanded) Group A plastics.~~

~~Slats in slatted rack shelving shall be a minimum nominal 2 in. (50 mm) thick by maximum nominal 6 in. (150 mm) wide with the slats held in place by spacers that maintain a minimum 2 in. (50 mm) opening between each slat.~~

~~Where K-11.2 (160), K-14.0 (200), or K-16.8 (240) orifice sprinklers are used, there shall be no slatted shelf levels in the rack above 12 ft (3.7 m). Open rack shelving using wire mesh shall be permitted for shelf levels above 12 ft (3.7 m).~~

~~Transverse flue spaces at least 3 in. (75 mm) wide shall be provided at least every 10 ft (3.0 m) horizontally.~~

~~Longitudinal flue spaces at least 6 in. (150 mm) wide shall be provided for double-row racks. Longitudinal flue spaces shall not be required when ESFR sprinklers are used.~~

~~The aisle widths shall be at least 7 ½ ft (2.3 m).~~

~~The maximum roof height shall be 27 ft (8.2 m) or 30 ft (9.1 m) where ESFR sprinklers are used.~~

~~The maximum storage height shall be 20 ft (6.1 m).~~

~~Solid plywood or similar materials shall not be placed on the slatted shelves so that they block the 2 in. (50 mm) spaces between slats, nor shall they be placed on the wire mesh shelves.~~

Submitter Information Verification

Submitter Full Name: AUT-HBS
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Mon Jun 26 09:31:19 EDT 2017

Committee Statement

Committee Statement: It appears that section 17.6 includes requirements from the 2016 edition, which were intended to be relocated to chapter 25 for in-rack sprinklers. The requirements of Section 17.6 have been relocated to 25.9.3 as Rack Storage of Group A Commodities Up To and Including 25 ft (7.6m) in Height

Response Message:

Public Comment No. 151-NFPA 13-2017 [Section No. 17.6]

Second Revision No. 17-NFPA 13-2017 [Section No. 18.1]

18.1* Protection of Piping Against Damage Where Subject to Earthquakes.

A.18.1

Sprinkler systems are protected against earthquake damage by means of the following:

(1) Stresses that would develop in the piping due to differential building movement are minimized through the use of flexible joints or clearances.

(2) Bracing is used to keep the piping fairly rigid when supported from a building component expected to move as a unit, such as a ceiling.

Areas known to have a potential for earthquakes have been identified in building code and insurance maps.

Displacement due to story drift is addressed in Sections 18.2 through 18.4 .

Piping in racks needs to be treated like other sprinkler piping and protected in accordance with the proper rules. Piping to which in-rack sprinklers are directly attached should be treated as branch line piping. Piping that connects branch lines in the racks should be treated as mains. The bracing, restraint, flexibility, and requirements for flexible couplings are the same in the rack structures as at the ceiling.

Cloud ceilings can cause challenges for a sprinkler system in an earthquake where sprinklers are installed below the clouds to protect the floor below. Depending on the support structure of the cloud and the construction material of the cloud, differential movement could damage a sprinkler that is not installed in a fashion to accommodate the movement. Currently, there are no structural requirements in ASCE/SEI 7, *Minimum Design Loads for Buildings and Other Structures* , for the clouds to be seismically braced. Unbraced cloud ceilings in higher seismic areas could easily displace during design earthquakes half the suspension length or more. One solution might be to use flexible sprinkler hose with the bracket connected to the cloud so that the sprinkler will move with the cloud should seismic motion occur provided the ceiling system is constructed per ASTM C635/C635M, *Standard Specification for the Manufacture, Performance, and Testing of Metal Suspension Systems of Acoustical Tile and Lay-In Panel Ceilings* , and ASTM C636/C636M, *Standard Practice for Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-In Panels* , then special connections could require an engineered design. When a sprinkler is rigidly piped to the cloud, appropriate flexibility and clearances should be maintained to handle the anticipated movement.

18.1.1

Where water-based fire protection systems are required to be protected against damage from earthquakes, the requirements of ~~Section~~ Chapter ~~18.1~~ 18 shall apply, unless the requirements of 18.1.2 are met.

18.1.2

Alternative methods of providing earthquake protection of sprinkler systems based on a seismic analysis certified by a registered professional engineer such that system performance will be at least equal to that of the building structure under expected seismic forces shall be permitted.

18.1.3 Obstructions to Sprinklers.

Braces and restraints shall not obstruct sprinklers and shall comply with the obstruction rules of Chapters ~~8~~ 10 through 14 .

Submitter Information Verification

Submitter Full Name: AUT-HBS

Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Tue Jul 11 14:47:05 EDT 2017

Committee Statement

Committee Statement: Restore previous annex language A.9.3.1 as A.18.1. Cloud ceilings are discussed in the installation section of NFPA 13. However, the materials of construction as well as the support system of a cloud can vary dramatically from one project to another. These variations will produce a different amount of movement. It is important to make sure that the fire sprinkler is installed in a way so that it is unlikely that the fire sprinkler will be damaged during an earthquake event. This language at least offers an awareness to the user that they need to be concerned about this interaction.

Response Message:

Second Revision No. 8-NFPA 13-2017 [Section No. 18.2.3.1]

18.2.3.1

The flexible couplings shall be installed as follows:

(1)* Within 24 in. (600 mm) of the top and bottom of all risers, unless the following provisions are met:

(a) In risers less than 3 ft (900 mm) in length, flexible couplings shall be permitted to be omitted.

(b) In risers 3 ft to 7 ft (900 mm to 2.1 m) in length, one flexible coupling shall be adequate.

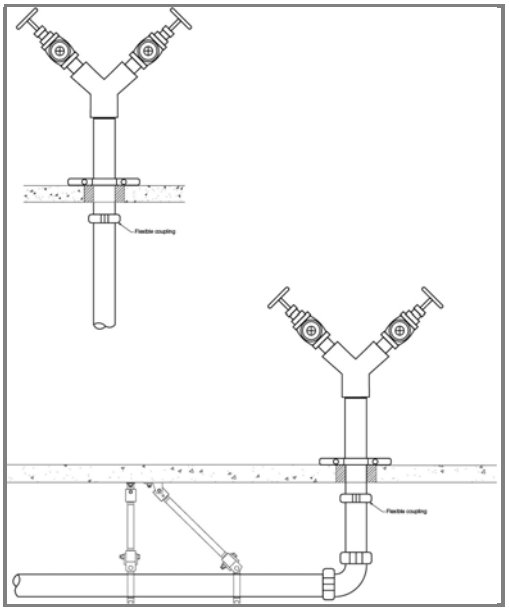
(2) Within 12 in. (300 mm) above and within 24 in. (600 mm) below the floor in multistory buildings, unless the following provision is met:

(a)* In risers up to 7 ft (2.1 m) in length terminating above the roof assembly or top landing, the flexible coupling shall not be required above the landing or roof assembly.

A.18.2.3.1(2)(a)

See Figure A.18.2.3.1(2)(a) .

Figure A.18.2.3.1(2)(a) Flexible Coupling on Upper Landing or Roof Assembly.



(3) On both sides of concrete or masonry walls within 1 ft (300 mm) of the wall surface, unless clearance is provided in accordance with Section 18.4

(4)* Within 24 in. (600 mm) of building expansion joints

(5) Within 24 in. (600 mm) of the top of drops exceeding 15 ft (4.6 m) in length to portions of systems supplying more than one sprinkler, regardless of pipe size

(6) Within 24 in. (600 mm) above and 24 in. (600 mm) below any intermediate points of support for a riser or other vertical pipe

Supplemental Information

File Name	Description	Approved

Figure_A.18.2.3.1_2_a_Flexible_Coupling_on_Upper_Landing_or_Roof.pdf	Figure A.18.2.3.1(2)(a) Flexible Coupling on Upper Landing or Roof Assembly. For staff use.
18.2.3.1.docx	For Clarity of list in 18.2.3.1 see attached word doc. For staff use.

Submitter Information Verification

Submitter Full Name: AUT-HBS
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Mon Jul 10 15:01:40 EDT 2017

Committee Statement

Committee Statement: When standpipe risers terminate at the top floor, the coupling above the floor level provides no benefit for the protection of pipe.

Response Message:

Public Comment No. 204-NFPA 13-2017 [Section No. 18.2.3.1]

Second Revision No. 6-NFPA 13-2017 [Section No. 18.4.1]

18.4.1*

Clearance shall be provided around all piping extending through walls, floors, platforms, and foundations, including drains, fire department connections, and other auxiliary piping.

A.18.4.1

Penetrations with or without clearance for seismic protection also need to meet building code requirements for fire resistance ratings as applicable.

Submitter Information Verification

Submitter Full Name: AUT-HBS
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Street Address:
City:
State:
Zip:
Submittal Date: Tue Jun 27 08:00:41 EDT 2017

Committee Statement

Committee Statement: Fire resistance ratings need to be considered in addition to seismic performance requirements. Use of annular openings around pipes or rigid pipe passing through an assembly with flexible couplings on either side would still be required to comply with fire resistance rating requirements of the building code.

Response Message:

Public Comment No. 152-NFPA 13-2017 [New Section after A.18.4]

Second Revision No. 5-NFPA 13-2017 [Sections 18.5.5.11.1, 18.5.5.11.2]

18.5.5.11.1

Branch lines shall comply with the following:

(1) The branch lines shall be individually supported by wraparound u-hooks or u-hooks arranged to keep pipe tight to the ~~underside of the~~ structural element provided the legs are bent out at least 30 degrees from the vertical and the maximum length of each leg and the rod size satisfies the conditions of Table 18.5.11.8(a), Table 18.5.11.8(b), and Table 18.5.11.8(c), or the length of the rod shall be calculated .

(2) At least 75 percent of all the hangers on the branch line shall meet the requirements of 18.5.5.11.2(1).

(3) Consecutive hangers on the branch line shall not be permitted to exceed the limitation in 18.5.5.11.2(1).

18.5.5.11.2

Mains shall comply with all the following:

(1) The main piping shall be individually supported by wraparound u-hooks or u-hooks arranged to keep pipe tight to the ~~underside of the~~ structural element provided the legs are bent out at least 30 degrees from the vertical and the maximum length of each leg and rod size satisfies the conditions of Table 18.5.11.8(a), Table 18.5.11.8(b), and Table 18.5.11.8(c).

(2) At least 75 percent of all the hangers on the main shall meet the requirements of 18.5.5.11.2(1).

(3) Consecutive hangers on the main shall not be permitted to exceed the limitation in 18.5.5.11.2(1).

(4) The seismic coefficient (C_p) shall not exceed 0.5.

(5) The nominal pipe diameter shall not exceed 6 in. (152 mm) for feed mains and 4 in. (102 mm) for cross mains.

(6) Hangers shall not be omitted in accordance with 17.4.4.3, 17.4.4.4, or 17.4.4.5.

Submitter Information Verification

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Organization: [Not Specified]
Street Address:
City:
State:
Zip:
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Committee Statement

Committee Statement: The pipe may be laid on top of the structural element. This would be common in sprinkler retrofit applications where a suspended ceiling is attached to the underside the the joists.

Response Message:

Public Comment No. 210-NFPA 13-2017 [Sections 18.5.5.11.1, 18.5.5.11.2]

Second Revision No. 7-NFPA 13-2017 [Section No. 18.5.8.1]

18.5.8.1*

Tops of risers exceeding 3 ft (900 mm) in length shall be provided with a four-way brace.

18.5.8.1.1*

The four-way brace shall not be required for risers up to 7 ft (2.1 m) in length that terminate above the roof assembly or top landing.

A.18.5.8.1.1

See Figure A.18.2.3.1(2)(a) .

Submitter Information Verification

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Organization: [Not Specified]
Street Address:
City:
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Zip:
Submittal Date: Tue Jun 27 10:13:24 EDT 2017

Committee Statement

Committee Statement: When fire department connections, standpipe risers, or similar terminate at the top floor or above the roof level, the four-way brace does not provide any benefit.

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Victaulic grooved products have consistently demonstrated the ability to withstand considerable forces during earthquakes. When exposed to bending forces, they have remained intact. A bending moment will occur when the joint deflects beyond its maximum allowable angular deflection.

Minimum Required Bending Moment at Coupling on Standard Wall Pipe

Coupling Size 4 in. - Bending Moment 3645 ft-lb

Coupling Size 6 in. - Bending Moment 7085 ft-lb

Response Message:

Public Comment No. 206-NFPA 13-2017 [Section No. 18.5.8.1]

Second Revision No. 12-NFPA 13-2017 [Section No. 18.5.12.2]

18.5.12.2*

For individual fasteners, unless alternative allowable loads are determined and certified by a registered professional engineer, the loads determined in 18.5.9 shall not exceed the allowable loads provided in Table 18.5.12.2(a) through Table 18.5.12.2(m) or 18.5.12.7.

Table 18.5.12.2(a) Maximum Load for Wedge Anchors in 3000 psi (207 bar) Lightweight Cracked Concrete on Metal Deck

Wedge Anchors in 3000 psi Sand Lightweight Cracked Concrete on 4 ½ in. Flute Wi									
Diameter (in.)	Min. Nom. Embedment (in.)	Min. Slab Thickness (in.)	Max. Flute Center Offset (in.)	A	B	C	D	E	F
				Pr ≤ 2.0	*Pr* ≤ 1.1	*Pr* ≤ 0.7	*Pr* ≤ 1.2	*Pr* ≤ 1.1	*Pr* ≤
⅜	2.375	6.25	1	123	183	233	—	—	—
½	3.750	6.25	1	147	231	310	—	—	—
⅝	3.875	6.25	1	188	292	387	—	—	—
¾	4.500	6.25	1	255	380	486			
Diameter (in.)	Min. Nom. Embedment (in.)	Min. Slab Thickness (in.)	Max. Flute Center Offset (in.)	A	B	C	D	E	F
				Pr 2.1–3.5	*Pr* 1.2–1.8	*Pr* 0.8–1.0	*Pr* 1.3–1.7	*Pr* 1.2–1.8	*Pr* 1.2-
⅜	2.375	6.25	1	79	133	193	—	—	—
½	3.750	6.25	1	86	160	247	—	—	—
⅝	3.875	6.25	1	113	204	311	—	—	—
¾	4.500	6.25	1	165	275	402	—	—	—
Diameter (in.)	Min. Nom. Embedment (in.)	Min. Slab Thickness (in.)	Max. Flute Center Offset (in.)	A	B	C	D	E	F
				Pr 3.6–5.0	*Pr* 1.9–2.5	*Pr* 1.1–1.3	*Pr* 1.8–2.2	*Pr* 1.9–2.5	*Pr* 2.1–2
⅜	2.375	6.25	1	56	104	165	—	—	—
½	3.750	6.25	1	60	121	205	—	—	—
⅝	3.875	6.25	1	79	157	260	—	—	—
¾	4.500	6.25	1	116	216	343	—	—	—
Diameter (in.)	Min. Nom. Embedment (in.)	Min. Slab Thickness (in.)	Max. Flute Center Offset (in.)	A	B	C	D	E	F
				Pr 5.1–6.5	*Pr* 2.6–3.2	*Pr* 1.4–1.6	*Pr* 2.3–2.7	*Pr* 2.6–3.2	*Pr* 3.0–3
⅜	2.375	6.25	1	43	85	144	—	—	—
½	3.750	6.25	1	46	94	175	—	—	—
⅝	3.875	6.25	1	60	124	224	—	—	—
¾	4.500	6.25	1	89	177	299	—	—	—

* *Pr* = Prying Factor Range. (Refer to Annex for additional information.)

Table 18.5.12.2(b) Maximum Load for Wedge Anchors in 3000 psi (207 bar) Lightweight Cracked Concrete

Wedge Anchors in 3000 psi Lightweight Cracked Concrete (lb)									
Diameter (in.)	Min. Nom. Embedment (in.)	Min. Slab Thickness (in.)	Min. Edge Distance (in.)	A	B	C	D	E	
				Pr ≤ 2.0	*Pr* ≤ 1.1	*Pr* ≤ 0.7	*Pr* ≤ 1.2	*Pr* ≤ 1.1	*Pr*

Wedge Anchors in 3000 psi Lightweight Cracked Concrete (lb)									
Diameter (in.)	Min. Nom. Embedment (in.)	Min. Slab Thickness (in.)	Min. Edge Distance (in.)	A	B	C	D	E	
				Pr ≤ 2.0	*Pr* ≤ 1.1	*Pr* ≤ 0.7	*Pr* ≤ 1.2	*Pr* ≤ 1.1	*Pr*
3/8	2.375	5	4	142	216	280	162	216	2
1/2	3.750	6	6	200	314	419	243	314	3
5/8	3.875	6	6	259	394	512	297	394	4
3/4	4.500	7	8	356	552	731	424	552	6
Diameter (in.)	Min. Nom. Embedment (in.)	Min. Slab Thickness (in.)	Min. Edge Distance (in.)	A	B	C	D	E	
				Pr 2.1–3.5	*Pr* 1.2–1.8	*Pr* 0.8–1.0	*Pr* 1.3–1.7	*Pr* 1.2–1.8	*Pr* 1
3/8	2.375	5	4	89	154	229	133	154	1
1/2	3.750	6	6	119	218	335	195	218	2
5/8	3.875	6	6	163	281	418	244	281	2
3/4	4.500	7	8	214	386	588	343	386	3
Diameter (in.)	Min. Nom. Embedment (in.)	Min. Slab Thickness (in.)	Min. Edge Distance (in.)	A	B	C	D	E	
				Pr 3.6–5.0	*Pr* 1.9–2.5	*Pr* 1.1–1.3	*Pr* 1.8–2.2	*Pr* 1.9–2.5	*Pr* 2
3/8	2.375	5	4	62	119	194	113	119	1
1/2	3.750	6	6	83	167	279	163	167	1
5/8	3.875	6	6	113	218	354	207	218	1
3/4	4.500	7	8	150	297	492	288	297	2
Diameter (in.)	Min. Nom. Embedment (in.)	Min. Slab Thickness (in.)	Min. Edge Distance (in.)	A	B	C	D	E	
				Pr 5.1–6.5	*Pr* 2.6–3.2	*Pr* 1.4–1.6	*Pr* 2.3–2.7	*Pr* 2.6–3.2	*Pr* 3
3/8	2.375	5	4	47	97	168	98	97	
1/2	3.750	6	6	63	130	239	140	130	1
5/8	3.875	6	6	87	178	306	179	178	1
3/4	4.500	7	8	115	234	422	248	234	1

* *Pr* = Prying Factor Range. (Refer to Annex for additional information.)

Table 18.5.12.2(c) Maximum Load for Wedge Anchors in 3000 psi (207 bar) Normal Weight Cracked Concrete

Wedge Anchors in 3000 psi Normal Weight Cracked Concrete (lb)										
Diameter (in.)	Min. Nom. Embedment (in.)	Min. Slab Thickness (in.)	Min. Edge Distance (in.)	A	B	C	D	E	F	G
				Pr ≤ 2.0	*Pr* ≤ 1.1	*Pr* ≤ 0.7	*Pr* ≤ 1.2	*Pr* ≤ 1.1	*Pr* ≤ 1.1	*Pr* ≤ 1.4
3/8	2.375	5	4	189	274	342	197	274	340	170
1/2	3.750	6	6	272	423	563	326	423	490	281
5/8	3.875	6	6	407	623	814	472	623	733	406
3/4	4.500	7	8	613	940	1232	715	940	1104	615
Diameter (in.)	Min. Nom. Embedment (in.)	Min. Slab Thickness (in.)	Min. Edge Distance (in.)	A	B	C	D	E	F	G
				Pr 2.1–3.5	*Pr* 1.2–1.8	*Pr* 0.8–1.0	*Pr* 1.3–1.7	*Pr* 1.2–1.8	*Pr* 1.2–2.0	*Pr* 1.5–1.9	1

Wedge Anchors in 3000 psi Normal Weight Cracked Concrete (lb)

Diameter (in.)	Min. Nom. Embedment (in.)	Min. Slab Thickness (in.)	Min. Edge Distance (in.)	A *Pr* ≤ 2.0	B *Pr* ≤ 1.1	C *Pr* ≤ 0.7	D *Pr* ≤ 1.2	E *Pr* ≤ 1.1	F *Pr* ≤ 1.1	G *Pr* ≤ 1.4
3/8	2.375	5	4	125	203	288	167	203	219	147
1/2	3.750	6	6	162	295	451	263	295	285	233
5/8	3.875	6	6	252	441	662	386	441	442	341
3/4	4.500	7	8	378	665	999	583	665	662	515

Diameter (in.)	Min. Nom. Embedment (in.)	Min. Slab Thickness (in.)	Min. Edge Distance (in.)	A *Pr* 3.6–5.0	B *Pr* 1.9–2.5	C *Pr* 1.1–1.3	D *Pr* 1.8–2.2	E *Pr* 1.9–2.5	F *Pr* 2.1–2.9	G *Pr* 2.0–2.4	1
3/8	2.375	5	4	92	162	249	145	162	159	130	
1/2	3.750	6	6	113	226	377	220	226	196	199	
5/8	3.875	6	6	176	341	557	326	341	304	293	
3/4	4.500	7	8	264	514	841	493	514	456	443	

Diameter (in.)	Min. Nom. Embedment (in.)	Min. Slab Thickness (in.)	Min. Edge Distance (in.)	A *Pr* 5.1–6.5	B *Pr* 2.6–3.2	C *Pr* 1.4–1.6	D *Pr* 2.3–2.7	E *Pr* 2.6–3.2	F *Pr* 3.0–3.8	G *Pr* 2.5–2.9	1
3/8	2.375	5	4	70	134	220	128	134	121	116	
1/2	3.750	6	6	87	178	323	190	178	149	173	
5/8	3.875	6	6	135	276	481	283	276	232	258	
3/4	4.500	7	8	203	413	725	426	413	348	389	

* *Pr* = Prying Factor Range. (Refer to Annex for additional information.)

Table 18.5.12.2(d) Maximum Load for Wedge Anchors in 4000 psi (276 bar) Normal Weight Cracked Concrete

Wedge Anchors in 4000 psi Normal Weight Cracked Concrete (lb)

Diameter (in.)	Min. Nom. Embedment (in.)	Min. Slab Thickness (in.)	Min. Edge Distance (in.)	A *Pr* ≤ 2.0	B *Pr* ≤ 1.1	C *Pr* ≤ 0.7	D *Pr* ≤ 1.2	E *Pr* ≤ 1.1	*Pr*
3/8	2.375	5	4	206	293	360	208	293	3
1/2	3.750	6	6	304	466	610	353	466	5
5/8	3.875	6	6	469	716	935	542	716	8
3/4	4.500	7	8	657	997	1293	750	997	1

Diameter (in.)	Min. Nom. Embedment (in.)	Min. Slab Thickness (in.)	Min. Edge Distance (in.)	A *Pr* 2.1–3.5	B *Pr* 1.2–1.8	C *Pr* 0.8–1.0	D *Pr* 1.3–1.7	E *Pr* 1.2–1.8	1.2
3/8	2.375	5	4	138	221	307	178	221	2
1/2	3.750	6	6	188	330	495	289	330	3
5/8	3.875	6	6	291	508	761	444	508	5
3/4	4.500	7	8	414	711	1057	617	711	7

Diameter (in.)	Min. Nom. Embedment (in.)	Min. Slab Thickness (in.)	Min. Edge Distance (in.)	A *Pr* 3.6–5.0	B *Pr* 1.9–2.5	C *Pr* 1.1–1.3	D *Pr* 1.8–2.2	E *Pr* 1.9–2.5	*Pr* 2

Wedge Anchors in 4000 psi Normal Weight Cracked Concrete (lb)									
Diameter (in.)	Min. Nom. Embedment (in.)	Min. Slab Thickness (in.)	Min. Edge Distance (in.)	A	B	C	D	E	
				Pr ≤ 2.0	*Pr* ≤ 1.1	*Pr* ≤ 0.7	*Pr* ≤ 1.2	*Pr* ≤ 1.1	*Pr*
3/8	2.375	5	4	103	177	268	156	177	1
1/2	3.750	6	6	131	255	417	244	255	2
5/8	3.875	6	6	203	393	641	375	393	3
3/4	4.500	7	8	289	553	894	524	553	5
Diameter (in.)	Min. Nom. Embedment (in.)	Min. Slab Thickness (in.)	Min. Edge Distance (in.)	A	B	C	D	E	
				Pr 5.1–6.5	*Pr* 2.6–3.2	*Pr* 1.4–1.6	*Pr* 2.3–2.7	*Pr* 2.6–3.2	*Pr* 3
3/8	2.375	5	4	80	148	237	139	148	1
1/2	3.750	6	6	100	205	360	211	205	1
5/8	3.875	6	6	156	319	554	325	319	2
3/4	4.500	7	8	222	452	774	455	452	3

* *Pr* = Prying Factor Range. (Refer to Annex for additional information.)

Table 18.5.12.2(e) Maximum Load for Wedge Anchors in 6000 psi (414 bar) Normal Weight Cracked Concrete

Wedge Anchors in 6000 psi Normal Weight Cracked Concrete (lb)									
Diameter (in.)	Min. Nom. Embedment (in.)	Min. Slab Thickness (in.)	Min. Edge Distance (in.)	A	B	C	D	E	
				Pr ≤ 2.0	*Pr* ≤ 1.1	*Pr* ≤ 0.7	*Pr* ≤ 1.2	*Pr* ≤ 1.1	*Pr*
3/8	2.375	5	4	225	313	379	219	313	4
1/2	3.750	6	6	354	529	676	392	529	6
5/8	3.875	6	6	546	812	1036	601	812	9
3/4	4.500	7	8	763	1127	1429	829	1127	1
Diameter (in.)	Min. Nom. Embedment (in.)	Min. Slab Thickness (in.)	Min. Edge Distance (in.)	A	B	C	D	E	
				Pr 2.1–3.5	*Pr* 1.2–1.8	*Pr* 0.8–1.0	*Pr* 1.3–1.7	*Pr* 1.2–1.8	*Pr* 1
3/8	2.375	5	4	153	240	327	190	240	2
1/2	3.750	6	6	228	382	559	326	382	4
5/8	3.875	6	6	353	589	859	500	589	6
3/4	4.500	7	8	496	822	1190	693	822	8
Diameter (in.)	Min. Nom. Embedment (in.)	Min. Slab Thickness (in.)	Min. Edge Distance (in.)	A	B	C	D	E	
				Pr 3.6–5.0	*Pr* 1.9–2.5	*Pr* 1.1–1.3	*Pr* 1.8–2.2	*Pr* 1.9–2.5	*Pr* 2
3/8	2.375	5	4	115	194	288	168	194	2
1/2	3.750	6	6	161	299	477	279	299	2
5/8	3.875	6	6	249	462	733	429	462	4
3/4	4.500	7	8	354	647	1019	596	647	6
Diameter (in.)	Min. Nom. Embedment (in.)	Min. Slab Thickness (in.)	Min. Edge Distance (in.)	A	B	C	D	E	
				Pr 5.1–6.5	*Pr* 2.6–3.2	*Pr* 1.4–1.6	*Pr* 2.3–2.7	*Pr* 2.6–3.2	*Pr* 3

Wedge Anchors in 6000 psi Normal Weight Cracked Concrete (lb)									
Diameter (in.)	Min. Nom. Embedment (in.)	Min. Slab Thickness (in.)	Min. Edge Distance (in.)	A	B	C	D	E	
				Pr ≤ 2.0	*Pr* ≤ 1.1	*Pr* ≤ 0.7	*Pr* ≤ 1.2	*Pr* ≤ 1.1	*Pr*
3/8	2.375	5	4	91	163	257	150	163	1
1/2	3.750	6	6	123	246	415	243	246	2
5/8	3.875	6	6	192	380	639	375	380	3
3/4	4.500	7	8	272	533	891	523	533	4

* *Pr* = Prying Factor Range. (Refer to Annex for additional information.)

Table 18.5.12.2(f) Maximum Load for Metal Deck Inserts in 3000 psi (207 bar) Lightweight Cracked Concrete on Metal Deck

Metal Deck Inserts in 3000 psi Sand Lightweight Cracked Concrete on 4 1/2 in. Flute W									
Diameter (in.)	Min. Effect. Embedment (in.)	Min. Slab Thickness (in.)	Max. Flute Center Offset (in.)	A	B	C	D	E	F
				Pr ≤ 2.0	*Pr* ≤ 1.1	*Pr* ≤ 0.7	*Pr* ≤ 1.2	*Pr* ≤ 1.1	*Pr* ≤
3/8	1.750	6.25	1	135	192	236	—	—	—
1/2	1.750	6.25	1	138	199	247	—	—	—
5/8	1.750	6.25	1	138	199	247	—	—	—
3/4	1.750	6.25	1	164	257	344			
Diameter (in.)	Min. Effect. Embedment (in.)	Min. Slab Thickness (in.)	Max. Flute Center Offset (in.)	A	B	C	D	E	F
				Pr 2.1–3.5	*Pr* 1.2–1.8	*Pr* 0.8–1.0	*Pr* 1.3–1.7	*Pr* 1.2–1.8	*Pr* 1.2
3/8	1.750	6.25	1	90	144	201	—	—	—
1/2	1.750	6.25	1	91	148	209	—	—	—
5/8	1.750	6.25	1	91	148	209	—	—	—
3/4	1.750	6.25	1	97	178	275	—	—	—
Diameter (in.)	Min. Effect. Embedment (in.)	Min. Slab Thickness (in.)	Max. Flute Center Offset (in.)	A	B	C	D	E	F
				Pr 3.6–5.0	*Pr* 1.9–2.5	*Pr* 1.1–1.3	*Pr* 1.8–2.2	*Pr* 1.9–2.5	*Pr* 2.1
3/8	1.750	6.25	1	67	115	175	—	—	—
1/2	1.750	6.25	1	67	118	181	—	—	—
5/8	1.750	6.25	1	67	118	181	—	—	—
3/4	1.750	6.25	1	67	136	229	—	—	—
Diameter (in.)	Min. Effect. Embedment (in.)	Min. Slab Thickness (in.)	Max. Flute Center Offset (in.)	A	B	C	D	E	F
				Pr 5.1–6.5	*Pr* 2.6–3.2	*Pr* 1.4–1.6	*Pr* 2.3–2.7	*Pr* 2.6–3.2	*Pr* 3.0
3/8	1.750	6.25	1	52	96	155	—	—	—
1/2	1.750	6.25	1	52	98	160	—	—	—
5/8	1.750	6.25	1	52	98	160	—	—	—
3/4	1.750	6.25	1	52	106	196	—	—	—

* *Pr* = Prying Factor Range. (Refer to Annex for additional information.)

Table 18.5.12.2(g) Maximum Load for Wood Form Inserts in 3000 psi (207 bar) Lightweight Cracked Concrete

				Wood Form Inserts in 3000 psi Lightweight Cracked Concrete (lb)					
Diameter (in.)	Min. Effect. Embedment (in.)	Min. Slab Thickness (in.)	Min. Edge Distance (in.)	A	B	C	D	E	
				Pr ≤ 2.0	*Pr* ≤ 1.1	*Pr* ≤ 0.7	*Pr* ≤ 1.2	*Pr* ≤ 1.1	*Pr*
3/8	1.100	4	6	224	316	387	223	316	4
1/2	1.690	4	6	252	376	480	278	376	4
5/8	1.750	4	8	252	376	480	278	376	4
3/4	1.750	4	8	252	376	480	278	376	4
Diameter (in.)	Min. Effect. Embedment (in.)	Min. Slab Thickness (in.)	Min. Edge Distance (in.)	A	B	C	D	E	
				Pr 2.1–3.5	*Pr* 1.2–1.8	*Pr* 0.8–1.0	*Pr* 1.3–1.7	*Pr* 1.2–1.8	*Pr* 1
3/8	1.100	4	6	150	239	331	192	239	2
1/2	1.690	4	6	163	272	398	231	272	2
5/8	1.750	4	8	163	272	398	231	272	2
3/4	1.750	4	8	163	272	398	231	272	2
Diameter (in.)	Min. Effect. Embedment (in.)	Min. Slab Thickness (in.)	Min. Edge Distance (in.)	A	B	C	D	E	
				Pr 3.6–5.0	*Pr* 1.9–2.5	*Pr* 1.1–1.3	*Pr* 1.8–2.2	*Pr* 1.9–2.5	*Pr* 2
3/8	1.100	4	6	113	193	290	169	193	1
1/2	1.690	4	6	115	213	339	198	213	1
5/8	1.750	4	8	115	213	339	198	213	1
3/4	1.750	4	8	115	213	339	198	213	1
Diameter (in.)	Min. Effect. Embedment (in.)	Min. Slab Thickness (in.)	Min. Edge Distance (in.)	A	B	C	D	E	
				Pr 5.1–6.5	*Pr* 2.6–3.2	*Pr* 1.4–1.6	*Pr* 2.3–2.7	*Pr* 2.6–3.2	*Pr* 3
3/8	1.100	4	6	88	161	257	150	161	1
1/2	1.690	4	6	88	175	296	173	175	1
5/8	1.750	4	8	88	175	296	173	175	1
3/4	1.750	4	8	88	175	296	173	175	1

* *Pr* = Prying Factor Range. (Refer to Annex for additional information.)

Table 18.5.12.2(h) Maximum Load for Wood Form Inserts in 3000 psi (207 bar) Normal Weight Cracked Concrete

				Wood Form Inserts in 3000 psi Normal Weight Cracked Concrete (l					
Diameter (in.)	Min. Effect. Embedment (in.)	Min. Slab Thickness (in.)	Min. Edge Distance (in.)	A	B	C	D	E	
				Pr ≤ 2.0	*Pr* ≤ 1.1	*Pr* ≤ 0.7	*Pr* ≤ 1.2	*Pr* ≤ 1.1	*Pr*
3/8	1.100	4	6	248	342	411	237	342	4
1/2	1.690	4	6	297	443	565	327	443	5
5/8	1.750	4	8	297	443	565	327	443	5
3/4	1.750	4	8	297	443	565	327	443	5

Wood Form Inserts in 3000 psi Normal Weight Cracked Concrete (l									
Diameter (in.)	Min. Effect. Embedment (in.)	Min. Slab Thickness (in.)	Min. Edge Distance (in.)	A	B	C	D	E	
				Pr ≤ 2.0	*Pr* ≤ 1.1	*Pr* ≤ 0.7	*Pr* ≤ 1.2	*Pr* ≤ 1.1	*Pr*
Diameter (in.)	Min. Effect. Embedment (in.)	Min. Slab Thickness (in.)	Min. Edge Distance (in.)	A	B	C	D	E	
				Pr 2.1–3.5	*Pr* 1.2–1.8	*Pr* 0.8–1.0	*Pr* 1.3–1.7	*Pr* 1.2–1.8	*Pr* 1
⅜	1.100	4	6	170	264	357	207	264	2
½	1.690	4	6	192	321	468	272	321	3
⅝	1.750	4	8	192	321	468	272	321	3
¾	1.750	4	8	192	321	468	272	321	3
Diameter (in.)	Min. Effect. Embedment (in.)	Min. Slab Thickness (in.)	Min. Edge Distance (in.)	A	B	C	D	E	
				Pr 3.6–5.0	*Pr* 1.9–2.5	*Pr* 1.1–1.3	*Pr* 1.8–2.2	*Pr* 1.9–2.5	*Pr* 2
⅜	1.100	4	6	129	215	315	184	215	2
½	1.690	4	6	135	251	399	233	251	2
⅝	1.750	4	8	135	251	399	233	251	2
¾	1.750	4	8	135	251	399	233	251	2
Diameter (in.)	Min. Effect. Embedment (in.)	Min. Slab Thickness (in.)	Min. Edge Distance (in.)	A	B	C	D	E	
				Pr 5.1–6.5	*Pr* 2.6–3.2	*Pr* 1.4–1.6	*Pr* 2.3–2.7	*Pr* 2.6–3.2	*Pr* 3
⅜	1.100	4	6	104	181	282	165	181	1
½	1.690	4	6	104	207	348	204	207	1
⅝	1.750	4	8	104	207	348	204	207	1
¾	1.750	4	8	104	207	348	204	207	1

* *Pr* = Prying Factor Range. (Refer to Annex for additional information.)

Table 18.5.12.2(i) Maximum Load for Wood Form Inserts in 4000 psi (276 bar) Normal Weight Cracked Concrete

Wood Form Inserts in 4000 psi Normal Weight Cracked Concrete (l									
Diameter (in.)	Min. Effect. Embedment (in.)	Min. Slab Thickness (in.)	Min. Edge Distance (in.)	A	B	C	D	E	
				Pr ≤ 2.0	*Pr* ≤ 1.1	*Pr* ≤ 0.7	*Pr* ≤ 1.2	*Pr* ≤ 1.1	*Pr*
⅜	1.100	4	6	270	364	431	249	364	4
½	1.690	4	6	335	493	623	361	493	6
⅝	1.750	4	8	344	511	653	378	511	6
¾	1.750	4	8	344	511	653	378	511	6
Diameter (in.)	Min. Effect. Embedment (in.)	Min. Slab Thickness (in.)	Min. Edge Distance (in.)	A	B	C	D	E	
				Pr 2.1–3.5	*Pr* 1.2–1.8	*Pr* 0.8–1.0	*Pr* 1.3–1.7	*Pr* 1.2–1.8	*Pr* 1
⅜	1.100	4	6	188	287	379	220	287	3
½	1.690	4	6	218	361	520	303	361	3
⅝	1.750	4	8	222	371	541	315	371	3
¾	1.750	4	8	222	371	541	315	371	3

Wood Form Inserts in 4000 psi Normal Weight Cracked Concrete (I									
Diameter (in.)	Min. Effect. Embedment (in.)	Min. Slab Thickness (in.)	Min. Edge Distance (in.)	A	B	C	D	E	
				Pr ≤ 2.0	*Pr* ≤ 1.1	*Pr* ≤ 0.7	*Pr* ≤ 1.2	*Pr* ≤ 1.1	*Pr*
Diameter (in.)	Min. Effect. Embedment (in.)	Min. Slab Thickness (in.)	Min. Edge Distance (in.)	A	B	C	D	E	
				Pr 3.6–5.0	*Pr* 1.9–2.5	*Pr* 1.1–1.3	*Pr* 1.8–2.2	*Pr* 1.9–2.5	*Pr* 2
⅜	1.100	4	6	145	236	338	197	236	2
½	1.690	4	6	157	284	446	261	284	2
⅝	1.750	4	8	157	290	461	270	290	2
¾	1.750	4	8	157	290	461	270	290	2
Diameter (in.)	Min. Effect. Embedment (in.)	Min. Slab Thickness (in.)	Min. Edge Distance (in.)	A	B	C	D	E	
				Pr 5.1–6.5	*Pr* 2.6–3.2	*Pr* 1.4–1.6	*Pr* 2.3–2.7	*Pr* 2.6–3.2	*Pr* 3
⅜	1.100	4	6	117	201	305	178	201	2
½	1.690	4	6	120	234	390	229	234	2
⅝	1.750	4	8	120	239	402	236	239	2
¾	1.750	4	8	120	239	402	236	239	2

* *Pr* = Prying Factor Range. (Refer to Annex for additional information.)

Table 18.5.12.2(j) Maximum Load for Wood Form Inserts in 6000 psi (414 bar) Normal Weight Cracked Concrete

Wood Form Inserts in 6000 psi Normal Weight Cracked Concrete (I									
Diameter (in.)	Min. Effect. Embedment (in.)	Min. Slab Thickness (in.)	Min. Edge Distance (in.)	A	B	C	D	E	
				Pr ≤ 2.0	*Pr* ≤ 1.1	*Pr* ≤ 0.7	*Pr* ≤ 1.2	*Pr* ≤ 1.1	*Pr*
⅜	1.100	4	6	302	395	458	264	395	5
½	1.690	4	6	385	551	680	394	551	6
⅝	1.750	4	8	421	627	800	463	627	7
¾	1.750	4	8	421	627	800	463	627	7
Diameter (in.)	Min. Effect. Embedment (in.)	Min. Slab Thickness (in.)	Min. Edge Distance (in.)	A	B	C	D	E	
				Pr 2.1–3.5	*Pr* 1.2–1.8	*Pr* 0.8–1.0	*Pr* 1.3–1.7	*Pr* 1.2–1.8	*Pr* 1
⅜	1.100	4	6	216	319	409	237	319	3
½	1.690	4	6	256	413	578	336	413	4
⅝	1.750	4	8	272	454	662	386	454	4
¾	1.750	4	8	272	454	662	386	454	4
Diameter (in.)	Min. Effect. Embedment (in.)	Min. Slab Thickness (in.)	Min. Edge Distance (in.)	A	B	C	D	E	
				Pr 3.6–5.0	*Pr* 1.9–2.5	*Pr* 1.1–1.3	*Pr* 1.8–2.2	*Pr* 1.9–2.5	*Pr* 2
⅜	1.100	4	6	169	267	370	215	267	2
½	1.690	4	6	192	330	503	293	330	3
⅝	1.750	4	8	192	356	565	331	356	3
¾	1.750	4	8	192	356	565	331	356	3

Wood Form Inserts in 6000 psi Normal Weight Cracked Concrete (l

Diameter (in.)	Min. Effect. Embedment (in.)	Min. Slab Thickness (in.)	Min. Edge Distance (in.)	A	B	C	D	E	
				Pr ≤ 2.0	*Pr* ≤ 1.1	*Pr* ≤ 0.7	*Pr* ≤ 1.2	*Pr* ≤ 1.1	*Pr*
Diameter (in.)	Min. Effect. Embedment (in.)	Min. Slab Thickness (in.)	Min. Edge Distance (in.)	A	B	C	D	E	
				Pr 5.1–6.5	*Pr* 2.6–3.2	*Pr* 1.4–1.6	*Pr* 2.3–2.7	*Pr* 2.6–3.2	*Pr* 3
⅜	1.100	4	6	138	229	337	196	229	2
½	1.690	4	6	147	275	445	260	275	2
⅝	1.750	4	8	147	293	493	289	293	2
¾	1.750	4	8	147	293	493	289	293	2

* *Pr* = Prying Factor Range. (Refer to Annex for additional information.)

~~Table 18.5.12.2(a) Maximum Load for Wedge Anchors in 3000 psi (207 bar) Lightweight Cracked Concrete on Metal Deck~~

~~Wedge Anchors in 3000 psi Lightweight Cracked Concrete on Metal Deck (lb)~~

~~Diameter (in.)~~	~~Embedment (in.)~~	~~A~~	~~B~~	~~C~~	~~D~~	~~E~~	~~F~~	~~G~~	~~H~~	~~I~~
		~~*Pr* * ≤2.0~~	~~*Pr* ≤1.1~~	~~*Pr* ≤0.7~~	~~*Pr* ≤1.2~~	~~*Pr* ≤1.1~~	~~*Pr* ≤1.1~~	~~*Pr* ≤1.4~~	~~*Pr* ≤0.9~~	~~*Pr* ≤0.8~~
~~⅜~~	~~2~~	~~117~~	~~184~~	~~246~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~
~~½~~	~~2 ⅜~~	~~164~~	~~257~~	~~344~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~
~~⅝~~	~~3 ⅛~~	~~214~~	~~326~~	~~424~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~
~~Diameter (in.)~~	~~Embedment (in.)~~	~~A~~	~~B~~	~~C~~	~~D~~	~~E~~	~~F~~	~~G~~	~~H~~	~~I~~
		~~*Pr* 2.1–3.5~~	~~*Pr* 1.2–1.8~~	~~*Pr* 0.8–1.0~~	~~*Pr* 1.3–1.7~~	~~*Pr* 1.2–1.8~~	~~*Pr* 1.2–2.0~~	~~*Pr* 1.5–1.9~~	~~*Pr* 1.0–1.3~~	~~*Pr* 0.9–1.1~~
~~⅜~~	~~2~~	~~69~~	~~127~~	~~196~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~
~~½~~	~~2 ⅜~~	~~97~~	~~178~~	~~274~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~
~~⅝~~	~~3 ⅛~~	~~133~~	~~232~~	~~346~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~
~~Diameter (in.)~~	~~Embedment (in.)~~	~~A~~	~~B~~	~~C~~	~~D~~	~~E~~	~~F~~	~~G~~	~~H~~	~~I~~
		~~*Pr* 3.6–5.0~~	~~*Pr* 1.9–2.5~~	~~*Pr* 1.1–1.3~~	~~*Pr* 1.8–2.2~~	~~*Pr* 1.9–2.5~~	~~*Pr* 2.1–2.9~~	~~*Pr* 2.0–2.4~~	~~*Pr* 1.4–1.7~~	~~*Pr* 1.2–1.4~~
~~⅜~~	~~2~~	~~48~~	~~97~~	~~163~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~
~~½~~	~~2 ⅜~~	~~67~~	~~136~~	~~228~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~
~~⅝~~	~~3 ⅛~~	~~93~~	~~179~~	~~292~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~
~~Diameter (in.)~~	~~Embedment (in.)~~	~~A~~	~~B~~	~~C~~	~~D~~	~~E~~	~~F~~	~~G~~	~~H~~	~~I~~
		~~*Pr* 5.1–6.5~~	~~*Pr* 2.6–3.2~~	~~*Pr* 1.4–1.6~~	~~*Pr* 2.3–2.7~~	~~*Pr* 2.6–3.2~~	~~*Pr* 3.0–3.8~~	~~*Pr* 2.5–2.9~~	~~*Pr* 1.8–2.1~~	~~*Pr* 1.5–1.7~~
~~⅜~~	~~2~~	~~36~~	~~75~~	~~139~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~
~~½~~	~~2 ⅜~~	~~51~~	~~106~~	~~196~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~
~~⅝~~	~~3 ⅛~~	~~71~~	~~146~~	~~252~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~

~~* *Pr* = Prying Factor Range. (Refer to Annex for additional information.)~~

~~1 lb = 0.45 kg~~

~~Table 18.5.12.2(c) Maximum Load for Wedge Anchors in 3000 psi (207 bar) Lightweight Cracked Concrete~~

Wedge Anchors in 3000 psi Lightweight Cracked Concrete (lb)

Diameter (in.)	Embedment (in.)	A	B	C	D	E	F	G	H	I
		Pr *	*Pr*	*Pr*	*Pr*	*Pr*	*Pr*	*Pr*	*Pr*	*Pr*
		≤2.0	≤1.1	≤0.7	≤1.2	≤1.1	≤1.1	≤1.4	≤0.9	≤0.8
3/8	2	102	144	175	101	144	184	87	128	152
1/2	2 3/8	140	196	238	137	196	251	118	174	207
5/8	3 1/4	222	308	372	215	308	397	220	272	323
3/4	4 1/8	327	469	580	336	469	586	289	426	504
		A	B	C	D	E	F	G	H	I
		Pr	*Pr*	*Pr*	*Pr*	*Pr*	*Pr*	*Pr*	*Pr*	*Pr*
Diameter (in.)	Embedment (in.)	2.1–3.5	1.2–1.8	0.8–1.0	1.3–1.7	1.2–1.8	1.2–2.0	1.5–1.9	1.0–1.3	0.9–1.1
3/8	2	69	109	150	87	109	121	76	110	133
1/2	2 3/8	94	149	205	119	149	166	104	150	181
5/8	3 1/4	151	237	322	187	237	265	201	236	285
3/4	4 1/8	217	351	492	286	351	380	252	362	436
		A	B	C	D	E	F	G	H	I
		Pr	*Pr*	*Pr*	*Pr*	*Pr*	*Pr*	*Pr*	*Pr*	*Pr*
Diameter (in.)	Embedment (in.)	3.6–5.0	1.9–2.5	1.1–1.3	1.8–2.2	1.9–2.5	2.1–2.9	2.0–2.4	1.4–1.7	1.2–1.4
3/8	2	52	88	132	76	88	90	68	97	118
1/2	2 3/8	71	121	180	104	121	124	93	132	161
5/8	3 1/4	114	192	284	165	192	198	185	208	254
3/4	4 1/8	162	280	427	249	280	281	223	315	385
		A	B	C	D	E	F	G	H	I
		Pr	*Pr*	*Pr*	*Pr*	*Pr*	*Pr*	*Pr*	*Pr*	*Pr*
Diameter (in.)	Embedment (in.)	5.1–6.5	2.6–3.2	1.4–1.6	2.3–2.7	2.6–3.2	3.0–3.8	2.5–2.9	1.8–2.1	1.5–1.7
3/8	2	41	74	117	68	74	70	61	86	106
1/2	2 3/8	56	101	160	93	101	97	84	118	145
5/8	3 1/4	91	161	253	148	161	157	172	186	230
3/4	4 1/8	124	233	378	221	233	214	200	279	344

* *Pr* = Prying Factor Range. (Refer to Annex for additional information.)

1 lb = 0.45 kg

Table 18.5.12.2(e) Maximum Load for Wedge Anchors in 3000 psi (207 bar) Normal Weight Cracked Concrete

Wedge Anchors in 3000 psi Normal Weight Cracked Concrete (lb)

Diameter (in.)	Embedment (in.)	A	B	C	D	E	F	G	H	I
		Pr *	*Pr*	*Pr*	*Pr*	*Pr*	*Pr*	*Pr*	*Pr*	*Pr*
		≤2.0	≤1.1	≤0.7	≤1.2	≤1.1	≤1.1	≤1.4	≤0.9	≤0.8
3/8	2	171	240	292	169	240	307	145	214	254
1/2	3 5/8	412	567	682	394	567	735	340	498	592
5/8	3 7/8	480	668	809	468	668	859	479	591	703
3/4	4 1/8	545	780	965	559	780	976	482	709	839
		A	B	C	D	E	F	G	H	I
		Pr	*Pr*	*Pr*	*Pr*	*Pr*	*Pr*	*Pr*	*Pr*	*Pr*
Diameter (in.)	Embedment (in.)	2.1–3.5	1.2–1.8	0.8–1.0	1.3–1.7	1.2–1.8	1.2–2.0	1.5–1.9	1.0–1.3	0.9–1.1

Wedge Anchors in 3000 psi Normal Weight Cracked Concrete (lb)

3/8	2	116	183	252	146	183	203	128	184	223
1/2	3 5/8	282	438	592	344	438	493	302	434	523
5/8	3 7/8	327	512	699	406	512	571	438	512	618
3/4	4 1/8	363	584	819	477	584	634	420	604	727
		A	B	C	D	E	F	G	H	I
Diameter (in.)	Embedment (in.)	Pr 3.6–5.0	Pr 1.9–2.5	Pr 1.1–1.3	Pr 1.8–2.2	Pr 1.9–2.5	Pr 2.1–2.9	Pr 2.0–2.4	Pr 1.4–1.7	Pr 1.2–1.4
3/8	2	87	148	221	128	148	152	114	162	198
1/2	3 5/8	214	357	523	305	357	371	271	384	469
5/8	3 7/8	247	415	615	359	415	428	404	452	551
3/4	4 1/8	271	467	712	416	467	468	371	526	641
		A	B	C	D	E	F	G	H	I
Diameter (in.)	Embedment (in.)	Pr 5.1–6.5	Pr 2.6–3.2	Pr 1.4–1.6	Pr 2.3–2.7	Pr 2.6–3.2	Pr 3.0–3.8	Pr 2.5–2.9	Pr 1.8–2.1	Pr 1.5–1.7
3/8	2	69	124	197	115	124	118	103	145	178
1/2	3 5/8	173	301	469	274	301	296	247	345	425
5/8	3 7/8	197	349	549	321	349	337	374	404	498
3/4	4 1/8	208	389	629	369	389	357	333	465	573

* *Pr* = Prying Factor Range. (Refer to Annex for additional information.)

1 lb = 0.45 kg

Table 18.5.12.2(e) Maximum Load for Wedge Anchors in 4000 psi (276 bar) Normal Weight Cracked Concrete

Wedge Anchors in 4000 psi Normal Weight Cracked Concrete (lb)

		A	B	C	D	E	F	G	H	I
Diameter (in.)	Embedment (in.)	Pr * ≤2.0	Pr ≤1.1	Pr ≤0.7	Pr ≤1.2	Pr ≤1.1	Pr ≤1.1	Pr ≤1.4	Pr ≤0.9	Pr ≤0.8
3/8	2	200	282	344	199	282	359	171	251	299
1/2	3 5/8	430	607	742	430	607	770	370	544	645
5/8	3 7/8	532	729	872	505	729	950	511	636	758
3/4	4 1/8	630	903	1117	647	903	1129	558	821	971
		A	B	C	D	E	F	G	H	I
Diameter (in.)	Embedment (in.)	Pr 2.1–3.5	Pr 1.2–1.8	Pr 0.8–1.0	Pr 1.3–1.7	Pr 1.2–1.8	Pr 1.2–2.0	Pr 1.5–1.9	Pr 1.0–1.3	Pr 0.9–1.1
3/8	2	135	214	295	171	214	236	150	216	261
1/2	3 5/8	289	460	636	370	460	506	325	467	563
5/8	3 7/8	367	566	760	442	566	642	470	557	672
3/4	4 1/8	419	676	948	552	676	733	486	699	841
		A	B	C	D	E	F	G	H	I
Diameter (in.)	Embedment (in.)	Pr 3.6–5.0	Pr 1.9–2.5	Pr 1.1–1.3	Pr 1.8–2.2	Pr 1.9–2.5	Pr 2.1–2.9	Pr 2.0–2.4	Pr 1.4–1.7	Pr 1.2–1.4
3/8	2	101	172	258	150	172	176	134	190	232
1/2	3 5/8	218	370	556	325	370	377	290	410	500
5/8	3 7/8	280	463	674	393	463	484	435	494	603

Wedge Anchors in 4000 psi Normal Weight Cracked Concrete (lb)

3/4	4 1/8	313	540	824	481	540	541	430	608	741
		A	B	C	D	E	F	G	H	I
Diameter (in.)	Embedment (in.)	Pr 5.1–6.5	Pr 2.6–3.2	Pr 1.4–1.6	Pr 2.3–2.7	Pr 2.6–3.2	Pr 3.0–3.8	Pr 2.5–2.9	Pr 1.8–2.1	Pr 1.5–1.7
3/8	2	79	144	230	134	144	137	121	169	209
1/2	3 5/8	170	310	494	289	310	292	261	365	449
5/8	3 7/8	226	391	605	354	391	389	406	445	547
3/4	4 1/8	241	449	728	427	449	413	386	538	663

* *Pr* = Prying Factor Range. (Refer to Annex for additional information.)

1 lb = 0.45 kg

Table 18.5.12.2(k) Maximum Load for Wedge Anchors in 6000 psi (414 bar) Normal Weight Cracked Concrete

Wedge Anchors in 6000 psi Normal Weight Cracked Concrete (lb)

		A	B	C	D	E	F	G	H	I
Diameter (in.)	Embedment (in.)	Pr * ≤2.0	Pr ≤1.1	Pr ≤0.7	Pr ≤1.2	Pr ≤1.1	Pr ≤1.1	Pr ≤1.4	Pr ≤0.9	Pr ≤0.8
3/8	2 1/4	254	354	428	199	354	585	213	313	372
1/2	3 5/8	527	744	910	418	744	1227	454	667	791
5/8	3 7/8	652	893	1069	504	893	1481	626	780	928
3/4	4 1/8	772	1106	1369	622	1106	1819	684	1005	1190
		A	B	C	D	E	F	G	H	I
Diameter (in.)	Embedment (in.)	Pr 2.1–3.5	Pr 1.2–1.8	Pr 0.8–1.0	Pr 1.3–1.7	Pr 1.2–1.8	Pr 1.2–2.0	Pr 1.5–1.9	Pr 1.0–1.3	Pr 0.9–1.1
3/8	2 1/4	172	271	370	215	271	302	188	271	327
1/2	3 5/8	355	564	780	453	564	621	399	573	690
5/8	3 7/8	450	694	932	542	694	786	576	682	823
3/4	4 1/8	514	828	1162	676	828	898	595	856	1030
		A	B	C	D	E	F	G	H	I
Diameter (in.)	Embedment (in.)	Pr 3.6–5.0	Pr 1.9–2.5	Pr 1.1–1.3	Pr 1.8–2.2	Pr 1.9–2.5	Pr 2.1–2.9	Pr 2.0–2.4	Pr 1.4–1.7	Pr 1.2–1.4
3/8	2 1/4	130	219	325	189	219	226	169	239	292
1/2	3 5/8	267	454	682	398	454	462	355	502	613
5/8	3 7/8	343	567	826	481	567	593	534	606	739
3/4	4 1/8	384	662	1009	590	662	663	527	745	909
		A	B	C	D	E	F	G	H	I
Diameter (in.)	Embedment (in.)	Pr 5.1–6.5	Pr 2.6–3.2	Pr 1.4–1.6	Pr 2.3–2.7	Pr 2.6–3.2	Pr 3.0–3.8	Pr 2.5–2.9	Pr 1.8–2.1	Pr 1.5–1.7
3/8	2 1/4	103	184	290	170	184	178	153	214	263
1/2	3 5/8	209	380	606	355	380	358	320	447	551
5/8	3 7/8	277	480	741	433	480	476	497	545	671
3/4	4 1/8	295	551	892	523	551	506	473	660	813

* *Pr* = Prying Factor Range. (Refer to Annex for additional information.)

1 lb = 0.45 kg

Table 18.5.12.2(l) Maximum Load for Undercut Anchors in 3000 psi (207 bar) Normal Weight Cracked Concrete

Undercut Anchors in 3000 psi Normal Weight Cracked Concrete (lb)										
Diameter (in.)	Embedment (in.)	A	B	C	D	E	F	G	H	I
		Pr *	*Pr*	*Pr*	*Pr*	*Pr*	*Pr*	*Pr*	*Pr*	*Pr*
		≤2.0	≤1.1	≤0.7	≤1.2	≤1.1	≤1.1	≤1.4	≤0.9	≤0.8
3/8	4 3/8	501	638	726	420	638	889	362	525	630
1/2	7	700	911	1051	608	911	1245	525	761	912
5/8	9 1/2	1106	1535	1855	1074	1535	1975	1098	1356	1612
3/4	12	1701	2404	2946	1707	2404	3041	1472	2161	2561
Diameter (in.)	Embedment (in.)	A	B	C	D	E	F	G	H	I
		Pr	*Pr*	*Pr*	*Pr*	*Pr*	*Pr*	*Pr*	*Pr*	*Pr*
		2.1–3.5	1.2–1.8	0.8–1.0	1.3–1.7	1.2–1.8	1.2–2.0	1.5–1.9	1.0–1.3	0.9–1.1
3/8	4 3/8	368	526	658	381	526	643	333	477	578
1/2	7	505	738	942	547	738	882	479	685	829
5/8	9 1/2	754	1179	1604	933	1179	1318	1005	1177	1419
3/4	12	1143	1819	2520	1468	1819	1996	1291	1854	2233
Diameter (in.)	Embedment (in.)	A	B	C	D	E	F	G	H	I
		Pr	*Pr*	*Pr*	*Pr*	*Pr*	*Pr*	*Pr*	*Pr*	*Pr*
		3.6–5.0	1.9–2.5	1.1–1.3	1.8–2.2	1.9–2.5	2.1–2.9	2.0–2.4	1.4–1.7	1.2–1.4
3/8	4 3/8	291	447	601	350	447	504	309	437	534
1/2	7	395	620	854	497	620	683	440	622	760
5/8	9 1/2	572	957	1413	825	957	989	927	1039	1268
3/4	12	860	1463	2202	1287	1463	1486	1149	1624	1980
Diameter (in.)	Embedment (in.)	A	B	C	D	E	F	G	H	I
		Pr	*Pr*	*Pr*	*Pr*	*Pr*	*Pr*	*Pr*	*Pr*	*Pr*
		5.1–6.5	2.6–3.2	1.4–1.6	2.3–2.7	2.6–3.2	3.0–3.8	2.5–2.9	1.8–2.1	1.5–1.7
3/8	4 3/8	241	389	554	323	389	414	287	403	496
1/2	7	324	535	780	455	535	557	407	570	701
5/8	9 1/2	456	806	1263	739	806	781	859	931	1145
3/4	12	670	1223	1955	1146	1223	1147	1035	1444	1778

* *Pr* = Prying Factor Range. (Refer to Annex for additional information.)

1 lb = 0.45 kg

Table 18.5.12.2(k) Maximum Load for Connections to Steel Using Unfinished Steel Bolts

Connections to Steel (Values Assume Bolt Perpendicular to Mounting Surface																		
Diameter of Unfinished Steel Bolt (in.)																		
1/4									3/8									
A	B	C	D	E	F	G	H	I	A	B	C	D	E	F	G	H	I
400	500	600	300	500	650	325	458	565	900	1200	1400	800	1200	1550	735	1035	1278
Diameter of Unfinished Steel Bolt (in.)																		
1/2									5/8									
A	B	C	D	E	F	G	H	I	A	B	C	D	E	F	G	H	I
1600	2050	2550	1450	2050	2850	1300	1830	2260	2500	3300	3950	2250	3300	4400	2045	2880	3557

Table 18.5.12.2(l) Maximum Load for Through-Bolts in Sawn Lumber or Glue-Laminated Timbers

Through-Bolts in Sawn Lumber or Glue-Laminated Timbers (Load Perpendicular to Gra

Length of Bolt in Timber (in.)		Bolt Diameter (in.)																								
		½									⅝										¾					
		A	B	C	D	E	F	G	H	I	A	B	C	D	E	F	G	H	I	A	B	C	D	E
	1½	115	165	200	135	230	395	130	215	310	135	190	235	155	270	460	155	255	380	155	220	270	180	31(
	2½	140	200	240	160	280	480	165	275	410	160	225	280	185	320	550	190	320	495	180	255	310	205	36(
	3½	175	250	305	200	350	600	200	330	485	200	285	345	230	400	685	235	405	635	220	310	380	255	44(
	5½	—	—	—	—	—	—	—	—	—	280	395	485	325	560	960	315	515	735	310	440	535	360	62(

Note: Wood fastener maximum capacity values are based on the 2001 National Design Specifications (NDS) for wood with a specific gravity of 0.35. Values for other types of wood can be obtained by multiplying the above values by the factors in ~~Table 9.3.5.12.2(j)~~ Table 18.5.12.2(n). .

Table 18.5.12.2(m) Maximum Load for Lag Screws and Lag Bolts in Wood

Lag Screws and Lag Bolts in Wood (Load Perpendicular to Grain — Holes Predrilled Using Good

Length of Bolt in Timber (in.)		Lag Bolt Diameter (in.)																								
		½									⅝										¾					
		A	B	C	D	E	F	G	H	I	A	B	C	D	E	F	G	H	I	A	B	C	D	E
	3½	165	190	200	170	220	310	80	120	170	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	4½	180	200	200	175	235	350	80	120	170	300	355	380	315	400	550	145	230	325	—	—	—	—	—
	5½	190	200	200	175	245	380	80	120	170	320	370	380	320	420	610	145	230	325	435	525	555	425	550
	6½	195	205	200	175	250	400	80	120	170	340	375	380	325	435	650	145	230	325	465	540	555	430	570

Note: Wood fastener maximum capacity values are based on the 2001 National Design Specifications (NDS) for wood with a specific gravity of 0.35. Values for other types of wood can be obtained by multiplying the above values by the factors in ~~Table 9.3.5.12.2(j)~~ Table 18.5.12.2(n). .

Table 18.5.12.2(n) Factors for Wood Based on Specific Gravity

Specific Gravity of Wood	Multiplier
0.36 thru 0.49	1.17
0.50 thru 0.65	1.25
0.66 thru 0.73	1.50

Supplemental Information

File Name	Description	Approved
Tables_18.5.12.2_a-j.pdf	New Table 18.5.12.2(a) through Table 18.5.12.2(j). For staff use.	

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Committee Statement

Committee Statement: Tables have been revised to reflect recalculated shear and tension values supplied by several concrete anchor manufacturers. New tables have been added to address concrete inserts. Renumber remaining tables.

Response Message:

Second Revision No. 10-NFPA 13-2017 [Section No. 18.5.12.7.1]

18.5.12.7.1*

~~Concrete~~ Post-installed concrete anchors shall be prequalified for seismic applications in accordance with ACI 355.2, *Qualification of Post-Installed Mechanical Anchors in Concrete and Commentary*, and installed in accordance with the manufacturer's instructions.

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Committee Statement

Committee Statement: Editorial revision.
Response Message:

Second Revision No. 11-NFPA 13-2017 [New Section after 18.5.12.7.4]

18.5.12.7.5

Headed cast-in specialty inserts (concrete inserts) as prescribed in Table 18.5.12.2(a) through Table 18.5.12.2(j) shall be prequalified for seismic applications in accordance with ICC-ES AC446, *Acceptance Criteria for Headed Cast-in Specialty Inserts in Concrete* , and installed in accordance with the manufacturer's instructions.

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Committee Statement

Committee Statement: The added text gives descriptive information for concrete inserts that have been added to Table 18.5.12.2(a) through Table 18.5.12.2(j).
Response Message:

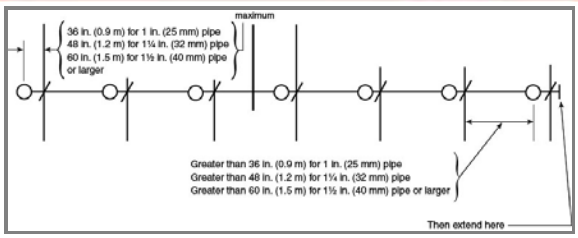
Second Revision No. 1032-NFPA 13-2017 [Section No. A.17.4.3.4]

A.17.4.3.4

Sprinkler piping should be adequately secured to restrict the movement of piping upon sprinkler operation. The reaction forces caused by the flow of water through the sprinkler could result in displacement of the sprinkler, thereby adversely affecting sprinkler discharge. Listed CPVC pipe has specific requirements for piping support to include additional pipe bracing of sprinklers. *(See Figure A.17.4.3.4.)*

Figure A.17.4.3.4 Distance from Sprinkler to Hanger.





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Committee Statement: Editorial.
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A.17.4.3.4.4

See Figure A.17.4.3.4.4(a) and Figure A.17.4.3.4.4(b).

Figure A.17.4.3.4.4(a) Distance from Sprinkler to Hanger Where Maximum Pressure Exceeds 100 psi (6.9 bar) and Branch Line Above Ceiling Supplies Pendent Sprinklers Below Ceiling.

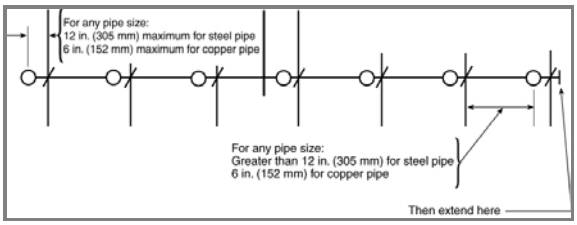
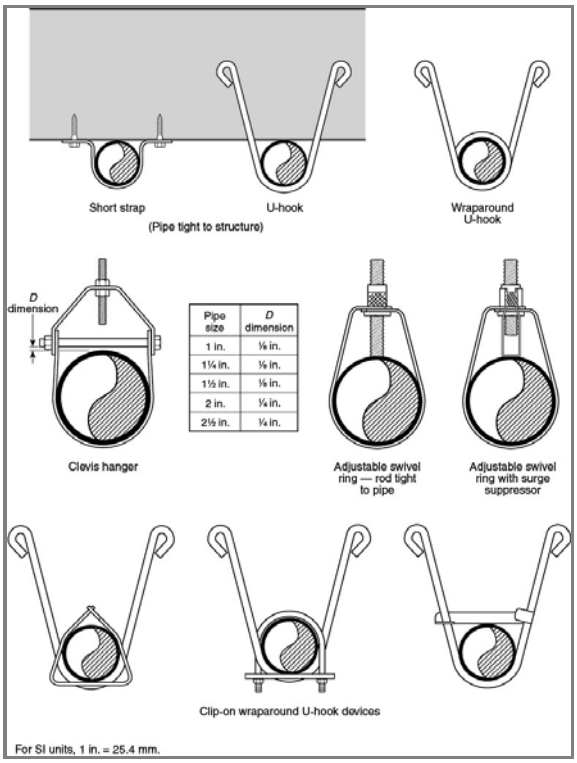


Figure A.17.4.3.4.4(b) Examples of Acceptable Hangers for End-of-Line (or Armover) Pendent Sprinklers.



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A.18.5.7.2

See Figure A.18.5.7.2.

Figure A.18.5.7.2 Examples of Brace Locations for Change in Direction of Pipe.



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Second Revision No. 13-NFPA 13-2017 [Section No. A.18.5.12]

A.18.5.12

~~Current fasteners for anchoring to concrete are referred to as post-installed anchors.~~ Concrete anchors can be cast-in-place [installed before the concrete is placed — see Figure A.18.5.12(a) and Figure A.18.5.12(b)] or post-installed [installed in hardened concrete — see Figure A.18.5.12(c)]. Examples of cast-in-place concrete anchors are embedded steel bolts or concrete inserts. There are several types of post-installed anchors, including expansion anchors, chemical or adhesive anchors, and undercut anchors. The criteria in Table 18.5.12.2(a) through ~~Table 18.5.12.2(l)~~ Table 18.5.12.2(j) are based on the use of listed cast-in-place concrete inserts and listed post-installed wedge expansion anchors ~~and undercut anchors~~ . The values for “effective embedment” for cast-in-place anchors and “nominal embedment” for post-installed anchors as shown in the tables represent the majority of commonly available anchors on the market at the time of publishing. Use of other anchors in concrete should be in accordance with the listing provisions of the anchor. Anchorage designs are usable under allowable stress design (ASD) methods.

Values in Table 18.5.12.2(a) through ~~Table 18.5.12.2(l)~~ Table 18.5.12.2(j) are based on ultimate strength design values obtained using the procedures in ACI 318, ~~Appendix D~~ *Building Code Requirements for Structural Concrete and Commentary* , Chapter 17 , which are then adjusted for ASD. Concrete inserts are installed into wood forms for concrete members using fasteners prior to the casting of concrete or inserted into wood forms for concrete members using fasteners prior to the casting of concrete or inserted into a hole cut in steel deck that will be filled with concrete topping slab. A bolt or rod can be installed into the internally threaded concrete insert after the wood form is removed from the concrete or from the underside of the steel deck after it is filled with concrete topping slab. Wedge anchors are torque-controlled expansion anchors that are set by applying a torque to the anchor's nut, which causes the anchor to rise while the wedge stays in place. This causes the wedge to be pulled onto a coned section of the anchor and presses the wedge against the wall of the hole. Undercut anchors might or might not be torque-controlled. Typically, the main hole is drilled, a special second drill bit is inserted into the hole, and flare is drilled at the base of the main hole. Some anchors are self-drilling and do not require a second drill bit. The anchor is then inserted into the hole, and when torque is applied, the bottom of the anchor flares out into the flared hole, and a mechanical lock is obtained. Consideration should be given with respect to the position near the edge of a slab and the spacing of anchors. For full capacity in Table 18.5.12.2(a) through Table 18.5.12.2(j), the edge distance spacing between anchors and the thickness of concrete should conform to the anchor manufacturer’s recommendations.

Calculation of ASD shear and tension values to be used in A.18.5.12.2 calculations should be performed in accordance with ACI 318, Chapter 17 formulas using the variables and recommendations obtained from the approved evaluation service reports (such as ICC-ES Reports) for a particular anchor, which should then be adjusted to ASD values. All post-installed concrete anchors must be prequalified in accordance with ACI 355.2, *Qualification of Post-Installed Mechanical Anchors in Concrete and Commentary*, or other approved qualification procedures (ASCE/SEI 7, *Minimum Design Loads for Buildings and Other Structures* , Section 13.4.2.3). This information is usually available from the anchor manufacturer.

The following variables ~~below~~ are among those contained in the approved evaluation reports for use in ACI 318, Chapter 17 calculations. These variables do not include the allowable tension and shear capacities but do provide the information needed to calculate them. The strength design capacities must be calculated using the appropriate procedures in ACI 318, Chapter 17, and then converted to allowable stress design capacities.

D_a = ~~Anchor~~ anchor diameter

L_{anch} = total anchor length

h_{nom}= ~~Nominal~~ nominal embedment

h_{ef} = ~~Effective~~ effective embedment

h_{min} = ~~Min.~~ minimum concrete thickness

C_{ac} = ~~Critical~~ critical edge distance

N_{sa} = ~~Steel~~ steel strength in tension

l_e = ~~Length~~ length of anchor in shear

$N_{p,cr}$ = ~~Pull~~ pull -out strength cracked concrete

K_{cp} = ~~Coefficient~~ coefficient for pryout strength

$V_{sa,eq}$ = ~~Shear~~ shear strength single anchor seismic loads

$V_{st.deck,eq}$ = ~~Shear~~ shear strength single anchor seismic loads installed through the soffit of the metal deck

Figure A.18.5.12(a) Metal Deck Insert.

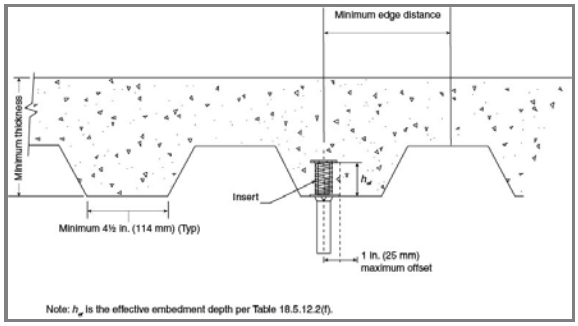


Figure A.18.5.12(b) Wood Form Insert.

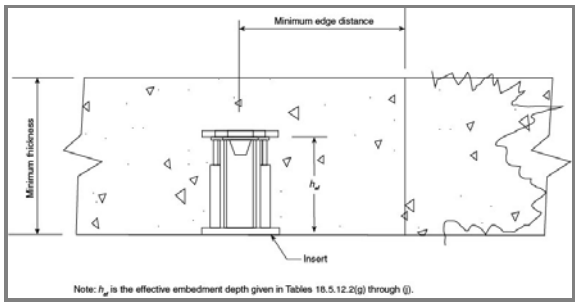
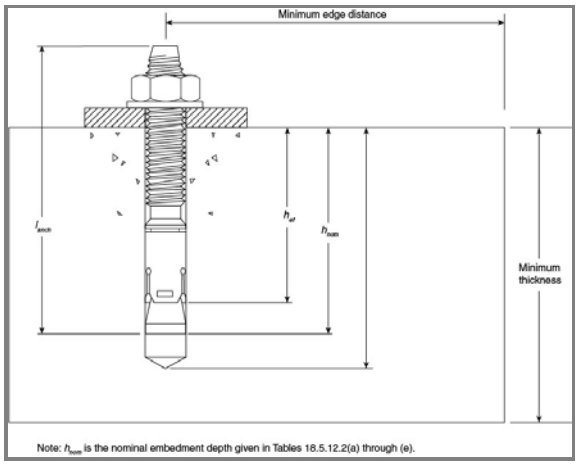


Figure A.18.5.12(c) Wedge Anchor.



Supplemental Information

File Name	Description	Approved
Metal_Deck_Rev19Jun_4pm_Fig_A.JPG	Figure A-for staff use	
Wood_Form_Insert_Rev19Jun_4pm_Fig_B.JPG	Figure B--for staff use	
Wedge_Anchor_Rev19Jun_4pm_Fig_C.JPG	Figure C---for staff use	

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Response Message:

Second Revision No. 14-NFPA 13-2017 [Section No. A.18.5.12.2]

A.18.5.12.2

The values for the concrete insert and wedge anchor tables ~~and the undercut anchor tables~~ have been developed using the following formula:

$$\left(\frac{T}{T_{allow}}\right)+\left(\frac{T}{V_{allow}}\right)\leq 1.2 \qquad \textbf{[A.18.5.12.2a]}$$

where:

T = applied service tension load, including the effect of prying ($F_{pw} \times Pr$)

F_{pw} = horizontal earthquake load

Pr = prying factor based on fitting geometry and brace angle from vertical

T_{allow} = allowable service tension load

V = applied service shear load

V_{allow} = allowable service shear load

T/T_{allow} = shall not be greater than 1.0.

V/V_{allow} = shall not be greater than 1.0.

The allowable tension and shear loads come from the anchor manufacturer's published data. The design loads have been amplified by an overstrength factor of 2.0, and the allowable strength of the anchors has been increased by a factor of 1.2. The effect of prying on the tension applied to the anchor is considered when developing appropriate capacity values. The applied tension equation includes the prying effect, which varies with the orientation of the fastener in relationship to the brace necessary at various brace angles. The letters A through D in the following equations are dimensions of the attachment geometry as indicated in Figure A.18.5.12.2(a) through Figure A.18.5.12.2(c).

where:

Cr = critical angle at which prying flips to the toe or the heel of the structure attachment fitting

Pr = prying factor for service tension load effect of prying

*Tan*θ = tangent of brace angle from vertical

*Sin*θ = sine of brace angle from vertical

The greater *Pr* value calculated in tension or compression applies.

The *Pr* value cannot be less than 1.000/*Tan*θ for designated angle category A, B, and C; 1.000 for designated angle category D, E, and F; or 0.000 for designated angle category G, H, and I.

For designated angle category A, B, and C, the applied tension, including the effect of prying (*Pr*), is as follows:

$$Cr = Tan^{-1}\left(\frac{C}{D}\right) \qquad \textbf{[A.18.5.12.2b]}$$

For braces acting in **TENSION**

If *Cr* > brace angle from vertical:

$$Pr = \frac{\left(\frac{C+A}{Tan\theta}\right)-D}{A} \qquad \textbf{[A.18.5.12.2c]}$$

If *Cr* < brace angle from vertical:

$$Pr = \frac{D-\left(\frac{C-B}{Tan\theta}\right)}{B} \qquad \textbf{[A.18.5.12.2d]}$$

For braces acting in **COMPRESSION**

If *Cr* > brace angle from vertical:

$$Pr = \frac{\left(\frac{C-B}{Tan\theta}\right) - D}{B} \quad \text{[A.18.5.12.2e]}$$

If *Cr* < brace angle from vertical:

$$Pr = \frac{D - \left(\frac{C+A}{Tan\theta}\right)}{A} \quad \text{[A.18.5.12.2f]}$$

For designated angle category D, E, and F, the applied tension, including the effect of prying (*Pr*), is as follows:

$$Cr = Tan^{-1}\left(\frac{D}{C}\right) \quad \text{[A.18.5.12.2g]}$$

For braces acting in **TENSION**

If *Cr* > brace angle from vertical:

$$Pr = \frac{\left(\frac{D}{Tan\theta}\right) - (C-B)}{B} \quad \text{[A.18.5.12.2h]}$$

If *Cr* < brace angle from vertical:

$$Pr = \frac{(C+A) - \left(\frac{D}{Tan\theta}\right)}{A} \quad \text{[A.18.5.12.2i]}$$

For braces acting in **COMPRESSION**

If *Cr* > brace angle from vertical:

$$Pr = \frac{\left(\frac{D}{Tan\theta}\right) - (C+A)}{A} \quad \text{[A.18.5.12.2j]}$$

If *Cr* < brace angle from vertical:

$$Pr = \frac{(C-B) - \left(\frac{D}{Tan\theta}\right)}{B} \quad \text{[A.18.5.12.2k]}$$

For designated angle category G, H, and I the applied tension, including the effect of prying (*Pr*), is as follows:

For braces acting in **TENSION**

$$Pr = \frac{\left(\frac{D}{B}\right)}{Sin\theta} \quad \text{[A.18.5.12.2l]}$$

For braces acting in **COMPRESSION**

$$Pr = \frac{\left(\frac{D}{A}\right)}{Sin\theta} \quad \text{[A.18.5.12.2m]}$$

The lightweight concrete anchor tables, Table 18.5.12.2(a)~~and~~ through Table 18.5.12.2(c) were based on sand lightweight concrete, which represents a conservative assumption for the strength of the material. For seismic applications, cracked concrete was assumed.

Figure A.18.5.12.2(a) Dimensions of Concrete Anchor for Orientations A, B, and C.

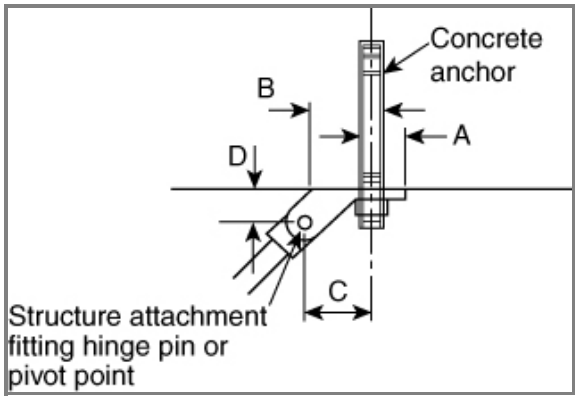


Figure A.18.5.12.2(b) Dimensions of Concrete Anchor for Orientations D, E, and F.

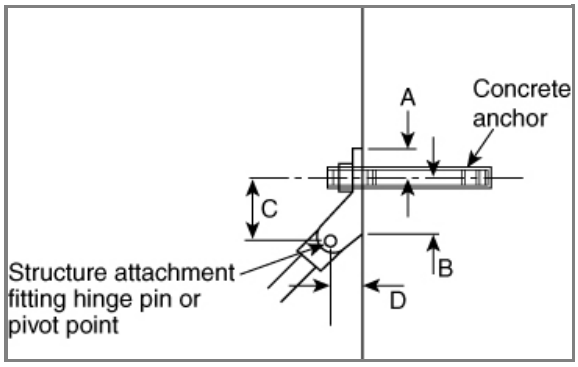
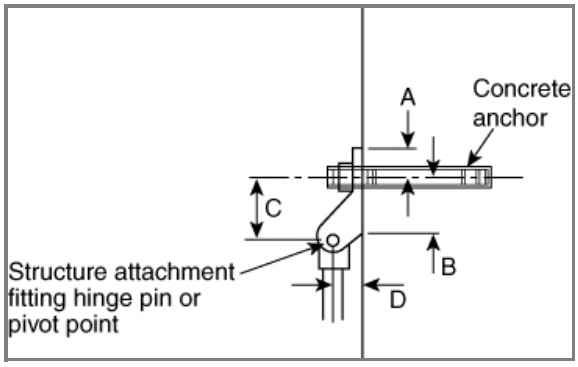


Figure A.18.5.12.2(c) Dimensions of Concrete Anchor for Orientations G, H, and I.



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Second Revision No. 15-NFPA 13-2017 [Chapter E]

Annex E Development of the Design Approach to Conform with ~~SEI/ASCE 7~~ ASCE/SEI 7 and Suggested Conversion Factor Adjustments for Locations Outside the United States

This annex is not a part of the requirements of this NFPA document but is included for informational purposes only.

E.1 General.

Seismic design of nonstructural components is governed by the provisions of Chapter 13 of ASCE/SEI 7, *Minimum Design Loads for Buildings and Other Structures*. In ASCE/SEI 7, fire sprinkler piping is classified as a "Designated Seismic System," due to its critical safety function. Design earthquake forces are multiplied by an ~~Importance Factor, I_p = 1.5, and both the bracing and the piping itself must be designed for seismic forces~~ importance factor, I_p = 1.5, and both the bracing and the piping itself must be designed for seismic forces. The seismic design requirements for the hanging and bracing of sprinkler piping systems provided in NFPA 13, Chapter 18, presume that sprinkler piping is being constructed in the United States or in a country or jurisdictions where the seismic requirements are those specified in ASCE/SEI 7. There are locations outside the United States that wish to use the seismic design requirements of NFPA 13, Chapter 18. In Section E.3 of this annex, suggested conversion factor adjustments are provided to adjust country building code design ground motion criteria to those in ASCE/SEI 7 so the procedures of NFPA 13, Chapter 18, can be used.

The lateral sway bracing provisions of 18.5.5 were developed to allow the use of the concept of ~~Zone~~ zone of ~~Influence~~ influence (ZOI), while providing designs that comply with ASCE/SEI 7. One of the main changes between the current seismic sway bracing design approach adopted in NFPA 13 and the approach used in early editions of NFPA 13 is that the spacing of the sway braces can be constrained by the flexural capacity of the pipe, as well as the capacity of the brace assembly or the capacity of the connection between the brace assembly and the supporting structure. NFPA 13 provides a design that complies with the seismic design requirements of ASCE/SEI 7 for the pipe itself.

The ZOI approach yields the force demand on the bracing element and connections to the structure. Another way to look at a ZOI force is as a reaction in a system of continuous beams (i.e., the multiple spans of a piping system). By using conservative simplifying assumptions, a maximum ZOI force limited by the flexural capacity of the pipe can be developed for a given pipe size and span (spacing between horizontal sway braces). The method used to develop these maximum ZOI forces is described in the following paragraphs, along with a discussion of the assumptions on the geometry of the piping system, the determination of the seismic design force coefficients, and the flexural capacity of the pipe.

In the discussion that follows, the term "main" can be taken to mean a sprinkler main, either a feed main or a cross-main, that requires sway bracing.

E.2 Assumptions on System Geometry.

While every fire sprinkler system is uniquely designed for a particular structure, there are general similarities in the layout and geometry that can be used to simplify the design approach for earthquake protection. These similarities were used to develop assumptions on the effects of piping system continuity on the distribution of bending and shear forces in the pipe, and assumptions on spacing of branch lines between sway brace locations.

E.2.1 Continuity in Piping Systems.

For lateral brace design purposes, piping systems can be idealized as a system of continuous beams. The bending moments in the sprinkler mains (the beams) were computed assuming three continuous spans, which generates the largest bending moment in any system of continuous beams. The loads generated by the branch lines are idealized as point loads. The tributary mass of the main is lumped along with the mass of the branch lines as point loads at the assumed branch line locations.

E.2.2 Branch Line Locations.

In many sprinkler system installations, the branch lines constitute a substantial portion of the seismic mass. While there are significant variations in the spacing of the branch lines, their geometry is constrained by the need to provide adequate water coverage, which imposes limits on the spacing of the branches. Defining a “span” of the main as the distance between lateral sway braces, the seismic provisions make the following assumptions:

(1) There is a branch located at the center of the sprinkler main for spans of 25 ft (7.6 m) or less.

(2) There are branches at third-points of the sprinkler main for spans greater than 25 ft (7.6 m) and less than 40 ft (12.2 m).

(3) There are branches at quarter-points of the sprinkler main for spans of 40 ft (12.2 m).

It was further assumed that there is a branch line located in close proximity to each sway brace.

The layout of branch lines, maximum bending moment M_{max} in the pipe, and reaction R_{max} (horizontal loads at sway brace locations) for sprinkler mains with spans less than 25 ft (7.6 m) is illustrated in Figure E.2.2(a). Maximum demands for spans greater than 25 ft (7.6 m) and less than 40 ft (12.2 m) are given in Figure E.2.2(b), and for spans of 40 ft (12.2 m) in Figure E.2.2(c).

Figure E.2.2(a) Maximum Demands for Spans Less Than 25 ft (7.6 m) .

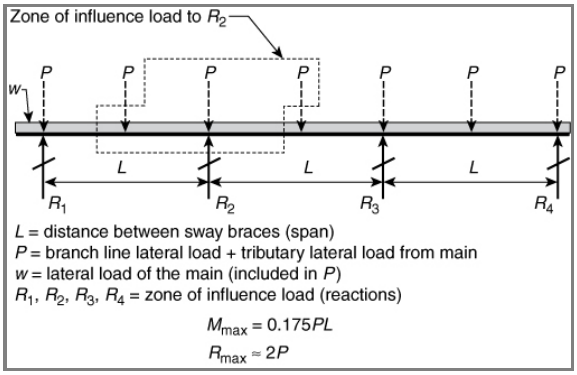


Figure E.2.2(b) Maximum Demands for Spans Greater Than 25 ft (7.6 m) and Less Than 40 ft (12.2 m) .

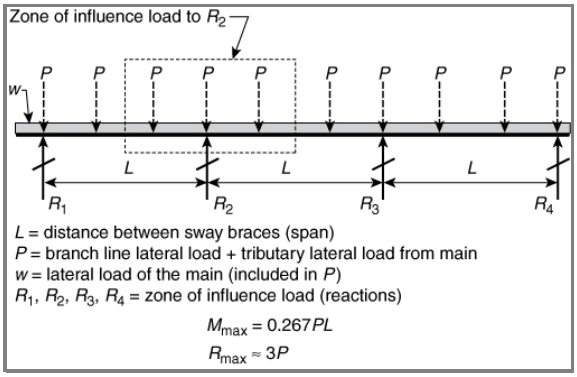
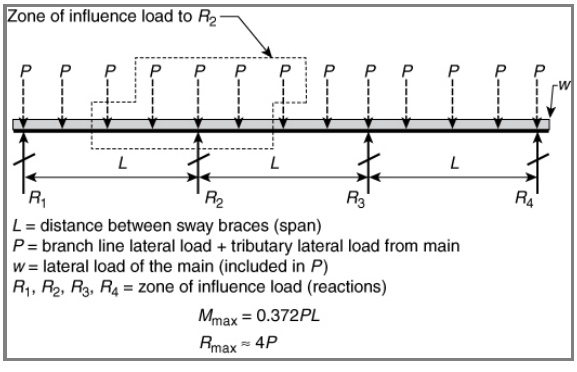


Figure E.2.2(c) Maximum Demands for Spans of 40 ft (12.2 m) .



E.3 Computing the Seismic Demand on Piping Systems.

In ASCE/SEI 7, seismic demands on nonstructural components and systems are a function of the ground shaking intensity, the ductility and dynamic properties of the component or system, and the height of attachment of the component in the structure. Seismic forces are determined at strength design (SD) levels. The horizontal seismic design force is given by

$$F_p = \frac{0.4 a_p S_{DS} W_p}{\left(\frac{R_p}{I_p}\right)}\left(1 + 2\frac{z}{h}\right) \qquad \textbf{[E.3a]}$$

where:

F_p = seismic design force

S_{DS} = short period spectral acceleration, which takes into account soil conditions at the site

a_p = component amplification factor, taken as 2.5 for piping systems

I_p = component importance factor, taken as 1.5 for fire sprinkler systems

z = height of the component attachment to the structure

h = average roof height of the structure

W_p = component operating weight

R_p = component response modification factor as follows:

R_p = 9 for high-deformability piping with joints made by welding or brazing

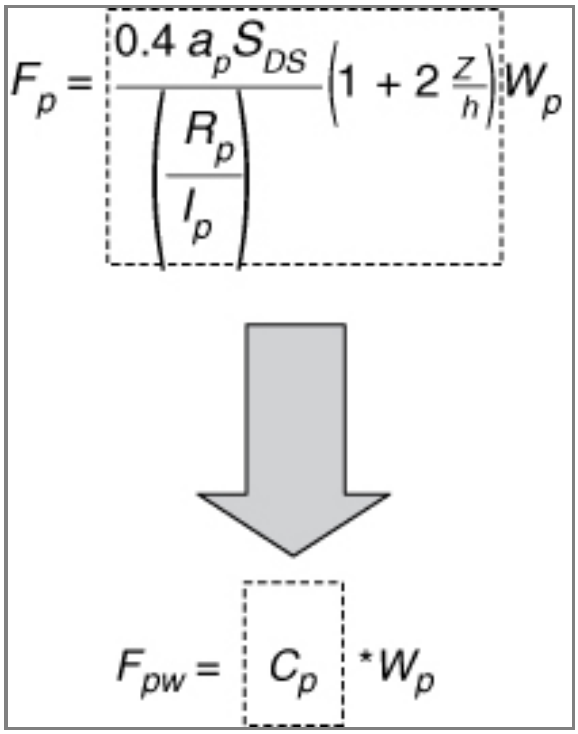
R_p = 4.5 for high- or limited-deformability piping with joints made by threading, bonding, compression couplings, or grooved couplings

R_p = 1.5 for low-deformability piping such as cast iron and nonductile plastics

F_p need not be greater than 1.6 $S_{DS}I_pW_p$ and cannot be less than 0.30 $S_{DS}I_pW_p$.

As illustrated in Figure E.3, NFPA 13 uses a simplified seismic factor, C_p, which combines ground shaking S_{DS}, dynamic amplification a_p, component response R_p/I_p, and location in the building (z/h) into a single variable. Conservative assumptions are made for each variable so that the only information needed to find C_p is the short-period mapped spectral acceleration for the ~~Maximum Considered Earthquake~~ maximum considered earthquake (MCE), S_S.

Figure E.3 Simplified Seismic Factor, C_p.



The importance factor (I_p) for fire sprinkler systems is specified in ASCE/SEI 7 as 1.5. The amplification factor (a_p) for piping systems is specified as 2.5. Piping systems (even when seismically braced) are considered flexible, since the fundamental period of vibration for the system is greater than 0.06 seconds. A component response factor of R_p = 4.5 was assumed for all piping. Finally, it was assumed that the system is installed at the roof level, h.

Assume the system is laterally braced at the roof, $z = h$ and substitute these values into the lateral force equation

$$F_p = \frac{0.4 a_p S_{DS} W_p}{\left(\frac{R_p}{I_p}\right)}\left(1+2\frac{z}{h}\right) = \frac{0.4(2.5) S_{DS} W_p}{\left(\frac{4.5}{1.5}\right)}\left(1+2\frac{h}{h}\right) = (1.0) S_{DS} W_p \qquad \textbf{[E.3b]}$$

ASCE/SEI 7 forces are determined at the strength design (SD) level. NFPA 13 is based on ~~Allowable Stress Design~~ allowable stress design (ASD). To convert F_p to an ASD load, F_{pw}, the load from ASCE/SEI 7 is multiplied by a 0.7 load factor.

$$F_{pw} = 0.7 F_p = 0.7 S_{DS} W_p = C_p W_p \qquad \textbf{[E.3c]}$$

Solving for C_p,

$$C_p = 0.7 S_{DS} \qquad \textbf{[E.3d]}$$

The short-period spectral acceleration, S_{DS}, is obtained by modifying the mapped short-period spectral acceleration, S_S, for the effects of the local soil conditions. In the United States, values for S_S are obtained from seismic hazard maps published by the U.S. Geological Survey (USGS). ~~Free software~~ Web-based tools available from USGS will generate values for S_S based on the latitude and longitude of the project site. ~~The spectral acceleration used for seismic design is determined by~~ Most countries do not base their seismic hazard maps on the ground motion criteria that USGS uses to determine the S_S values specified in ASCE/SEI 7. Instead, these countries might use seismic zones [similar to those in the outdated Uniform Building Code (UBC)] to convey the seismic hazard. Although different countries might use different zone identifiers, often zones are numbered, with the highest number seismic zone having the strongest potential ground motions (e.g., in the UBC, Zones 0 to 4 were used, and Zone 4 had the highest seismic hazard). Although not universally true, often there is a zone factor, Z, associated with each zone that represents the peak ground acceleration based on design

earthquake ground motions having a 10 percent chance of being exceeded in a 50-year period (i.e., about a 500-year return period). For these countries, a suggested correlating adjustment is $S_S = 3.75Z$. The 3.75 factor was determined by multiplying the peak ground acceleration by a factor of 2.5 to convert it to peak spectral acceleration and then by a factor of 1.5 to convert design earthquake ground motions to maximum considered earthquake ground motions, which are the basis for determining S_S. For example, for a Z factor of 0.4 (the highest value in the UBC), the value of S_S would be 1.5 (resulting in $C_p = 0.7$ from Table 18.5.9.3). Also, for these countries, if a value of S_1 is needed, the value might be taken as $1.5Z$, which is the same relative relationship between the short period and one second spectral acceleration that was used in the 1997 UBC. The spectral acceleration used for seismic design is determined by

$$-S_{DS} = \frac{2}{3} S_S F_a \qquad \textbf{[E.3e]}$$

F_a is an amplification factor based on soil conditions and the intensity of ground shaking expected (measured by S_S). Soil conditions are defined by site classification, ranging from Site Class A (hard rock) to Site Class F (extremely soft soils and fill). The values of F_a are given in ASCE/SEI 7 Table 11.4-1, and vary from 0.8 to 2.5. For the purposes of the ZOI method, the values of F_a are taken as the maximum tabulated values and are summarized in Table E.3.

Table E.3 Values of F_a

-	Mapped Maximum Considered Earthquake Spectral Response Acceleration Parameter at Short Period					
-	$S_S \le 0.33$	$S_S = 0.5$	$S_S = 0.75$	$S_S = 0.95$	$S_S = 1.0$	$S_S \ge 1.25$
F_a	2.24	1.7	1.2	1.1	1.1	1.0

Note: Use straight-line interpolation for intermediate values of S_S.

$$C_p = 0.7S_{DS} = \frac{2}{3}\left(0.7S_s F_a\right) = 0.467 S_s F_a \qquad \textbf{[E.3f]}$$

Table 18.5.9.3 was populated by solving for C_p for different values of S_S. For example when $S_S = 1.0$:

$$C_p = 0.467 S_s F_a = 0.467(1.0)(1.1) = 0.51 \qquad \textbf{[E.3g]}$$

E.4 Flexural Capacity of Piping.

The flexural capacity for different diameters and thicknesses of pipe were computed using ~~Allowable Stress Design~~ allowable stress design (ASD). NFPA 13 has traditionally used ASD for design. While ASCE/SEI 7 generally uses the ~~Strength Design~~ strength design (SD) approach, ASD is preferred for the design of piping systems. For example, the ASTM B31, *Standards of Pressure Piping*, series of piping codes are based on ASD. ASD was chosen for sprinkler piping design to limit the complexity of the analysis. Use of SD would require the use of the plastic modulus, *Z*, of the pipe rather than the elastic section modulus, *S*. Use of *Z* would trigger analysis of local and global buckling behavior of the pipe. SD is most appropriate when used with compact pipe sections that can develop the full limit capacity of the material, including strain hardening. Thin-wall pipes and materials without well-defined post-elastic behavior are not easily considered using SD.

Permissible stresses in the pipe for seismic loading are from 13.6.11 of ASCE/SEI 7. Assuming high- or limited-deformability pipe with threaded or grooved couplings, the permissible flexural stress under SD level demands is $0.7F_y$, where F_y is the yield stress of the material. Since seismic design in NFPA 13 is based on ASD, the SD capacity must be reduced to an ASD level.

The permissible flexural stress for ASD is determined by adjusting the SD level flexural capacity. The SD capacity is first reduced by a load factor to ASD levels, and then can be increased by the allowable stress increase for seismic loading. The use of an allowable stress increase for piping systems is typical when determining the strength of the pipe itself.

For fire sprinkler piping, the SD flexural capacity, M_{cap}, is reduced by a load factor of 0.7 to yield the ASD flexural capacity. The duration of load factor for the piping system, taken as 1.33, is then applied. Taking *S* as the section modulus of pipe, this yields an allowable moment capacity in the pipe.

$$M_{cap} = 0.7(1.33)\left(0.7SF_y\right) = 0.65SF_y \quad \textbf{[E.4a]}$$

To populate Table 18.5.5.2(a) through Table 18.5.5.2(i), which give the maximum ~~Zone of Influence~~ zone of influence loads, the largest reaction (due to branch lines and the tributary mass of the main) limited by flexure for a given pipe size and span between sway braces was computed.

For example, to determine the maximum permissible ZOI for a 4 in. (100 mm) diameter steel Schedule 10 main spanning 30 ft (9.1 m), first compute the flexural capacity of the pipe.

S = 1.76 in.^{3} (28800 mm^3)

F_y = 30,000 psi (2050 bar)

The flexural capacity of the pipe is

$$M_{cap} = \left(0.65F_y\right)S = (0.65)(30{,}000)(1.76) \quad \textbf{[E.4b]}$$

= 34,320 in.-lb (3900 kgn) = 2860 ft-lb (395 kgn)

For spans greater than 25 ft (7.6 m) and less than 40 ft (12 m), the branch lines are assumed to be located at ⅓-points in the span. The point load *P* is associated with the branch line and tributary mass of the main and *L* is distance between sway braces. From Figure E.2.2(b), the maximum moment in the main, M_{max}, is

$M_{max} = 0.267PL$

Setting $M_{cap} = M_{max}$ and solving for *P*,

$$M_{cap} = \left(0.65F_y\right)S = 0.267PL$$
$$P = \frac{M_{cap}}{0.267L} \quad \textbf{[E.4c]}$$
$$= \frac{2860}{0.267(30) = 357 \text{ lb}}$$

The maximum permissible ZOI load = 3*P* = 1071 lb. (485 kg).

E.5 Sample Seismic Calculation ~~using~~ Using the ZOI Method.

To illustrate the application of the ZOI method, the approach can be applied to a sample problem based on the sample seismic bracing calculation in Figure A.18.5(b). The sample calculation yielded a total weight of 480 lb (220 kg), which was obtained using a seismic factor of 0.5. To determine our own seismic factor, to get the total weight of the water-filled pipe, divide by the seismic factor of 0.5,

$$W_p = \frac{480}{0.5} = 960 \text{ lb } (435 \text{ kg}) \quad \textbf{[E.5a]}$$

Assume the 4 in. (100 mm) Schedule 10 pipe is the main that will be braced and that distance between sway braces (span) is 20 ft (6.1 m). The installation is in a region of high seismicity, and based on the latitude and longitude of the building site, S_S = 1.75.

To calculate the seismic load, use Table 18.5.9.3 to determine the seismic coefficient, C_p. The value of S_S = 1.75 coordinates to 0.82.

The horizontal force on the brace, from 18.5.6.2, is

$$F_{pw} = C_p W_p = 0.82(960) = 787 \text{ lb} \quad \textbf{[E.5b]}$$

From Table 18.5.5.2(a), the maximum ZOI load, F_{pw}, for a 4 in. Schedule 10 pipe spanning 20 ft (6.1 m) is 1634 lb (740 kg), which is larger than the calculated demand of 787 lb (355 kg). The 4 in. (100 mm) Schedule 10 pipe is adequate for the seismic load and a brace would be selected with a minimum capacity of 787 lb (355 kg).

If the sway brace was attached to the 2 in. (50 mm) Schedule 40 pipe, the ZOI demand F_{pw} of 787 lb (355 kg) would be compared to the maximum capacity for a 2 in. (50 mm) Schedule 40 pipe found in ~~Table 18.5.5.2(a)~~ Table 18.5.5.2(c) and Table 18.5.5.2(d) . For a 20 ft (6.1 m) span, this is 520 lb (~~235~~ 236 kg), less than the demand of 787 lb (355 kg). A 2 in. (50 mm) pipe would be inadequate, and a sway brace would have to be added to reduce the ZOI demand, or the system pipe size increased.

E.6 Limitations of the ZOI Method.

The ZOI approach can be used for a variety of piping materials. There are, however, important limitations of which the designer should be aware. The first is that the appropriate component response factor, R_p, must be used. To select the proper value, the piping systems must be classified as high-, limited-, or low-deformability. Definitions of these terms are given in Section 11.2 of ASCE/SEI 7. The second major assumption is that the flexural behavior of the pipe is not governed by local buckling of the pipe wall. For steel pipe, this can be achieved by observing the thickness to diameter limits given in the *AISC Specifications for the Design, Fabrication, and Erection of Structural Steel Buildings*. Establishing the local buckling characteristics of pipe fabricated from other materials can require testing.

The tables for the maximum load, F_{pw}, in zone of influence are based on common configurations of mains and branch lines. There can be cases where the actual configuration of the piping system could generate higher stresses in the piping than assumed in the tables. For example, a main braced at 40 ft (12.2 m) intervals, with a single branch line in the center of the span, can have a smaller maximum load capacity, F_{pw}, than the tabulated value. Where the configuration of the mains and branch lines vary significantly from the assumed layout, the pipe stresses should be checked by engineering analysis.

E.7 Allowable Loads for Concrete Anchors.

This section provides step-by-step examples of the procedures for determining the allowable loads for concrete anchors as they are found in Table 18.5.12.2(a) through Table 18.5.12.2(j). Table 18.5.12.2(a) through Table 18.5.12.2(j) were developed using the prying factors found in Table E.7(a) and the representative strength design seismic shear and tension values for concrete anchors found in Table E.7(b).

Table E.7(a) Prying Factors for Table ~~9.3.5.12.2~~ 18.5.12.2 (a) through Table ~~9.3.5.12.2~~ 18.5.12.2 (j) Concrete Anchors

***Pr* Range**	**~~Fig. 9.3.5.12.1~~ Figure 18.5.12.1 Designated Angle Category**								
	A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**
Lowest	2	1.1	0.7	1.2	1.1	1.1	1.4	0.9	0.8
Low	3.5	1.8	1.0	1.7	1.8	2.0	1.9	1.3	1.1
High	5.0	2.5	1.3	2.2	2.5	2.9	2.4	1.7	1.4
Highest	6.5	3.2	1.6	2.7	3.2	3.8	2.9	2.1	1.7

Table E.7(b) Representative Strength Design Seismic Shear and Tension Values Used for Concrete Anchors

Anchor Dia. (in.)	**Min. Nominal Embedment (in.)**	**LRFD Tension (lb)**	**LRFD Shear (lb)**	**Anchor Dia. (in.)**	**Min. Effective Embedment (in.)**	**LRFD Tension (lb)**	**LRFD Shear (lb)**
Wedge Anchors in 3000 psi (207 bar) Lightweight Sand Concrete on 4 ½ in. Flute Width Metal Deck				**Metal Deck Inserts in 3000 psi (207 bar) Lightweight Sand Concrete on 4 ½ in. Flute Width Metal Deck**			
⅜	2.375	670	871	⅜	1.750	804	774
½	3.750	714	1489	½	1.750	804	837
⅝	3.875	936	1739	⅝	1.750	804	837
¾	4.500	1372	1833	¾	1.750	804	1617
Wedge Anchors in 3000 psi (207 bar) Lightweight Sand Concrete				**Wood Form Inserts in 3000 psi (207 bar) Lightweight Sand Concrete**			
⅜	2.375	739	1141	⅜	1.100	1358	1235
½	3.750	983	1955	½	1.690	1358	1811
⅝	3.875	1340	2091	⅝	1.750	1358	1811
¾	4.500	1762	3280	¾	1.750	1358	1811
Wedge Anchors in 3000 psi (207 bar) Normal Weight Concrete				**Wood Form Inserts in 3000 psi (207 bar) Normal Weight Concrete**			
⅜	2.375	1087	1170	⅜	1.100	1598	1235
½	3.750	1338	2574	½	1.690	1598	2130
⅝	3.875	2070	3424	⅝	1.750	1598	2130
¾	4.500	3097	5239	¾	1.750	1598	2130
Wedge Anchors in 4000 psi (276 bar) Normal Weight Concrete				**Wood Form Inserts in 4000 psi (276 bar) Normal Weight Concrete**			
⅜	2.375	1233	1170	⅜	1.100	1845	1235
½	3.750	1545	2574	½	1.690	1845	2249
⅝	3.875	2390	3900	⅝	1.750	1845	2460
¾	4.500	3391	5239	¾	1.750	1845	2460
Wedge Anchors in 6000 psi (414 bar) Normal Weight Concrete				**Wood Form Inserts in 6000 psi (414 bar) Normal Weight Concrete**			
⅜	2.375	1409	1170	⅜	1.100	2259	1235
½	3.750	1892	2574	½	1.690	2259	2249

Anchor Dia. (in.)	Min. Nominal Embedment (in.)	LRFD Tension (lb)	LRFD Shear (lb)	-	Anchor Dia. (in.)	Min. Effective Embedment (in.)	LRFD Tension (lb)	LRFD Shear (lb)
5/8	3.875	2928	3900		5/8	1.750	2259	3013
3/4	4.500	4153	5239		3/4	1.750	2259	3013

~~Table E.7(b) Representative Strength Design Seismic Shear and Tension Values Used for Concrete Anchors~~

~~Anchor Dia.(in.)~~	~~Nominal Embedment (in.)~~	~~LRFD Tension(lb)~~	~~LRFD Shear(lb)~~
~~Wedge Anchors in 3000 psi LW Sand Concrete on Metal Deck~~			
~~3/8~~	~~2~~	~~573~~	~~1172~~
~~1/2~~	~~2.375~~	~~804~~	~~1616~~
~~5/8~~	~~3.125~~	~~1102~~	~~1744~~
~~Wedge Anchors in 3000 psi LW Sand Concrete~~			
~~3/8~~	~~2~~	~~637~~	~~550~~
~~1/2~~	~~3.625~~	~~871~~	~~745~~
~~5/8~~	~~3.875~~	~~1403~~	~~1140~~
~~3/4~~	~~4.125~~	~~1908~~	~~1932~~
~~Wedge Anchors in 3000 psi NW Concrete~~			
~~3/8~~	~~2~~	~~1063~~	~~917~~
~~1/2~~	~~3.625~~	~~2639~~	~~2052~~
~~5/8~~	~~3.875~~	~~3004~~	~~2489~~
~~3/4~~	~~4.125~~	~~3179~~	~~3206~~
~~Wedge Anchors in 4000 psi NW Concrete~~			
~~3/8~~	~~2~~	~~1226~~	~~1088~~
~~1/2~~	~~3.625~~	~~2601~~	~~2369~~
~~5/8~~	~~3.875~~	~~3469~~	~~2586~~
~~3/4~~	~~4.125~~	~~3671~~	~~3717~~
~~Wedge Anchors in 6000 psi NW Concrete~~			
~~3/8~~	~~2.25~~	~~1592~~	~~1322~~
~~1/2~~	~~3.625~~	~~3186~~	~~2902~~
~~5/8~~	~~3.875~~	~~4249~~	~~3167~~
~~3/4~~	~~4.125~~	~~4497~~	~~4553~~
~~Undercut Anchors in 3000 psi NW Concrete~~			
~~3/8~~	~~5~~	~~4096~~	~~1867~~
~~1/2~~	~~7~~	~~5322~~	~~2800~~
~~5/8~~	~~9.5~~	~~6942~~	~~5675~~
~~3/4~~	~~12~~	~~10182~~	~~9460~~

E.7.1 Selecting a Wedge Anchor Using Table ~~9.3.5.12.2~~ 18.5.12.2 (a) through Table ~~9.3.5.12.2(f)~~ 18.5.12.2(e) .

E.7.1.1 Procedure.

Step 1. Determine the ASD horizontal earthquake load F_{pw}.

Step 1a. Calculate the weight of the water-filled pipe within the zone of influence of the brace.

Step 1b. Find the applicable seismic coefficient C_p in Table 18.5.9.3

Step 1c. Multiply the zone of influence weight by C_p to determine the ASD horizontal earthquake load F_{pw}.

Step 2. Select a concrete anchor from Table 18.5.12.2(a) through Table 18.5.12.2(e) with a maximum load capacity that is greater than the calculated horizontal earthquake load F_{pw} from Step 1.

Step 2a. Locate the table for the applicable concrete strength.

Step 2b. Find the column in the selected table for the applicable designated angle category (A thru I) and the appropriate prying factor *Pr* range.

Step 2c. Scan down the category column to find a concrete anchor diameter, embedment depth, and maximum load capacity that is greater than the calculated horizontal earthquake load F_{pw} from Step 1.

(ALTERNATIVE) Step 2. As an alternative to using the maximum load values in Table 18.5.12.2(a) through Table 18.5.12.2(e), select ~~an AC355.2 seismically pre-qualified~~ a concrete anchor ~~with a load-carrying capacity~~ that ~~exceeds the calculated F_{pw} , with calculations~~ has been tested in accordance with ACI 355.2, *Qualification of Post-Installed Mechanical Anchors in Concrete and Commentary* , for seismic loading and that has an allowable strength , including the effects of prying, ~~based on seismic shear and tension values~~ taken ~~from an ICC-ES Report and calculated~~ as 0.43 times the normal strength determined in accordance with ACI 318, *Building Code Requirements for Structural Concrete and Commentary* , Chapter 17, ~~and adjusted to ASD values by multiplying by 0.43~~ as per 18.5.12.7.3(D).

E.7.1.2 Example.

Step 1. Zone of influence F_{pw}.

Step 1a. 40 ft of 2½ in. Sch. 10 pipe plus 15% fitting allowance

40 × 5.89 lb/ft × 1.15 = 270.94 lb

Step 1b. Seismic coefficient C_p from Table 18.5.9.3

C_p = 0.35

Step 1c. F_{pw} = 0.35 × 270.94 = 94.8 lb

Step 2. Select a concrete anchor from Table 18.5.12.2(a) through Table 18.5.12.2(e).

Step 2a. Use the table for 4000 psi Normal Weight Concrete.

Step 2b. Fastener orientation “A” – assume the manufacturer's prying factor is 3.0 for the fitting. Use the *Pr* range of 2.1–3.5.

Step 2c. Allowable F_{pw} on ⅜ in. dia. with ~~2~~ 2.375 in. embedment = ~~135~~ 138 lb and is greater than the calculated F_{pw} of 94.8 lb.

E.7.2 Calculation for Maximum Load Capacity of Concrete Anchors.

This example shows how the effects of prying and brace angle are calculated when using Table E.7(a) .

E.7.2.1 Procedure.

Step 1. Determine the allowable seismic tension value (T_{allow}) and the allowable seismic shear value (V_{allow}) for the anchor, based on data found in the anchor manufacturer's approved evaluation report. Note that, in this example, it is assumed the evaluation report provides the allowable tension and shear capacities. If this is not the case, the strength design anchor capacities must be determined using the procedures in ACI 318, Chapter 17, which are then converted to ASD values by dividing by a factor of 1.4. As an alternative to calculating the allowable seismic tension value (T_{allow}) and the allowable seismic shear value (V_{allow}) for the anchor, the seismic tension and shear values that were used to calculate ~~the~~ Figure 18.5.12.1 for anchor allowable load tables can be used.

Step 1a. Find the ASD seismic tension capacity (T_{allow}) for the anchor according to the strength of concrete, diameter of the anchor, and embedment depth of the anchor. Divide the ASD tension value by 2.0 and then multiply by 1.2.

Step 1b. Find the ASD seismic shear capacity (V_{allow}) for the anchor according to the strength of concrete, diameter of the anchor, and embedment depth of the anchor. Divide the ASD shear value by 2.0 and then multiply by 1.2.

Step 2. Calculate the applied seismic tension (T) and the applied seismic shear (V) based on the calculated horizontal earthquake load F_{pw}.

Step 2a. Calculate the designated angle category applied tension factor, including the effects of prying (Pr), using the following formulas:

Category A, B, and C

$$Pr = \frac{\left(\frac{C+A}{Tan\theta}\right) - D}{A} \quad \textbf{[E.7.2.1a]}$$

Category D, E, and F

$$Pr = \frac{(C+A) - \left(\frac{D}{Tan\theta}\right)}{A} \quad \textbf{[E.7.2.1b]}$$

Category G, H, and I

$$Pr = \frac{\left(\frac{D}{B}\right)}{Sin\theta} \quad \textbf{[E.7.2.1c]}$$

Step 2b. Calculate the ASD applied seismic tension (T) on the anchor, including the effects of prying, and when applied at the applicable brace angle from vertical and the designated angle category (A through I) using the following formula:

$$T = F_{pw} \times Pr \quad \textbf{[E.7.2.1d]}$$

Step 2c. Calculate the ASD applied seismic shear (V) on the anchor, when applied at the applicable brace angle from vertical and the designated angle category (A through I) using the following formulas:

Category A, B, and C

$$V = F_{pw} \quad \textbf{[E.7.2.1e]}$$

Category D, E, and F

$$V = \frac{F_{pw}}{Tan\theta} \quad \textbf{[E.7.2.1f]}$$

Category G, H, and I

$$V = \frac{F_{pw}}{Sin\theta} \quad \textbf{[E.7.2.1g]}$$

Step 3. Check the anchor for combined tension and shear loads using the following formula:

$$\left(\frac{T}{T_{allow}}\right) + \left(\frac{V}{V_{allow}}\right) \leq 1.2 \quad \textbf{[E.7.2.1h]}$$

Confirm that T/T_{allow} and $V/V_{allow} \leq 1.0$.

E.7.2.2 Example: Sample Calculation, Maximum Load Capacity of Concrete Anchors as Shown in Table ~~9.3.5.12.2(a)~~ 18.5.12.2(a) through Table ~~9.3.5.12.2(f)~~ 18.5.12.2(e) .

In this example, a sample calculation is provided showing how the values in Table 18.5.12.2(a) through Table 18.5.12.2(e) were calculated.

Step 1. Determine the allowable seismic tension value (T_{allow}) and the allowable seismic shear value (V_{allow}) for a concrete anchor in Figure 18.5.12.1.

Step 1a. The Table E.7(b) strength design seismic tension value (T_{allow}) for a ½ in. carbon steel anchor with 3⅝ ¾ in. embedment depth in 4000 psi normal weight concrete is ~~2601~~ 1545 lb. Therefore, the allowable stress design seismic tension value (T_{allow}) is ~~2601~~ 1545 /1.4/2.0 × 1.2 = ~~1115~~ 662 lb.

Step 1b. The Table E.7(b) strength design seismic shear value (V_{allow}) for a ½ in. carbon steel anchor with 3⅝ ¾ in. embedment is ~~2369~~ 2574 lb. Therefore, the allowable stress design seismic shear value (V_{allow}) is ~~2369~~ 2574 /1.4/2.0 × 1.2 = ~~1015~~ 1103 lb.

Step 2. Use the applied seismic tension value (T) and the applied seismic shear value (V) based on an ASD horizontal earthquake load (F_{pw}) of ~~170~~ 100 lb, a 30-degree brace angle from vertical, and designated angle category A.

Step 2a. Calculate the ASD applied seismic tension value (T) on the anchor, including the effects of prying, using the following formula and Figure E.7.2.2.

$$T = \frac{F_{pw}\left[\left(\frac{C+A}{Tan\theta}\right) - D\right]}{A} \qquad \textbf{[E.7.2.2a]}$$

where:

T = applied service tension load, including the effect of prying

F_{pw} = horizontal earthquake load (F_{pw} = 170)

Tan = tangent of brace angle from vertical ($Tan\theta$ 0°= 0.5774)

A = 0.7500

B = 1.5000

C = 2.6250

$T = F_{pw} \times Pr$

$$T = \frac{\left\{F_{pw}\left[\left(\frac{2.625+0.75}{0.5774}\right) - 1.0\right]\right\}}{0.75}$$

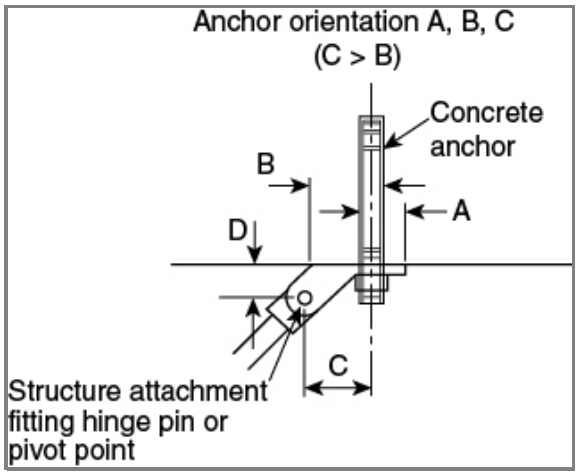
$$T = \frac{\left[F_{pw}\left(5.8452 - 1.0\right)\right]}{0.75}$$

$$T = F_{pw}\left(\frac{4.8451}{0.75}\right)$$

$T = F_{pw} \times 6.46$

T = ~~170~~ 100 lb × 6.46 = ~~1098~~ 646 lb

Figure E.7.2.2 Concrete Anchor for Sample Calculation in E.7.2.2.



Step 2b. The ASD applied seismic shear value (V) on the anchor for anchor orientations A, B, and C is equal to the ASD horizontal earthquake load F_{pw} = ~~170~~ 100 lb.

Step 3. Calculate the maximum allowable horizontal earthquake load F_{pw} using the formula:

$$\left(\frac{T}{T_{allow}}\right)+\left(\frac{V}{V_{allow}}\right)\leq 1.2 \qquad \text{[E.7.2.2b]}$$

$$\left(\frac{1098.2}{1115}\right)+\left(\frac{170}{1015}\right)=0.9849+0.1675=1.1524(\leq 1.2)$$

$$\left(\frac{646}{662}\right)+\left(\frac{100}{1103}\right)=1.0665(\leq 1.2)$$

Supplemental Information

File Name	Description	Approved
Table_E_7_b_rev_6-24-17.pdf	New Table E.7(b). For staff use.	

Submitter Information Verification

Submitter Full Name: AUT-HBS
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Tue Jul 11 13:41:46 EDT 2017

Committee Statement

Committee Statement: General text revisions have been added to clarify the use of wedge-type anchors and concrete inserts. The reason for this change is to provide guidance to jurisdictions/sprinkler contractors outside the United States that want to use the seismic provisions of NFPA 13 but do not have a criteria that converts their building code ground motions design criteria to those used in Chapter 18.

Response Message:

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Second Revision No. 1040-NFPA 13-2017 [Global Comment]

PRI-AAA

Update metric conversions in NFPA 13 to match that as shown on the attached list and pdf of NFPA 13.

Supplemental Information

File Name	Description	Approved
13-PRI_metrics.pdf	Metric conversions for PRI-AAA	✓
Metric_values_used_in_NFPA_13..docx		✓

Submitter Information Verification

Submitter Full Name: AUT-PRI
Organization: National Fire Protection Assoc
Street Address:
City:
State:
Zip:
Submittal Date: Fri Oct 06 13:33:12 EDT 2017

Committee Statement and Meeting Notes

Committee Statement: The metric conversions in the attached list are considered to be “soft” or approximate conversions and are intended to consider trade sizes for pipe and other materials and have been appropriately rounded with the number of significant digits taken into account. The intent of this list is to provide for consistent use of metric conversions throughout the standard with the understanding that it is acceptable for an engineer, authority having jurisdiction, designer or, installer to use an exact conversion rather than an approximate conversion as used in the standard when necessary.

The attached list has been reviewed by the NFPA 13 Metric Task Group.

Response Message:

Pressure tanks shall be provided with an approved means for automatically maintaining the required air pressure.

5.2.4.1.3
Where a pressure tank is the sole water supply, an approved trouble alarm shall also be provided to indicate low air pressure and low water level with the alarm supplied from an electrical branch circuit independent of the air compressor.

5.2.4.1.4
Pressure tanks shall not be used to supply other than sprinklers and hand hose attached to sprinkler piping.

5.2.4.2 Capacity.

5.2.4.2.1
In addition to the requirements of 5.1.2, the water capacity of a pressure tank shall include the extra capacity needed to fill dry pipe or preaction systems where installed.

5.2.4.2.2
The total volume shall be based on the water capacity plus the air capacity required by 5.2.4.3.

5.2.4.3* Water Level and Air Pressure.

5.2.4.3.1
Pressure tanks shall be kept with a sufficient supply of water to meet the demand of the fire protection system as calculated in Chapter 23 for the duration required by Chapter 11, Chapter 12, or Chapter 22.

5.2.4.3.2
The pressure shall be sufficient to push all of the water out of the tank while maintaining the necessary residual pressure (required by Chapter 23) at the top of the system.

5.2.5 Gravity Tanks.
An elevated tank installed in accordance with NFPA 22 shall be an acceptable water supply source.

5.2.6 Penstocks, Flumes, Rivers, or Lakes.
Water supply connections from penstocks, flumes, rivers, lakes, or reservoirs shall be arranged to avoid mud and sediment and shall be provided with approved double removable screens or approved strainers installed in an approved manner.

Chapter 6 Installation Underground Piping

6.1* Piping.
[**24:**10.1]

6.1.1*
All piping used in private fire service mains shall be in accordance with 6.1.1.1, 6.1.1.2 or 6.1.1.3.
[**24:**10.1.1]

6.1.1.1 Listing.
Piping manufactured in accordance with **Table 6.1.1.1** shall be permitted to be used. [**24:**10.1.1.1]

Table 6.1.1.1 Manufacturing Standards for Underground Pipe

Materials and Dimensions	Standard
Ductile Iron	

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Materials and Dimensions	Standard
Cement Mortar Lining for Ductile Iron Pipe and Fittings for Water	AWWA C104
Polyethylene Encasement for Ductile Iron Pipe Systems	AWWA C105
Rubber-Gasket Joints for Ductile Iron Pressure Pipe and Fittings	AWWA C111
Flanged Ductile Iron Pipe with Ductile Iron or Gray Iron Threaded Flanges	AWWA C115
Thickness Design of Ductile Iron Pipe	AWWA C150
Ductile Iron Pipe, Centrifugally Cast for Water	AWWA C151
Standard for the Installation of Ductile Iron Water Mains and Their Appurtenances	AWWA C600
Concrete	
Reinforced Concrete Pressure Pipe, Steel-Cylinder Type	AWWA C300
Prestressed Concrete Pressure Pipe, Steel-Cylinder Type	AWWA C301
Reinforced Concrete Pressure Pipe, Non-Cylinder Type	AWWA C302
Reinforced Concrete Pressure Pipe, Steel-Cylinder Type, Pretensioned	AWWA C303
Standard for Asbestos-Cement Distribution Pipe, 4 in. Through 16 in., for Water Distribution Systems	AWWA C400
Cement-Mortar Lining of Water Pipe Lines 4 in. and Larger — in Place	AWWA C602
Plastic	
Polyvinyl Chloride (PVC) Pressure Pipe, 4 in. Through 12 in., for Water Distribution	AWWA C900
Polyvinyl Chloride (PVC) Pressure Pipe, 14 in. Through 48 in., for Water Distribution	AWWA C905
Polyethylene (PE) Pressure Pipe and Fittings, 4 in. (100 mm) Through 63 in. (1575 mm) for Water Distribution	AWWA C906
Molecularly Oriented Polyvinyl Chloride (PVCO) 4-24 in.	AWWA C909
Brass	
Specification for Seamless Red Brass Pipe	ASTM B43

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Materials and Dimensions	Standard
Copper	
Specification for Seamless Copper Tube	ASTM B75
Specification for Seamless Copper Water Tube	ASTM B88
Requirements for Wrought Seamless Copper and Copper-Alloy Tube	ASTM B251

[**24:**Table 10.1.1.1]

6.1.1.2
Piping specifically listed for use in private fire service mains shall be permitted to be used. [**24:**10.1.1.2]

6.1.1.2.1
Where listed pipe is used, it shall be installed in accordance with the listing limitations including installation instructions. [**24:**10.1.1.2.1]

6.1.1.2.2
Where listing limitations or installation instructions differ from the requirements of this standard, the listing limitations and installation instructions shall apply. [**24:**10.1.1.2.2]

6.1.1.3
Steel piping manufactured in accordance with Table 6.1.1.3 that is externally coated and wrapped and internally galvanized shall be permitted to be used between the hose coupling(s) on the fire department connection and the check valve installed in the fire department connection piping. [**24:**10.1.1.3]

Table 6.1.1.3 Steel Piping for Fire Department Connections

Materials and Dimensions	Standard
Specification for Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless Steel Pipe for Fire Protection Use	ASTM A795
Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless	ASTM A53
Standard Specification for Electric-Resistance Welded Steel Pipe	ASTM A135

[**24:**Table 10.1.1.3]

6.1.1.3.1
External coating and wrapping as required by 6.1.1.3 shall be approved. [**24:**10.1.1.3.1]

6.1.1.4 Dry Pipe Underground.

6.1.1.4.1
Where necessary to place pipe that will be under air pressure underground, the pipe shall be protected against corrosion.

6.1.1.4.2
Unprotected cast-iron or ductile-iron pipe shall be permitted where joined with a gasketed joint listed for air service underground.

6.1.2*
All piping used in private fire service mains shall be rated for the maximum system working pressure to which the piping is exposed to but shall not be rated at less than 150 psi (10 bar). [**24:**10.1.2]

6.1.3*
When lined piping is used, the manufacturer's literature for internal diameter shall be used for all hydraulic calculations. [**24:**10.1.3]

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6.1.4
Where piping installed in a private fire service main must be installed above grade, the piping materials shall conform to NFPA 13. [**24:**10.1.4]

6.1.4.1*
Underground piping shall be permitted to extend into the building through the slab or wall not more than 24 in. (600 mm). [**24:**10.1.4.1]

6.2 Fittings.
[**24:**10.2]

6.2.1
All fittings used in private fire service mains shall be in accordance with 6.2.1.1 or 6.2.1.2. [**24:**10.2.1]

6.2.1.1
Fittings manufactured in accordance with Table 6.2.1.1 shall be permitted to be used. [**24:**Table 10.2.1.1]

Table 6.2.1.1 Fittings Materials and Dimensions

Materials and Dimensions	Standard
Cast Iron	
Gray Iron Threaded Fittings, Classes 125 and 250	ASME B16.4
Gray Iron Pipe Flanges and Flanged Fittings, Classes 25, 125, and 250	ASME B16.1
Ductile Iron	
Ductile Iron and Gray Iron Fittings, 3 in. Through 48 in., for Water and other Liquids	AWWA C110
Ductile Iron Compact Fittings, 3 in. Through 24 in. and 54 in. through 64 in. for Water Service	AWWA C153
Malleable Iron	
Malleable Iron Threaded Fittings, Class 150 and 300	ASME B16.3
Steel	
Factory-Made Wrought Steel Buttweld Fittings	ASME B16.9
Buttwelding Ends	ASME B16.25
Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures	ASTM A234
Pipe Flanges and Flanged Fittings, NPS ½ Through 24	ASME B16.5
Forged Steel Fittings, Socket Welded and Threaded	ASME B16.11
Steel Pipe Flanges for Waterworks Service — Sizes 4 in. Through 144 in.	AWWA C207
Dimensions for Fabricated Steel Water Pipe Fittings	AWWA C208

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Materials and Dimensions	Standard
Copper	
Wrought Copper and Bronze Solder Joint Pressure Fittings	ASME B16.22
Cast Cast Bronze Solder Joint Pressure Fittings	ASME B16.18
Bronze Fittings	
Cast Bronze Threaded Fittings	ASTM B16.15

[**24:**Table 10.2.2.1]

6.2.1.2
Fittings specifically listed for use in private fire service mains shall be permitted to be used. [**24:**10.2.1.2]

6.2.1.2.1
Where listed fittings are used, they shall be installed in accordance with their listing limitations including installation instructions. [**24:**10.2.1.2.1]

6.2.1.2.2
Where listing limitations or installation instructions differ from the requirements of this standard, the listing limitations and installation instructions shall apply. [**24:**10.2.1.2.2]

6.2.2
All fittings used in private fire service mains shall be rated for the maximum system working pressure to which the fittings are exposed, but shall not be rated at less than 150 psi (10 bar). [**24:**10.2.2]

6.2.3
Where fittings installed in a private fire service main must be installed above grade, the fittings shall conform to NFPA 13. [**24:**10.2.3]

6.2.3.1
Fittings in accordance with 6.2.1 shall be permitted for the transition to the above ground piping or fittings. [**24:**10.2.3.1]

6.3 Connection of Pipe Fittings and Appurtenances.
[**24:**10.3]

6.3.1*
Connection of all fittings and appurtenances to piping shall be in accordance with Section 6.3. [**24:**10.3.1]

6.3.2
Connections of pipe and fittings indicated in Table 6.1.1.1 and Table 6.2.1.1 shall be in accordance with the referenced standard in the Table. [**24:**10.3.2]

6.3.3 Listed Connections.
Connections utilizing listed products shall be in accordance with the listing limitations and the manufacturer's installation instructions. [**24:**10.3.3]

6.3.3.1
Where listing limitations or installation instructions differ from the requirements of this standard, the listing limitations and installation instructions shall apply. [**24:**10.3.3.1]

6.3.4
Where pipe, fittings or appurtenances are connected using threads, all threads shall be in accordance with ANSI/ASME B1.20.1. [**24:**10.3.4]

6.3.5 Grooved Connections.

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Where pipe, fittings or appurtenances are connected using grooves, they shall be connected in accordance with 6.3.5.1 through 6.3.5.3. [**24:**10.3.5]

6.3.5.1
Pipe, fittings, and appurtenances to be joined with grooved couplings shall contain cut, rolled, or cast grooves that are dimensionally compatible with the couplings. [**24:**10.3.5.1]

6.3.5.2
Pipe, fittings, and appurtenances that are connected with grooved couplings and are part of a listed assembly shall be permitted to be used. [**24:**10.3.5.2]

6.3.5.3*
Pipe joined with grooved fittings shall be joined by a listed combination of fittings, gaskets, and grooves. [**24:**10.3.5.3]

6.3.6
All joints for the connection of copper tube shall be brazed or joined using pressure fittings as specified in Table 6.2.1.1. [**24:**10.3.6]

6.4 Protection of Private Fire Service Mains. [24:10.4]

6.4.1 Protection from Corrosion.
[**24:**10.4.1]

6.4.1.1 Coatings.
All bolted joint accessories shall be cleaned and thoroughly coated with asphalt or other corrosion-retarding material after installation. [**24:**10.4.1.1]

6.4.1.2
The requirements of 6.4.1.1 shall not apply to epoxy coated fittings, valves, glands, or other accessories. [**24:**10.4.1.2]

6.4.1.3*
Where it is necessary to join metal pipe with pipe of dissimilar metal, the joint shall be insulated against the passage of an electric current using an approved method. [**24:**10.4.1.3]

6.4.2* Protection of Piping. [24:10.4.2]

6.4.2.1 Protection from Freezing.
The depth of cover for private fire service mains and their appurtenances to protect against freezing shall be in accordance with 6.4.2. [**24:**10.4.2.1]

6.4.2.1.1*
The top of the pipe shall be buried not less than 1 ft (300 mm) below the frost line for the locality. [**24:**10.4.2.1.1]

6.4.2.1.2
The depth of piping shall be measured from the top of the piping to the final grade. [**24:**10.4.2.1.2]

6.4.2.1.3
Where listed piping is used and the bury depth differs from this standard, the listing limitations shall apply. [**24:**10.4.2.1.3]

6.4.2.1.4
Where private fire service mains are installed above ground, they shall be protected from freezing in accordance with NFPA 13. [**24:**10.4.2.1.4]

6.4.2.1.5
Private fire service mains installed in water raceways or shallow streams shall be installed so that the piping will remain in the running water throughout the year. [**24:**10.4.2.1.5]

6.4.2.1.6

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Where piping is installed adjacent to a vertical face, it shall be installed from the vertical face at the same distance as if the piping were buried. [**24:**10.4.2.1.6]

6.4.2.1.7
Protection of private fire service mains from freezing using heat tracing shall be permitted when the heat tracing is specifically listed for underground use. [**24:**10.4.2.1.7]

6.4.2.1.7.1
Heat tracing not listed for underground use shall be permitted when piping is installed in accordance with 6.1.4. [**24:**10.4.2.1.7.1]

6.4.2.2 Protection from Mechanical Damage.
The depth of cover for private fire service mains and their appurtenances to protect against mechanical damage shall be in accordance with 6.4.2.2.3. [**24:**10.4.2.2]

6.4.2.2.1
The depth of piping shall be measured from the top of the piping to the final grade. [**24:**10.4.2.2.1]

6.4.2.2.2
In locations where freezing is not a factor, the depth of cover shall not be less than 30 in. (0.8 m) below grade to prevent mechanical damage. [**24:**10.4.2.2.2]

6.4.2.2.2.1
Where listed piping is used and the bury depth differs from this standard, the listing limitations shall apply. [**24:**10.4.2.2.2.1]

6.4.2.2.3
Private fire service mains installed under driveways or roadways shall be buried at a minimum depth of 3 ft (900 mm). [**24:**10.4.2.2.3]

6.4.2.2.3.1
Sidewalks, walkways and other paved or concrete pedestrian passageways shall not be required to comply with 6.4.2.2.3. [**24:**10.4.2.2.3.1]

6.4.2.2.4
Private fire service mains installed under railroad tracks shall be buried at a minimum depth of 4 ft (1.2 m). [**24:**10.4.2.2.4]

6.4.2.2.4.1
Where railroad operators require a greater depth of bury, the greater depth shall apply. [**24:**10.4.2.2.4.1]

6.4.2.2.5
Private fire service mains installed under large piles of heavy commodities or subject to heavy shock and vibrations shall be buried at a minimum depth of 4 ft (1.2 m). [**24:**10.4.2.2.5]

6.4.2.2.6
Where private fire service mains are installed above ground, they shall be protected with bollards or other means as approved by the AHJ when subject to mechanical damage. [**24:**10.4.2.2.6]

6.4.3 Private Fire Service Mains Under Buildings.
Except as allowed by 6.4.3, private fire service mains shall not be allowed to run under buildings. [**24:**10.4.3]

6.4.3.1*
Private fire service mains supplying fire protection systems within the building shall be permitted to extend no more than 10 ft (3 m), as measured from the outside of the building, under the building to the riser location. [**24:**10.4.3.1]

6.4.3.1.1*
Pipe joints shall not be located directly under foundation fittings. [**24:**10.4.3.1.1]

6.4.3.1.2*
Piping shall be installed a minimum of 12 in. (300 mm) below the bottom of building foundations or footers. [**24:**10.4.3.1.2]

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6.4.3.1.2.1
The requirements of 6.4.3.1.2 shall not apply when the piping is sleeved with an approved material. [**24:**10.4.3.1.2.1]

6.4.3.2*
Where approved, private fire service mains supplying systems within the building shall be permitted to extend more than 10 ft (3 m) under the building when all the requirements of 6.4.3.2.1, through 6.4.3.2.4 are met. [**24:**10.4.3.2]

6.4.3.2.1
Where the piping is installed under the building, all foundations or footers over the private fire service main shall be arched to create a minimum of 24 in. (600 mm) clearance. [**24:**10.4.3.2.1]

6.4.3.2.2
It shall be acceptable to install the piping in covered trenches where the trenches are accessible from within the building. [**24:**10.4.3.2.2]

6.4.3.2.3
All joints shall be mechanically restrained. [**24:**10.4.3.2.3]

6.4.3.2.4
A valve shall be installed before the piping enters under the building and within 24 in. (600 mm) of where the piping enters the building. [**24:**10.4.3.2.4]

6.5 Grounding and Bonding.
[**24:**10.5]

6.5.1*
In no case shall the underground piping be used as a grounding electrode for electrical systems. [**24:**10.5.1]

6.5.1.1*
The requirement of 6.5.1 shall not preclude the bonding of the underground piping to the lightning protection grounding system as required by NFPA 780 in those cases where lightning protection is provided for the structure. [**24:**10.5.1.1]

6.6* Restraint.
Private fire service mains shall be restrained against movement at changes in direction in accordance with 6.6.1, 6.6.2 or 6.6.3. [**24:**10.6]

6.6.1* Thrust Blocks.

6.6.1.1
Thrust blocks shall be permitted where soil is stable and capable of resisting the anticipated thrust forces. [**24:**10.6.1.1]

6.6.1.2
Thrust blocks shall be of concrete, of a mix not leaner than one part cement, two and one-half parts sand, and five parts stone. [**24:**10.6.1.2]

6.6.1.3
Thrust blocks shall be placed between undisturbed earth and the fitting to be restrained and shall be capable of resisting the calculated thrust forces. [**24:**10.6.1.3]

6.6.1.4
Wherever possible, thrust blocks shall be located so that the joints are accessible for repair. [**24:**10.6.1.4]

6.6.2* Restrained Joint Systems.
Private fire service mains using restrained joint systems shall include one or more of the following:
(1) Locking mechanical or push-on joints

(2) Mechanical joints utilizing setscrew retainer glands

(3) Bolted flange joints

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(4) Pipe clamps and tie rods

(5) Other approved methods or devices

[**24:**10.6.2]

6.6.2.1 Sizing Clamps, Rods, Bolts, and Washers.
[**24:**10.6.2.1]

6.6.2.1.1 Clamps.
[**24:**10.6.2.1.1]

6.6.2.1.1.1
Clamps shall have the following dimensions:
(1) ½ in. × 2 in. (12 mm × 50 mm) for 4 in. (100 mm) to 6 in. (150 mm) pipe

(2) ⅝ in. × 2½ in. (16 mm × 65 mm) for 8 in. (200 mm) to 10 in. (250 mm) pipe

(3) ⅝ in. × 3 in. (16 mm × 75 mm) for 12 in. (300 mm) pipe

[**24:**10.6.2.1.1.1]

6.6.2.1.1.2
The diameter of a bolt hole shall be ⅛ in. (3 mm) larger than that of the corresponding bolts.
[**24:**10.6.2.1.1.2]

6.6.2.1.2 Rods.
[**24:**10.6.2.1.2]

6.6.2.1.2.1
Rods shall be not less than ⅝ in. (16 mm) in diameter. [**24:**10.6.2.1.2.1]

6.6.2.1.2.2
Table 6.6.2.1.2.2 provides numbers of various diameter rods that shall be used for a given pipe size.
[**24:**10.6.2.1.2.2]

Table 6.6.2.1.2.2 Rod Number — Diameter Combinations

Nominal Pipe Size (in.) (mm)	⅝ in. (16 mm)	¾ in. (20 mm)	⅞ in. (22 mm)	1 in. (25 mm)
4 (100)	2	—	—	—
6 (150)	2	—	—	—
8 (200)	3	2	—	—
10 (250)	4	3	2	—
12 (300)	6	4	3	2
14 (350)	8	5	4	3
16 (400)	10	7	5	4

Note: This table has been derived using pressure of 225 psi (15.5 bar) and design stress of 25,000 psi (172.4 MPa).

[**24:**Table 10.6.2.1.2.2]

6.6.2.1.2.3
When using bolting rods, the diameter of mechanical joint bolts shall limit the diameter of rods to ¾ in. (20 mm). [**24:**10.6.2.1.2.3]

6.6.2.1.2.4
Threaded sections of rods shall not be formed or bent. [**24:**10.6.2.1.2.4]

6.6.2.1.2.5

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Where using clamps, rods shall be used in pairs for each clamp. [**24:**10.6.2.1.2.5]

6.6.2.1.2.6
Assemblies in which a restraint is made by means of two clamps canted on the barrel of the pipe shall be permitted to use one rod per clamp if approved for the specific installation by the AHJ. [**24:**10.6.2.1.2.6]

6.6.2.1.2.7
Where using combinations of rods, the rods shall be symmetrically spaced. [**24:**10.6.2.1.2.7]

6.6.2.1.3 Clamp Bolts.
Clamp bolts shall have the following diameters:
(1) 5/8 in. (16 mm) for pipe 4 in. (100 mm), 6 in. (150 mm), and 8 in. (200 mm)

(2) 3/4 in. (20 mm) for 10 in. (250 mm) pipe

(3) 7/8 in. (22.2 mm) for 12 in. (300 mm) pipe

[**24:**10.6.2.1.3]

6.6.2.1.4 Washers.
[**24:**10.6.2.1.4]

6.6.2.1.4.1
Washers shall be permitted to be cast iron or steel and round or square. [**24:**10.6.2.1.4.1]

6.6.2.1.4.2
Cast-iron washers shall have the following dimensions:
(1) 5/8 in. × 3 in. (16 mm × 75 mm) for 4 in. (100 mm), 6 in. (150 mm), 8 in. (200 mm), and 10 in. (250 mm) pipe

(2) 3/4 in. × 3½ in. (20 mm × 90 mm) for 12 in. (300 mm) pipe

[**24:**10.6.2.1.4.2]

6.6.2.1.4.3
Steel washers shall have the following dimensions:
(1) 1/2 in. × 3 in. (12 mm × 75 mm) for 4 in. (100 mm), 6 in. (150 mm), 8 in. (200 mm), and 10 in. (250 mm) pipe

(2) 1/2 in. × 3½ in. (12 mm × 75 mm) for 12 in. (300 mm) pipe

[**24:**10.6.2.1.4.3]

6.6.2.1.4.4
The diameter of holes shall be 1/8 in. (3.2 mm) larger than that of bolts or rods. [**24:**10.6.2.1.4.4]

6.6.2.2 Sizes of Restraint Straps for Tees.
[**24:**10.6.2.2]

6.6.2.2.1
Restraint straps for tees shall have the following dimensions:
(1) 5/8 in. (16 mm) thick and 2½ in. (65 mm) wide for 4 in. (100 mm), 6 in. (150 mm), 8 in. (200 mm), and 10 in. (250 mm) pipe

(2) 5/8 in. (16 mm) thick and 3 in. (75 mm) wide for 12 in. (300 mm) pipe

[**24:**10.6.2.2.1]

6.6.2.2.2
The diameter of rod holes shall be 1/16 in. (1.6 mm) larger than that of rods. [**24:**10.6.2.2.2]

6.6.2.2.3
Figure 6.6.2.2.3 and Table 6.6.2.2.3 shall be used in sizing the restraint straps for both mechanical and push-on joint tee fittings. [**24:**10.6.2.2.3]

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Figure 6.6.2.2.3 Restraint Straps for Tees. [24:Figure 10.6.2.2.3]

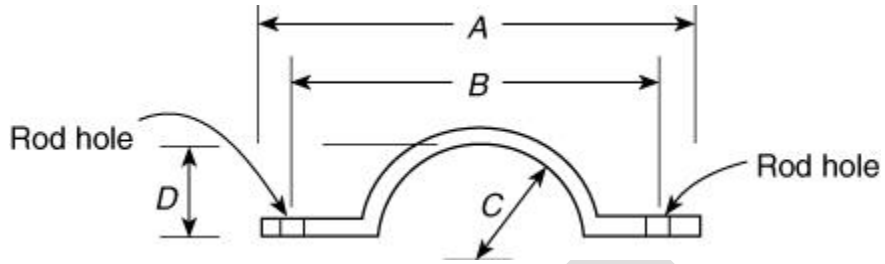


Table 6.6.2.2.3 Restraint Straps for Tees

Nominal Pipe Size		A		B		C		D	
in.	mm	in.	mm	in.	mm	in.	mm	in.	mm
4	100	12½	318	10⅛	257	2½	64	1¾	44
6	150	14½	368	12⅛	308	3 9/16	90	2 13/16	71
8	200	16¾	425	14⅜	365	4 21/32	118	3 29/32	99
10	250	19 1/16	484	16 11/16	424	5¾	146	5	127
12	300	22 5/16	567	19 3/16	487	6¾	171	5⅞	149

[**24:**Table 10.6.2.2.3]

6.6.2.3 Sizes of Plug Strap for Bell End of Pipe.
[**24:**10.6.2.3]

6.6.2.3.1
The strap shall be ¾ in. (20 mm) thick and 2½ in. (65 mm) wide. [**24:**10.6.2.3.1]

6.6.2.3.2
The strap length shall be the same as dimension *A* for tee straps as shown in Figure 6.6.2.2.3. [**24:**10.6.2.3.2]

6.6.2.3.3
The distance between the centers of rod holes shall be the same as dimension *B* for tee straps as shown in Figure 6.6.2.2.3. [**24:**10.6.2.3.31]

6.6.2.4* Material.
Clamps, rods, rod couplings or turnbuckles, bolts, washers, restraint straps, and plug straps shall be of a material that has physical and chemical characteristics that indicate its deterioration under stress can be predicted with reliability. [**24:**10.6.2.4]

6.6.2.5 Corrosion Resistance.
After installation, rods, nuts, bolts, washers, clamps, and other restraining devices shall be cleaned and thoroughly coated with a bituminous or other acceptable corrosion-retarding material. [**24:**10.6.2.5]

6.6.2.5.1

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The requirements of **6.6.2.5** shall not apply to epoxy coated fittings, valves, glands or other accessories. [**24:**10.6.2.5.1]

6.6.3*
Private fire service mains utilizing one or more of the following connection methods shall not require additional restraint, provided that such joints can pass the hydrostatic test of 6.10.2.2 without shifting of piping.

(1) Threaded connections

(2) Grooved connections

(3) Welded connections

(4) Heat fused connections

(5) Chemical or solvent cemented connections

[**24:**10.6.3]

6.7 Steep Grades.
[**24:**10.7]

6.7.1
On steep grades, mains shall be additionally restrained to prevent slipping. [**24:**10.7.1]

6.7.1.1
Pipe shall be restrained at the bottom of a hill and at any turns (lateral or vertical). [**24:**10.7.1.1]

6.7.1.1.1
The restraint specified in **6.7.1.1** shall be to natural rock or to suitable piers built on the downhill side of the bell. [**24:**10.7.1.1.1]

6.7.1.2
Bell ends shall be installed facing uphill. [**24:**10.7.1.2]

6.7.1.3
Straight runs on hills shall be restrained as determined by a design professional. [**24:**10.7.1.3]

6.8 Installation Requirements.
[**24:**10.8]

6.8.1
Piping, valves, hydrants, gaskets, and fittings shall be inspected for damage when received and shall be inspected prior to installation. [**24:**10.8.1]

6.8.2
The tightness of bolted joints shall be verified by the bolt torque or by the method described in the listing information or manufacturer's installation instructions. [**24:**10.8.2]

6.8.3
Pipe, valves, hydrants, and fittings shall be clean and free from internal debris. [**24:**10.8.3]

6.8.4
When work is stopped, the open ends of piping, valves, hydrants, and fittings shall be plugged or covered to prevent foreign materials from entering. [**24:**10.8.4]

6.8.5
All piping, fittings, valves, and hydrants shall be examined for cracks or other defects while suspended above the trench and lowered into the trench using appropriate equipment. [**24:**10.8.5]

6.8.6
Plain ends shall be inspected for signs of damage prior to installation. [**24:**10.8.6]

6.8.7

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Piping, fittings, valves, hydrants and appurtenances shall not be dropped, dumped or rolled or skidded against other materials. [**24:**10.8.7]

6.8.8
Pipes shall be supported in the trench throughout their full length and shall not be supported by the bell ends only or by blocks. [**24:**10.8.8]

6.8.9
If the ground is soft, other means shall be provided to support the pipe. [**24:**10.8.9]

6.8.10
Valves and fittings used with nonmetallic pipe shall be supported and restrained in accordance with the manufacturer's installation instructions. [**24:**10.8.10]

6.9 Backfilling.
[**24:**10.9]

6.9.1
Backfill material shall be tamped in layers or puddled under and around pipes to prevent settlement or lateral movement. [**24:**10.9.1]

6.9.2
Backfill material shall not contain ash, cinders, refuse, organic matter or other corrosive materials. [**24:**10.9.2]

6.9.3
Rocks shall not be used for backfill. [**24:**10.9.3]

6.9.4
Frozen earth shall not be used as backfill material. [**24:**10.9.4]

6.9.5
In trenches cut through rock, tamped backfill shall be used for at least 6 in. (150 mm) under and around the pipe and for at least 2 ft (600 mm) above the pipe. [**24:**10.9.5]

6.9.6
Where using piping listed for private fire service mains, the manufacturer's installation instructions for backfill shall be followed. [**24:**10.9.6]

6.10 Testing and Acceptance.
[**24:**10.10]

6.10.1 Approval of Underground Piping.
The installing contractor shall be responsible for the following:
(1) Notifying the AHJ and the owner's representative of the time and date testing is to be performed

(2) Performing all required acceptance tests

(3) Completing and signing the contractor's material and test certificate(s) shown in Figure 6.10.1.

[**24:**10.10.1]

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Figure 6.10.1 Sample of Contractor's Material and Test Certificate for Underground Piping. [24: Figure 10.10.1]

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Contractor's Material and Test Certificate for Underground Piping

PROCEDURE

Upon completion of work, inspection and tests shall be made by the contractor's representative and witnessed by an owner's representative. All defects shall be corrected and system left in service before contractor's personnel finally leave the job.

A certificate shall be filled out and signed by both representatives. Copies shall be prepared for approving authorities, owners, and contractor. It is understood the owner's representative's signature in no way prejudices any claim against contractor for faulty material, poor workmanship, or failure to comply with approving authority's requirements or local ordinances.

Property name	Date
Property address	

Plans

Accepted by approving authorities (names)

Address

Installation conforms to accepted plans ❑ Yes ❑ No

Equipment used is approved ❑ Yes ❑ No
If no, state deviations

Instructions

Has person in charge of fire equipment been instructed as to location of control valves and care and maintenance of this new equipment? ❑ Yes ❑ No
If no, explain

Have copies of appropriate instructions and care and maintenance charts been left on premises? ❑ Yes ❑ No
If no, explain

Location

Supplies buildings

Underground pipes and joints

Pipe types and class | Type joint

Pipe conforms to _____ standard ❑ Yes ❑ No
Fittings conform to _____ standard ❑ Yes ❑ No
If no, explain

Joints needing anchorage clamped, strapped, or blocked in accordance with _____ standard ❑ Yes ❑ No
If no, explain

Test description

Flushing: Flow the required rate until water is clear as indicated by no collection of foreign material in burlap bags at outlets such as hydrants and blow-offs. Flush in accordance with the requirements of 6.10.2.1.3.

Hydrostatic: All piping and attached appurtenances subjected to system working pressure shall be hydrostatically tested at 200 psi (13.8 bar) or 50 psi (3.4 bar) in excess of the system working pressure, whichever is greater, and shall maintain that pressure ±5 psi (0.34 bar) for 2 hours.

Hydrostatic Testing Allowance: Where additional water is added to the system to maintain the test pressures required by 6.10.2.2.1, the amount of water shall be measured and shall not exceed the limits of the following equation (for metric equation, see 6.10.2.2.6):

$$L = \frac{SD\sqrt{P}}{148{,}000}$$

L = testing allowance (makeup water), in gallons per hour
S = length of pipe tested, in feet
D = nominal diameter of the pipe, in inches
P = average test pressure during the hydrostatic test, in pounds per square inch (gauge)

Flushing tests

New underground piping flushed according to _____ standard by (company) ❑ Yes ❑ No
If no, explain

How flushing flow was obtained
❑ Public water ❑ Tank or reservoir ❑ Fire pump

Through what type opening
❑ Hydrant butt ❑ Open pipe

Lead-ins flushed according to _____ standard by (company) ❑ Yes ❑ No
If no, explain

How flushing flow was obtained
❑ Public water ❑ Tank or reservoir ❑ Fire pump

Through what type opening
❑ Y connection to flange and spigot ❑ Open pipe

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Hydrostatic test	All new underground piping hydrostatically tested at _____ psi for _____ hours	Joints covered ❑ Yes ❑ No
Leakage test	Total amount of leakage measured _____ gallons _____ hours	
	Allowable leakage _____ gallons _____ hours	
Forward flow test of backflow preventer	Foward flow test performed in accordance with 6.10.2.5.2:	❑ Yes ❑ No
Hydrants	Number installed / Type and make	All operate satisfactorily ❑ Yes ❑ No
Control valves	Water control valves left wide open If no, state reason	❑ Yes ❑ No
	Hose threads of fire department connections and hydrants interchangeable with those of fire department answering alarm	❑ Yes ❑ No
Remarks	Date left in service	
Signatures	Name of installing contractor	
	Tests witnessed by	
	For property owner (signed) / Title / Date	
	For installing contractor (signed) / Title / Date	

Additional explanation and notes

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6.10.2 Acceptance Requirements.
[**24:**10.10.2]

6.10.2.1* Flushing of Piping.
[**24:**10.10.2.1]

6.10.2.1.1
Underground piping, from the water supply to the system riser, and lead-in connections to the system riser, including all hydrants, shall be completely flushed before connection is made to downstream fire protection system piping. [**24:**10.10.2.1.1]

6.10.2.1.2
The flushing operation shall continue until water flow is verified to be clear of debris. [**24:**10.10.2.1.2]

6.10.2.1.3
The minimum rate of flow shall be in accordance with Table 6.10.2.1.3. [**24:**10.10.2.1.3]

Table 6.10.2.1.3 Flow Required to Produce a Velocity of 10 ft/sec (3 m/sec) in Pipes

Pipe Size		Flow Rate	
in.	**mm**	**gpm**	**L/min**
2	50	100	379
2½	65	150	568
3	75	220	833
4	100	390	1,500
5	125	610	2,300
6	150	880	3,350
8	200	1,560	5,900
10	250	2,440	9,250
12	300	3,520	13,300

[**24:** Table 10.10.2.1.3]

6.10.2.1.3.1
Where the flow rates established in Table 6.10.2.1.3 are not attainable, the maximum flow rate available to the system shall be acceptable. [**24:**10.10.2.1.3.1]

6.10.2.1.4
Provision shall be made for the proper disposal of water used for flushing or testing. [**24:**10.10.2.1.4]

6.10.2.2 Hydrostatic Test.
[**24:**10.10.2.2]

6.10.2.2.1*
All piping and attached appurtenances subjected to system working pressure shall be hydrostatically tested at gauge pressure of 200 psi (13.8 bar) or 50 psi (3.4 bar) in excess of the system working pressure, whichever is greater, and shall maintain that pressure at gauge pressure of ±5 psi (0.34 bar) for 2 hours. [**24:**10.10.2.2.1]

6.10.2.2.2
Acceptable test results shall be determined by indication of either a pressure loss less than gauge pressure of 5 psi or by no visual leakage. [**24:**10.10.2.2.2]

6.10.2.2.3
The test pressure shall be read from one of the following, located at the lowest elevation of the system or the portion of the system being tested:
(1) A gauge located at one of the hydrant outlets

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(2) A gauge located at the lowest point where no hydrants are provided

[**24:**10.10.2.2.3]

6.10.2.2.4*
The trench shall be backfilled between joints before testing to prevent movement of pipe. [**24:**10.10.2.2.4]

6.10.2.2.5
Where required for safety measures presented by the hazards of open trenches, the pipe and joints shall be permitted to be backfilled, provided the installing contractor takes the responsibility for locating and correcting leakage. [**24:**10.10.2.2.5]

6.10.2.2.6* Hydrostatic Testing Allowance.
Where additional water is added to the system to maintain the test pressures required by 6.10.2.2.1, the amount of water shall be measured and shall not exceed the limits of Table 6.10.2.2.6, which are based upon the following equation:

U.S. Customary Units:

$$L = \frac{SD\sqrt{P}}{148{,}000}$$ **[6.10.2.2.6a]**

where:

L = testing allowance (makeup water) [gph (gal/hr)]

S = length of pipe tested (ft)

D = nominal diameter of the pipe (in.)

P = average test pressure during hydrostatic test (gauge psi)

Metric Units:

$$L = \frac{SD\sqrt{P}}{794{,}797}$$ **[6.10.2.2.6b]**

where:

L = testing allowance (makeup water) (L/hr)

S = length of pipe tested (m)

D = nominal diameter of pipe (mm)

P = average test pressure during the hydrostatic test (kPa)

[**24:**10.10.2.2.6]

Table 6.10.2.2.6 Hydrostatic Testing Allowance at 200 psi (gph/100 ft of Pipe)

Nominal Pipe Diameter	Testing Allowance
in.(mm)	in.(mm)
2 (50)	0.019 (0.236)
4 (100)	0.038 (0.472)
6 (150)	0.057 (0.708)
8 (200)	0.076 (0.944)
10 (250)	0.096 (1.19)
12 (300)	0.115 (1.43)
14 (350)	0.134 (1.66)

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Nominal Pipe Diameter	Testing Allowance
in.(mm)	in.(mm)
16 (400)	0.153 (1.90)
18 (450)	0.172 (2.14)
20 (500)	0.191 (2.37)
24 (600)	0.229 (2.84)

Notes:

(1) For other length, diameters, and pressures, utilize Equation 10.10.2.2.6a or 10.10.2.2.6b to determine the appropriate testing allowance.

(2) For test sections that contain various sizes and sections of pipe, the testing allowance is the sum of the testing allowances for each size and section.

[**24:** Table 10.10.2.2.6]

6.10.2.3 Other Means of Hydrostatic Tests.
Where required by the AHJ, hydrostatic tests shall be permitted to be completed in accordance with the requirements of AWWA C600, AWWA C602, AWWA C603, and AWWA C900. [**24:**10.10.2.3]

6.10.2.4 Operating Test.
[**24:**10.10.2.4]

6.10.2.4.1
Each hydrant shall be fully opened and closed under system water pressure. [**24:**10.10.2.4.1]

6.10.2.4.2
Dry barrel hydrants shall be checked for proper drainage. [**24:**10.10.2.4.2]

6.10.2.4.3
All control valves shall be fully closed and opened under system water pressure to ensure proper operation. [**24:**10.10.2.4.3]

6.10.2.4.4
Where fire pumps supply the private fire service main, the operating tests required by 6.10.2.4 shall be completed with the pumps running. [**24:**10.10.2.4.4]

6.10.2.5 Backflow Prevention Assemblies.
[**24:**10.10.2.5]

6.10.2.5.1
The backflow prevention assembly shall be forward flow tested to ensure proper operation. [**24:**10.10.2.5.1]

6.10.2.5.2
The minimum flow rate required by 6.10.2.5.1 shall be the system demand, including hose stream demand where applicable. [**24:**10.10.2.5.2]

Chapter 7 Requirements for System Components and Hardware

7.1 General.

This chapter shall provide requirements for correct use of sprinkler system components and hardware.

7.1.1* Listing.

7.1.1.1

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Length					
.003”	.08 mm	7.5”	190 mm	26”	650 mm
.0315”	.8 mm	8”	200 mm	27.6”	690 mm
1/32”	0.8 mm	8.5”	215 mm	28”	700 mm
1/16”	1.6 mm	9”	225 mm	29”	725 mm
3/32”	2 mm	9.25”	230 mm	30”	750 mm
1/8”	3 mm	9.5”	240 mm	30.5”	765 mm
3/16”	5 mm	10”	250 mm	31”	775 mm
¼”	6 mm	11”	275 mm	32”	800 mm
5/16”	8 mm	11.5”	290 mm	33”	825 mm
3/8”	10 mm	12”	300 mm	35”	875 mm
½”	13 mm	12.25”	305 mm	35.4”	885 mm
17/32”	13 mm	12.5”	315 mm	36”	900 mm
9/16”	14 mm	12.75”	320 mm	37”	925 mm
5/8”	16 mm	14”	350 mm	38”	950 mm
¾”	19 mm	15”	375 mm	40”	1000 mm
7/8”	22 mm	15.5”	390 mm	42”	1050 mm
1”	25 mm	16”	400 mm	44”	1100 mm
1.5”	40 mm	16.25”	410 mm	47”	1175 mm
1.75”	45 mm	16.5”	415 mm	48”	1200 mm
2”	50 mm	17”	425 mm	54”	1350 mm
2.5”	65 mm	17.5”	440 mm	55”	1375 mm
2.75”	70 mm	18”	450 mm	57”	1425 mm
3”	75 mm	19”	475 mm	58”	1450 mm
3.5”	90 mm	20”	500 mm	66”	1650 mm
4”	100 mm	21”	525 mm	68”	1700 mm
4.5”	115 mm	22”	550 mm	72”	1800 mm
5”	125 mm	22.5”	565 mm	76”	1900 mm
5.5”	140 mm	23”	575 mm	78”	1950 mm
5.75”	145 mm	24”	600 mm	96”	2400 mm
6”	150 mm	25”	625 mm	102”	2550 mm
7”	175 mm	25.5”	640 mm	120”	3000 mm
				148”	3700 mm

Length					
3.5ft	1.1 m	10’-10”	3.3 m	22’-6”	6.9 m
3’-8”	1.1 m	11’-0”	3.4 m	24ft	7.3 m
4ft	1.2 m	11’-3”	3.4 m	25ft	7.6 m
4’-2”	1.3 m	11’-5”	3.5 m	25’-3”	7.7 m
4.5ft	1.4 m	11’-6”	3.5 m	26ft	7.9 m
4’-7”	1.4 m	11’-611/16”	3.5 m	27ft	8.2 m
4’-9”	1.4 m	11’-8”	3.6 m	28ft	8.5 m
5ft	1.5 m	12ft	3.7 m	28’-8”	8.7 m
5’-2”	1.6 m	12’-4”	3.8 m	29’-8”	9 m
5.5ft	1.7 m	13ft	4.0 m	30ft	9.1 m
5’-8”	1.7 m	13’-6”	4.1 m	32ft	10 m
5’-9 5/16”	1.8 m	13’-71/2”	4.2 m	33ft	10 m
6ft	1.8 m	13’-11”	4.2 m	35ft	11 m
6’-3”	1.9 m	14ft	4.3 m	36ft	11 m
6’-4”	1.9 m	14’-6”	4.4 m	40ft	12 m
6.5ft	2 m	15ft	4.6 m	41’-3”	13 m
6’-10”	2.1 m	15’-4”	4.7 m	45ft	14 m
7ft	2.1 m	16ft	4.9 m	50ft	15 m
7.5ft	2.3 m	16’-6”	5.0 m	51’-6”	16 m
7’-7”	2.3 m	16’-8”	5.1 m	55ft	17 m
7’-9”	2.4 m	17ft	5.2 m	60ft	18 m
8ft	2.4 m	18ft	5.5 m	65ft	20 m
8’-2”	2.5 m	18’-6”	5.6 m	70ft	21 m
8’-4”	2.5 m	19’-2”	5.8 m	75ft	23 m
8’-77/8”	2.6 m	19’-10”	6 m	76ft	23 m
9ft	2.7 m	19’-11”	6.1 m	80ft	24 m
9’-5”	2.9 m	20ft	6.1 m	100ft	30 m
9’-6”	2.9 m	20’-8”	6.3 m	200ft	61 m
10ft	3 m	21’-6”	6.6 m	250ft	76 m
10.5ft	3.2 m	21’-10”	6.7 m	300ft	91 m
10’-9”	3.3 m	22 ft	6.7 m	400ft	120 m

Area					
3.5 ft2	0.3 m2	256 ft2	24 m2	2,700 ft2	250 m2
6 ft2	0.6 m2	300 ft2	28 m2	2,734 ft2	255 m2
10 ft2	0.9 m2	306 ft2	28 m2	2,800 ft2	260 m2
12 ft2	1.1 m2	324 ft2	30 m2	3,000 ft2	280 m2
16 ft2	1.5 m2	395 ft2	37 m2	3,250 ft2	300 m2
18 ft2	1.7m2	400 ft2	37 m2	3,300 ft2	305 m2
20 ft2	1.9m2	450 ft2	42 m2	3,450 ft2	320 m2
24 ft2	2.2m2	504 ft2	47 m2	3,500 ft2	325 m2
25 ft2	2.3 m2	585 ft2	54 m2	3,600 ft2	335 m2
32 ft2	3.0 m2	600 ft2	56 m2	3,750 ft2	350 m2
50 ft2	4.6 m2	648 ft2	60 m2	3,900 ft2	360 m2
55 ft2	5.1 m2	700 ft2	65 m2	4,000 ft2	370 m2
64 ft2	5.9 m2	756 ft2	70 m2	4,100 ft2	380 m2
70 ft2	6.5 m2	768 ft2	71 m2	4,500 ft2	420 m2
80 ft2	7.4 m2	800 ft2	74 m2	4,800 ft2	445 m2
90 ft2	8.4 m2	1,000 ft2	93 m2	5,000 ft2	465 m2
100 ft2	9 m2	1,200ft2	112 m2	6,000 ft2	555 m2
110 ft2	10 m2	1,300 ft2	120 m2	6,400 ft2	595 m2
120 ft2	11 m2	1,365 ft2	125 m2	8,000 ft2	740 m2
124 ft2	12 m2	1,400 ft2	130 m2	8,800 ft2	820 m2
130 ft2	12 m2	1,500 ft2	140 m2	10,000 ft2	930 m2
144 ft2	13 m2	1,700 ft2	160 m2	13,100 ft2	1 215 m2
150 ft2	14 m2	1,800 ft2	165 m2	25,000 ft2	2 320 m2
168 ft2	16 m2	1,950 ft2	180 m2	40,000 ft2	3 720 m2
175 ft2	16 m2	2,000 ft2	185 m2	50,000 ft2	4 650 m2
196 ft2	18 m2	2,300 ft2	215 m2	52,000 ft2	4 830 m2
200 ft2	18 m2	2,500 ft2	230m2	100,000 ft2	9 230 m2
225 ft2	20 m2	2,535 ft2	235 m2		
250 ft2	23 m2	2,600 ft2	240 m2		

Volume			
1.76 cuin	28 ml	160 ft3	4.5 m3
15.5 ft3	0.5 m3	400 ft3	11 m3
17.4 ft3	0.5 m3	1,000 ft3	28 m3
17.6 ft3	0.5 m3	1,800 ft3	51 m3
20.7 ft3	0.6 m3	2,100 ft3	59 m3
21.1 ft3	0.6 m3	2,300 ft3	65 m3
22 ft3	0.6 m3	6,500 ft3	184 m3
100 ft3	2.8 m3	2.25M ft3	63,720 m3

Capacity	
16 oz.	0.5 l
32 oz.	1 l
1 gal	4 l
5 gal	20 l
40 gal	150 l
100 gal	380 l
150 gal	570 l
250 gal	950 l
500 gal	1900 l
750 gal	2850 l
300,000 gal	1,135,500 l

Drill Size	
3/32”	2,3 mm
1/8”	3,2 mm
3/8”	10 mm

Density of Cotton Bales	
22.0 lb/ft^3	350 kg/m^3
22.7 lb/ft^3	365 kg/m^3
24.2 lb/ft^3	390 kg/m^3
28.4 lb/ft^3	455 kg/m^3
28.7 lb/ft^3	460 kg/m^3
32.2 lb/ft^3	515 kg/m^3

Flow					
30 gpm	115 lpm	300 gpm	1150 lpm	1000 gpm	3800 lpm
15 gpm	57 lpm	400 gpm	1500 lpm	1500 gpm	5700 lpm
20 gpm	75 lpm	500 gpm	1900 lpm	1992 gpm	7540 lpm
50 gpm	190 lpm	600 gpm	2250 lpm	1993 gpm	7543 lpm
60 gpm	230 lpm	700 gpm	2650 lpm	2156 gpm	8160 lpm
100 gpm	380 lpm	750 gpm	2850 lpm	2575 gpm	9750 lpm
102.8 gpm	390 lpm	800 gpm	3050 lpm	4907 gpm	18,572 lpm
200 gpm	760 lpm	850 gpm	3200 lpm		
215.8 gpm	815 lpm	900 gpm	3400 lpm		
250 gpm	950 lpm				

Pressure			
5 psi	0.3 bar	75	5.2 bar
7	0.5 bar	90	6.2 bar
10	0.7 bar	100	6.9 bar
11	.8 bar	150	10 bar
15	1.0 bar	165	11 bar
20	1.4 bar	175	12 bar
22	15 bar	189	13 bar
25	1.7 bar	200	14 bar
30	2.1 bar	259	17 bar
35	2.4 bar	300	21 bar
50	3.4 bar	400	28 bar
63	4.3 bar		

Gauge	
12	2.8 mm
14	1.98 mm
16	1.57 mm
22	.78 mm
24	.63mm

Weight			
6 lb	2.7 kg	350 lb	160 kg
10 lb	4.5 kg	440 lb	200 kg
20 lb	9.1 kg	520 lb	235 kg
40 lb	18 kg	750 lb	340 kg
61 lb	27 kg	787 lb	355 kg
91 lb	41 kg	1200 lb	544 kg
131 lb	59 kg	1634 lb	740 kg
200 lb	91 kg	2000 lb	907 kg
250 lb	115 kg	2300 lb	1043 kg
		4000 lb	1815 kg

Velocity	
30 mph	49 km/h

Discharge Density			
gpm/ft2	mm/min	gpm/ft2	mm/min
.005	.2	.425	17.3
.05	2.04	.426	17.4
.1	4.1	.44	17.9
.15	6.1	.45	18.3
.16	6.5	.46	18.7
.17	7.0	.49	20
.18	7.3	.5	20.4
.19	7.7	.55	22.4
.2	8.2	.56	22.8
.21	8.6	.57	23.2
.225	9.2	.6	24.5
.24	9.8	.61	24.9
.25	10.2	.65	26.5
.26	10.6	.68	27.7
.28	11.4	.7	28.5
.29	11.8	.74	30.2
.3	12.2	.75	30.6
.31	12.6	.77	31.4
.32	13.0	.8	32.6
.33	13.4	.85	34.6
.34	13.9	.9	36.7
.35	14.3	.92	37.5
.37	15.1	.96	39.1
.375	15.3	1.1	44.8
.39	15.9	1.2	48.9
.4	16.3	6.0	245
.42	17.1	7.5	306

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Chapter 6 Installation Underground Piping

6.1* Piping.

[**24:**10.1]

A.6.1

Copper tubing (Type K) with brazed joints conforming to Table 6.1.1.1 and Table 6.2.1.1 is acceptable for underground service.

(1) *Listing and labeling.*~~certification~~ Certification organizations list or label the following:

(a) Cast iron and ductile iron pipe (cement-lined and unlined, coated and uncoated)

(b) Steel pipe

(c) Copper pipe

(d) Fiberglass filament-wound epoxy pipe and couplings

(e) Polyethylene pipe

(f) Polyvinyl chloride (PVC) pipe and couplings

(g) Reinforced concrete pipe (cylinder pipe, nonprestressed and prestressed)

[**24:**A.10.1]

6.1.1*

All piping used in private fire service mains shall be in accordance with 6.1.1.1, 6.1.1.2, or 6.1.1.3. [**24:**10.1.1]

6.1.1.1 Listing.

Piping manufactured in accordance with Table 6.1.1.1 shall be permitted to be used. [**24:**10.1.1.1]

Table 6.1.1.1 Manufacturing Standards for Underground Pipe

Materials and Dimensions	Standard
Ductile Iron	
Cement-Mortar Lining for Ductile-Iron Pipe and Fittings ~~for Water~~	AWWA C104/A21.4
Polyethylene Encasement for Ductile-Iron Pipe Systems	AWWA C105/A21.5
Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings	AWWA C111/A21.11
Flanged Ductile-Iron Pipe with Ductile-Iron or Gray-Iron Threaded Flanges	AWWA C115/A21.15
Thickness Design of Ductile-Iron Pipe	AWWA C150/A21.50
Ductile-Iron Pipe, Centrifugally Cast ~~for Water~~	AWWA C151/A21.51
Standard for the Installation of Ductile Iron Water Mains and Their Appurtenances	AWWA C600
Concrete	
Reinforced Concrete Pressure Pipe, Steel-Cylinder Type	AWWA C300
Prestressed Concrete Pressure Pipe, Steel-Cylinder Type	AWWA C301
Reinforced Concrete Pressure Pipe, Non-Cylinder Type	AWWA C302
Reinforced Concrete Pressure Pipe, Steel-Cylinder Type, Pretensioned	AWWA C303
~~Standard for Asbestos-Cement Distribution Pipe, 4 in. Through 16 in., for Water Distribution Systems~~	~~AWWA C400~~
Cement-Mortar Lining of Water Pipe Lines in Place, 4 in. (100 mm) and Larger ~~— in Place~~	AWWA C602
Plastic	
Polyvinyl Chloride (PVC) Pressure Pipe, 4 in. Through 12 in.(100 mm Through 300 mm) , for Water Transmission and Distribution	AWWA C900
Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings , 14 in. Through 48 in. (350 mm Through 1200 mm) , for Water Transmission and Distribution	AWWA C905
Polyethylene (PE) Pressure Pipe and Fittings, 4 in. (100 mm) Through 63 in. (1575 mm) for Waterworks ~~Distribution~~	AWWA C906
Molecularly Oriented Polyvinyl Chloride (PVCO) 4 in. Through 24 in. (100 mm Through 600 mm) for Water, Wastewater, and Reclaimed Water Service	AWWA C909
Brass	
Specification for Seamless Red Brass Pipe, Standard Sizes	ASTM B43
Copper	
Specification for Seamless Copper Tube	ASTM B75/B75M
Specification for Seamless Copper Water Tube	ASTM B88
Requirements for Wrought Seamless Copper and Copper-Alloy Tube	ASTM B251
Stainless Steel	

Materials and Dimensions	Standard
Specification for Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes	ASTM A312/312M

[**24:**Table 10.1.1.1]

6.1.1.2

Piping specifically listed for use in private fire service mains shall be permitted to be used. [**24:**10.1.1.2]

6.1.1.2.1

Where listed pipe is used, it shall be installed in accordance with the listing limitations including installation instructions. [**24:**10.1.1.2.1]

6.1.1.2.2

Where listing limitations or installation instructions differ from the requirements of this standard, the listing limitations and installation instructions shall apply. [**24:**10.1.1.2.2]

6.1.1.3

Steel piping manufactured in accordance with Table 6.1.1.3 that is externally coated and wrapped and internally galvanized shall be permitted to be used between the hose coupling(s) on the fire department connection and the check valve installed in the fire department connection piping. [**24:**10.1.1.3]

Table 6.1.1.3 Steel Piping for Fire Department Connections

Materials and Dimensions	Standard
Standard Specification for Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless Steel Pipe for Fire Protection Use	ASTM A795/A795M
Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless	ASTM A53/A53M
Standard Specification for Electric-Resistance-Welded Steel Pipe	ASTM A135/A135M

[**24:**Table 10.1.1.3]

6.1.1.3.1

External coating and wrapping as required by 6.1.1.3 shall be approved. [**24:**10.1.1.3.1]

6.1.1.4 Dry Pipe Underground.

6.1.1.4.1

Where necessary to place pipe that will be under air pressure underground, the pipe shall be protected against corrosion.

6.1.1.4.2

Unprotected cast-iron or ductile-iron pipe shall be permitted where joined with a gasketed joint listed for air service underground.

6.1.2*

All piping used in private fire service mains shall be rated for the maximum system working pressure to which the piping is exposed to but shall not be rated at less than 150 psi (~~10~~ 10.3 bar). [**24:**10.1.2]

6.1.3*

When lined piping is used, the manufacturer's literature for internal diameter shall be used for all hydraulic calculations. [**24:**10.1.3]

A.6.1.3

~~For internal diameters of cement-lined ductile iron pipe, see~~ See Table A.6.1.3. [**24:** A.10.1.3]

Table A.6.1.3 Internal Diameters (IDs) for Cement-Lined Ductile Iron Pipe

Pipe Size (in.)	OD (in.)	Pressure Class	Thickness Class	Wall Thickness	Minimum Lining Thickness*	ID (in.) with Lining
3	3.96	350		0.25	1/16	3.34
3	3.96		51	0.25	1/16	3.34
3	3.96		52	0.28	1/16	3.28
3	3.96		53	0.31	1/16	3.22
3	3.96		54	0.34	1/16	3.16
3	3.96		55	0.37	1/16	3.10
3	3.96		56	0.40	1/16	3.04
4	4.80	350		0.25	1/16	4.18
4	4.80		51	0.26	1/16	4.16
4	4.80		52	0.29	1/16	4.10
4	4.80		53	0.32	1/16	4.04
4	4.80		54	0.35	1/16	3.98
4	4.80		55	0.38	1/16	3.92
4	4.80		56	0.41	1/16	3.86
6	6.90	350		0.25	1/16	6.28
6	6.90		50	0.25	1/16	6.28
6	6.90		51	0.28	1/16	6.22
6	6.90		52	0.31	1/16	6.16
6	6.90		53	0.34	1/16	6.10
6	6.90		54	0.37	1/16	6.04
6	6.90		55	0.40	1/16	5.98
6	6.90		56	0.43	1/16	5.92
8	9.05	350		0.25	1/16	8.43
8	9.05		50	0.27	1/16	8.39
8	9.05		51	0.30	1/16	8.33
8	9.05		52	0.33	1/16	8.27
8	9.05		53	0.36	1/16	8.21
8	9.05		54	0.39	1/16	8.15
8	9.05		55	0.42	1/16	8.09
8	9.05		56	0.45	1/16	8.03
10	11.10	350		0.26	1/16	10.46
10	11.10		50	0.29	1/16	10.40
10	11.10		51	0.32	1/16	10.34
10	11.10		52	0.35	1/16	10.28
10	11.10		53	0.38	1/16	10.22
10	11.10		54	0.41	1/16	10.16
10	11.10		55	0.44	1/16	10.10
10	11.10		56	0.47	1/16	10.04
12	13.20	350		0.28	1/16	12.52
12	13.20		50	0.31	1/16	12.46
12	13.20		51	0.34	1/16	12.40

Pipe Size (in.)	OD (in.)	Pressure Class	Thickness Class	Wall Thickness	Minimum Lining Thickness*	ID (in.) with Lining
12	13.20		52	0.37	1/16	12.34
12	13.20		53	0.40	1/16	12.28
12	13.20		54	0.43	1/16	12.22
12	13.20		55	0.46	1/16	12.16
12	13.20		56	0.49	1/16	12.10
14	15.30	250		0.28	3/32	14.55
14	15.30	300		0.30	3/32	14.51
14	15.30	350		0.31	3/32	14.49
14	15.30		50	0.33	3/32	14.45
14	15.30		51	0.36	3/32	14.39
14	15.30		52	0.39	3/32	14.33
14	15.30		53	0.42	3/32	14.27
14	15.30		54	0.45	3/32	14.21
14	15.30		55	0.48	3/32	14.15
14	15.30		56	0.51	3/32	14.09
16	17.40	250		0.30	3/32	16.61
16	17.40	300		0.32	3/32	16.57
16	17.40	350		0.34	3/32	16.53
16	17.40		50	0.34	3/32	16.53
16	17.40		51	0.37	3/32	16.47
16	17.40		52	0.40	3/32	16.41
16	17.40		53	0.43	3/32	16.35
16	17.40		54	0.46	3/32	16.29
16	17.40		55	0.49	3/32	16.23
16	17.40		56	0.52	3/32	16.17
18	19.50	250		0.31	3/32	18.69
18	19.50	300		0.34	3/32	18.63
18	19.50	350		0.36	3/32	18.59
18	19.50		50	0.35	3/32	18.61
18	19.50		51	0.35	3/32	18.61
18	19.50		52	0.41	3/32	18.49
18	19.50		53	0.44	3/32	18.43
18	19.50		54	0.47	3/32	18.37
18	19.50		55	0.50	3/32	18.31
18	19.50		56	0.53	3/32	18.25
20	21.60	250		0.33	3/32	20.75
20	21.60	300		0.36	3/32	20.69
20	21.60	350		0.38	3/32	20.65
20	21.60		50	0.36	3/32	20.69
20	21.60		51	0.39	3/32	20.63
20	21.60		52	0.42	3/32	20.57
20	21.60		53	0.45	3/32	20.51
20	21.60		54	0.48	3/32	20.45
20	21.60		55	0.51	3/32	20.39

Pipe Size (in.)	OD (in.)	Pressure Class	Thickness Class	Wall Thickness	Minimum Lining Thickness*	ID (in.) with Lining
20	21.60		56	0.54	3⁄32	20.33
24	25.80	200		0.33	3⁄32	24.95
24	25.80	250		0.37	3⁄32	24.87
24	25.80	300		0.40	3⁄32	24.81
24	25.80	350		0.43	3⁄32	24.75
24	25.80		50	0.38	3⁄32	24.85
24	25.80		51	0.41	3⁄32	24.79
24	25.80		52	0.44	3⁄32	24.73
24	25.80		53	0.47	3⁄32	24.67
24	25.80		54	0.50	3⁄32	24.61
24	25.80		55	0.53	3⁄32	24.55
24	25.80		56	0.56	3⁄32	24.49

ID: internal diameter; OD: outside diameter.

*Note: This table is appropriate for single lining thickness only. The actual lining thickness should be obtained from the manufacturer. [**24:**Table A.10.1.3]

6.1.4*

~~Where piping installed in a private fire service main must be installed above grade, the piping materials shall conform to NFPA 13. [**24:** 10.1.4]~~ Underground piping shall be permitted to extend into the building through the slab or wall not more than 24 in. (600 mm). [**24:** 10.1.4]

~~**6.1.4.1**~~

~~Underground piping shall be permitted to extend into the building through the slab or wall not more than 24 in. (600 mm). [**24:** 10.1.4.1]~~

6.2 Fittings.

[**24:**10.2]

6.2.1

All fittings used in private fire service mains shall be in accordance with 6.2.1.1 or 6.2.1.2. [**24:**10.2.1]

6.2.1.1

Fittings manufactured in accordance with Table 6.2.1.1 shall be permitted to be used. [**24:**~~Table~~ 10.2.1.1]

Table 6.2.1.1 Fittings Materials and Dimensions

Materials and Dimensions	Standard
Cast Iron	
Gray Iron Threaded Fittings, Classes 125 and 250	ASME B16.4
Gray Iron Pipe Flanges and Flanged Fittings, Classes 25, 125, and 250	ASME B16.1
Ductile Iron	
Ductile-Iron and Gray-Iron Fittings~~, 3 in. Through 48 in., for Water and other Liquids~~	AWWA C110/A21.10
Ductile-Iron Compact Fittings~~, 3 in. Through 24 in. and 54 in. through 64 in. for Water Service~~	AWWA C153/A21.53
Malleable Iron	
Malleable Iron Threaded Fittings, Classes 150 and 300	ASME B16.3
~~Steel~~	
~~Factory-Made Wrought Steel Buttweld Fittings~~	~~ASME B16.9~~
~~Buttwelding Ends~~	~~ASME B16.25~~
~~Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures~~	~~ASTM A234~~
~~Pipe Flanges and Flanged Fittings NPS ½ Through 24~~	~~ASME B16.5~~
~~Forged Steel Fittings, Socket-Welded and Threaded~~	~~ASME B16.11~~
~~Steel Pipe Flanges for Waterworks Service — Sizes 4 in. Through 144 in.~~	~~AWWA C207~~
~~Dimensions for Fabricated Steel Water Pipe Fittings~~	~~AWWA C208~~
Copper	
Wrought Copper and ~~Bronze~~ Copper Alloy Solder Joint Pressure Fittings	ASME B16.22
~~Cast Cast Bronze~~ Cast Copper Alloy Solder Joint Pressure Fittings	ASME B16.18
Bronze Fittings	
Cast ~~Bronze~~ Copper Alloy Threaded Fittings, Classes 125 and 250	ASTM B16.15

[**24:**Table ~~10.2.2.1~~ 10.2.1.1]

6.2.1.2 Special Listed Fittings.

Fittings specifically listed for use in private fire service mains shall be permitted to be used. [**24:**10.2.1.2]

6.2.1.2.1

Where listed fittings are used, they shall be installed in accordance with their listing limitations including installation instructions. [**24:**10.2.1.2.1]

6.2.1.2.2

Where listing limitations or installation instructions differ from the requirements of this standard, the listing limitations and installation instructions shall apply. [**24:**10.2.1.2.2]

6.2.2

All fittings used in private fire service mains shall be rated for the maximum system working pressure to which the fittings are exposed, but shall not be rated at less than 150 psi (~~10~~ 10.3 bar). [**24:**10.2.2]

6.2.3

Where fittings installed in a private fire service main must be installed above grade, the fittings shall conform to NFPA 13. [**24:**10.2.3]

6.2.3.1

Fittings in accordance with 6.2.1 shall be permitted for the transition to the above ground piping or fittings. [**24:**10.2.3.1]

6.3 Connection of Pipe, Fittings, and Appurtenances.

[**24:**10.3]

6.3.1*

Connection of all fittings and appurtenances to piping shall be in accordance with Section 6.3. [**24:**10.3.1]

A.6.3.1

The following standards apply to joints used with the various types of pipe:

(1) ASME B16.1, ~~*Cast*~~ *Gray Iron Pipe Flanges and Flanged Fittings Classes 25, 125, and 250*

(2) AWWA C111/A21.11 , *Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings*

(3) AWWA C115/A21.15 , *Flanged Ductile-Iron Pipe with Ductile-Iron or Gray-Iron Threaded Flanges*

(4) AWWA C206, *Field Welding of Steel Water Pipe*

(5) AWWA C606, *Grooved and Shouldered Joints*

[**24:**A.10.3.1]

6.3.2

Connections of pipe and fittings indicated in Table 6.1.1.1 and Table 6.2.1.1 shall be in accordance with the referenced standard in the ~~Table~~ table . [**24:**10.3.2]

6.3.3 Listed Connections.

Connections utilizing listed products shall be in accordance with the listing limitations and the manufacturer's installation instructions. [**24:**10.3.3]

6.3.3.1

Where listing limitations or installation instructions differ from the requirements of this standard, the listing limitations and installation instructions shall apply. [**24:**10.3.3.1]

6.3.4 Threaded Pipe and Fittings.

Where pipe, fittings or appurtenances are connected using threads, all threads shall be in accordance with ~~ANSI/~~ ASME B1.20.1, *Pipe Threads, General Purpose (Inch)* . [**24:**10.3.4]

6.3.5 Grooved Connections.

Where pipe, fittings, or appurtenances are connected using grooves, they shall be connected in accordance with 6.3.5.1 through 6.3.5.3. [**24:**10.3.5]

6.3.5.1

Pipe, fittings, and appurtenances to be joined with grooved couplings shall contain cut, rolled, or cast grooves that are dimensionally compatible with the couplings. [**24:**10.3.5.1]

6.3.5.2

Pipe, fittings, and appurtenances that are connected with grooved couplings and are part of a listed assembly shall be permitted to be used. [**24:**10.3.5.2]

6.3.5.3*

Pipe joined with grooved fittings shall be joined by a listed combination of fittings, gaskets, and grooves. [**24:**10.3.5.3]

6.3.6 Copper Tube.

All joints for the connection of copper tube shall be brazed or joined using pressure fittings as specified in Table 6.2.1.1. [**24:**10.3.6]

6.4 Protection of Private Fire Service Mains. [24:10.4]

6.4.1 Protection from Corrosion.

[**24:**10.4.1]

6.4.1.1 Coatings.

All bolted joint accessories shall be cleaned and thoroughly coated with asphalt or other corrosion-retarding material after installation. [**24:**10.4.1.1]

6.4.1.2

The requirements of ~~6.4.1.1~~ 6.3.5.3 shall not apply to epoxy-coated fittings, valves, glands, or other accessories. [**24:**10.4.1.2]

6.4.1.3*

Where it is necessary to join metal pipe with pipe of dissimilar metal, the joint shall be insulated against the passage of an electric current using an approved method. [**24:**10.4.1.3]

A.6.4.1.3

Gray cast iron is not considered galvanically dissimilar to ductile iron. Rubber gasket joints (unrestrained push-on or mechanical joints) are not considered connected electrically. Metal thickness should not be considered a protection against corrosive environments. In the case of cast iron or ductile iron pipe for soil evaluation and external protection systems, see Appendix A of AWWA C105/A21.5 , *Polyethylene Encasement for Ductile-Iron Pipe Systems*. [**24:**A.10.4.1.3]

6.4.2* Protection of Piping. [24:10.4.2]

6.4.2.1 Protection from Freezing.

The depth of cover for private fire service mains and their appurtenances to protect against freezing shall be in accordance with 6.4.2. [**24:**10.4.2.1]

6.4.2.1.1*

The top of the pipe shall be buried not less than 1 ft (300 mm) below the frost line for the locality. [**24:**10.4.2.1.1]

6.4.2.1.2

The depth of piping shall be measured from the top of the piping to the final grade. [**24:**10.4.2.1.2]

6.4.2.1.3

Where listed piping is used and the bury depth differs from this standard, the listing limitations shall apply. [**24:**10.4.2.1.3]

6.4.2.1.4

Where private fire service mains are installed above ground, they shall be protected from freezing in accordance with NFPA 13. [**24:**10.4.2.1.4]

6.4.2.1.5

Private fire service mains installed in water raceways or shallow streams shall be installed so that the piping will remain in the running water throughout the year. [**24:**10.4.2.1.5]

6.4.2.1.6

Where piping is installed adjacent to a vertical face, it shall be installed from the vertical face at the same distance as if the piping were buried. [**24:**10.4.2.1.6]

6.4.2.1.7

Protection of private fire service mains from freezing using heat tracing shall be permitted when the heat tracing is specifically listed for underground use. [**24:**10.4.2.1.7]

6.4.2.1.7.1

Heat tracing not listed for underground use shall be permitted when piping is installed in accordance with 6.1.4. [**24:**10.4.2.1.7.1]

6.4.2.2 Protection from Mechanical Damage.

The depth of cover for private fire service mains and their appurtenances to protect against mechanical damage shall be in accordance with ~~6.4.2.2.3~~ 6.4.2.2 . [**24:**10.4.2.2]

6.4.2.2.1

The depth of piping shall be measured from the top of the piping to the final grade. [**24:**10.4.2.2.1]

6.4.2.2.2

In locations where freezing is not a factor, the depth of cover shall not be less than 30 in. (0.8 m) below grade to prevent mechanical damage. [**24:**10.4.2.2.2]

6.4.2.2.2.1

Where listed piping is used and the bury depth differs from this standard, the listing limitations shall apply. [**24:**10.4.2.2.2.1]

6.4.2.2.3

Private fire service mains installed under driveways or roadways shall be buried at a minimum depth of 3 ft (900 mm). [**24:**10.4.2.2.3]

6.4.2.2.3.1

Sidewalks, walkways, and other paved or concrete pedestrian passageways shall not be required to comply with 6.4.2.2.3. [**24:**10.4.2.2.3.1]

6.4.2.2.4

Private fire service mains installed under railroad tracks shall be buried at a minimum depth of 4 ft (1.2 m). [**24:**10.4.2.2.4]

6.4.2.2.4.1

Where railroad operators require a greater depth of bury, the greater depth shall apply. [**24:**10.4.2.2.4.1]

6.4.2.2.5

Private fire service mains installed under large piles of heavy commodities or subject to heavy shock and vibrations shall be buried at a minimum depth of 4 ft (1.2 m). [**24:**10.4.2.2.5]

6.4.2.2.6

Where private fire service mains are installed above ground, they shall be protected with bollards or other means as approved by the AHJ when subject to mechanical damage. [**24:**10.4.2.2.6]

6.4.3 Private Fire Service Mains Under Buildings.

Except as allowed by 6.4.3, private fire service mains shall not be allowed to run under buildings. [**24:**10.4.3]

6.4.3.1*

Private fire service mains supplying fire protection systems within the building shall be permitted to extend no more than 10 ft (~~3~~ 3.0 m), as measured from the outside of the building, under the building to the riser location. [**24:**10.4.3.1]

6.4.3.1.1*

Pipe joints shall not be located directly under foundation fittings. [**24:**10.4.3.1.1]

6.4.3.1.2*

Piping shall be installed a minimum of 12 in. (300 mm) below the bottom of building foundations or footers. [**24:**10.4.3.1.2]

6.4.3.1.2.1

The requirements of 6.4.3.1.2 shall not apply when the piping is sleeved with an approved material. [**24:**10.4.3.1.2.1]

6.4.3.2*

~~Where approved, private fire service mains supplying systems within the building shall~~ Private fire service mains shall not be permitted to extend more than 10 ft (3 m) under the building ~~when all the requirements of~~ except as allowed in 6.4.3.2.1~~, through 6.4.3.2.4 are met~~ . [**24:**10.4.3.2]

6.4.3.2.1

~~Where the piping is installed under the building, all foundations or footers over the private fire service main shall be arched to create a minimum of 24 in. (600 mm) clearance.~~ Where private fire service mains extend more than 10 ft (3 m) into the building, they shall be run in a covered trench. [**24:**10.4.3.2.1]

6.4.3.2.1.1*

~~It shall be acceptable to install the piping in covered trenches where the trenches are~~ The trench shall be accessible from within the building. [**24:**~~10.4.3.2.2~~ 10.4.3.2.1.1]

A.6.4.3.2.1.1

A grate or steel plate are common methods of accessing the trench. [**24:** A.10.4.3.2.1.1]

6.4.3.2.1.2

~~All joints shall be mechanically restrained.~~ The trench shall have rigid walls and a base. [**24:**~~10.4.3.2.3~~ 10.4.3.2.1.2]

6.4.3.2.1.3

~~A valve shall be installed before the piping enters under the building and within 24 in. (600 mm) of where the piping enters the building.~~ The trench shall be constructed of noncombustible materials. [**24:**~~10.4.3.2.4~~ 10.4.3.2.1.3]

6.4.3.2.1.4*

Provisions for draining water shall be provided for the trench. [**24:** 10.4.3.2.1.4]

6.4.3.2.1.5

Where the piping in the trench is installed under foundations or footers, clearance shall be provided in accordance with 6.4.3.1.2 or 6.4.3.1.2.1 . [**24:** 10.4.3.2.1.5]

6.4.3.2.2

Piping in the trench shall be permitted to be in accordance with 6.1.1 . [**24:** 10.4.3.2.2]

6.4.3.2.2.1

Aboveground piping in accordance with NFPA 13 shall be permitted to be used. [**24:** 10.4.3.2.2.1]

6.4.3.2.2.2

Where piping installed in the trench is in accordance with 6.1.1 , all joints shall be restrained in accordance with 6.6.2 or 6.6.3 . [**24:** 10.4.3.2.2.2]

6.4.3.2.3*

Where piping is installed in a trench as permitted by 6.4.3.2.1 , a valve shall be provided where the underground piping enters the trench. [**24:** 10.4.3.2.3]

6.4.3.2.4

When piping is installed in a trench, bury depths of 6.4.2.2 shall not apply. [**24:** 10.4.3.2.4]

6.4.3.2.4.1

Piping in the trench shall be protected from freezing in accordance with 6.4.2.1.4 . [**24:** 10.4.3.2.4.1]

6.5 Grounding and Bonding.

[**24:**10.5]

6.5.1*

In no case shall the underground piping be used as a grounding electrode for electrical systems. [**24:**10.5.1]

6.5.1.1*

The requirement of 6.5.1 shall not preclude the bonding of the underground piping to the lightning protection grounding system as required by NFPA 780 in those cases where lightning protection is provided for the structure. [**24:**10.5.1.1]

6.6* Restraint.

Private fire service mains shall be restrained against movement at changes in direction in accordance with 6.6.1, 6.6.2, or 6.6.3. [**24:**10.6]

6.6.1* Thrust Blocks.

A.6.6.1

The use of concrete thrust blocks is one method of restraint, provided that stable soil conditions prevail and space requirements permit placement. Successful blocking is dependent on factors such as location, availability and placement of concrete, and possibility of disturbance by future excavations.

Resistance is provided by transferring the thrust force to the soil through the larger bearing area of the block so that the resultant pressure against the soil does not exceed the horizontal bearing strength of the soil. The design of thrust blocks consists of determining the appropriate bearing area of the block for a particular set of conditions. The parameters involved in the design include pipe size, design pressure, angle of the bend (or configuration of the fitting involved), and the horizontal bearing strength of the soil.

Table A.6.6.1(a) gives the nominal thrust at fittings for various sizes of ductile-iron and PVC piping. Figure A.6.6.1(a) shows an example of how thrust forces act on a piping bend.

Table A.6.6.1(a) Thrust at Fittings at 100 psi (6.9 bar) Water Pressure for Ductile Iron and PVC Pipe

Nominal Pipe Diameter (in.)	Total Pounds					
	Dead End	90 Degree Bend	45 Degree Bend	22½ Degree Bend	11¼ Degree Bend	5⅛ Degree Bend
4	1,810	2,559	1,385	706	355	162
6	3,739	5,288	2,862	1,459	733	334
8	6,433	9,097	4,923	2,510	1,261	575
10	9,677	13,685	7,406	3,776	1,897	865
12	13,685	19,353	10,474	5,340	2,683	1,224
14	18,385	26,001	14,072	7,174	3,604	1,644
16	23,779	33,628	18,199	9,278	4,661	2,126
18	29,865	42,235	22,858	11,653	5,855	2,670
20	36,644	51,822	28,046	14,298	7,183	3,277
24	52,279	73,934	40,013	20,398	10,249	4,675
30	80,425	113,738	61,554	31,380	15,766	7,191
36	115,209	162,931	88,177	44,952	22,585	10,302
42	155,528	219,950	119,036	60,684	30,489	13,907
48	202,683	286,637	155,127	79,083	39,733	18,124

Notes:

(1) For SI units, 1 lb = 0.454 kg; 1 in. = 25.4 mm.

(2) To determine thrust at pressure other than 100 psi (6.9 bar), multiply the thrust obtained in the table by the ratio of the pressure to 100 psi (6.9 bar). For example, the thrust on a 12 in., 90 degree bend at 125 psi (8.6 bar) is 19,353 × 125/100 = 24,191 lb (10,973 kg).

[**24:**Table A.10.6.1(a)]

Table A.6.6.1(b) Required Horizontal Bearing Block Area

Nominal Pipe Diameter (in.)	Bearing Block Area (ft^2)	Nominal Pipe Diameter (in.)	Bearing Block Area (ft^2)	Nominal Pipe Diameter (in.)	Bearing Block Area (ft^2)
3	2.6	12	29.0	24	110.9
4	3.8	14	39.0	30	170.6
6	7.9	16	50.4	36	244.4
8	13.6	18	63.3	42	329.9
10	20.5	20	77.7	48	430.0

Notes:

(1) Although the bearing strength values in this table have been used successfully in the design of thrust blocks and are considered to be conservative, their accuracy is totally dependent on the accurate soil identification and evaluation. The ultimate responsibility for selecting the proper bearing strength of a

particular soil type must rest with the design engineer.

(2) Values listed are based on a 90-degree horizontal bend, an internal pressure of 100 psi, a soil horizontal bearing strength of 1,000 lb/ft^2, a safety factor of 1.5, and ductile-iron pipe outside diameters.

(a) For other horizontal bends, multiply by the following coefficients: for 45 degree: 0.541; for 22½ degree: 0.276; for 11¼ degree: 0.139.

(b) For other internal pressures, multiply by ratio to 100 psi.

(c) For other soil horizontal bearing strengths, divide by ratio to 1,000 lb/ft^2.

(d) For other safety factors, multiply by ratio to 1.5.

Example. Using Table A.6.6.1(b), find the horizontal bearing block area for a 6 in. diameter, 45-degree bend with an internal pressure of 150 psi. The soil bearing strength is 3000 lb/ft^2, and the safety factor is 1.5.

From Table A.6.6.1(b), the required bearing block area for a 6 in. diameter, 90-degree bend with an internal pressure of 100 psi and a soil horizontal bearing strength of 1000 psi is 7.9 ft^2.

For example:

$$Area = \frac{7.9\ \text{ft}^2 (0.541) \frac{150}{100}}{\frac{3000}{1000}} = 2.1\ \text{ft}^2$$

~~[A.10.6.1a]~~ [A.6

[**24:**Table A.10.6.1(b)]

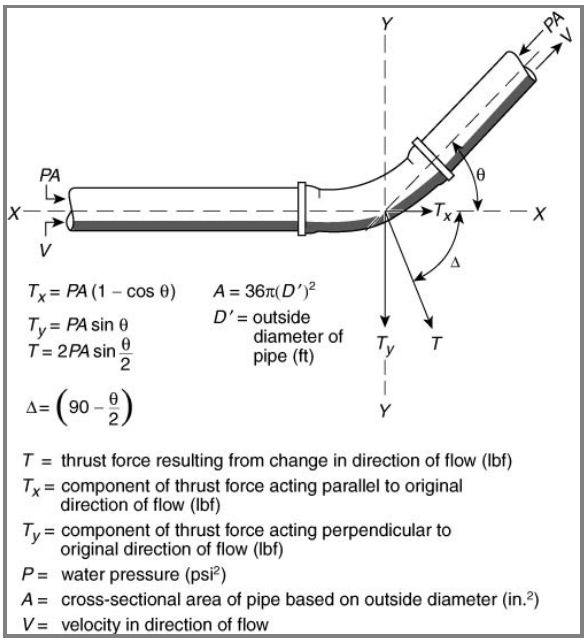
Table A.6.6.1(c) Horizontal Bearing Strengths

	Bearing Strength, S_b	
Soil	lb/ft^2	kN/m^2
Muck	0	0
Soft clay	1000	47.9
Silt	1500	71.8
Sandy silt	3000	143.6
Sand	4000	191.5
Sandy clay	6000	287.3
Hard clay	9000	430.9

Note: Although the bearing strength values in this table have been used successfully in the design of thrust blocks and are considered to be conservative, their accuracy is totally dependent on accurate soil identification and evaluation. The ultimate responsibility for selecting the proper bearing strength of a particular soil type must rest with the design engineer.

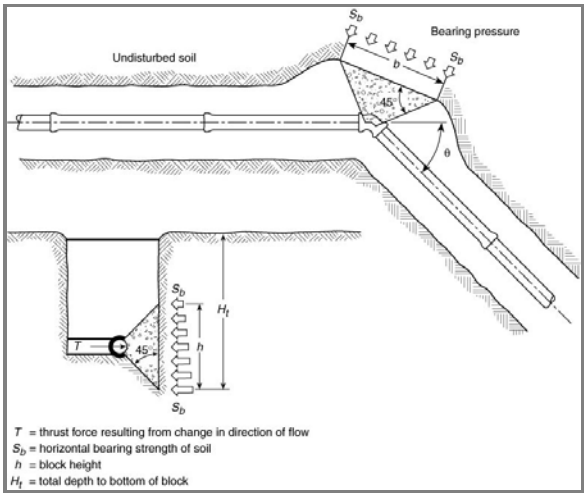
[**24:**Table A.10.6.1(c)]

Figure A.6.6.1(a) Thrust Forces Acting on a~~ Bend. [24:Figure A.10.6.1(a)]



Thrust blocks are generally categorized into two groups — bearing and gravity blocks. Figure A.6.6.1(b) depicts a typical bearing thrust block on a horizontal bend. [**24:**A.10.6.1]

Figure A.6.6.1(b) Bearing Thrust Block. [24:Figure A.10.6.1(b)]



The following are general criteria for bearing block design:

(1) The bearing surface should, where possible, be placed against undisturbed soil.

(2) Where it is not possible to place the bearing surface against undisturbed soil, the fill between the bearing surface and undisturbed soil must be compacted to at least 90 percent Standard Proctor density.

(3) Block height *(h)* should be equal to or less than one-half the total depth to the bottom of the block *(H_t)* but not less than the pipe diameter *(D)*.

(4) Block height *(h)* should be chosen such that the calculated block width *(b)* varies between one and two times the height.

(5) Gravity thrust blocks can be used to resist thrust at vertical down bends. In a gravity thrust block, the weight of the block is the force providing equilibrium with the thrust force. The design problem is then to calculate the required volume of the thrust block of a known density. The vertical component of the thrust force in Figure A.6.6.1(c) is balanced by the weight of the block. For required horizontal bearing block areas, see Table A.6.6.1(b).

The required block area (A_b) is as follows:

$$A_b = (h)(b) = \frac{T(S_f)}{S_b}$$ [A.10.6.1b] [A.6

where:

A_b = required block area (ft^2)

h = block height (ft)

b = calculated block width (ft)

T = thrust force (lbf)

S_f = safety factor (usually 1.5)

S_b = bearing strength (lb/ft^2)

Then, for a horizontal bend, the following formula is used:

$$b = \frac{2(S_f)(P)(A)\sin\frac{\theta}{2}}{(h)(S_b)}$$ [A.10.6.2.1c] [A

where:

b = calculated block width (ft)

S_f = safety factor (usually 1.5 for thrust block design)

P = water pressure ($lb/in.^2$)

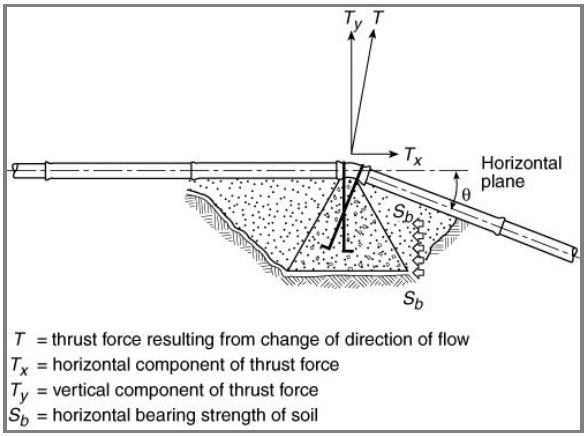
A = cross-sectional area of the pipe based on outside diameter

h = block height (ft)

S_b = horizontal bearing strength of ~~the~~ soil (lb/ft^2) ($in.^2$)

A similar approach can be used to design bearing blocks to resist the thrust forces at locations such as tees and dead ends. Typical values for conservative horizontal bearing strengths of various soil types are listed in Table A.6.6.1(c). [**24:**A.10.6.1]

Figure A.6.6.1(c) Gravity Thrust Block. [24:Figure A.10.6.1(c)]



In lieu of the values for soil bearing strength shown in Table A.6.6.1(c), a designer might choose to use calculated Rankine passive pressure (P_p) or other determination of soil-bearing strength based on actual soil properties.

It can be easily ~~be~~ shown that $T_Y = PA \sin\theta$. The required volume of the block is as follows:

$$V_g = \frac{S_f PA \sin\theta}{W_m}$$ [A.10.6.2.1d] [A

where:

V_g = block volume (ft^3)

S_f = safety factor

P = water pressure (psi)

A = cross-sectional area of ~~the~~ pipe interior

W_m = density of ~~the~~ block material (lb/ft^3)

In a case such as the one shown, the horizontal component of thrust force is calculated as follows:

$$T_x = PA(1 - \cos\ \theta)$$ ~~[A.10.6.2.1e]~~ [A

where:

T_X = horizontal component of ~~the~~ thrust force

P = water pressure (psi)

A = cross-sectional area of ~~the~~ pipe interior

The horizontal component of thrust force ~~should~~ must be resisted by the bearing of the right side of the block against the soil. Analysis of this aspect follows the same principles as the previous section on bearing blocks. [**24:**A.10.6.1]

6.6.1.1

Thrust blocks shall be permitted where soil is stable and capable of resisting the anticipated thrust forces. [**24:**10.6.1.1]

6.6.1.2

Thrust blocks shall be ~~of~~ concrete of a mix not leaner than one part cement, two and one-half parts sand, and five parts stone. [**24:**10.6.1.2]

6.6.1.3

Thrust blocks shall be placed between undisturbed earth and the fitting to be restrained and shall be capable of resisting the calculated thrust forces. [**24:**10.6.1.3]

6.6.1.4

Wherever possible, thrust blocks shall be located so that the joints are accessible for repair. [**24:**10.6.1.4]

6.6.2* Restrained Joint Systems.

Private fire service mains using restrained joint systems shall include one or more of the following:

(1) Locking mechanical or push-on joints

(2) Mechanical joints utilizing setscrew retainer glands

(3) Bolted flange joints

(4) Pipe clamps and tie rods

(5) Other approved methods or devices

[**24:**10.6.2]

6.6.2.1 Sizing Clamps, Rods, Bolts, and Washers.

[**24:**10.6.2.1]

6.6.2.1.1 Clamps.

[**24:**10.6.2.1.1]

6.6.2.1.1.1

Clamps shall have the following dimensions:

(1) ½ in. × 2 in. (12 mm × 50 mm) for 4 in. (100 mm) to 6 in. (150 mm) pipe

(2) ⅝ in. × 2½ in. (16 mm × 65 mm) for 8 in. (200 mm) to 10 in. (250 mm) pipe

(3) ⅝ in. × 3 in. (16 mm × 75 mm) for 12 in. (300 mm) pipe

[**24:**10.6.2.1.1.1]

6.6.2.1.1.2

The diameter of a bolt hole shall be ⅛ in. (~~3~~ 3.2 mm) larger than that of the corresponding bolts. [**24:**10.6.2.1.1.2]

6.6.2.1.2 Rods.

[**24:**10.6.2.1.2]

6.6.2.1.2.1

Rods shall be not less than ⅝ in. (16 mm) in diameter. [**24:**10.6.2.1.2.1]

6.6.2.1.2.2

Table 6.6.2.1.2.2 provides the numbers of various diameter rods that shall be used for a given pipe size. [**24:**10.6.2.1.2.2]

Table 6.6.2.1.2.2 Rod Number — Diameter Combinations

Nominal Pipe Size (in.) (mm)	⅝ in. (16 mm)	¾ in. (20 mm)	⅞ in. (22 mm)	1 in. (25 mm)
4 (100)	2	—	—	—
6 (150)	2	—	—	—
8 (200)	3	2	—	—
10 (250)	4	3	2	—
12 (300)	6	4	3	2
14 (350)	8	5	4	3
16 (400)	10	7	5	4

Note: This table has been derived using pressure of 225 psi (15.5 bar) and design stress of 25,000 psi (172.4 MPa).

[**24:**Table 10.6.2.1.2.2]

6.6.2.1.2.3

When using bolting rods, the diameter of mechanical joint bolts shall limit the diameter of rods to ¾ in. (20 mm). [**24:**10.6.2.1.2.3]

6.6.2.1.2.4

Threaded sections of rods shall not be formed or bent. [**24:**10.6.2.1.2.4]

6.6.2.1.2.5

Where using clamps, rods shall be used in pairs for each clamp. [**24:**10.6.2.1.2.5]

6.6.2.1.2.6

Assemblies in which a restraint is made by means of two clamps canted on the barrel of the pipe shall be permitted to use one rod per clamp if approved for the specific installation by the AHJ. [**24:**10.6.2.1.2.6]

6.6.2.1.2.7

Where using combinations of rods, the rods shall be symmetrically spaced. [**24:**10.6.2.1.2.7]

6.6.2.1.3 Clamp Bolts.

Clamp bolts shall have the following diameters:

(1) ⅝ in. (16 mm) for pipe 4 in. (100 mm), 6 in. (150 mm), and 8 in. (200 mm)

(2) ¾ in. (20 mm) for 10 in. (250 mm) pipe

(3) ⅞ in. (22.2 mm) for 12 in. (300 mm) pipe

[**24:**10.6.2.1.3]

6.6.2.1.4 Washers.

[**24:**10.6.2.1.4]

6.6.2.1.4.1

Washers shall be permitted to be cast iron or steel and round or square. [**24:**10.6.2.1.4.1]

6.6.2.1.4.2

Cast-iron washers shall have the following dimensions:

(1) ⅝ in. × 3 in. (16 mm × 75 mm) for 4 in. (100 mm), 6 in. (150 mm), 8 in. (200 mm), and 10 in. (250 mm) pipe

(2) ¾ in. × 3½ in. (20 mm × 90 mm) for 12 in. (300 mm) pipe

[**24:**10.6.2.1.4.2]

6.6.2.1.4.3

Steel washers shall have the following dimensions:

(1) ½ in. × 3 in. (12 mm × 75 mm) for 4 in. (100 mm), 6 in. (150 mm), 8 in. (200 mm), and 10 in. (250 mm) pipe

(2) ½ in. × 3½ in. (12 mm × 90 mm) for 12 in. (300 mm) pipe

[**24:**10.6.2.1.4.3]

6.6.2.1.4.4

The diameter of holes shall be ⅛ in. (3.2 mm) larger than that of bolts or rods. [**24:**10.6.2.1.4.4]

6.6.2.2 Sizes of Restraint Straps for Tees.

[**24:**10.6.2.2]

6.6.2.2.1

Restraint straps for tees shall have the following dimensions:

(1) ⅝ in. (16 mm) thick and 2½ in. (65 mm) wide for 4 in. (100 mm), 6 in. (150 mm), 8 in. (200 mm), and 10 in. (250 mm) pipe

(2) ⅝ in. (16 mm) thick and 3 in. (75 mm) wide for 12 in. (300 mm) pipe

[**24:**10.6.2.2.1]

6.6.2.2.2

The diameter of rod holes shall be 1⁄16 in. (1.6 mm) larger than that of rods. [**24:**10.6.2.2.2]

6.6.2.2.3

Figure 6.6.2.2.3 and Table 6.6.2.2.3 shall be used in sizing the restraint straps for both mechanical and push-on joint tee fittings. [**24:**10.6.2.2.3]

Figure 6.6.2.2.3 Restraint Straps for Tees. [24:Figure 10.6.2.2.3]

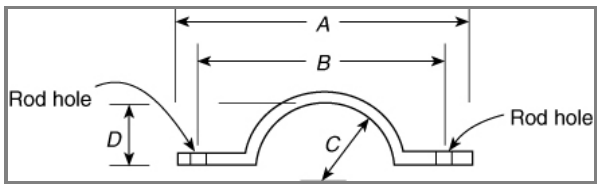


Table 6.6.2.2.3 Restraint Straps for Tees

Nominal Pipe Size		A		B		C		D	
in.	mm	in.	mm	in.	mm	in.	mm	in.	mm
4	100	12½	318	10⅛	257	2½	64	1¾	44
6	150	14½	368	12⅛	308	3 9/16	90	2 13/16	71
8	200	16¾	425	14⅜	365	4 21/32	118	3 29/32	99
10	250	19 1/16	484	16 11/16	424	5¾	146	5	127
12	300	22 5/16	567	19 3/16	487	6¾	171	5⅞	149

[**24:**Table 10.6.2.2.3]

6.6.2.3 Sizes of Plug Strap for Bell End of Pipe.

[**24:**10.6.2.3]

6.6.2.3.1

The strap shall be ¾ in. (20 mm) thick and 2½ in. (65 mm) wide. [**24:**10.6.2.3.1]

6.6.2.3.2

The strap length shall be the same as dimension *A* for tee straps as shown in Figure 6.6.2.2.3. [**24:**10.6.2.3.2]

6.6.2.3.3

The distance between the centers of rod holes shall be the same as dimension *B* for tee straps as shown in Figure 6.6.2.2.3. [**24:**10.6.2.3.3~~1~~]

6.6.2.4 Material.

Clamps, rods, rod couplings or turnbuckles, bolts, washers, restraint straps, and plug straps shall be of a material that has physical and chemical characteristics that indicate its deterioration under stress can be predicted with reliability. [**24:**10.6.2.4]

6.6.2.5* Corrosion Resistance.

After installation, rods, nuts, bolts, washers, clamps, and other restraining devices shall be cleaned and thoroughly coated with a bituminous or other acceptable corrosion-retarding material. [**24:**10.6.2.5]

A.6.6.2.5

Examples of materials and the standards covering these materials are as follows:

(1) Clamps, steel

(2) Rods, steel

(3) Bolts, steel (ASTM A307, *Standard Specification for Carbon Steel Bolts, Studs, Threaded Rod 60,000 psi Tensile Strength*)

(4) Washers, steel, cast iron (Class A cast iron as defined by ASTM A126, *Standard Specification for Gray Iron Castings for Valves, Flanges and Pipe Fittings*)

(5) Anchor straps ~~and~~ , plug straps, steel

(6) Rod couplings ~~or~~ , turnbuckles, malleable iron (ASTM A197/A197M, *Standard Specification for Cupola Malleable Iron*)

The materials specified in A.6.6.2.5(1) through A.6.6.2.5(6) do not preclude the use of other materials that will also satisfy the requirements of this section. [**24:**A.10.6.2.4 5]

6.6.2.5.1

The requirements of 6.6.2.5 shall not apply to epoxy-coated fittings, valves, glands, or other accessories. [**24:**10.6.2.5.1]

6.6.3*

Private fire service mains utilizing one or more of the following connection methods shall not require additional restraint, provided that such joints can pass the hydrostatic test of 6.10.2.2 without shifting of piping.

(1) Threaded connections

(2) Grooved connections

(3) Welded connections

(4) Heat-fused connections

(5) Chemical or solvent cemented connections

[**24:**10.6.3]

6.7 Steep Grades.

[**24:**10.7]

6.7.1

On steep grades, mains shall be additionally restrained to prevent slipping. [**24:**10.7.1]

6.7.1.1

Pipe shall be restrained at the bottom of a hill and at any turns (lateral or vertical). [**24:**10.7.1.1]

6.7.1.1.1

The restraint specified in 6.7.1.1 shall be to natural rock or to suitable piers built on the downhill side of the bell. [**24:**10.7.1.1.1]

6.7.1.2

Bell ends shall be installed facing uphill. [**24:**10.7.1.2]

6.7.1.3

Straight runs on hills shall be restrained as determined by a design professional. [**24:**10.7.1.3]

6.8 Installation Requirements.

[**24:**10.8]

6.8.1

Piping, valves, hydrants, gaskets, and fittings shall be inspected for damage when received and shall be inspected prior to installation. [**24:**10.8.1]

6.8.2

The tightness of bolted joints shall be verified by the bolt torque or by the method described in the listing information or manufacturer's installation instructions. [**24:**10.8.2]

6.8.3

Pipe, valves, hydrants, and fittings shall be clean and free from internal debris. [**24:**10.8.3]

6.8.4

When work is stopped, the open ends of piping, valves, hydrants, and fittings shall be plugged or covered to prevent foreign materials from entering. [**24:**10.8.4]

6.8.5

All piping, fittings, valves, and hydrants shall be examined for cracks or other defects while suspended above the trench and lowered into the trench using appropriate equipment. [**24:**10.8.5]

6.8.6

Plain ends shall be inspected for signs of damage prior to installation. [**24:**10.8.6]

6.8.7

Piping, fittings, valves, hydrants, and appurtenances shall not be dropped, dumped or rolled or skidded against other materials. [**24:**10.8.7]

6.8.8

Pipes shall be supported in the trench throughout their full length and shall not be supported by the bell ends only or by blocks. [**24:**10.8.8]

6.8.9

If the ground is soft, other means shall be provided to support the pipe. [**24:**10.8.9]

6.8.10

Valves and fittings used with nonmetallic pipe shall be supported and restrained in accordance with the manufacturer's installation instructions. [**24:**10.8.10]

6.9 Backfilling.

[**24:**10.9]

6.9.1

Backfill material shall be tamped in layers or in ~~puddled~~ puddles under and around pipes to prevent settlement or lateral movement and shall contain no ashes, cinders, refuse, organic matter, or other corrosive materials . [**24:**10.9.1]

6.9.2

Backfill material shall not contain ash, cinders, refuse, organic matter or other corrosive materials. [**24:**10.9.2]

6.9.3*

~~Rocks shall not be used for backfill.~~ In the absence of specific guidelines or specifications, the maximum allowable particle size for backfill within 1 ft (300 mm) of the pipe shall not be larger than 1 ½ in. (40 mm). [**24:**10.9.3]

A.6.9.3

The maximum particle size allowed next to most types of pipe can be found in ASTM C136/136M, *Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates*, ASTM D2487, *Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)*, AWWA M55, *PE Pipe — Design and Installation* , AWWA M23, *PVC Pipe — Design and Installation*, trade association handbooks, or manufacturers' literature. These publications typically recommend one maximum allowable particle size that applies to the bedding, embedment, and backfill, which might be different materials. The maximum particle size might be dependent on the pipe diameter. [**24:** A.10.9.3]

6.9.3.1

Nominal pipe sizes of 4 in. (100 mm) or smaller shall not exceed ½ in. (13 mm) maximum particle size. [**24:** 10.9.3.1]

6.9.3.2

Nominal pipe sizes of 6 in. to 12 in. (150 mm to 300 mm) shall not exceed ¾ in. (19 mm) maximum particle size. [**24:** 10.9.3.2]

6.9.4

Frozen earth shall not be used as backfill material. [**24:**10.9.4]

6.9.5

In trenches cut through rock, tamped backfill shall be used for at least 6 in. (150 mm) under and around the pipe and for at least 2 ft (600 mm) above the pipe. [**24:**10.9.5]

6.9.6

Where using piping listed for private fire service mains, the manufacturer's installation instructions for backfill shall be followed. [**24:**10.9.6]

6.10 Testing and Acceptance.

[**24:**10.10]

6.10.1 Approval of Underground Piping.

The installing contractor shall be responsible for the following:

(1) Notifying the AHJ and the owner's representative of the time and date testing is to be performed

(2) Performing all required acceptance tests

(3) Completing and signing the contractor's material and test certificate(s) shown in Figure 6.10.1

[**24:**10.10.1]

Figure 6.10.1 Sample of Contractor's Material and Test Certificate for Underground Piping. [24:Figure 10.10.1]



Contractor's Material and Test Certificate for Underground Piping

PROCEDURE
Upon completion of work, inspection and tests shall be made by the contractor's representative and witnessed by an owner's representative. All defects shall be corrected and system left in service before contractor's personnel finally leave the job.
A certificate shall be filled out and signed by both representatives. Copies shall be prepared for approving authorities, owners, and contractor. It is understood the owner's representative's signature in no way prejudices any claim against contractor for faulty material, poor workmanship, or failure to comply with approving authority's requirements or local ordinances.

Property name | Date

Property address

Plans
Accepted by approving authorities (names)
Address
Installation conforms to accepted plans ❑ Yes ❑ No
Equipment used is approved ❑ Yes ❑ No
If no, state deviations

Instructions
Has person in charge of fire equipment been instructed as to location of control valves and care and maintenance of this new equipment? ❑ Yes ❑ No
If no, explain
Have copies of appropriate instructions and care and maintenance charts been left on premises? ❑ Yes ❑ No
If no, explain

Location
Supplies buildings

Underground pipes and joints
Pipe types and class | Type joint
Pipe conforms to _____ standard ❑ Yes ❑ No
Fittings conform to _____ standard ❑ Yes ❑ No
If no, explain
Joints needing anchorage clamped, strapped, or blocked in accordance with _____ standard ❑ Yes ❑ No
If no, explain

Test description
Flushing: Flow the required rate until water is clear as indicated by no collection of foreign material in burlap bags at outlets such as hydrants and blow-offs. Flush in accordance with the requirements of 6.10.2.1.3.
Hydrostatic: All piping and attached appurtenances subjected to system working pressure shall be hydrostatically tested at 200 psi (13.8 bar) or 50 psi (3.4 bar) in excess of the system working pressure, whichever is greater, and shall maintain that pressure ±5 psi (0.34 bar) for 2 hours.
Hydrostatic Testing Allowance: Where additional water is added to the system to maintain the test pressures required by 6.10.2.2.1, the amount of water shall be measured and shall not exceed the limits of the following equation (for metric equation, see 6.10.2.2.6):

$$L = \frac{SD\sqrt{P}}{148{,}000}$$

L = testing allowance (makeup water), in gallons per hour
S = length of pipe tested, in feet
D = nominal diameter of the pipe, in inches
P = average test pressure during the hydrostatic test, in pounds per square inch (gauge)

Flushing tests
New underground piping flushed according to _____ standard by (company) ❑ Yes ❑ No
If no, explain
How flushing flow was obtained ❑ Public water ❑ Tank or reservoir ❑ Fire pump | Through what type opening ❑ Hydrant butt ❑ Open pipe
Lead-ins flushed according to _____ standard by (company) ❑ Yes ❑ No
If no, explain
How flushing flow was obtained ❑ Public water ❑ Tank or reservoir ❑ Fire pump | Through what type opening ❑ Y connection to flange and spigot ❑ Open pipe

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Hydrostatic test
All new underground piping hydrostatically tested at _____ psi for _____ hours | Joints covered ❑ Yes ❑ No

Leakage test
Total amount of leakage measured _____ gallons _____ hours
Allowable leakage _____ gallons _____ hours

Forward flow test of backflow preventer
Foward flow test performed in accordance with 6.10.2.5.2: ❑ Yes ❑ No

Hydrants
Number installed | Type and make | All operate satisfactorily ❑ Yes ❑ No

Control valves
Water control valves left wide open ❑ Yes ❑ No
If no, state reason
Hose threads of fire department connections and hydrants interchangeable with those of fire department answering alarm ❑ Yes ❑ No

Remarks
Date left in service

Signatures
Name of installing contractor
Tests witnessed by
For property owner (signed) | Title | Date
For installing contractor (signed) | Title | Date

Additional explanation and notes

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6.10.2 Acceptance Requirements.

[**24:**10.10.2]

6.10.2.1* Flushing of Piping.

[**24:**10.10.2.1]

6.10.2.1.1

Underground piping, from the water supply to the system riser, and lead-in connections to the system riser, including all hydrants, shall be completely flushed before connection is made to downstream fire protection system piping. [**24:**10.10.2.1.1]

6.10.2.1.2

The flushing operation shall continue until water flow is verified to be clear of debris. [**24:**10.10.2.1.2]

6.10.2.1.3*

The minimum rate of flow shall be in accordance with Table 6.10.2.1.3. [**24:**10.10.2.1.3]

Table 6.10.2.1.3 Flow Required to Produce ~~a~~ Velocity of 10 ft/sec (~~3~~ 3.0 m/sec) in Pipes

Nominal Pipe Size		Flow Rate	
in.	mm	gpm	L/min
2	50	100	379
2½	65	150	568
3	75	220	833
4	100	390	1,500
5	125	610	2,300
6	150	880	3,350
8	200	1,560	5,900
10	250	2,440	9,250
12	300	3,520	13,300

[**24:**Table 10.10.2.1.3]

A.6.10.2.1.3

The velocity of approximately 10 ft/sec (3.0 m/sec) was used to develop Table 6.10.2.1.3 because this velocity has been shown to be sufficient for moving obstructive material out of the pipes. It is not important that the velocity equal exactly 10 ft/sec (3.0 m/sec), so there is no reason to increase the flow during the test for slightly different internal pipe dimensions. Note that where underground pipe serves as suction pipe for a fire pump, NFPA 20 requires greater flows for flushing the pipe. [**24:** A.10.10.2.1.3]

6.10.2.1.3.1

Where the flow rates established in Table 6.10.2.1.3 are not attainable, the maximum flow rate available to the system shall be acceptable. [**24:**10.10.2.1.3.1]

6.10.2.1.4

Provision shall be made for the proper disposal of water used for flushing or testing. [**24:**10.10.2.1.4]

6.10.2.2 Hydrostatic Test.

[**24:**10.10.2.2]

6.10.2.2.1*

All piping and attached appurtenances subjected to system working pressure shall be hydrostatically tested at gauge pressure of 200 psi (13.8 bar) or 50 psi (3.4 bar) in excess of the system working pressure, whichever is greater, and shall maintain that pressure at gauge pressure of ±5 psi (0.34 bar) for 2 hours. [**24:**10.10.2.2.1]

6.10.2.2.2

Acceptable test results shall be determined by indication of either a pressure loss less than gauge pressure of 5 psi or by no visual leakage. [**24:**10.10.2.2.2]

6.10.2.2.3

The test pressure shall be read from one of the following, located at the lowest elevation of the system or the portion of the system being tested:

(1) A gauge located at one of the hydrant outlets

(2) A gauge located at the lowest point where no hydrants are provided

[**24:**10.10.2.2.3]

6.10.2.2.4*

The trench shall be backfilled between joints before testing to prevent movement of pipe. [**24:**10.10.2.2.4]

6.10.2.2.5

Where required for safety measures presented by the hazards of open trenches, the pipe and joints shall be permitted to be backfilled, provided the installing contractor takes the responsibility for locating and correcting leakage. [**24:**10.10.2.2.5]

6.10.2.2.6* Hydrostatic Testing Allowance.

Where additional water is added to the system to maintain the test pressures required by 6.10.2.2.1, the amount of water shall be measured and shall not exceed the limits of Table 6.10.2.2.6, which are based upon the following equations : U.S. Customary Units:

$$L = \frac{SD\sqrt{P}}{148{,}000} \quad \textbf{[6.10.2.2.6a]}$$

where:

L = testing allowance (makeup water) [gph (gal/hr)]

S = length of pipe tested (ft)

D = nominal diameter of ~~the~~ pipe (in.)

P = average test pressure during hydrostatic test (gauge psi) Metric Units:

$$L = \frac{SD\sqrt{P}}{794{,}797} \quad \textbf{[6.10.2.2.6b]}$$

where:

L = testing allowance (makeup water) (L/hr)

S = length of pipe tested (m)

D = nominal diameter of pipe (mm)

P = average test pressure during ~~the~~ hydrostatic test (kPa) [**24:**10.10.2.2.6]

Table 6.10.2.2.6 Hydrostatic Testing Allowance at 200 psi (13.8 bar) (gph/100 ft of Pipe) (lph/100 m of Pipe)

Nominal Pipe Diameter	**Testing Allowance**
in.(mm)	**~~in.(mm)~~ gph/100 ft of pipe (lph/100 m of pipe)**
2 (50)	0.019 (0.236)
4 (100)	0.038 (0.472)
6 (150)	0.057 (0.708)
8 (200)	0.076 (0.944)
10 (250)	0.096 (1.19)
12 (300)	0.115 (1.43)
14 (350)	0.134 (1.66)
16 (400)	0.153 (1.90)
18 (450)	0.172 (2.14)
20 (500)	0.191 (2.37)
24 (600)	0.229 (2.84)

Notes:

(1) For other length, diameters, and pressures, utilize Equation ~~10.10.2.2.6a~~ 6.10.2.2.6a or ~~10.10.2.2.6b~~ 6.10.2.2.6b to determine the appropriate testing allowance.

(2) For test sections that contain various sizes and sections of pipe, the testing allowance is the sum of the testing allowances for each size and section.

[**24:**Table 10.10.2.2.6]

A.6.10.2.2.6

One acceptable means of completing this test is to utilize a pressure pump that draws its water supply from a full container. At the completion of the 2-hour test, the amount of water to refill the container can be measured to determine the amount of makeup water. ~~To~~ In order to minimize pressure loss, the piping should be flushed to remove any trapped air. Additionally, the piping ~~should~~ could be pressurized ~~for 1 day~~ prior to the hydrostatic test to account for expansion, absorption, entrapped air, and so on.

The use of a blind flange or skillet is preferred for ~~use when~~ hydrostatically testing segments of new work. Metal-seated valves are susceptible to developing slight imperfections during transport, installation, and operation and thus can be likely to leak more than 1 fl oz/in. (1.2 mL/mm) of valve diameter per hour. For this reason, the blind flange should be used when hydrostatically testing. [**24:**A.10.10.2.2.6]

6.10.2.3* Other Means of Hydrostatic Tests.

Where ~~required by~~ acceptable to the AHJ, hydrostatic tests shall be permitted to be completed in accordance with the ~~requirements of~~ guidelines provided in AWWA C600, *Installation of Ductile-Iron Mains and Their Appurtenances,* AWWA M9, *Concrete Pressure Pipe,* AWWA M23, *PVC Pipe — Design and Installation,* or ~~C602, AWWA C603, and AWWA C900.~~ AWWA M55, *PE Pipe — Design and Installation* , as long as the test pressure and test duration requirements of 6.10.2.2.1 are still employed. [**24:**10.10.2.3]

6.10.2.4 Operating Test.

[**24:**10.10.2.4]

6.10.2.4.1

Each hydrant shall be fully opened and closed under system water pressure. [**24:**10.10.2.4.1]

6.10.2.4.2

Dry barrel hydrants shall be checked for proper drainage. [**24:**10.10.2.4.2]

6.10.2.4.3

All control valves shall be fully closed and opened under system water pressure to ensure proper operation. [**24:**10.10.2.4.3]

6.10.2.4.4

Where fire pumps supply the private fire service main, the operating tests required by 6.10.2.4 shall be completed with the pumps running. [**24:**10.10.2.4.4]

6.10.2.5 Backflow Prevention Assemblies.

[**24:**10.10.2.5]

6.10.2.5.1

The backflow prevention assembly shall be forward flow tested to ensure proper operation. [**24:**10.10.2.5.1]

6.10.2.5.2

The minimum flow rate ~~required by~~ tested in 6.10.2.5.1 shall be the system demand, including hose stream demand where applicable. [**24:**10.10.2.5.2]

Supplemental Information

File Name	Description	Approved
Chapter_6_extract_updates.docx	For staff use	✓

Submitter Information Verification

Submitter Full Name: AUT-PRI
Organization: National Fire Protection Assoc
Street Address:

City:
State:
Zip:
Submittal Date: Wed Aug 16 11:31:59 EDT 2017

Committee Statement and Meeting Notes

Committee Statement: Updates extracted material form NFPA 24.
Response Message:

Editorial Comment

Click here

Second Revision No. 21-NFPA 24-2017 [Section No. 2.3.2]

2.3.2 ASTM Publications.

ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959.

ASTM A53/A53M, *Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless*, 2012.

ASTM A135/A135M, *Standard Specification for Electric-Resistance-Welded Steel Pipe*, 2009 (reapproved 2014).

~~ASTM A234/A234M, *Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service* , 2015.~~

ASTM A312/312M, *Specification for Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes* , 2017.

ASTM A795/A795M, *Standard Specification for Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless Steel Pipe for Fire Protection Use*, 2013.

ASTM B43, *Specification for Seamless Red Brass Pipe, Standard Sizes*, 2015.

ASTM B75/B75M, *Specification for Seamless Copper Tube*, 2011.

ASTM B88, *Specification for Seamless Copper Water Tube*, 2014.

ASTM B251, *Requirements for Wrought Seamless Copper and Copper-Alloy Tube*, 2010.

ASTM C136/136M, *Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates* , 2014.

ASTM D2487, *Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)* , 2011.

ASTM SI10, *Standard for Use of the International System of Units (SI): The Modern Metric System*, 2010.

Submitter Information Verification

Submitter Full Name: David Hague
Organization: National Fire Protection Assoc
Street Address:
City:
State:
Zip:
Submittal Date: Thu Sep 21 11:11:37 EDT 2017

Committee Statement

Committee Statement: Includes ASTM A312 as referenced in CHapter 10.
Response Message:

Second Revision No. 1-NFPA 24-2017 [Section No. 7.1.1.2]

7.1.1.2

A listed control valve shall be installed in each hydrant connection.

7.1.1.2.1

A valve required by 7.1.1.2 shall be permitted to be a listed, nonindicating valve, such as an underground gate valve in a roadway box.

7.1.1.2.2

Valves required by 7.1.1.2 shall be installed within 20 ft (6.1 m) of the hydrant.

7.1.1.2.2.1

Valves shall be clearly identified and kept free of obstructions.

7.1.1.2.3

Where valves cannot be located in accordance with ~~7.1.1.2.1~~ 7.1.1.2.2 , valve locations shall be permitted where approved by the AHJ.

Submitter Information Verification

Submitter Full Name: David Hague
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Mon Jun 19 08:22:34 EDT 2017

Committee Statement

Committee Statement: As currently written in 7.1.1.2, the standard does require a fire hydrant's control valve to be listed. This omission should be rectified.

Additionally, while a Committee Statement was not provided to explain why Public Input No. 31 was resolved, it was expressed during the first Draft Meeting that indicating valves in accordance with 6.1.1 should not be necessary to control a fire hydrant and that it should not be necessary to obtain AHJ permission to utilize a nonindicating valve in a roadway box. If this is the Committee's intent then it should be clearly stated in the standard.

Response Message:

Public Comment No. 9-NFPA 24-2017 [Section No. 7.1.1.2]

Second Revision No. 22-NFPA 24-2017 [Section No. 10.1.1.1]

10.1.1.1 Listing.

Piping manufactured in accordance with Table 10.1.1.1 shall be permitted to be used.

Table 10.1.1.1 Manufacturing Standards for Underground Pipe

Materials and Dimensions	Standard
Ductile Iron	
Cement-Mortar Lining for Ductile-Iron Pipe and Fittings	AWWA C104/A21.4
Polyethylene Encasement for Ductile-Iron Pipe Systems	AWWA C105/A21.5
Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings	AWWA C111/A21.11
Flanged Ductile-Iron Pipe with Ductile-Iron or Gray-Iron Threaded Flanges	AWWA C115/A21.15
Thickness Design of Ductile-Iron Pipe	AWWA C150/A21.50
Ductile-Iron Pipe, Centrifugally Cast	AWWA C151/A21.51
Standard for the Installation of Ductile Iron Water Mains and Their Appurtenances	AWWA C600
Concrete	
Reinforced Concrete Pressure Pipe, Steel-Cylinder Type	AWWA C300
Prestressed Concrete Pressure Pipe, Steel-Cylinder Type	AWWA C301
Reinforced Concrete Pressure Pipe, Non-Cylinder Type	AWWA C302
Reinforced Concrete Pressure Pipe, Steel-Cylinder Type, Pretensioned	AWWA C303
Cement-Mortar Lining of Water Pipe Lines in Place, 4 in. (100 mm) and Larger	AWWA C602
Plastic	
Polyvinyl Chloride (PVC) Pressure Pipe, 4 in. Through 12 in. (100 mm Through 300 mm), for Water Transmission and Distribution	AWWA C900
Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 14 in. Through 48 in. (350 mm Through 1200 mm), for Water Transmission and Distribution	AWWA C905
Polyethylene (PE) Pressure Pipe and Fittings, 4 in. (100 mm) Through 63 in. (1575 mm) for Waterworks	AWWA C906
Molecularly Oriented Polyvinyl Chloride (PVCO), 4 in. Through 24 in. (100 mm Through 600 mm) for Water, Wastewater, and Reclaimed Water Service	AWWA C909
Brass	
Specification for Seamless Red Brass Pipe, Standard Sizes	ASTM B43
Copper	
Specification for Seamless Copper Tube	ASTM B75/B75M
Specification for Seamless Copper Water Tube	ASTM B88
Requirements for Wrought Seamless Copper and Copper-Alloy Tube	ASTM B251
Stainless Steel	
Specification for Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes	ASTM A312/312M

Submitter Information Verification

Submitter Full Name: David Hague
Organization: National Fire Protection Assoc
Street Address:
City:
State:
Zip:
Submittal Date: Tue Sep 26 11:52:11 EDT 2017

Committee Statement

Committee Statement: The addition of this material into this section would allow the use of an appropriate material already allowed for use in Table 6.3.1.1 of the 2016 version of NFPA 13, and is currently included in Table 7.3.1.1 of the proposed 2019 version. This is the same material for the same application.

Response Message:

Public Comment No. 5-NFPA 24-2017 [Section No. 10.1.1.1]

Second Revision No. 7-NFPA 24-2017 [Section No. 10.2.1.1]

10.2.1.1

Fittings manufactured in accordance with Table 10.2.1.1 shall be permitted to be used.

Table 10.2.1.1 Fittings Materials and Dimensions

Materials and Dimensions	Standard
Cast Iron	
Gray Iron Threaded Fittings, Classes 125 and 250	ASME B16.4
Gray Iron Pipe Flanges and Flanged Fittings, Classes ~~12, 125~~ 25 , 125, and 250	ASME B16.1
Ductile Iron	
~~Ductile Iron and Gray Iron~~ Ductile-Iron and Gray-Iron Fittings	AWWA C110/A21.10
Ductile-Iron Compact Fittings	AWWA C153/A21.53
Malleable Iron	
Malleable Iron Threaded Fittings, Classes 150 and 300	ASME B16.3
~~Steel~~	
~~Factory-Made Wrought Steel Buttweld Fittings~~	~~ASME B16.9~~
~~Buttwelding Ends~~	~~ASME B16.25~~
~~Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service~~	~~ASTM A234/A234M~~
~~Pipe Flanges and Flanged Fittings NPS ½ through 24~~	~~ASME B16.5~~
~~Forged Fittings, Socket-Welded and Threaded~~	~~ASME B16.11~~
~~Steel Pipe Flanges for Waterworks Service — Sizes 4 in. Through 144 in. (100 mm Through 3,600 mm)~~	~~AWWA C207~~
~~Dimensions for Fabricated Steel Water Pipe Fittings~~	~~AWWA C208~~
~~Copper~~	
~~Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings~~	~~ASME B16.22~~
~~Cast Copper Alloy Solder Joint Pressure Fittings~~	~~ASME B16.18~~
~~Bronze Fittings~~	
~~Cast Copper Alloy Threaded Fittings, Classes 125 and 250~~	~~ASME B16.15~~

Supplemental Information

File Name	Description	Approved
NFPA_24_SR_7_Table_10.2.1.1.docx	Corrected Table 10.2.1.1. For staff use.	

Submitter Information Verification

Submitter Full Name: David Hague

Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Mon Jun 19 10:44:48 EDT 2017

Committee Statement

Committee Statement: As per the decision during the last cycle to delete the references to steel pipe from Table 10.1.1.1 and as confirmed during the First Draft per the resolution of PI No. 24, the references to steel pipe fittings should be similarly deleted from table 10.2.1.1, because they are not suitable for underground service.

As noted in the Committee Statement for PI No. 24, “Steel piping used for underground needs to be listed due to issues surrounding corrosion.”

Response Message:

Public Comment No. 11-NFPA 24-2017 [Section No. 10.2.1.1]

Public Comment No. 6-NFPA 24-2017 [Section No. 10.2.1.1]

Second Revision No. 8-NFPA 24-2017 [Section No. 10.4.3]

10.4.3 Private Fire Service Mains Under Buildings.

Except as allowed by 10.4.3, private fire service mains shall not be allowed to run under buildings.

10.4.3.1*

Private fire service mains supplying fire protection systems within the building shall be permitted to extend no more than 10 ft (3.0 m), as measured from the outside of the building, under the building to the riser location.

10.4.3.1.1*

Pipe joints shall not be located directly under foundation footings.

10.4.3.1.2*

Piping shall be installed a minimum of 12 in. (300 mm) below the bottom of building foundations or footers.

10.4.3.1.2.1

The requirements of 10.4.3.1.2 shall not apply when the piping is sleeved with an approved material.

10.4.3.2*

Private fire service mains shall not be permitted to extend more than 10 ft (3 m) under the building except as allowed in 10.4.3.2.1.

10.4.3.2.1

Where private fire service mains extend more than 10 ft (3 m) into the building, they shall be run in a covered trench.

10.4.3.2.1.1*

The trench shall be accessible from within the building.

10.4.3.2.1.2

The trench shall have rigid walls and a base.

10.4.3.2.1.3

The trench shall be constructed of noncombustible materials.

10.4.3.2.1.4*

Provisions for draining water shall be provided for the trench.

10.4.3.2.1.5

Where the piping in the trench is installed under foundations or footers, ~~the foundation or footer shall be arched to create a minimum of 24 in. (610 mm) clearance~~ clearance shall be provided in accordance with 10.4.3.1.2 or 10.4.3.1.2.1 .

~~**10.4.3.2.1.5.1**~~

~~Where acceptable to the AHJ, pipe sleeves shall be permitted to be used.~~

10.4.3.2.2

Piping in the trench shall be permitted to be in accordance with 10.1.1.

10.4.3.2.2.1

~~Where the trench is entirely of concrete construction, aboveground~~ Aboveground piping in accordance with NFPA 13 shall be permitted to be used.

10.4.3.2.2.2

Where piping installed in the trench is in accordance with 10.1.1, all joints shall be restrained in accordance with 10.6.2 or 10.6.3.

10.4.3.2.3*

Where piping is installed in a trench as permitted by 10.4.3.2.1, a valve shall be provided where the underground piping enters the trench.

10.4.3.2.4

~~A valve shall be installed before the piping enters under the building and within 24 in. (600 mm) of where the piping enters the building.~~ When piping is installed in a trench, bury depths of 10.4.2.2 shall not apply.

10.4.3.2.4.1

Piping in the trench shall be protected from freezing in accordance with 10.4.2.1.4 .

Supplemental Information

File Name	Description	Approved
SR_8.docx	Revised text for under buildings. For staff use.	

Submitter Information Verification

Submitter Full Name: David Hague
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Mon Jun 19 11:10:33 EDT 2017

Committee Statement

Committee Statement: Clarifies the issues between the valving and pipe under a building slab.
Response Message:

Second Revision No. 11-NFPA 24-2017 [Section No. 10.9.3]

10.9.3*

~~Rocks shall not be used for backfill.~~ In the absence of specific guidelines or specifications, the maximum allowable particle size for backfill within 1 ft (300 mm) of the pipe shall not be larger than 1 ½ in. (40 mm).

10.9.3.1

Nominal pipe sizes of 4 in. (100 mm) or smaller shall not exceed ½ in. (13 mm) maximum particle size.

10.9.3.2

Nominal pipe sizes of 6 in. to 12 in. (150 mm to 300 mm) shall not exceed ¾ in. (19 mm) maximum particle size.

Supplemental Information

File Name	Description	Approved
SR-11_A.10.9.3.docx		

Submitter Information Verification

Submitter Full Name: David Hague
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Wed Jul 12 14:44:56 EDT 2017

Committee Statement

Committee Statement: Provides guidance for maximum particle size for backfill based on similar requirements in ASTM standards.
Response Message:

SR-11, new annex

A.10.9.3
The maximum particle size allowed next to most types of pipe can be found in ASTM C136/136M, *Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates*, ASTM D2487, *Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)*, AWWA M55, *PE Pipe — Design and Installation*, AWWA M23, *PVC Pipe — Design and Installation*, trade association handbooks, or manufacturers' literature. These publications typically recommend one maximum allowable particle size that applies to the bedding, embedment, and backfill, which might be different materials. The maximum particle size might be dependent on the pipe diameter.

Second Revision No. 4-NFPA 24-2017 [Section No. 10.10.1]

10.10.1 Approval of Underground Piping.

The installing contractor shall be responsible for the following:

(1) Notifying the AHJ and the owner's representative of the time and date testing is to be performed

(2) Performing all required acceptance tests

(3) Completing and signing the contractor's material and test certificate(s) shown in Figure 10.10.1

Figure 10.10.1 Sample of Contractor's Material and Test Certificate for Underground Piping.

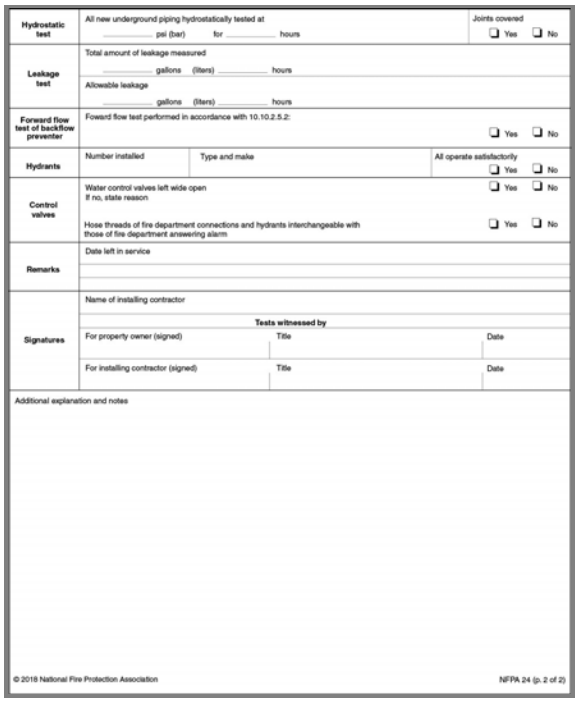
Contractor's Material and Test Certificate for Underground Piping

PROCEDURE
Upon completion of work, inspection and tests shall be made by the contractor's representative and witnessed by an owner's representative. All defects shall be corrected and system left in service before contractor's personnel finally leave the job.

A certificate shall be filled out and signed by both representatives. Copies shall be prepared for approving authorities, owners, and contractor. It is understood the owner's representative's signature in no way prejudices any claim against contractor for faulty material, poor workmanship, or failure to comply with approving authority's requirements or local ordinances.

Property name		Date
Property address		
Plans	Accepted by approving authorities (names)	
	Address	
	Installation conforms to accepted plans	❑ Yes ❑ No
	Equipment used is approved	❑ Yes ❑ No
	If no, state deviations	
Instructions	Has person in charge of fire equipment been instructed as to location of control valves and care and maintenance of this new equipment? If no, explain	❑ Yes ❑ No
	Have copies of appropriate instructions and care and maintenance charts been provided to the owner or owner's representative? If no, explain	❑ Yes ❑ No
Location	Supplies buildings	
Underground pipes and joints	Pipe types and class	Type joint
	Pipe conforms to _____ standard	❑ Yes ❑ No
	Fittings conform to _____ standard	❑ Yes ❑ No
	If no, explain	
	Joints needing anchorage clamped, strapped, or blocked in accordance with _____ standard	❑ Yes ❑ No
	If no, explain	
Test description	Flushing: Flow the required rate until water is clear as indicated by no collection of foreign material at outlets such as hydrants and blow-offs. Flush at one of the flow rates as specified in 10.10.2.1.3. Hydrostatic: All piping and attached appurtenances subjected to system working pressure shall be hydrostatically tested at 200 psi (13.8 bar) or 50 psi (3.4 bar) in excess of the system working pressure, whichever is greater, and shall maintain that pressure ±5 psi (0.34 bar) for 2 hours. Hydrostatic Testing Allowance: Where additional water is added to the system to maintain the test pressures required by 10.10.2.2.1, the amount of water shall be measured and shall not exceed the limits of the following equation (for metric equation, see 10.10.2.2.6): $L = \frac{SD\sqrt{P}}{148{,}000}$ L = testing allowance (makeup water), in gallons per hour (lph) S = length of pipe tested, in feet (m) D = nominal diameter of the pipe, in inches (mm) P = average test pressure during the hydrostatic test, in pounds per square inch (gauge) (bar)	
Flushing tests	New underground piping flushed according to _____ standard by (company)	❑ Yes ❑ No
	If no, explain	
	How flushing flow was obtained ❑ Public water ❑ Tank or reservoir ❑ Fire pump	Through what type opening ❑ Hydrant butt ❑ Open pipe
	Lead-ins flushed according to _____ standard by (company)	❑ Yes ❑ No
	If no, explain	
	How flushing flow was obtained ❑ Public water ❑ Tank or reservoir ❑ Fire pump	Through what type opening ❑ Y connection to flange and spigot ❑ Open pipe

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Hydrostatic test	All new underground piping hydrostatically tested at _____ psi (bar) for _____ hours	Joints covered ❑ Yes ❑ No
Leakage test	Total amount of leakage measured _____ gallons (liters) _____ hours Allowable leakage _____ gallons (liters) _____ hours	
Forward flow test of backflow preventer	Foward flow test performed in accordance with 10.10.2.5.2:	❑ Yes ❑ No
Hydrants	Number installed / Type and make	All operate satisfactorily ❑ Yes ❑ No
Control valves	Water control valves left wide open ❑ Yes ❑ No If no, state reason Hose threads of fire department connections and hydrants interchangeable with those of fire department answering alarm ❑ Yes ❑ No	
Remarks	Date left in service	
Signatures	Name of installing contractor **Tests witnessed by** For property owner (signed) / Title / Date For installing contractor (signed) / Title / Date	
Additional explanation and notes		

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Submitter Information Verification

Submitter Full Name: David Hague
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Mon Jun 19 09:08:09 EDT 2017

Committee Statement

Committee Statement: As currently proposed, the text on flushing still speaks to “collection of foreign material”, but the standard does not call for such collection, it only requires that the water is verified to be clear.

Response Message:

Public Comment No. 8-NFPA 24-2017 [Section No. 10.10.1]

Second Revision No. 9-NFPA 24-2017 [Section No. 10.10.2.3]

10.10.2.3* Other Means of Hydrostatic Tests.

Where acceptable to the AHJ, hydrostatic tests shall be permitted to be completed ~~by other means~~ in accordance with the guidelines provided in AWWA C600, *Installation of Ductile-Iron Mains and Their Appurtenances* , AWWA M9, *Concrete Pressure Pipe* , AWWA M23, *PVC Pipe — Design and Installation* , or AWWA M55, *PE Pipe — Design and Installation* , as long as the test pressure and test duration requirements of 10.10.2.2.1 are still employed .

Submitter Information Verification

Submitter Full Name: David Hague
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Wed Jul 12 14:32:42 EDT 2017

Committee Statement

Committee Statement: This is the result of the Hydrostatic Testing Task Group and provides guidelines for alternate means of testing.
Response Message:

Second Revision No. 6-NFPA 24-2017 [Section No. 12.1]

12.1 General.

Aboveground pipe and fittings shall comply with the applicable sections ~~of Chapters 6 and 8~~ of NFPA 13 that address pipe, fittings, joining methods, hangers, and installation.

Submitter Information Verification

Submitter Full Name: David Hague
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Mon Jun 19 09:41:41 EDT 2017

Committee Statement

Committee Statement: Directs user to NFPA 13 for aboveground pipe and fittings. It is not the intent to limit the reference to specific chapters.
Response Message:

Second Revision No. 10-NFPA 24-2017 [Section No. A.10.10.2.2.6]

A.10.10.2.2.6

One acceptable means of completing this test is to utilize a pressure pump that draws its water supply from a full container. At the completion of the 2-hour test, the amount of water to refill the container can be measured to determine the amount of makeup water. In order to minimize pressure loss, the piping ~~should~~ could be pressurized ~~for 1 day~~ prior to the hydrostatic test to account for expansion, absorption, entrapped air, and so on.

The use of a blind flange or skillet is preferred for hydrostatically testing segments of new work. Metal-seated valves are susceptible to developing slight imperfections during transport, installation, and operation and thus can be likely to leak more than 1 fl oz/in. (1.2 mL/mm) of valve diameter per hour. For this reason, the blind flange should be used when hydrostatically testing.

Submitter Information Verification

Submitter Full Name: David Hague
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Wed Jul 12 14:41:24 EDT 2017

Committee Statement

Committee Statement: Limiting pressurization of the piping to one day prior to the hydrostatic test is not necessary.
Response Message:

Second Revision No. 19-NFPA 24-2017 [Section No. C.4.7.3]

C.4.7.3

The formula used to compute the discharge, *Q*, in gpm (L/min) from these measurements is as ~~follows:~~ shown in Equations C.4.7.3a and C.4.7.3b.

$$Q = 29.84cd^2\sqrt{p}$$ **[C.4.7.3a]**

where:

c = coefficient of discharge *(see Figure C.4.7.1)*

d = diameter of the outlet in inches

p = pitot pressure (velocity head) in psi

$$Q_M = 0.0666cd^2\sqrt{p}_M$$ **[C.4.7.3b]**

where:

Q_M = flow (L/min)

p_M = pressure (kPa or bar)

[**291:** 4.7.3]

Supplemental Information

File Name	Description	Approved
24-SR-19_C.4.7.3_leg_changes.docx	For staff use.	

Submitter Information Verification

Submitter Full Name: Sonia Barbosa
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Wed Sep 20 10:49:38 EDT 2017

Committee Statement

Committee Statement: Updates extracted text form NFPA 291
Response Message:

Second Revision No. 20-NFPA 24-2017 [Section No. C.4.10.1 [Excluding any Sub-Sections]]

The discharge in gpm (L/min) for each outlet flowed is obtained from Table C.4.10.1(a) and Table C.4.10.1(b) or by the use of Equations C.4.7.3a and C.4.7.3b .

Table C.4.10.1(a) Theoretical Discharge Through Circular Orifices (U.S. Gallons of Water per Minute)

Pitot Pressure* (psi)	Feet†	Velocity Discharge (ft/sec)	Orifice Size (in.)											
			2	2.25	2.375	2.5	2.625	2.75	3	3.25	3.5	3.75	4	4.5
1	2.31	12.2	119	151	168	187	206	226	269	315	366	420	477	604
2	4.61	17.25	169	214	238	264	291	319	380	446	517	593	675	855
3	6.92	21.13	207	262	292	323	356	391	465	546	633	727	827	1047
4	9.23	24.39	239	302	337	373	411	451	537	630	731	839	955	1209
5	11.54	27.26	267	338	376	417	460	505	601	705	817	938	1068	1351
6	13.84	29.87	292	370	412	457	504	553	658	772	895	1028	1169	1480
7	16.15	32.26	316	400	445	493	544	597	711	834	967	1110	1263	1599
8	18.46	34.49	338	427	476	528	582	638	760	891	1034	1187	1350	1709
9	20.76	36.58	358	453	505	560	617	677	806	946	1097	1259	1432	1813
10	23.07	38.56	377	478	532	590	650	714	849	997	1156	1327	1510	1911
11	25.38	40.45	396	501	558	619	682	748	891	1045	1212	1392	1583	2004
12	27.68	42.24	413	523	583	646	712	782	930	1092	1266	1454	1654	2093
13	29.99	43.97	430	545	607	672	741	814	968	1136	1318	1513	1721	2179
14	32.3	45.63	447	565	630	698	769	844	1005	1179	1368	1570	1786	2261
15	34.61	47.22	462	585	652	722	796	874	1040	1221	1416	1625	1849	2340
16	36.91	48.78	477	604	673	746	822	903	1074	1261	1462	1679	1910	2417
17	39.22	50.28	492	623	694	769	848	930	1107	1300	1507	1730	1969	2491
18	41.53	51.73	506	641	714	791	872	957	1139	1337	1551	1780	2026	2564
19	43.83	53.15	520	658	734	813	896	984	1171	1374	1593	1829	2081	2634
20	46.14	54.54	534	676	753	834	920	1009	1201	1410	1635	1877	2135	2702
22	50.75	57.19	560	709	789	875	964	1058	1260	1478	1715	1968	2239	2834
24	55.37	59.74	585	740	825	914	1007	1106	1316	1544	1791	2056	2339	2960
26	59.98	62.18	609	770	858	951	1048	1151	1369	1607	1864	2140	2434	3081
28	64.6	64.52	632	799	891	987	1088	1194	1421	1668	1934	2220	2526	3197
30	69.21	66.79	654	827	922	1022	1126	1236	1471	1726	2002	2298	2615	3310
32	73.82	68.98	675	855	952	1055	1163	1277	1519	1783	2068	2374	2701	3418
34	78.44	71.1	696	881	981	1087	1199	1316	1566	1838	2131	2447	2784	3523
36	83.05	73.16	716	906	1010	1119	1234	1354	1611	1891	2193	2518	2865	3626
38	87.67	75.17	736	931	1038	1150	1268	1391	1656	1943	2253	2587	2943	3725
40	92.28	77.11	755	955	1065	1180	1300	1427	1699	1993	2312	2654	3020	3822
42	96.89	79.03	774	979	1091	1209	1333	1462	1740	2043	2369	2719	3094	3916
44	101.51	80.88	792	1002	1116	1237	1364	1497	1781	2091	2425	2783	3167	4008
46	106.12	82.7	810	1025	1142	1265	1395	1531	1821	2138	2479	2846	3238	4098
48	110.74	84.48	827	1047	1166	1292	1425	1563	1861	2184	2533	2907	3308	4186

Pitot Pressure* (psi)	Velocity Discharge Feet†	(ft/sec)	Orifice Size (in.) 2	2.25	2.375	2.5	2.625	2.75	3	3.25	3.5	3.75	4	4.5
50	115.35	86.22	844	1068	1190	1319	1454	1596	1899	2229	2585	2967	3376	4273
52	119.96	87.93	861	1089	1214	1345	1483	1627	1937	2273	2636	3026	3443	4357
54	124.58	89.61	877	1110	1237	1370	1511	1658	1974	2316	2686	3084	3508	4440
56	129.19	91.2	893	1130	1260	1396	1539	1689	2010	2359	2735	3140	3573	4522
58	133.81	92.87	909	1150	1282	1420	1566	1719	2045	2400	2784	3196	3636	4602
60	138.42	94.45	925	1170	1304	1445	1593	1748	2080	2441	2831	3250	3698	4681
62	143.03	96.01	940	1189	1325	1469	1619	1777	2115	2482	2878	3304	3759	4758
64	147.65	97.55	955	1209	1347	1492	1645	1805	2148	2521	2924	3357	3820	4834
66	152.26	99.07	970	1227	1367	1515	1670	1833	2182	2561	2970	3409	3879	4909
68	156.88	100.55	984	1246	1388	1538	1696	1861	2215	2599	3014	3460	3937	4983
70	161.49	102.03	999	1264	1408	1560	1720	1888	2247	2637	3058	3511	3995	5056
72	166.1	103.47	1013	1282	1428	1583	1745	1915	2279	2674	3102	3561	4051	5127
74	170.72	104.9	1027	1300	1448	1604	1769	1941	2310	2711	3144	3610	4107	5198
76	175.33	106.3	1041	1317	1467	1626	1793	1967	2341	2748	3187	3658	4162	5268
78	179.95	107.69	1054	1334	1487	1647	1816	1993	2372	2784	3228	3706	4217	5337
80	184.56	109.08	1068	1351	1505	1668	1839	2018	2402	2819	3269	3753	4270	5405
82	189.17	110.42	1081	1368	1524	1689	1862	2043	2432	2854	3310	3800	4323	5472
84	193.79	111.76	1094	1385	1543	1709	1885	2068	2461	2889	3350	3846	4376	5538
86	198.4	113.08	1107	1401	1561	1730	1907	2093	2491	2923	3390	3891	4428	5604
88	203.02	114.39	1120	1417	1579	1750	1929	2117	2519	2957	3429	3936	4479	5668
90	207.63	115.68	1132	1433	1597	1769	1951	2141	2548	2990	3468	3981	4529	5733
92	212.24	116.96	1145	1449	1614	1789	1972	2165	2576	3023	3506	4025	4579	5796
94	216.86	118.23	1157	1465	1632	1808	1994	2188	2604	3056	3544	4068	4629	5859
96	221.47	119.48	1169	1480	1649	1827	2015	2211	2631	3088	3582	4111	4678	5921
98	226.09	120.71	1182	1495	1666	1846	2035	2234	2659	3120	3619	4154	4726	5982
100	230.7	121.94	1194	1511	1683	1865	2056	2257	2686	3152	3655	4196	4774	6043
102	235.31	123.15	1205	1526	1700	1884	2077	2279	2712	3183	3692	4238	4822	6103
104	239.93	124.35	1217	1541	1716	1902	2097	2301	2739	3214	3728	4279	4869	6162
106	244.54	125.55	1229	1555	1733	1920	2117	2323	2765	3245	3763	4320	4916	6221
108	249.16	126.73	1240	1570	1749	1938	2137	2345	2791	3275	3799	4361	4962	6280
110	253.77	127.89	1252	1584	1765	1956	2157	2367	2817	3306	3834	4401	5007	6338
112	258.38	129.05	1263	1599	1781	1974	2176	2388	2842	3336	3869	4441	5053	6395
114	263	130.2	1274	1613	1797	1991	2195	2409	2867	3365	3903	4480	5098	6452
116	267.61	131.33	1286	1627	1813	2009	2215	2430	2892	3395	3937	4519	5142	6508
118	272.23	132.46	1297	1641	1828	2026	2234	2451	2917	3424	3971	4558	5186	6564
120	276.84	133.57	1308	1655	1844	2043	2252	2472	2942	3453	4004	4597	5230	6619

Pitot Pressure*		Velocity Discharge	Orifice Size (in.)											
(psi)	Feet†	(ft/sec)	2	2.25	2.375	2.5	2.625	2.75	3	3.25	3.5	3.75	4	4.5
122	281.45	134.69	1318	1669	1859	2060	2271	2493	2966	3481	4038	4635	5273	6674
124	286.07	135.79	1329	1682	1874	2077	2290	2513	2991	3510	4070	4673	5317	6729
126	290.68	136.88	1340	1696	1889	2093	2308	2533	3015	3538	4103	4710	5359	6783
128	295.3	137.96	1350	1709	1904	2110	2326	2553	3038	3566	4136	4748	5402	6836
130	299.91	139.03	1361	1722	1919	2126	2344	2573	3062	3594	4168	4784	5444	6890
132	304.52	140.1	1371	1736	1934	2143	2362	2593	3086	3621	4200	4821	5485	6942
134	309.14	141.16	1382	1749	1948	2159	2380	2612	3109	3649	4231	4858	5527	6995
136	313.75	142.21	1392	1762	1963	2175	2398	2632	3132	3676	4263	4894	5568	7047

Notes:

(1) This table is computed from the formula: $Q = 29.84cd^2\sqrt{p}$ with c = 1.00. The theoretical discharge of seawater, as from fireboat nozzles, can be found by subtracting 1 percent from the figures in Table C.4.10.2.1, or from the formula:

$$Q = 29.84cd^2\sqrt{p}$$

(2) Appropriate coefficient should be applied where it is read from hydrant outlet. Where more accurate results are required, a coefficient appropriate on the particular nozzle must be selected and applied to the figures of the table. The discharge from circular openings of sizes other than those in the table can readily be computed by applying the principle that quantity discharged under a given head varies as the square of the diameter of the opening.

~~*This pressure corresponds to velocity head.~~

‡ ~~1 psi = 2.307 ft of water. For pressure in bar, multiply by 0.07.~~

~~Table C.4.10.1(b) Theoretical Discharge Through Circular Orifices (Liters of Water per Minute)~~

Pitot Pressure*		Velocity Discharge	Orifice Size (mm)										
(kPa)	Meters ‡	(m/sec)	51	57	60	64	67	70	76	83	89	95	101
6.89	0.7	3.72	455	568	629	716	785	857	1010	1204	1385	1578	1783
13.8	1.41	5.26	644	804	891	1013	1111	1212	1429	1704	1960	2233	2524
20.7	2.11	6.44	788	984	1091	1241	1360	1485	1750	2087	2400	2735	3091
27.6	2.81	7.43	910	1137	1260	1433	1571	1714	2021	2410	2771	3158	3569
34.5	3.52	8.31	1017	1271	1408	1602	1756	1917	2259	2695	3099	3530	3990
41.4	4.22	9.1	1115	1392	1543	1755	1924	2100	2475	2952	3394	3867	4371
48.3	4.92	9.83	1204	1504	1666	1896	2078	2268	2673	3189	3666	4177	4722
55.2	5.63	10.51	1287	1608	1781	2027	2221	2425	2858	3409	3919	4466	5048
62	6.33	11.15	1364	1704	1888	2148	2354	2570	3029	3613	4154	4733	5349
68.9	7.03	11.75	1438	1796	1990	2264	2482	2709	3193	3808	4379	4989	5639
75.8	7.73	12.33	1508	1884	2087	2375	2603	2841	3349	3995	4593	5233	5915
82.7	8.44	12.87	1575	1968	2180	2481	2719	2968	3498	4172	4797	5466	6178
89.6	9.14	13.4	1640	2048	2270	2582	2830	3089	3641	4343	4994	5690	6431
96.5	9.84	13.91	1702	2126	2355	2680	2937	3206	3779	4507	5182	5905	6674

Pitot Pressure*		Velocity Discharge	Orifice Size (mm)										
(kPa)	Meters ‡	(m/sec)	51	57	60	64	67	70	76	83	89	95	101
103	10.55	14.39	1758	2196	2433	2769	3034	3312	3904	4656	5354	6100	6895
110	11.25	14.87	1817	2269	2515	2861	3136	3423	4035	4812	5533	6304	7125
117	11.95	15.33	1874	2341	2593	2951	3234	3530	4161	4963	5706	6502	7349
124	12.66	15.77	1929	2410	2670	3038	3329	3634	4284	5109	5874	6693	7565
131	13.36	16.2	1983	2477	2744	3122	3422	3735	4403	5251	6038	6880	7776
138	14.06	16.62	2035	2542	2817	3205	3512	3834	4519	5390	6197	7061	7981
152	15.47	17.43	2136	2668	2956	3363	3686	4023	4743	5657	6504	7410	8376
165	16.88	18.21	2225	2779	3080	3504	3840	4192	4941	5893	6776	7721	8727
179	18.28	18.95	2318	2895	3208	3650	4000	4366	5147	6138	7058	8042	9090
193	19.69	19.67	2407	3006	3331	3790	4153	4534	5344	6374	7329	8350	9438
207	21.1	20.36	2492	3113	3450	3925	4301	4695	5535	6601	7590	8648	9775
221	22.5	21.03	2575	3217	3564	4055	4444	4851	5719	6821	7842	8935	10100
234	23.91	21.67	2650	3310	3668	4173	4573	4992	5884	7018	8070	9195	10393
248	25.31	22.3	2728	3408	3776	4296	4708	5139	6058	7225	8308	9466	10699
262	26.72	22.91	2804	3502	3881	4416	4839	5282	6227	7426	8539	9729	10997
276	28.13	23.5	2878	3595	3983	4532	4967	5422	6391	7622	8764	9986	11287
290	29.53	24.09	2950	3685	4083	4646	5091	5557	6551	7813	8984	10236	11570
303	30.94	24.65	3015	3767	4173	4748	5204	5681	6696	7986	9183	10463	11826
317	32.35	25.21	3084	3853	4269	4857	5323	5810	6849	8169	9393	10702	12096
331	33.75	25.75	3152	3937	4362	4963	5439	5937	6999	8347	9598	10935	12360
345	35.16	26.28	3218	4019	4453	5067	5553	6061	7145	8522	9799	11164	12619
358	36.57	26.8	3278	4094	4536	5161	5657	6175	7279	8681	9981	11373	12855
372	37.97	27.31	3341	4173	4624	5261	5766	6294	7419	8849	10175	11593	13104
386	39.38	27.8	3403	4251	4711	5360	5874	6412	7558	9014	10364	11809	13348
400	40.78	28.31	3465	4328	4795	5456	5979	6527	7694	9176	10551	12021	13588
414	42.19	28.79	3525	4403	4878	5551	6083	6640	7827	9335	10734	12230	13823
427	43.6	29.26	3580	4471	4954	5637	6178	6743	7949	9481	10901	12420	14039
441	45	29.73	3638	4544	5035	5729	6278	6853	8078	9635	11078	12622	14267
455	46.41	30.2	3695	4616	5114	5819	6377	6961	8206	9787	11253	12821	14492
469	47.82	30.65	3751	4686	5192	5908	6475	7067	8331	9936	11425	13017	14713
483	49.22	31.1	3807	4756	5269	5995	6570	7172	8454	10083	11594	13210	14931
496	50.63	31.54	3858	4819	5340	6075	6658	7268	8567	10218	11749	13386	15131
510	52.03	31.97	3912	4887	5415	6161	6752	7370	8687	10361	11913	13574	15343
524	53.44	32.71	3965	4953	5488	6245	6844	7470	8806	10503	12076	13759	15552
538	54.85	32.82	4018	5019	5561	6327	6934	7569	8923	10642	12236	13942	15758
552	56.25	33.25	4070	5084	5633	6409	7024	7667	9038	10780	12394	14122	15962

Pitot Pressure* (kPa)	Meters ‡	Velocity Discharge (m/sec)	Orifice Size (mm) 51	57	60	64	67	70	76	83	89	95	101	
565	57.66	33.66	4118	5143	5699	6484	7106	7757	9144	10906	12539	14287	16149	2
579	59.07	34.06	4168	5207	5769	6564	7194	7853	9256	11040	12694	14463	16348	2
593	60.47	34.47	4218	5269	5839	6643	7280	7947	9368	11173	12846	14637	16544	2
607	61.88	34.87	4268	5331	5907	6721	7366	8040	9478	11304	12997	14809	16738	2
620	63.29	35.26	4313	5388	5970	6793	7444	8126	9578	11424	13136	14966	16917	2
634	64.69	35.65	4362	5448	6037	6869	7528	8217	9686	11552	13283	15134	17107	2
648	66.1	36.04	4410	5508	6103	6944	7610	8307	9792	11679	13429	15301	17294	2
662	67.5	36.42	4457	5567	6169	7019	7692	8397	9898	11805	13573	15465	17480	2
676	68.91	36.79	4504	5626	6234	7093	7773	8485	10002	11929	13716	15628	17664	2
689	70.32	37.17	4547	5680	6293	7161	7848	8566	10097	12043	13847	15777	17833	2
703	71.72	37.54	4593	5737	6357	7233	7927	8653	10200	12165	13987	15937	18013	2
717	73.13	37.9	4638	5794	6420	7305	8005	8738	10301	12285	14126	16095	18192	2
731	74.54	38.27	4684	5850	6482	7376	8083	8823	10401	12405	14263	16251	18369	2
745	75.94	38.63	4728	5906	6544	7446	8160	8907	10500	12523	14399	16406	18544	2
758	77.35	38.98	4769	5957	6601	7510	8231	8985	10591	12632	14524	16548	18705	2
772	78.76	39.33	4813	6012	6662	7580	8307	9067	10688	12748	14658	16701	18877	2
786	80.16	39.68	4857	6066	6722	7648	8382	9149	10785	12863	14790	16851	19047	2
800	81.57	40.03	4900	6120	6781	7716	8456	9230	10880	12977	14921	17001	19216	2
813	82.97	40.37	4939	6170	6836	7778	8525	9305	10968	13082	15042	17138	19371	2
827	84.38	40.71	4982	6223	6895	7845	8598	9385	11063	13194	15171	17285	19538	2
841	85.79	41.05	5024	6275	6953	7911	8670	9464	11156	13305	15299	17431	19702	2
855	87.19	41.39	5065	6327	7011	7977	8742	9542	11248	13416	15425	17575	19866	2
869	88.6	41.72	5107	6379	7068	8042	8813	9620	11340	13525	15551	17719	20028	2
882	90.01	42.05	5145	6426	7121	8102	8879	9692	11424	13626	15667	17851	20177	2
896	91.41	42.38	5185	6477	7177	8166	8949	9768	11515	13734	15791	17992	20336	2
910	92.82	42.7	5226	6527	7233	8229	9019	9844	11604	13840	15914	18132	20495	2
924	94.23	43.03	5266	6577	7288	8292	9088	9920	11693	13947	16036	18271	20652	2
938	95.63	43.35	5305	6627	7343	8355	9156	9995	11782	14052	16157	18409	20807	2

Notes:

(1) This table is computed from the formula $Q_m = 0.0666cd^2\sqrt{P_m}$ with $c = 1.00$. The theoretical discharge of seawater, as from fireboat nozzles, can be found by subtracting 1 percent from the figures in Table C.4.10.2.1, or from the formula:

$$Q_m = 0.0659cd^2\sqrt{P_m}$$

(2) Appropriate coefficient should be applied where it is read from hydrant outlet. Where more accurate results are required, a coefficient appropriate on the particular nozzle must be selected and applied to the figures of the table. The discharge from circular openings of sizes other than those in the table can readily be computed by applying the principle that quantity discharged under a given head varies as the square of the diameter of the opening.

*This pressure corresponds to velocity head.

‡ 1 kPa = 0.102 m of water. For pressure in bar, multiply by 0.01.

Table C.4.10.1(b) Theoretical Discharge Through Circular Orifices (Liters of Water per Minute)

Pitot Pressure (kPa)	Pitot Pressure (bar)	Meters (m)	Velocity Discharge (m/sec)	Orifice Size (mm)									
				51	57	60	65	67	70	76	83	89	95
5	0.1	0.51	3.16	387	484	536	629	669	730	860	1026	1180	1344
10	0.1	1.02	4.47	548	684	758	890	945	1032	1216	1451	1668	1901
15	0.2	1.53	5.48	671	838	929	1090	1158	1264	1490	1777	2043	2328
20	0.2	2.04	6.33	775	968	1072	1258	1337	1459	1720	2052	2359	2688
25	0.3	2.55	7.07	866	1082	1199	1407	1495	1632	1923	2294	2638	3005
30	0.3	3.06	7.75	949	1185	1313	1541	1638	1787	2107	2513	2889	3292
35	0.4	3.57	8.37	1025	1280	1418	1665	1769	1931	2276	2714	3121	3556
40	0.4	4.08	8.95	1096	1369	1516	1780	1891	2064	2433	2902	3336	3801
45	0.5	4.59	9.49	1162	1452	1608	1888	2006	2189	2581	3078	3539	4032
50	0.5	5.1	10.00	1225	1530	1695	1990	2114	2308	2720	3244	3730	4250
55	0.6	5.61	10.49	1285	1605	1778	2087	2217	2420	2853	3403	3912	4458
60	0.6	6.12	10.96	1342	1676	1857	2180	2316	2528	2980	3554	4086	4656
65	0.7	6.63	11.41	1397	1745	1933	2269	2410	2631	3101	3699	4253	4846
70	0.7	7.14	11.84	1449	1810	2006	2354	2501	2730	3218	3839	4414	5029
75	0.8	7.65	12.25	1500	1874	2076	2437	2589	2826	3331	3973	4569	5205
80	0.8	8.16	12.65	1549	1935	2144	2517	2674	2919	3441	4104	4718	5376
85	0.9	8.67	13.04	1597	1995	2210	2594	2756	3009	3547	4230	4864	5542
90	0.9	9.18	13.42	1643	2053	2275	2669	2836	3096	3649	4353	5005	5702
95	1.0	9.69	13.79	1688	2109	2337	2743	2914	3181	3749	4472	5142	5858
100	1.0	10.2	14.15	1732	2164	2398	2814	2990	3263	3847	4588	5275	6011
105	1.1	10.71	14.50	1775	2217	2457	2883	3064	3344	3942	4701	5406	6159
110	1.1	11.22	14.84	1817	2269	2515	2951	3136	3423	4035	4812	5533	6304
115	1.2	11.73	15.17	1858	2320	2571	3018	3206	3500	4125	4920	5657	6446
120	1.2	12.24	15.50	1898	2370	2626	3082	3275	3575	4214	5026	5779	6584
125	1.3	12.75	15.82	1937	2419	2681	3146	3343	3649	4301	5130	5898	6720
130	1.3	13.26	16.13	1975	2467	2734	3208	3409	3721	4386	5231	6015	6853
140	1.4	14.28	16.74	2050	2560	2837	3329	3537	3861	4552	5429	6242	7112
150	1.5	15.3	17.33	2122	2650	2936	3446	3662	3997	4711	5619	6461	7362
160	1.6	16.32	17.89	2191	2737	3033	3559	3782	4128	4866	5804	6673	7603
170	1.7	17.34	18.44	2259	2821	3126	3669	3898	4255	5016	5982	6878	7837
180	1.8	18.36	18.98	2324	2903	3217	3775	4011	4378	5161	6156	7078	8064
190	1.9	19.38	19.50	2388	2983	3305	3879	4121	4498	5302	6324	7272	8285
200	2.0	20.4	20.01	2450	3060	3391	3979	4228	4615	5440	6489	7461	8500
210	2.1	21.42	20.50	2510	3136	3474	4078	4332	4729	5575	6649	7645	8710
220	2.2	22.44	20.98	2569	3209	3556	4174	4434	4840	5706	6805	7825	8915
230	2.3	23.46	21.45	2627	3282	3636	4267	4534	4949	5834	6958	8001	9116
240	2.4	24.48	21.92	2684	3352	3714	4359	4632	5056	5959	7108	8173	9312
250	2.5	25.5	22.37	2739	3421	3791	4449	4727	5160	6082	7254	8341	9504
260	2.6	26.52	22.81	2793	3489	3866	4537	4821	5262	6203	7398	8506	9692
270	2.7	27.54	23.25	2846	3556	3940	4624	4913	5362	6321	7539	8668	9877

Pitot Pressure (kPa)	Pitot Pressure (bar)	Meters (m)	Velocity Discharge (m/sec)	Orifice Size (mm)									
				51	57	60	65	67	70	76	83	89	95
285	2.9	29.07	23.88	2924	3653	4048	4750	5047	5509	6494	7746	8906	10147
300	3.0	30.6	24.50	3000	3748	4153	4874	5178	5652	6663	7947	9137	10411
315	3.2	32.13	25.11	3074	3840	4255	4994	5306	5792	6827	8143	9363	10668
330	3.3	33.66	25.70	3147	3931	4355	5112	5431	5928	6988	8335	9583	10919
345	3.5	35.19	26.28	3218	4019	4453	5226	5553	6061	7145	8522	9799	11164
360	3.6	36.72	26.84	3287	4106	4549	5339	5673	6192	7299	8705	10009	11404
375	3.8	38.25	27.39	3355	4190	4643	5449	5789	6320	7449	8885	10216	11640
390	3.9	39.78	27.94	3421	4273	4735	5557	5904	6445	7597	9061	10418	11870
405	4.1	41.31	28.47	3486	4355	4825	5663	6017	6567	7742	9233	10617	12096
420	4.2	42.84	28.99	3550	4435	4914	5767	6127	6688	7884	9403	10811	12318
435	4.4	44.37	29.50	3613	4513	5001	5869	6235	6806	8023	9569	11003	12536
450	4.5	45.9	30.01	3675	4590	5086	5969	6342	6923	8160	9733	11191	12751
465	4.7	47.43	30.51	3735	4666	5170	6068	6447	7037	8295	9894	11376	12961
480	4.8	48.96	30.99	3795	4741	5253	6165	6550	7150	8428	10052	11558	13169
495	5.0	50.49	31.47	3854	4814	5334	6260	6652	7261	8559	10208	11737	13373
510	5.1	52.02	31.95	3912	4887	5415	6355	6752	7370	8687	10361	11913	13574
525	5.3	53.55	32.41	3969	4958	5494	6447	6850	7477	8814	10513	12087	13772
540	5.4	55.08	32.87	4025	5028	5572	6539	6947	7583	8939	10662	12259	13967
555	5.6	56.61	33.33	4081	5098	5648	6629	7043	7688	9062	10809	12428	14160
570	5.7	58.14	33.77	4136	5166	5724	6718	7138	7791	9184	10954	12595	14350
585	5.9	59.67	34.22	4190	5234	5799	6806	7231	7893	9304	11097	12759	14538
600	6.0	61.2	34.65	4243	5300	5873	6892	7323	7994	9423	11238	12922	14723
615	6.2	62.73	35.08	4296	5366	5946	6978	7414	8093	9540	11378	13083	14906
630	6.3	64.26	35.51	4348	5431	6018	7063	7504	8191	9655	11516	13241	15087
645	6.5	65.79	35.93	4399	5495	6089	7146	7593	8288	9770	11652	13398	15265
660	6.6	67.32	36.34	4450	5559	6160	7229	7681	8384	9883	11787	13553	15442
675	6.8	68.85	36.75	4501	5622	6229	7311	7767	8479	9994	11920	13706	15616
690	6.9	70.38	37.16	4550	5684	6298	7391	7853	8572	10105	12052	13857	15789
705	7.1	71.91	37.56	4599	5745	6366	7471	7938	8665	10214	12182	14007	15959
720	7.2	73.44	37.96	4648	5806	6433	7550	8022	8757	10322	12311	14155	16128
735	7.4	74.97	38.35	4696	5866	6500	7629	8105	8847	10429	12439	14302	16295
750	7.5	76.5	38.74	4744	5926	6566	7706	8188	8937	10535	12565	14447	16461
765	7.7	78.03	39.13	4791	5985	6631	7783	8269	9026	10640	12690	14591	16625
780	7.8	79.56	39.51	4838	6043	6696	7859	8350	9114	10744	12814	14733	16787
795	8.0	81.09	39.89	4884	6101	6760	7934	8430	9201	10846	12936	14874	16947
810	8.1	82.62	40.26	4930	6158	6824	8008	8509	9288	10948	13058	15014	17107
825	8.3	84.15	40.63	4976	6215	6887	8082	8587	9373	11049	13178	15152	17264
840	8.4	85.68	41.00	5021	6271	6949	8155	8665	9458	11149	13298	15290	17421
855	8.6	87.21	41.36	5065	6327	7011	8228	8742	9542	11248	13416	15425	17575
870	8.7	88.74	41.73	5109	6382	7072	8300	8818	9626	11346	13533	15560	17729
885	8.9	90.27	42.08	5153	6437	7133	8371	8894	9708	11444	13649	15694	17881
900	9.0	91.8	42.44	5197	6492	7193	8442	8969	9790	11540	13764	15826	18032
915	9.2	93.33	42.79	5240	6545	7252	8512	9043	9871	11636	13878	15957	18182
930	9.3	94.86	43.14	5283	6599	7312	8581	9117	9952	11731	13992	16088	18330

Pitot Pressure (kPa)	Pitot Pressure (bar)	Meters (m)	Velocity Discharge (m/sec)	Orifice Size (mm)									
				51	57	60	65	67	70	76	83	89	95
945	9.5	96.39	43.49	5325	6652	7370	8650	9191	10032	11825	14104	16217	18477

Notes:

(1) This table is computed from the formula $Q_M = 0.0666cd^2\sqrt{p}_M$, with c = 1.00. The theoretical discharge of seawater, as from fireboat nozzles, can be found by subtracting 1 percent from the figures in Table C.4.10.2.1, or from the formula $Q_w = 0.065cd^2\sqrt{P_w}$.

(2) Appropriate coefficient should be applied where it is read from the hydrant outlet. Where more accurate results are required, a coefficient appropriate on the particular nozzle must be selected and applied to the figures of the table. The discharge from circular openings of sizes other than those in the table can readily be computed by applying the principle that quantity discharged under a given head varies as the square of the diameter of the opening. [**291:** 4.10.1]

Supplemental Information

File Name	Description	Approved
24-Table_C.4_10.1_b_Metric.xlsx	For staff use	
24-SR-20_C.4.10.1_leg_changes.docx	For staff use	

Submitter Information Verification

Submitter Full Name: Sonia Barbosa
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Wed Sep 20 11:12:26 EDT 2017

Committee Statement

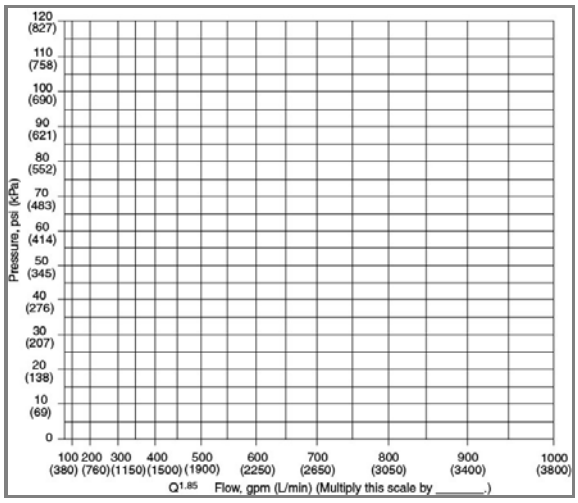
Committee Statement: Updates extracted text form NFPA 291
Response Message:

Second Revision No. 17-NFPA 24-2017 [Section No. C.4.11.4]

C.4.11.4

Results of the flow test should be indicated on a hydraulic graph, such as the one shown in Figure C.4.11.4.

Figure C.4.11.4 Sample Graph Sheet. [291:Figure 4.11.4]



Submitter Information Verification

Submitter Full Name: David Hague
Organization: National Fire Protection Assoc
Street Address:
City:
State:
Zip:
Submittal Date: Thu Aug 24 11:07:05 EDT 2017

Committee Statement

Committee Statement: Updates based on extracted text.

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E.1.1 NFPA Publications.

National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA 13 , *Standard for the Installation of Sprinkler Systems* , 2019 edition.

NFPA 20, *Standard for the Installation of Stationary Pumps for Fire Protection*, 2019 edition.

NFPA 22, *Standard for Water Tanks for Private Fire Protection*, 2018 edition.

~~NFPA 25 , *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems* , 2017 edition.~~

NFPA 70®, *National Electrical Code®*, 2017 edition.

NFPA 72®, *National Fire Alarm and Signaling Code®* , 2019 edition.

NFPA 291, *Recommended Practice for Fire Flow Testing and Marking of Hydrants*, ~~2016~~ 2019 edition.

NFPA 780, *Standard for the Installation of Lightning Protection Systems*, 2017 edition.

NFPA 1962, *Standard for the Care, Use, Inspection, Service Testing, and Replacement of Fire Hose, Couplings, Nozzles, and Fire Hose Appliances*, 2018 edition.

Submitter Information Verification

Submitter Full Name: David Hague
Organization: National Fire Protection Assoc
Street Address:
City:
State:
Zip:
Submittal Date: Fri Jul 28 13:18:48 EDT 2017

Committee Statement

Committee Statement: Added reference to NFPA 13.
Response Message:

Second Revision No. 18-NFPA 24-2017 [Section No. E.3]

E.3 References for Extracts in Informational Sections. ~~(Reserved)~~

NFPA 13, *Standard for the Installation of Sprinkler Systems,* 2019 edition.

NFPA 291, *Recommended Practice for Fire Flow Testing and Marking of Hydrants,* 2019 edition.

Submitter Information Verification

Submitter Full Name: Sonia Barbosa
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Wed Aug 30 13:07:30 EDT 2017

Committee Statement

Committee Statement: Due to extracted figures from NFPA 13.
Response Message:

Second Revision No. 3-NFPA 291-2017 [Section No. 4.7.3]

4.7.3

The formula used to compute the discharge, *Q*, in gpm (L/min) from these measurements is ~~as follows:~~ as shown in Equations 4.7.3a and 4.7.3b.

$$Q = 29.84cd^2\sqrt{p} \qquad \text{[4.7.3a]}$$

where:

c = coefficient of discharge (*see Figure 4.7.1*)

d = diameter of the outlet (in.) ~~inches~~

p = pitot pressure (velocity head) ~~in~~ (psi)

$$Q_M = 0.0666cd^2\sqrt{p_M} \qquad \text{[4.7.3b]}$$

where:

Q_M = flow (L/min)

P_M = pressure (kPa or bar)

Supplemental Information

File Name	Description	Approved
NFPA_291_SR_3.docx	Adds metric formula for determining flow in lpm, kPa/bar	

Submitter Information Verification

Submitter Full Name: David Hague
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Mon Jun 19 17:18:54 EDT 2017

Committee Statement

Committee Statement: Editorial, adds metric version of flow formula from Note 1 in Table 4.10(b).
Response Message:

$$Q_M = 0.0666cd^2 \sqrt{p_M}$$

Q_M = flow in lpm

p_M = pressure in kPa or bar

Second Revision No. 1-NFPA 291-2017 [Section No. 4.10.1 [Excluding any Sub-Sections]]

The discharge in gpm (L/min) for each outlet flowed is obtained from Table 4.10.1(a) and Table 4.10.1(b) or by the use of Equations 4.7.3a and 4.7.3b .

Table 4.10.1(a) Theoretical Discharge Through Circular Orifices (U.S. Gallons of Water per Minute)

Pitot Pressure* (psi)	Velocity Pressure‡ Feet	Discharge (ft/sec)	Orifice Size (in.)											
			2	2.25	2.375	2.5	2.625	2.75	3	3.25	3.5	3.75	4	4.5
1	2.31	12.20	119	151	168	187	206	226	269	315	366	420	477	604
2	4.61	17.25	169	214	238	264	291	319	380	446	517	593	675	855
3	6.92	21.13	207	262	292	323	356	391	465	546	633	727	827	1047
4	9.23	24.39	239	302	337	373	411	451	537	630	731	839	955	1209
5	11.54	27.26	267	338	376	417	460	505	601	705	817	938	1068	1351
6	13.84	29.87	292	370	412	457	504	553	658	772	895	1028	1169	1480
7	16.15	32.26	316	400	445	493	544	597	711	834	967	1110	1263	1599
8	18.46	34.49	338	427	476	528	582	638	760	891	1034	1187	1350	1709
9	20.76	36.58	358	453	505	560	617	677	806	946	1097	1259	1432	1813
10	23.07	38.56	377	478	532	590	650	714	849	997	1156	1327	1510	1911
11	25.38	40.45	396	501	558	619	682	748	891	1045	1212	1392	1583	2004
12	27.68	42.24	413	523	583	646	712	782	930	1092	1266	1454	1654	2093
13	29.99	43.97	430	545	607	672	741	814	968	1136	1318	1513	1721	2179
14	32.30	45.63	447	565	630	698	769	844	1005	1179	1368	1570	1786	2261
15	34.61	47.22	462	585	652	722	796	874	1040	1221	1416	1625	1849	2340
16	36.91	48.78	477	604	673	746	822	903	1074	1261	1462	1679	1910	2417
17	39.22	50.28	492	623	694	769	848	930	1107	1300	1507	1730	1969	2491
18	41.53	51.73	506	641	714	791	872	957	1139	1337	1551	1780	2026	2564
19	43.83	53.15	520	658	734	813	896	984	1171	1374	1593	1829	2081	2634
20	46.14	54.54	534	676	753	834	920	1009	1201	1410	1635	1877	2135	2702
22	50.75	57.19	560	709	789	875	964	1058	1260	1478	1715	1968	2239	2834
24	55.37	59.74	585	740	825	914	1007	1106	1316	1544	1791	2056	2339	2960
26	59.98	62.18	609	770	858	951	1048	1151	1369	1607	1864	2140	2434	3081
28	64.60	64.52	632	799	891	987	1088	1194	1421	1668	1934	2220	2526	3197
30	69.21	66.79	654	827	922	1022	1126	1236	1471	1726	2002	2298	2615	3310
32	73.82	68.98	675	855	952	1055	1163	1277	1519	1783	2068	2374	2701	3418
34	78.44	71.10	696	881	981	1087	1199	1316	1566	1838	2131	2447	2784	3523
36	83.05	73.16	716	906	1010	1119	1234	1354	1611	1891	2193	2518	2865	3626
38	87.67	75.17	736	931	1038	1150	1268	1391	1656	1943	2253	2587	2943	3725
40	92.28	77.11	755	955	1065	1180	1300	1427	1699	1993	2312	2654	3020	3822
42	96.89	79.03	774	979	1091	1209	1333	1462	1740	2043	2369	2719	3094	3916
44	101.51	80.88	792	1002	1116	1237	1364	1497	1781	2091	2425	2783	3167	4008
46	106.12	82.70	810	1025	1142	1265	1395	1531	1821	2138	2479	2846	3238	4098
48	110.74	84.48	827	1047	1166	1292	1425	1563	1861	2184	2533	2907	3308	4186
50	115.35	86.22	844	1068	1190	1319	1454	1596	1899	2229	2585	2967	3376	4273
52	119.96	87.93	861	1089	1214	1345	1483	1627	1937	2273	2636	3026	3443	4357
54	124.58	89.61	877	1110	1237	1370	1511	1658	1974	2316	2686	3084	3508	4440
56	129.19	91.20	893	1130	1260	1396	1539	1689	2010	2359	2735	3140	3573	4522
58	133.81	92.87	909	1150	1282	1420	1566	1719	2045	2400	2784	3196	3636	4602
60	138.42	94.45	925	1170	1304	1445	1593	1748	2080	2441	2831	3250	3698	4681

Pitot Pressure* (psi)	Feet‡	Velocity Discharge (ft/sec)	Orifice Size (in.)											
			2	2.25	2.375	2.5	2.625	2.75	3	3.25	3.5	3.75	4	4.5
62	143.03	96.01	940	1189	1325	1469	1619	1777	2115	2482	2878	3304	3759	4758
64	147.65	97.55	955	1209	1347	1492	1645	1805	2148	2521	2924	3357	3820	4834
66	152.26	99.07	970	1227	1367	1515	1670	1833	2182	2561	2970	3409	3879	4909
68	156.88	100.55	984	1246	1388	1538	1696	1861	2215	2599	3014	3460	3937	4983
70	161.49	102.03	999	1264	1408	1560	1720	1888	2247	2637	3058	3511	3995	5056
72	166.10	103.47	1013	1282	1428	1583	1745	1915	2279	2674	3102	3561	4051	5127
74	170.72	104.90	1027	1300	1448	1604	1769	1941	2310	2711	3144	3610	4107	5198
76	175.33	106.30	1041	1317	1467	1626	1793	1967	2341	2748	3187	3658	4162	5268
78	179.95	107.69	1054	1334	1487	1647	1816	1993	2372	2784	3228	3706	4217	5337
80	184.56	109.08	1068	1351	1505	1668	1839	2018	2402	2819	3269	3753	4270	5405
82	189.17	110.42	1081	1368	1524	1689	1862	2043	2432	2854	3310	3800	4323	5472
84	193.79	111.76	1094	1385	1543	1709	1885	2068	2461	2889	3350	3846	4376	5538
86	198.40	113.08	1107	1401	1561	1730	1907	2093	2491	2923	3390	3891	4428	5604
88	203.02	114.39	1120	1417	1579	1750	1929	2117	2519	2957	3429	3936	4479	5668
90	207.63	115.68	1132	1433	1597	1769	1951	2141	2548	2990	3468	3981	4529	5733
92	212.24	116.96	1145	1449	1614	1789	1972	2165	2576	3023	3506	4025	4579	5796
94	216.86	118.23	1157	1465	1632	1808	1994	2188	2604	3056	3544	4068	4629	5859
96	221.47	119.48	1169	1480	1649	1827	2015	2211	2631	3088	3582	4111	4678	5921
98	226.09	120.71	1182	1495	1666	1846	2035	2234	2659	3120	3619	4154	4726	5982
100	230.70	121.94	1194	1511	1683	1865	2056	2257	2686	3152	3655	4196	4774	6043
102	235.31	123.15	1205	1526	1700	1884	2077	2279	2712	3183	3692	4238	4822	6103
104	239.93	124.35	1217	1541	1716	1902	2097	2301	2739	3214	3728	4279	4869	6162
106	244.54	125.55	1229	1555	1733	1920	2117	2323	2765	3245	3763	4320	4916	6221
108	249.16	126.73	1240	1570	1749	1938	2137	2345	2791	3275	3799	4361	4962	6280
110	253.77	127.89	1252	1584	1765	1956	2157	2367	2817	3306	3834	4401	5007	6338
112	258.38	129.05	1263	1599	1781	1974	2176	2388	2842	3336	3869	4441	5053	6395
114	263.00	130.20	1274	1613	1797	1991	2195	2409	2867	3365	3903	4480	5098	6452
116	267.61	131.33	1286	1627	1813	2009	2215	2430	2892	3395	3937	4519	5142	6508
118	272.23	132.46	1297	1641	1828	2026	2234	2451	2917	3424	3971	4558	5186	6564
120	276.84	133.57	1308	1655	1844	2043	2252	2472	2942	3453	4004	4597	5230	6619
122	281.45	134.69	1318	1669	1859	2060	2271	2493	2966	3481	4038	4635	5273	6674
124	286.07	135.79	1329	1682	1874	2077	2290	2513	2991	3510	4070	4673	5317	6729
126	290.68	136.88	1340	1696	1889	2093	2308	2533	3015	3538	4103	4710	5359	6783
128	295.30	137.96	1350	1709	1904	2110	2326	2553	3038	3566	4136	4748	5402	6836
130	299.91	139.03	1361	1722	1919	2126	2344	2573	3062	3594	4168	4784	5444	6890
132	304.52	140.10	1371	1736	1934	2143	2362	2593	3086	3621	4200	4821	5485	6942
134	309.14	141.16	1382	1749	1948	2159	2380	2612	3109	3649	4231	4858	5527	6995
136	313.75	142.21	1392	1762	1963	2175	2398	2632	3132	3676	4263	4894	5568	7047

Notes:

(1) This table is computed from the formula $Q = 29.84cd^2\sqrt{p}$, with *c* = 1.00. The theoretical discharge of seawater, as from fireboat nozzles, can be found by subtracting 1 percent from the figures in Table 4.10.2.1, or from the formula $Q = 29.84cd^2\sqrt{p}$.

(2) Appropriate coefficient should be applied where it is read from hydrant outlet. Where more accurate results are required, a coefficient appropriate on the particular nozzle must be selected and applied to the figures of the table. The discharge from circular openings of sizes other than those in the table can readily be computed by applying the principle that quantity discharged under a given head varies as the square of the diameter of the opening.

*This pressure corresponds to velocity head.

†1 psi = 2.307 ft of water. For pressure in bars, multiply by 0.07.

Table 4.10.1(b) Theoretical Discharge Through Circular Orifices (Liters of Water per Minute)

Pitot Pressure* (kPa)	Meters†	Velocity Discharge (m/sec)	Orifice Size (mm)											
			50	57	60	65	67	70	80	83	90	95	100	
6.89	0.70	3.72	450	572	636	708	780	856	1015	1192	1385	1590	1806	22
13.79	1.41	5.26	640	810	901	999	1102	1208	1438	1688	1957	2245	2555	32
20.68	2.11	6.44	784	992	1105	1223	1360	1480	1760	2067	2396	2752	3131	39
27.58	2.81	7.43	905	1143	1276	1412	1556	1741	2033	2385	2767	3176	3615	45
34.47	3.52	8.31	1011	1279	1423	1579	1741	1912	2275	2669	3093	3551	4043	51
41.37	4.22	9.10	1105	1401	1560	1730	1908	2093	2491	2922	3388	3891	4425	56
48.26	4.92	9.83	1196	1514	1685	1866	2059	2260	2691	3157	3660	4202	4781	60
55.16	5.63	10.51	1279	1616	1802	1999	2203	2415	2877	3373	3914	4493	5110	64
62.05	6.33	11.15	1355	1715	1912	2120	2336	2563	3051	3581	4153	4766	5421	68
68.95	7.03	11.75	1427	1809	2014	2233	2461	2703	3214	3774	4376	5023	5716	72
75.84	7.74	12.33	1499	1896	2112	2343	2582	2831	3373	3956	4588	5269	5992	75
82.74	8.44	12.87	1563	1980	2207	2445	2695	2960	3520	4134	4792	5504	6261	79
89.63	9.14	13.40	1628	2063	2298	2544	2805	3081	3664	4300	4989	5727	6515	82
96.53	9.85	13.91	1692	2139	2385	2642	2911	3195	3804	4463	5178	5943	6761	85
103.42	10.55	14.39	1749	2214	2468	2733	3013	3308	3937	4622	5360	6151	6999	88
110.32	11.25	14.87	1806	2286	2548	2824	3112	3418	4066	4773	5534	6356	7230	91
117.21	11.95	15.33	1862	2358	2627	2911	3210	3520	4190	4921	5705	6549	7453	94
124.11	12.66	15.77	1915	2426	2703	2994	3301	3623	4312	5061	5871	6738	7669	97
131.00	13.36	16.20	1968	2491	2778	3078	3392	3725	4433	5201	6030	6924	7877	99
137.90	14.06	16.62	2021	2559	2850	3157	3483	3819	4546	5337	6189	7105	8082	10
151.68	15.47	17.43	2120	2684	2987	3312	3649	4005	4770	5595	6492	7450	8476	10
165.47	16.88	18.21	2214	2801	3123	3460	3812	4187	4982	5845	6780	7783	8854	11
179.26	18.28	18.95	2305	2915	3248	3600	3967	4357	5182	6083	7056	8101	9214	11
193.05	19.69	19.67	2392	3025	3373	3736	4119	4520	5379	6314	7321	8404	9562	12
206.84	21.10	20.36	2476	3131	3490	3869	4262	4679	5568	6534	7578	8699	9899	12
220.63	22.50	21.03	2555	3237	3604	3994	4402	4834	5750	6749	7828	8987	10224	12
234.42	23.91	21.67	2635	3335	3713	4115	4539	4982	5928	6958	8067	9263	10539	13
248.21	25.31	22.30	2710	3430	3823	4236	4671	5125	6098	7158	8301	9532	10845	13
262.00	26.72	22.91	2786	3524	3929	4353	4800	5266	6269	7355	8529	9793	11140	14
275.79	28.13	23.50	2858	3615	4031	4467	4921	5402	6431	7544	8752	10046	11432	14
289.58	29.53	24.09	2930	3706	4130	4577	5046	5534	6587	7734	8968	10293	11712	14
303.37	30.94	24.65	2998	3793	4225	4683	5163	5667	6742	7915	9180	10535	11988	15
317.16	32.35	25.21	3066	3880	4323	4789	5281	5795	6893	8093	9384	10773	12257	15
330.95	33.75	25.75	3131	3963	4414	4891	5394	5917	7045	8267	9588	11004	12522	15
344.74	35.16	26.28	3195	4043	4505	4993	5504	6042	7188	8438	9785	11231	12780	16
358.53	36.56	26.80	3259	4122	4595	5091	5614	6159	7332	8604	9978	11455	13033	16

Pitot Pressure* (kPa)	Meters†	Velocity Discharge (m/sec)	Orifice Size (mm)											
			50	57	60	65	67	70	80	83	90	95	100	
372.32	37.97	27.31	3320	4202	4683	5186	5720	6276	7472	8767	10168	11674	13279	16
386.11	39.38	27.80	3380	4278	4770	5284	5826	6394	7609	8930	10353	11886	13525	17
399.90	40.79	28.31	3441	4353	4853	5375	5928	6507	7741	9085	10539	12098	13764	17
413.69	42.19	28.79	3502	4429	4936	5470	6030	6617	7874	9240	10717	12303	13998	17
427.47	43.60	29.26	3558	4501	5016	5561	6129	6727	8006	9395	10894	12507	14229	18
441.26	45.00	29.73	3615	4577	5099	5648	6227	6833	8131	9543	11069	12708	14460	18
455.05	46.41	30.20	3672	4645	5175	5735	6322	6939	8260	9694	11243	12904	14684	18
468.84	47.82	30.65	3725	4717	5254	5822	6420	7045	8385	9838	11409	13098	14903	18
482.63	49.22	31.10	3782	4785	5330	5905	6511	7147	8506	9982	11576	13291	15123	19
496.42	50.63	31.54	3835	4853	5406	5992	6606	7249	8627	10122	11742	13480	15335	19
510.21	52.04	31.97	3888	4921	5481	6072	6696	7347	8744	10262	11901	13665	15547	19
524.00	53.44	32.40	3941	4985	5553	6155	6787	7446	8862	10402	12064	13847	15755	19
537.79	54.85	32.82	3990	5050	5629	6235	6874	7544	8979	10539	12219	14029	15963	20
551.58	56.25	33.25	4043	5114	5697	6314	6961	7639	9093	10671	12375	14207	16164	20
565.37	57.66	33.66	4092	5178	5769	6394	7048	7734	9206	10804	12530	14385	16364	20
579.16	59.07	34.06	4141	5243	5841	6469	7136	7828	9316	10936	12681	14559	16565	20
592.95	60.47	34.47	4190	5303	5909	6549	7219	7923	9429	11065	12833	14729	16762	21
606.74	61.88	34.87	4240	5364	5977	6624	7302	8014	9535	11193	12980	14899	16955	21
620.53	63.29	35.26	4285	5424	6045	6696	7385	8105	9645	11318	13128	15070	17144	21
634.32	64.69	35.65	4334	5485	6110	6772	7465	8195	9751	11443	13272	15236	17333	21
648.11	66.10	36.04	4380	5546	6178	6844	7548	8282	9857	11568	13416	15399	17523	22
661.90	67.50	36.42	4425	5602	6242	6916	7628	8370	9959	11689	13559	15562	17708	22
675.69	68.91	36.79	4474	5659	6306	6988	7703	8457	10065	11810	13699	15725	17890	22
689.48	70.32	37.17	4520	5720	6371	7060	7783	8544	10168	11932	13836	15884	18072	22
703.27	71.72	37.54	4561	5777	6435	7132	7862	8627	10266	12049	13976	16043	18253	23
717.05	73.13	37.90	4607	5833	6496	7200	7938	8710	10368	12166	14112	16198	18431	23
730.84	74.54	38.27	4652	5886	6560	7268	8014	8794	10467	12284	14245	16353	18609	23
744.63	75.94	38.63	4694	5943	6621	7336	8089	8877	10565	12397	14381	16508	18783	23
758.42	77.35	38.98	4739	5996	6681	7404	8165	8960	10664	12515	14513	16660	18954	23
772.21	78.75	39.33	4781	6053	6742	7472	8237	9040	10758	12628	14646	16811	19128	24
786.00	80.16	39.68	4823	6106	6802	7537	8309	9119	10853	12738	14747	16959	19298	24
799.79	81.57	40.03	4868	6159	6863	7605	8385	9199	10947	12851	14903	17106	19465	24
813.58	82.98	40.37	4910	6212	6920	7669	8457	9278	11042	12961	15032	17254	19631	24
827.37	84.38	40.71	4951	6265	6980	7734	8525	9358	11137	13071	15157	17402	19798	25
841.16	85.79	41.05	4989	6318	7037	7798	8597	9437	11228	13177	15285	17545	19960	25
854.95	87.19	41.39	5031	6367	7094	7862	8669	9513	11322	13287	15407	17689	20127	25
868.74	88.60	41.72	5072	6320	7151	7923	8737	9588	11413	13393	15532	17829	20286	25
882.53	90.01	42.05	5110	6469	7207	7987	8805	9664	11500	13499	15656	17973	20449	25
896.32	91.41	42.38	5152	6518	7264	8048	8873	9740	11591	13605	15778	18109	20608	26
910.11	92.82	42.70	5190	6571	7321	8112	8941	9816	11682	13707	15899	18249	20763	26
923.90	94.23	43.03	5231	6621	7374	8173	9009	9887	11769	13813	16016	18390	20992	26
937.69	95.63	43.35	5269	6670	7431	8233	9077	9963	11856	13915	16137	18526	21077	26

Notes:

(1) This table is computed from the formula $Q_m = 0.0666cd^2\sqrt{P_m}$, with c = 1.00. The theoretical discharge of seawater, as from fireboat nozzles, can be found by subtracting 1 percent from the figures in Table 4.10.2.1, or from the formula $Q_m = 0.0659cd^2m\sqrt{P_m}$.

(2) Appropriate coefficient should be applied where it is read from the hydrant outlet. Where more accurate results are required, a coefficient appropriate on the particular nozzle must be selected and applied to the figures of the table. The discharge from circular openings of sizes other than those in the table can readily be computed by applying the principle that quantity discharged under a given head varies as the square of the diameter of the opening.

*This pressure corresponds to velocity head.

†1 kPa = 0.102 m of water. For pressure in bars, multiply by 0.01.

Table 4.10.1(b) Theoretical Discharge Through Circular Orifices (Liters of Water per Minute)

Pitot Pressure (kPa)	Pitot Pressure (bar)	Meters (m)	Velocity Discharge (m/sec)	Orifice Size (mm)									
				51	57	60	65	67	70	76	83	89	95
5	0.1	0.51	3.16	387	484	536	629	669	730	860	1026	1180	1344
10	0.1	1.02	4.47	548	684	758	890	945	1032	1216	1451	1668	1901
15	0.2	1.53	5.48	671	838	929	1090	1158	1264	1490	1777	2043	2328
20	0.2	2.04	6.33	775	968	1072	1258	1337	1459	1720	2052	2359	2688
25	0.3	2.55	7.07	866	1082	1199	1407	1495	1632	1923	2294	2638	3005
30	0.3	3.06	7.75	949	1185	1313	1541	1638	1787	2107	2513	2889	3292
35	0.4	3.57	8.37	1025	1280	1418	1665	1769	1931	2276	2714	3121	3556
40	0.4	4.08	8.95	1096	1369	1516	1780	1891	2064	2433	2902	3336	3801
45	0.5	4.59	9.49	1162	1452	1608	1888	2006	2189	2581	3078	3539	4032
50	0.5	5.1	10.00	1225	1530	1695	1990	2114	2308	2720	3244	3730	4250
55	0.6	5.61	10.49	1285	1605	1778	2087	2217	2420	2853	3403	3912	4458
60	0.6	6.12	10.96	1342	1676	1857	2180	2316	2528	2980	3554	4086	4656
65	0.7	6.63	11.41	1397	1745	1933	2269	2410	2631	3101	3699	4253	4846
70	0.7	7.14	11.84	1449	1810	2006	2354	2501	2730	3218	3839	4414	5029
75	0.8	7.65	12.25	1500	1874	2076	2437	2589	2826	3331	3973	4569	5205
80	0.8	8.16	12.65	1549	1935	2144	2517	2674	2919	3441	4104	4718	5376
85	0.9	8.67	13.04	1597	1995	2210	2594	2756	3009	3547	4230	4864	5542
90	0.9	9.18	13.42	1643	2053	2275	2669	2836	3096	3649	4353	5005	5702
95	1.0	9.69	13.79	1688	2109	2337	2743	2914	3181	3749	4472	5142	5858
100	1.0	10.2	14.15	1732	2164	2398	2814	2990	3263	3847	4588	5275	6011
105	1.1	10.71	14.50	1775	2217	2457	2883	3064	3344	3942	4701	5406	6159
110	1.1	11.22	14.84	1817	2269	2515	2951	3136	3423	4035	4812	5533	6304
115	1.2	11.73	15.17	1858	2320	2571	3018	3206	3500	4125	4920	5657	6446
120	1.2	12.24	15.50	1898	2370	2626	3082	3275	3575	4214	5026	5779	6584
125	1.3	12.75	15.82	1937	2419	2681	3146	3343	3649	4301	5130	5898	6720
130	1.3	13.26	16.13	1975	2467	2734	3208	3409	3721	4386	5231	6015	6853
140	1.4	14.28	16.74	2050	2560	2837	3329	3537	3861	4552	5429	6242	7112
150	1.5	15.3	17.33	2122	2650	2936	3446	3662	3997	4711	5619	6461	7362
160	1.6	16.32	17.89	2191	2737	3033	3559	3782	4128	4866	5804	6673	7603
170	1.7	17.34	18.44	2259	2821	3126	3669	3898	4255	5016	5982	6878	7837
180	1.8	18.36	18.98	2324	2903	3217	3775	4011	4378	5161	6156	7078	8064
190	1.9	19.38	19.50	2388	2983	3305	3879	4121	4498	5302	6324	7272	8285

Pitot Pressure (kPa)	Pitot Pressure (bar)	Meters (m)	Velocity Discharge (m/sec)	Orifice Size (mm)									
				51	57	60	65	67	70	76	83	89	95
200	2.0	20.4	20.01	2450	3060	3391	3979	4228	4615	5440	6489	7461	8500
210	2.1	21.42	20.50	2510	3136	3474	4078	4332	4729	5575	6649	7645	8710
220	2.2	22.44	20.98	2569	3209	3556	4174	4434	4840	5706	6805	7825	8915
230	2.3	23.46	21.45	2627	3282	3636	4267	4534	4949	5834	6958	8001	9116
240	2.4	24.48	21.92	2684	3352	3714	4359	4632	5056	5959	7108	8173	9312
250	2.5	25.5	22.37	2739	3421	3791	4449	4727	5160	6082	7254	8341	9504
260	2.6	26.52	22.81	2793	3489	3866	4537	4821	5262	6203	7398	8506	9692
270	2.7	27.54	23.25	2846	3556	3940	4624	4913	5362	6321	7539	8668	9877
285	2.9	29.07	23.88	2924	3653	4048	4750	5047	5509	6494	7746	8906	10147
300	3.0	30.6	24.50	3000	3748	4153	4874	5178	5652	6663	7947	9137	10411
315	3.2	32.13	25.11	3074	3840	4255	4994	5306	5792	6827	8143	9363	10668
330	3.3	33.66	25.70	3147	3931	4355	5112	5431	5928	6988	8335	9583	10919
345	3.5	35.19	26.28	3218	4019	4453	5226	5553	6061	7145	8522	9799	11164
360	3.6	36.72	26.84	3287	4106	4549	5339	5673	6192	7299	8705	10009	11404
375	3.8	38.25	27.39	3355	4190	4643	5449	5789	6320	7449	8885	10216	11640
390	3.9	39.78	27.94	3421	4273	4735	5557	5904	6445	7597	9061	10418	11870
405	4.1	41.31	28.47	3486	4355	4825	5663	6017	6567	7742	9233	10617	12096
420	4.2	42.84	28.99	3550	4435	4914	5767	6127	6688	7884	9403	10811	12318
435	4.4	44.37	29.50	3613	4513	5001	5869	6235	6806	8023	9569	11003	12536
450	4.5	45.9	30.01	3675	4590	5086	5969	6342	6923	8160	9733	11191	12751
465	4.7	47.43	30.51	3735	4666	5170	6068	6447	7037	8295	9894	11376	12961
480	4.8	48.96	30.99	3795	4741	5253	6165	6550	7150	8428	10052	11558	13169
495	5.0	50.49	31.47	3854	4814	5334	6260	6652	7261	8559	10208	11737	13373
510	5.1	52.02	31.95	3912	4887	5415	6355	6752	7370	8687	10361	11913	13574
525	5.3	53.55	32.41	3969	4958	5494	6447	6850	7477	8814	10513	12087	13772
540	5.4	55.08	32.87	4025	5028	5572	6539	6947	7583	8939	10662	12259	13967
555	5.6	56.61	33.33	4081	5098	5648	6629	7043	7688	9062	10809	12428	14160
570	5.7	58.14	33.77	4136	5166	5724	6718	7138	7791	9184	10954	12595	14350
585	5.9	59.67	34.22	4190	5234	5799	6806	7231	7893	9304	11097	12759	14538
600	6.0	61.2	34.65	4243	5300	5873	6892	7323	7994	9423	11238	12922	14723
615	6.2	62.73	35.08	4296	5366	5946	6978	7414	8093	9540	11378	13083	14906
630	6.3	64.26	35.51	4348	5431	6018	7063	7504	8191	9655	11516	13241	15087
645	6.5	65.79	35.93	4399	5495	6089	7146	7593	8288	9770	11652	13398	15265
660	6.6	67.32	36.34	4450	5559	6160	7229	7681	8384	9883	11787	13553	15442
675	6.8	68.85	36.75	4501	5622	6229	7311	7767	8479	9994	11920	13706	15616
690	6.9	70.38	37.16	4550	5684	6298	7391	7853	8572	10105	12052	13857	15789
705	7.1	71.91	37.56	4599	5745	6366	7471	7938	8665	10214	12182	14007	15959
720	7.2	73.44	37.96	4648	5806	6433	7550	8022	8757	10322	12311	14155	16128
735	7.4	74.97	38.35	4696	5866	6500	7629	8105	8847	10429	12439	14302	16295
750	7.5	76.5	38.74	4744	5926	6566	7706	8188	8937	10535	12565	14447	16461
765	7.7	78.03	39.13	4791	5985	6631	7783	8269	9026	10640	12690	14591	16625
780	7.8	79.56	39.51	4838	6043	6696	7859	8350	9114	10744	12814	14733	16787
795	8.0	81.09	39.89	4884	6101	6760	7934	8430	9201	10846	12936	14874	16947
810	8.1	82.62	40.26	4930	6158	6824	8008	8509	9288	10948	13058	15014	17107

Pitot Pressure (kPa)	Pitot Pressure (bar)	Meters (m)	Velocity Discharge (m/sec)	Orifice Size (mm)									
				51	57	60	65	67	70	76	83	89	95
825	8.3	84.15	40.63	4976	6215	6887	8082	8587	9373	11049	13178	15152	17264
840	8.4	85.68	41.00	5021	6271	6949	8155	8665	9458	11149	13298	15290	17421
855	8.6	87.21	41.36	5065	6327	7011	8228	8742	9542	11248	13416	15425	17575
870	8.7	88.74	41.73	5109	6382	7072	8300	8818	9626	11346	13533	15560	17729
885	8.9	90.27	42.08	5153	6437	7133	8371	8894	9708	11444	13649	15694	17881
900	9.0	91.8	42.44	5197	6492	7193	8442	8969	9790	11540	13764	15826	18032
915	9.2	93.33	42.79	5240	6545	7252	8512	9043	9871	11636	13878	15957	18182
930	9.3	94.86	43.14	5283	6599	7312	8581	9117	9952	11731	13992	16088	18330
945	9.5	96.39	43.49	5325	6652	7370	8650	9191	10032	11825	14104	16217	18477

Notes:

(1) This table is computed from the formula $Q_m = 0.0666cd^2\sqrt{P_m}$, with c = 1.00. The theoretical discharge of seawater, as from fireboat nozzles, can be found by subtracting 1 percent from the figures in Table 4.10.2.1, or from the formula $Q_m = 0.065cd^2\sqrt{P_m}$.

(2) Appropriate coefficient should be applied where it is read from the hydrant outlet. Where more accurate results are required, a coefficient appropriate on the particular nozzle must be selected and applied to the figures of the table. The discharge from circular openings of sizes other than those in the table can readily be computed by applying the principle that quantity discharged under a given head varies as the square of the diameter of the opening.

Supplemental Information

File Name	Description	Approved
Copy_of_Copy_of_Table_4_10_b_Metric.xlsx	For staff use.	

Submitter Information Verification

Submitter Full Name: David Hague
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Mon Jun 19 10:15:21 EDT 2017

Committee Statement

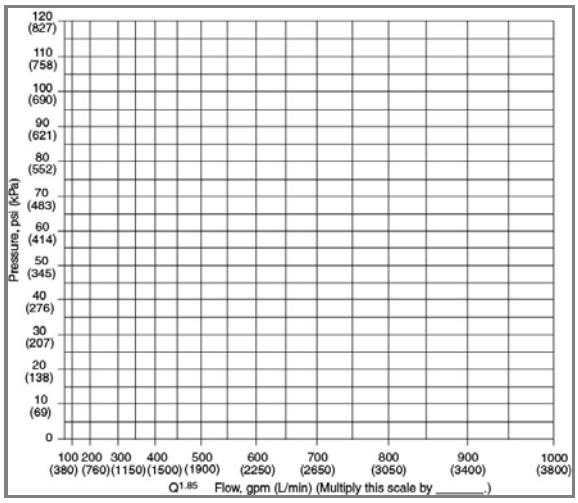
Committee Statement: Adds appropriate metric conversions for pressure in flow table.
Response Message:

Second Revision No. 4-NFPA 291-2017 [Section No. 4.11.4]

4.11.4

Results of the flow test should be indicated on a hydraulic graph, such as the one shown in Figure 4.11.4.

~~**Figure 4.11.4 Sample Graph Sheet.**~~



Supplemental Information

File Name	Description	Approved
291FCf04-11-4r1.pdf	corrected graph	

Submitter Information Verification

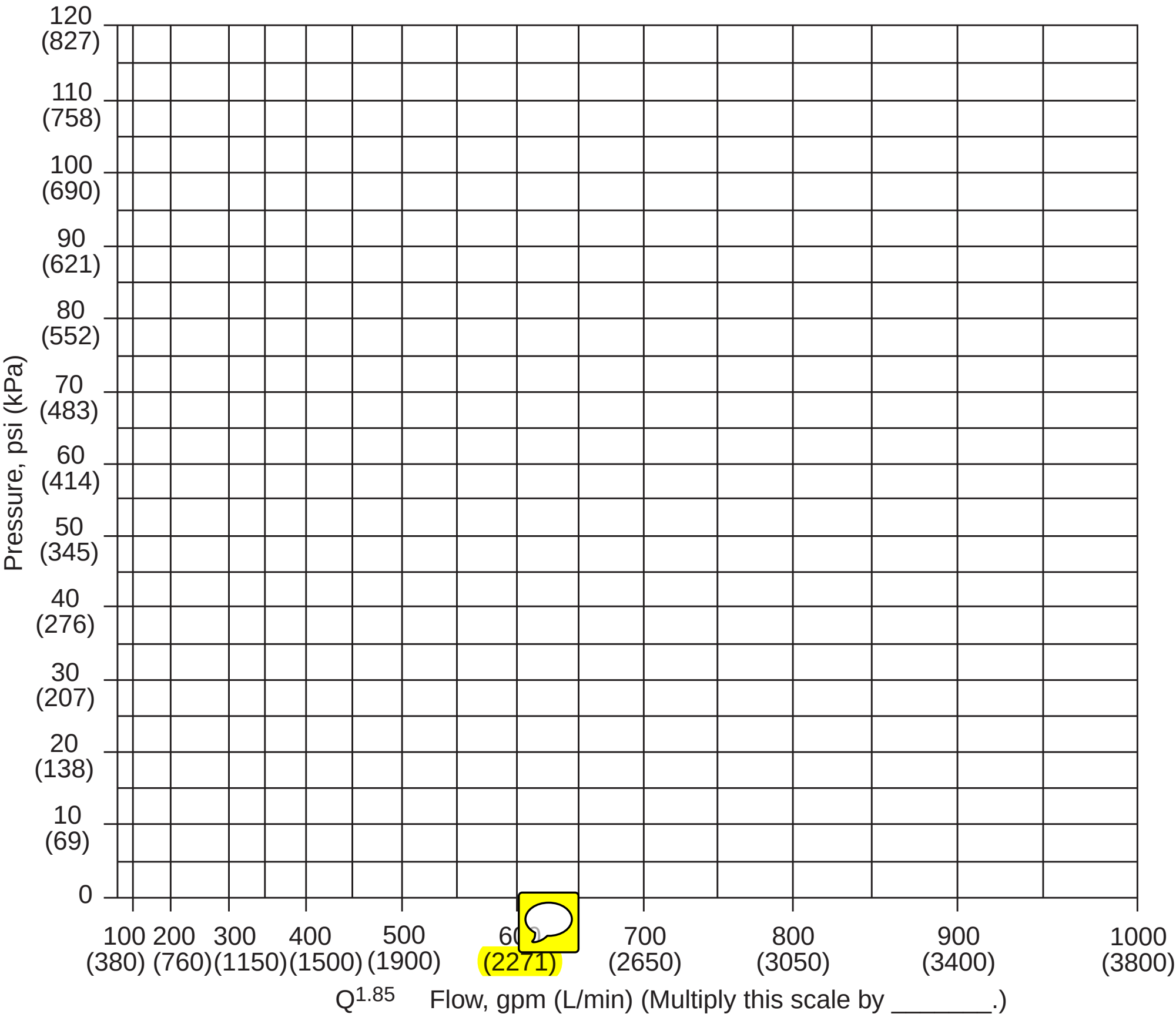
Submitter Full Name: David Hague
Organization: National Fire Protection Assoc
Street Address:
City:
State:
Zip:

Submittal Date: Mon Sep 11 09:12:11 EDT 2017

Committee Statement

Committee Statement: Revise graph to show corrected metric flow for 600 gpm (2250 L/min)

Response Message:


120
(827)
110
(758)
100
(690)
90
(621)
80
(552)
70
(483)
60
(414)
50
(345)
40
(276)
30
(207)
20
(138)
10
(69)
0
Pressure, psi (kPa)
100
(380)
200
(760)
300
(1150)
400
(1500)
500
(1900)
(2271)
700
(2650)
800
(3050)
900
(3400)
1000
(3800)
Q1.85
Flow, gpm (L/min) (Multiply this scale by _____.)

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Second Revision No. 1041-NFPA 13-2017 [Global Comment]

SSD-AAA

Update metric conversions in NFPA 13 to match that as shown on the attached list and pdf of NFPA 13.

Supplemental Information

File Name	Description	Approved
13-SSD_metrics.pdf	Metric conversions SSD-AAA	
Metric_values_used_in_NFPA_13..docx		

Submitter Information Verification

Submitter Full Name: AUT-SSD
Organization: National Fire Protection Assoc
Street Address:
City:
State:
Zip:
Submittal Date: Fri Oct 06 13:35:13 EDT 2017

Committee Statement

Committee Statement: The metric conversions in the attached list are considered to be “soft” or approximate conversions and are intended to consider trade sizes for pipe and other materials and have been appropriately rounded with the number of significant digits taken into account. The intent of this list is to provide for consistent use of metric conversions throughout the standard with the understanding that it is acceptable for an engineer, authority having jurisdiction, designer or, installer to use an exact conversion rather than an approximate conversion as used in the standard when necessary.

The attached list has been reviewed by the NFPA 13 Metric Task Group.

Response Message:

An assembly of fittings, pipe, flexible pipe, and/or couplings that permits movement in all directions to accommodate seismic differential movement across building seismic separation joints.

3.3.216 System Riser.
The aboveground horizontal or vertical pipe between the water supply and the mains (cross or feed) that contains a control valve (either directly or within its supply pipe), a pressure gauge, a drain, and a waterflow alarm device.

3.3.217 System Working Pressure.
The maximum anticipated static (nonflowing) or flowing pressure applied to sprinkler system components exclusive of surge pressures and exclusive of pressure from the fire department connection.

3.3.218 Sway Brace.
An assembly intended to be attached to the system piping to resist horizontal earthquake loads in two directions.

3.3.219 Thermal Barrier.
A material that limits the average temperature rise of the unexposed surface to not more than 250°F (121°C) above ambient for a specified fire exposure duration using the standard time–temperature curve of ASTM E119, *Standard Test Methods for Fire Tests of Building Construction and Materials*, or UL 263, *Standard for Fire Tests of Building Construction and Materials*.

3.3.220* Tiered Storage.
An arrangement in which bales are stored directly on the floor, two or more bales high.

3.3.221 Transverse Flue Space.
The space between rows of storage parallel to the direction of loading. *(See Figure A.3.3.118.)*

3.3.222 Type 1 Stair.
See 3.3.120.1.

3.3.223 Unit Load.
A pallet load or module held together in some manner and normally transported by material-handling equipment.

3.3.224 Unobstructed Construction.
See 3.3.43.2.

3.3.225 Upright Sprinkler.
See 3.3.206.3.6.

3.3.226 Vertical Roll Paper Storage.
See 3.3.183.4.

3.3.227 Waterflow Alarm Device.
An attachment to the sprinkler system that detects a predetermined water flow and is connected to a fire alarm system to initiate an alarm condition or is used to mechanically or electrically initiate a fire pump or local audible or visual alarm.

Chapter 4 General Requirements

4.1 Level of Protection.

4.1.1
A building, where protected by an automatic sprinkler system installation, shall be provided with sprinklers in all areas except where specific sections of this standard permit the omission of sprinklers.

4.1.2 Limited Area Systems.

4.1.2.1

DRAFT

When partial sprinkler systems are installed, the requirements of this standard shall be used insofar as they are applicable.

4.1.2.2
The authority having jurisdiction shall be consulted in each case.

4.2* Owner's Certificate.
The owner(s) of a building or structure where the fire sprinkler system is going to be installed or their authorized agent shall provide the sprinkler system installer with the following information prior to the layout and detailing of the fire sprinkler system *[see Figure A.4.6(b)]*:
(1) Intended use of the building including the materials within the building and the maximum height of any storage

(2) A preliminary plan of the building or structure along with the design concepts necessary to perform the layout and detail for the fire sprinkler system

(3) *Any special knowledge of the water supply, including known environmental conditions that might be responsible for corrosion, including microbiologically influenced corrosion (MIC)

4.3* Classification of Hazard.

4.3.1 General.

4.3.1.1
Occupancy classifications for this standard shall relate to sprinkler design, installation, and water supply requirements only.

4.3.1.2
Occupancy classifications shall not be intended to be a general classification of occupancy hazards.

4.3.1.3
Commodity classification and storage arrangement referenced in 4.3.2 through 4.3.6 shall be determined in accordance with Sections 20.3 through 20.5 for miscellaneous and low-piled storage per 4.3.1.5 through 4.3.1.7.

4.3.1.4* Miscellaneous Storage.

4.3.1.4.1
Miscellaneous storage shall not constitute more than 10 percent of the building area or 4000 ft^2 (372 m^2) of the sprinklered area, whichever is greater.

4.3.1.4.2
Miscellaneous storage shall not exceed 1000 ft^2 (93 m^2) in one pile or area.

4.3.1.4.3
Miscellaneous storage shall be separated from other storage piles or areas by at least 25 ft (7.6 m).

4.3.1.5 Low-Piled Storage.

4.3.1.5.1
For storage of Class I through Class IV 12 ft (3.7 m) or less in height that does not meet the definition of *Miscellaneous Storage* that is on solid shelf racks, in-rack sprinklers shall be provided in accordance with 16.1.6, and ceiling sprinkler protection shall be provided in accordance with Chapter 1313.

4.3.1.5.2
For storage of Group A Plastics 5 ft (1.5 m) or less in height that does not meet the definition of *Miscellaneous Storage* that is on solid shelf racks, in-rack sprinklers shall be provided in accordance with 17.1.5, and ceiling sprinkler protection shall be provided in accordance with Chapter 13.

4.3.1.6 Miscellaneous Tire Storage.

4.3.1.6.1

DRAFT

Miscellaneous tire storage shall not exceed 2000 ft² (186 m²).

4.3.1.6.2
Miscellaneous tire storage piles on-tread, regardless of storage method, shall not exceed 25 ft (7.6 m) in the direction of the wheel holes.

4.3.1.7 In-Rack Sprinklers.
Miscellaneous and low-piled storage per 4.3.1.5 through 4.3.1.7 that require in-rack sprinklers shall follow Chapter **25** for their installation and design requirements.

4.3.2* Light Hazard.
The following shall be protected with light hazard occupancy criteria in this standard:
(1) Spaces with low quantity and combustibility of contents

4.3.3* Ordinary Hazard (Group 1).
The following shall be protected with ordinary hazard group 1 occupancy criteria in this standard:
(1) Spaces with moderate quantity and low combustibility of contents

(2) Stockpiles of contents with low combustibility that do not exceed 8 ft (2.4 m)

(3) Miscellaneous storage or storage facilities of solid-piled, palletized, bin box, shelf, rack, and back-to-back shelf storage of Class I commodities not exceeding 12 ft (3.7 m)

(4) Miscellaneous storage or storage facilities of solid-piled, palletized, bin box, shelf, rack, and back-to-back shelf storage of Class II commodities not exceeding 10 ft (3.0 m)

4.3.4* Ordinary Hazard (Group 2).
The following shall be protected with ordinary hazard group 2 occupancy criteria in this standard:
(1) Spaces with moderate to high quantity and combustibility of contents

(2) Stockpiles of contents with moderate to high combustibility that do not exceed 12 ft (3.7 m)

(3) Miscellaneous or low-piled storage of solid-piled, palletized, bin box, shelf, rack, and back-to-back shelf storage of Class II commodities more than 10 ft (3.0 m) and not exceeding 12 ft (3.7 m)

(4) Miscellaneous or low-piled storage of solid-piled, palletized, bin box, shelf, rack, and back-to-back shelf storage of Class III commodities not exceeding 12 ft (3.7 m)

(5) Miscellaneous or low-piled storage of solid-piled, palletized, bin box, shelf, rack, and back-to-back shelf storage of Class IV commodities not exceeding 10 ft (3.0 m)

(6) Miscellaneous or low-piled storage of solid-piled, palletized, bin box, and shelf storage of Class IV commodities more than 10 ft (3.0 m) and not exceeding 12 ft (3.7 m) and a maximum ceiling height of 32 ft (9.8 m)

(7) Miscellaneous or low-piled storage of solid-piled, palletized, bin box, shelf, rack, and back-to-back shelf storage of Group A commodities not exceeding 5 ft (1.5 m)

(8) Miscellaneous storage of rack storage of Group A commodities more than 10 ft (3.0 m) and not exceeding 12 ft (3.7 m) and a maximum ceiling height of 32 ft (9.8 m) with the use of 1 level of in-rack sprinklers

(9) Miscellaneous storage of rack storage of exposed expanded Group A commodities more than 5 ft (1.5 m) and not exceeding 10 ft (3.0 m) and a maximum ceiling height of 20 ft (5.1 m) with the use of 1 level of in-rack sprinklers

(10) Miscellaneous tire storage stored on floor or in rack either on tread or on side not exceeding 5 ft (1.5 m)

(11) Miscellaneous tire storage stored on a fixed single-row rack either on tread or on side more than 5 ft (1.5 m) and not exceeding 12 ft (3.7 m) and a maximum ceiling height of 32 ft (9.8 m) with the use of 1 level of in-rack sprinklers

(12) Miscellaneous store of medium weight and heavyweight rolled paper stored on end not exceeding 10 ft (3.0 m) and a maximum ceiling height of 30 ft (9.1 m)

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4.3.5* Extra Hazard (Group 1).
The following shall be protected with extra hazard group 1 occupancy criteria in this standard:
(1) Spaces with very high quantity and combustibility of contents

(2) Spaces where dust, lint, or other materials are present, introducing the probability of rapidly developing fires

(3) Miscellaneous or low-piled storage of rack and back-to-back shelf storage of Class IV commodities more than 10 ft (3.0 m) and not exceeding 12 ft (3.7 m) and a maximum ceiling height of 32 ft (9.8 m)

(4) Miscellaneous or low-piled storage of solid-piled, palletized, bin box, shelf, rack, and back-to-back shelf storage of cartoned Group A commodities more than 5 ft (1.5 m) and not exceeding 10 ft (3.0 m) and a maximum ceiling height of 15 ft (4.6 m)

(5) Miscellaneous tire storage stored on floor on side or in single-row rack (portable and fixed) either on tread or on side more than 5 ft (1.5 m) and not exceeding 12 ft (3.7 m) and a maximum ceiling height of 32 ft (9.8 m)

(6) Miscellaneous storage of tissue and lightweight rolled paper stored on end not exceeding 10 ft (3.0 m) and a maximum ceiling height of 30 ft (9.1 m)

4.3.6* Extra Hazard (Group 2).
The following shall be protected with extra hazard group 2 occupancy criteria in this standard:
(1) Spaces with very high quantity and combustibility of contents

(2) Spaces with substantial amounts of combustible or flammable liquids

(3) Spaces where shielding of combustibles is extensive

(4) Miscellaneous or low-piled storage of solid-piled, palletized, bin box, shelf, rack, and back-to-back shelf storage of cartoned Group A commodities more than 5 ft (1.5 m) and not exceeding 10 ft (3.0 m) and a maximum ceiling height of 20 ft (6.1 m)

(5) Miscellaneous or low-piled storage of solid-piled, palletized, bin box, shelf, rack, and back-to-back shelf storage of cartoned Group A commodities more than 10 ft (3.0 m) and not exceeding

(6) Miscellaneous or low-piled storage of solid-piled, palletized, bin box, shelf, and back-to-back shelf storage of cartoned Group A commodities more than 10 ft (3.0 m) and not exceeding 12 ft (3.7 m) and a maximum ceiling height of 32 ft (9.8 m)

(7) Miscellaneous or low-piled storage of solid-piled, palletized, bin box, shelf, and back-to-back shelf storage of exposed Group A commodities more than 5 ft (1.5 m) and not exceeding 8 ft (2.4 m) and a maximum ceiling height of 28 ft (8.5 m)

(8) Miscellaneous storage of solid-piled, palletized, bin box, shelf, rack, and back-to-back shelf storage of exposed Group A commodities more than 5 ft (1.5 m) and not exceeding 10 ft (3.0 m) and a maximum ceiling height of 15 ft (4.6 m)

(9) Miscellaneous storage of solid-piled, palletized, bin box, shelf, rack, and back-to-back shelf storage of exposed unexpanded Group A commodities more than 5 ft (1.5 m) and not exceeding 10 ft (3.0 m) and a maximum ceiling height of 20 ft (6.1 m)

(10) Miscellaneous storage of solid-piled, palletized, bin box, shelf, and back-to-back shelf storage of exposed Group A commodities more than 10 ft (3.0 m) and not exceeding 12 ft (3.7 m) and a maximum ceiling height of 17 ft (5.2 m)

(11) Miscellaneous storage of rack storage of exposed Group A commodities more than 10 ft (3.0 m) and not exceeding 12 ft (3.7 m) and a maximum ceiling height of 17 ft (5.2 m)

4.3.7 High-Piled Storage.
Storage arrangements that do not meet the requirements of 4.3.2 through 4.3.6 shall be protected in accordance with Chapters 20 through 25.

4.3.8* Special Occupancy Hazards. (Reserved)

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4.3.9
Where K-11.2 (160) or larger sprinklers are used with EH1 or EH2 design curves, the design area shall be permitted to be reduced by 25 percent but not below 2000 ft² (186 m²), regardless of temperature rating.

4.4 Hose Connections.
Hose connections shall not be required for the protection of miscellaneous storage.

4.5 System Protection Area Limitations.

4.5.1
The maximum floor area on any one floor to be protected by sprinklers supplied by any one sprinkler system riser or combined system riser shall be as follows:
(1) Light hazard — 52,000 ft² (4830 m²)

(2) Ordinary hazard — 52,000 ft² (4830 m²)

(3) *Extra hazard — Hydraulically calculated — 40,000 ft² (3720 m²)

(4) High-piled Storage — High-piled storage (as defined in 3.3.95) and storage covered by other NFPA standards — 40,000 ft² (3720 m²)

(5) In-rack Storage — 40,000 ft² (3716 m²)

4.5.2
The floor area occupied by mezzanines shall not be included in the area limits of 4.5.1.

4.5.3
Where single systems protect extra hazard, high-piled storage, or storage covered by other NFPA standards, and ordinary or light hazard areas, the extra hazard or storage area coverage shall not exceed the floor area specified for that hazard and the total area coverage shall not exceed 52,000 ft² (4830 m²).

4.5.4
The area protected by a single in-rack system includes all of the floor area occupied by the racks, including aisles, regardless of the number of levels of in-rack sprinklers.

4.5.4.1
Multiple buildings attached by canopies, covered breezeways, common roofs, or a common wall(s) shall be permitted to be supplied by a single fire sprinkler riser.

4.5.4.2
The area protected by a single in-rack system shall include all of the floor area occupied by the racks, including aisles, regardless of the number of levels of in-rack sprinklers.

4.5.4.2.1
Multiple buildings attached by canopies, covered breezeways, common roofs, or a common wall(s) shall be permitted to be supplied by a single fire sprinkler riser.

4.5.4.3
The maximum system size shall comply with 4.5.1.

4.5.5* Detached Buildings.

4.5.5.1
Unless the requirements of 4.5.5.2 apply, detached buildings, regardless of separation distance, that do not meet the criteria of 4.5.4 shall be provided with separate fire sprinkler systems.

4.5.5.2
When acceptable to the authority having jurisdiction, detached structures shall be permitted to be supplied by the fire sprinkler system of an adjacent building.

4.6* Working Plans.

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4.6.1*
Working plans shall be submitted for approval to the authority having jurisdiction before any equipment is installed or remodeled.

4.6.1.1
Working plan submittals shall include the following:
(1) Working plans of the system(s), per 4.6.3

(2) Hydraulic calculations where systems are required to be calculated

(3) Data sheets for the system components where required by the AHJ

(4) *Signed owner's certificate

4.6.1.2
Submittals shall be permitted to be in electronic format when approved by the authority having jurisdiction.

4.6.1.3
A copy of the approved plans shall be given to the owner or owner's representative.

4.6.2
Deviation from approved plans shall require permission of the authority having jurisdiction.

4.6.3
Working plans shall be drawn to an indicated scale, on sheets of uniform size, with a plan of each floor, and shall show those items from the following list that pertain to the design of the system:
(1) Name of owner and occupant.

(2) Location, including street address.

(3) Point of compass.

(4) Full height cross section or schematic diagram, including structural member information if required for clarity and including ceiling construction and method of protection for nonmetallic piping.

(5) Ceiling/roof heights and slopes not shown in the full height cross section.

(6) Location of partitions.

(7) Location of fire walls.

(8) Occupancy class of each area or room.

(9) Location and size of concealed spaces, closets, attics, and bathrooms.

(10) Any small enclosures in which no sprinklers are to be installed.

(11) Size of city main in street and whether dead end or circulating; if dead end, direction and distance to nearest circulating main; and city main test results and system elevation relative to test hydrant.

(12) Other sources of water supply, with pressure or elevation.

(13) Make, type, model, and nominal K-factor of sprinklers, including sprinkler identification number.

(14) Temperature rating and location of high-temperature sprinklers.

(15) Total area protected by each system on each floor.

(16) Number of sprinklers on each riser per floor.

(17) Total number of sprinklers on each dry pipe system, preaction system, combined dry pipe–preaction system, or deluge system.

(18) Approximate capacity in gallons of each dry pipe system.

(19) Pipe type and schedule of wall thickness.

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(20) Nominal pipe size and cutting lengths of pipe (or center-to-center dimensions). Where typical branch lines prevail, it shall be necessary to size only one typical line.

(21) Location and size of riser nipples.

(22) Type of fittings and joints and location of all welds and bends. The contractor shall specify on drawing any sections to be shop welded and the type of fittings or formations to be used.

(23) Type and locations of hangers, sleeves, braces, and methods of securing sprinklers when applicable.

(24) All control valves, check valves, drain pipes, and test connections.

(25) Size, location, and valve and piping arrangement for means to forward flow test at system demand.

(26) Make, type, model, and size of alarm or dry pipe valve.

(27) Make, type, model, and size of preaction or deluge valve.

(28) Kind and location of alarm bells.

(29) Size and location of standpipe risers, hose outlets, hand hose, monitor nozzles, and related equipment.

(30) Private fire service main sizes, lengths, locations, weights, materials, point of connection to city main; the sizes, types and locations of valves, valve indicators, regulators, meters, and valve pits; and the depth that the top of the pipe is laid below grade.

(31) Piping provisions for flushing.

(32) Where the equipment is to be installed as an addition to an existing system, enough of the existing system indicated on the plans to make all conditions clear.

(33) For hydraulically designed systems, the information on the hydraulic data nameplate.

(34) A graphic representation of the scale used on all plans.

(35) Name, address, and phone number(s) of contractor.

(36) Hydraulic reference points shown on the plan that correspond with comparable reference points on the hydraulic calculation sheets.

(37) The minimum rate of water application (density or flow or discharge pressure), the design area of water application, in-rack sprinkler demand, and the water required for hose streams both inside and outside.

(38) The total quantity of water and the pressure required noted at a common reference point for each system.

(39) Relative elevations of sprinklers, junction points, and supply or reference points.

(40) If room design method is used, all unprotected wall openings throughout the floor protected.

(41) Calculation of loads for sizing and details of sway bracing.

(42) Zones of influence used in calculations for seismic bracing indicated on plans.

(43) The setting for pressure-reducing valves.

(44) Information about backflow preventers (manufacturer, size, type).

(45) Information about listed antifreeze solution used (type and amount).

(46) Size and location of hydrants showing size and number of outlets and if outlets are to be equipped with independent gate valves. Whether hose houses and equipment are to be provided, and by whom, shall be indicated. Static and residual hydrants that were used in flow tests shall be shown.

(47) Utility plans and/or plumbing plans necessary to show connection from water supply to fire sprinkler system.

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(48) Size, location, and piping arrangement of fire department connections.

(49) Ceiling/roof heights and slopes not shown in the full height cross section.

(50) Edition year of NFPA 13 to which the sprinkler system is designed.

4.6.4
A signed copy of the owner's certificate and the working plan submittal shall include the manufacturer's installation instructions for any specially listed equipment, including descriptions, applications, and limitations for any sprinklers, devices, piping, or fittings.

4.6.5* Working Plans for Automatic Sprinkler Systems with Non–Fire Protection Connections.
4.6.5.1
Special symbols shall be used and explained for auxiliary piping, pumps, heat exchangers, valves, strainers, and the like, clearly distinguishing these devices and piping runs from those of the sprinkler system.

4.6.5.2
Model number, type, and manufacturer's name shall be identified for each piece of auxiliary equipment.

4.7 Water Supply Information.

4.7.1 Water Supply Capacity Information.
The following information shall be included:
(1) Location and elevation of static and residual test gauge with relation to the riser reference point

(2) Flow location

(3) Static pressure, psi (bar)

(4) Residual pressure, psi (bar)

(5) Flow, gpm (L/min)

(6) Date

(7) Time

(8) Name of person who conducted the test or supplied the information

(9) Other sources of water supply, with pressure or elevation

4.7.1.1*
Where a waterflow test is used for the purposes of system design, the test shall be conducted no more than 12 months prior to working plan submittal unless otherwise approved by the authority having jurisdiction.

4.7.2 Water Supply Treatment Information.
The following information shall be included when water supply treatment is provided in accordance with 5.1.5:
(1) Type of condition that requires treatment

(2) Type of treatment needed to address the problem

(3) Details of treatment plan

4.8* Additives.
Additives or chemicals intended to stop leaks, such as sodium silicate or derivatives of sodium silicate, brine, or similar acting chemicals, shall not be used in sprinkler systems.

4.9 Air, Nitrogen, or Other Approved Gas.
Where air is used to charge, maintain, or supervise sprinkler systems, nitrogen or other approved gas shall also be permitted to be used.

4.10* Support of Nonsprinkler System Components.

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Sprinkler system components shall not be used to support nonsprinkler system components unless expressly permitted by this standard.

Chapter 5 Water Supplies

5.1 General.

5.1.1 Number of Supplies.
Every automatic sprinkler system shall have at least one automatic water supply.

5.1.2 Capacity.
Water supplies shall be capable of providing the required flow and pressure for the remote design area determined using the requirements and procedures as specified in Chapters 11 through 22 including hose stream allowance where applicable for the required duration.

5.1.3* Size of Fire Mains.

5.1.3.1
Except as provided in 5.1.3.2 or 5.1.3.3, no pipe smaller than 6 in. (150 mm) in diameter shall be installed as a private service main.

5.1.3.2
For mains that do not supply hydrants, sizes smaller than 6 in. (150 mm) shall be permitted to be used subject to the following restrictions:
(1) The main supplies only automatic sprinkler systems, open sprinkler systems, water spray fixed systems, foam systems, or Class II standpipe systems.

(2) Hydraulic calculations show that the main will supply the total demand at the appropriate pressure. Systems that are not hydraulically calculated shall have a main at least as large as the system riser.

5.1.3.3
Where a single main less than 4 in. (100 mm) in diameter serves both fire systems and other uses, the non-fire demand shall be added to the hydraulic calculations for the fire system at the point of connection unless provisions have been made to automatically isolate the non-fire demand during a fire event.

5.1.4 Underground Supply Pipe.
For pipe schedule systems, the underground supply pipe shall be at least as large as the system riser.

5.1.5* Water Supply Treatment.

5.1.5.1
Water supplies and environmental conditions shall be evaluated for the existence of microbes and conditions that contribute to microbiologically influenced corrosion (MIC). Where conditions are found that contribute to MIC, the owner(s) shall notify the sprinkler system installer and a plan shall be developed to treat the system using one of the following methods:
(1) Install a water pipe that will not be affected by the MIC microbes

(2) Treat all water that enters the system using an approved biocide

(3) Implement an approved plan for monitoring the interior conditions of the pipe at established time intervals and locations

(4) Install corrosion monitoring station and monitor at established intervals

5.1.5.2
Water supplies and environmental conditions shall be evaluated for conditions that contribute to unusual corrosive properties. Where conditions are found that contribute to unusual corrosive properties, the owner(s) shall notify the sprinkler system installer and a plan shall be developed to treat the system using one of the following methods:
(1) Install a water pipe that is corrosion resistant

(2) Implement an approved plan for monitoring the interior conditions of the pipe at established intervals and locations

(3) Install corrosion monitoring station and monitor at established intervals

(4) Fill dry-pipe or preaction systems with nitrogen as a supervisory gas to mitigate against corrosion.

(5) When using a generator, use an approved nitrogen generator.

5.1.5.3
Where listed biocides and/or corrosion inhibitors are used, they shall be compatible with system components. Where used together, they shall also be compatible with each other.

5.1.6 Arrangement.

5.1.6.1 Connection Between Underground and Aboveground Piping.

5.1.6.1.1
The connection between the system piping and underground piping shall be made with a suitable transition piece and shall be properly strapped or fastened by approved devices.

5.1.6.1.2
Where required due to specific mechanical or environmental conditions, the transition piece shall be protected against possible damage from corrosive agents, solvent attack, or mechanical damage.

5.1.6.2* Connection Passing Through or Under Foundation Walls.
When system piping pierces a foundation wall below grade or is located under the foundation wall, clearance shall be provided to prevent breakage of the piping due to building settlement.

5.1.7* Meters.
Where meters are required by other authorities, they shall be listed.

5.1.8* Connection from Waterworks System.

5.1.8.1
The requirements of the public health authority having jurisdiction shall be determined and followed.

5.1.8.2
Where equipment is installed to guard against possible contamination of the public water system, such equipment and devices shall be listed for fire protection service.

5.2 Types.

5.2.1*
Water supplies for sprinkler systems shall be one of the following or any combination:
(1) A connection to an approved public or private waterworks system in accordance with 5.2.2

(2) A connection including a fire pump in accordance with 5.2.3

(3) A connection to a water storage tank at grade or below grade installed in accordance with NFPA 22 and filled from an approved source

(4) A connection to a pressure tank in accordance with 5.2.4 and filled from an approved source

(5) A connection to a gravity tank in accordance with 5.2.5 and filled from an approved source

(6) A penstock, flume, river, lake, pond, or reservoir in accordance with 5.2.6

(7) *A source of recycled or reclaimed water where the building owner (or their agent) has analyzed the source of the water and the treatment process (if any) that the water undergoes before being made available to the sprinkler system and determined that any materials, chemicals, or contaminants in the water will not be detrimental to the components of the sprinkler system it comes in contact with

5.2.2* Connections to Waterworks Systems.

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5.2.2.1
A connection to a reliable waterworks system shall be an acceptable water supply source.

5.2.2.2
The volume and pressure of a public water supply shall be determined from waterflow test data or other approved methods.

5.2.2.2.1
Where a waterflow test is conducted, the volume and pressure available for use for a fire protection system shall be determined in accordance with 5.2.2.2.1.1. If knowledge of the water supply is unavailable, the volume and pressure shall be determined in accordance with 5.2.2.2.1.2.

5.2.2.2.1.1*
Water supply adjustments shall be based on knowledge of the water supply and engineering judgment, taking into account daily and seasonal fluctuations, not extreme conditions.

5.2.2.2.1.2*
If knowledge of the water supply is unavailable, the following formula shall be used to determine volume and pressure:

$$P = (P_R - P_S)\left(\frac{Q}{Q_R}\right)^{1.85} + P_L$$ **[5.2.2.2.1.2]**

where:

- P = pressure available from the water supply to use for a fire protection system that will be calculated for a given flow (Q)
- P_R = residual pressure measured during the waterflow test while the flow Q_R was discharging from the water supply
- P_S = static pressure measured during the waterflow test
- Q = flow that will be used to calculate the available pressure from the water supply
- Q_R = flow discharging from the water supply when PR was measured
- P_L = expected low static pressure at the location of the test results accounting for daily and seasonal fluctuations (not extreme conditions) obtained from the water utility

5.2.2.2.1.3
Where the water authority does not provide a value for P_L, the value of P_L shall be calculated from the following formula:

$$P_L = P_S(0.9)$$ **[5.2.2.2.1.3]**

5.2.3* Pumps.
A single automatically controlled fire pump installed in accordance with NFPA 20 shall be an acceptable water supply source.

5.2.4 Pressure Tanks.

5.2.4.1 Acceptability.

5.2.4.1.1
A pressure tank installed in accordance with NFPA 22 shall be an acceptable water supply source.

5.2.4.1.2

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Pressure tanks shall be provided with an approved means for automatically maintaining the required air pressure.

5.2.4.1.3
Where a pressure tank is the sole water supply, an approved trouble alarm shall also be provided to indicate low air pressure and low water level with the alarm supplied from an electrical branch circuit independent of the air compressor.

5.2.4.1.4
Pressure tanks shall not be used to supply other than sprinklers and hand hose attached to sprinkler piping.

5.2.4.2 Capacity.

5.2.4.2.1
In addition to the requirements of 5.1.2, the water capacity of a pressure tank shall include the extra capacity needed to fill dry pipe or preaction systems where installed.

5.2.4.2.2
The total volume shall be based on the water capacity plus the air capacity required by 5.2.4.3.

5.2.4.3* Water Level and Air Pressure.

5.2.4.3.1
Pressure tanks shall be kept with a sufficient supply of water to meet the demand of the fire protection system as calculated in Chapter 23 for the duration required by Chapter 11, Chapter 12, or Chapter 22.

5.2.4.3.2
The pressure shall be sufficient to push all of the water out of the tank while maintaining the necessary residual pressure (required by Chapter 23) at the top of the system.

5.2.5 Gravity Tanks.
An elevated tank installed in accordance with NFPA 22 shall be an acceptable water supply source.

5.2.6 Penstocks, Flumes, Rivers, or Lakes.
Water supply connections from penstocks, flumes, rivers, lakes, or reservoirs shall be arranged to avoid mud and sediment and shall be provided with approved double removable screens or approved strainers installed in an approved manner.

Chapter 6 Installation Underground Piping

6.1* Piping.
[**24:**10.1]

6.1.1*
All piping used in private fire service mains shall be in accordance with 6.1.1.1, 6.1.1.2 or 6.1.1.3.
[**24:**10.1.1]

6.1.1.1 Listing.
Piping manufactured in accordance with **Table 6.1.1.1** shall be permitted to be used. [**24:**10.1.1.1]

Table 6.1.1.1 Manufacturing Standards for Underground Pipe

Materials and Dimensions	Standard
Ductile Iron	

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Chapter 19 Design Approaches and Calculations

19.1 General.
Chapter 19 shall be utilized for design approaches and calculation procedures.

19.2 General Design Approaches.
The requirements of Section 19.2 shall apply to all sprinkler systems unless modified by a specific section of Chapter 11 or Chapter 12.

19.2.1
A building or portion thereof shall be permitted to be protected in accordance with any applicable design approach at the discretion of the designer.

19.2.2* Adjacent Hazards or Design Methods.
For buildings with two or more adjacent hazards or design methods, the following shall apply:
(1) Where areas are not physically separated by a draft curtain, barrier, or partition capable of delaying heat from a fire in one area from fusing sprinklers in the adjacent area, the required sprinkler protection for the more demanding design basis shall extend 15 ft (4.6 m) beyond its perimeter.

(2) The requirements of 19.2.2(1) shall not apply where the areas are separated by a draft curtain, or barrier located above an aisle, where the aisle has a minimum 2 ft (600 mm) horizontal separation from the adjacent hazard on each side, or a partition that is capable of delaying heat from a fire in one area from fusing sprinklers in the adjacent area.

(3) The requirements of 19.2.2(1) shall not apply to the extension of more demanding criteria from an upper ceiling level to beneath a lower ceiling level where the difference in height between the ceiling levels is at least 2 ft (600 mm), located above an aisle, where the aisle has a minimum 2 ft (600 mm) horizontal separation from the adjacent hazard on each side.

19.2.3
For hydraulically calculated systems, the total system water supply requirements for each design basis shall be determined in accordance with the procedures of Section 19.6 unless modified by a section of Chapter 11 or Chapter 12.

19.2.4 Water Demand.

19.2.4.1*
The water demand requirements shall be determined from the following:
(1) Occupancy hazard fire control approach and special design approaches of Chapter 11

(2) Storage design approaches of Chapter 12 through Chapter 20

(3) Special occupancy approaches of Chapter 22

19.2.4.2*
The minimum water demand requirements for a sprinkler system shall be determined by adding the hose stream allowance to the water demand for sprinklers.

19.2.5 Water Supplies.

19.2.5.1
The minimum water supply shall be available for the minimum duration specified in Chapter **11**.

19.2.5.2*
Tanks shall be sized to supply the equipment that they serve.

19.2.5.3*
Pumps shall be sized to supply the equipment that they serve.

19.2.6 Hose Allowance.

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19.2.6.1 Systems with Multiple Hazard Classifications.
For systems with multiple hazard classifications, the hose stream allowance and water supply duration shall be in accordance with one of the following:
(1) The water supply requirements for the highest hazard classification within the system shall be used.

(2) The water supply requirements for each individual hazard classification shall be used in the calculations for the design area for that hazard.

(3) *For systems with multiple hazard classifications where the higher classification only lies within single rooms less than or equal to 400 ft^2 (37 m^2) in area with no such rooms adjacent, the water supply requirements for the principal occupancy shall be used for the remainder of the system.

19.2.6.2*
Water allowance for outside hose shall be added to the sprinkler requirement at the connection to the city main or a private fire hydrant, whichever is closer to the system riser.

19.2.6.3
Where inside hose connections are planned or are required, the following shall apply:
(1) A total water allowance of 50 gpm (190 L/min) for a single hose connection installation shall be added to the sprinkler requirements.

(2) A total water allowance of 100 gpm (380 L/min) for a multiple hose connection installation shall be added to the sprinkler requirements.

(3) The water allowance shall be added in 50 gpm (190 L/min) increments beginning at the most remote hose connection, with each increment added at the pressure required by the sprinkler system design at that point.

19.2.6.3.1
Where the system is a combined sprinkler/standpipe system (Class I or Class III) and the building is fully sprinklered in accordance with NFPA 13, no inside hose demand shall be required at any of the standpipe outlets.

19.2.6.4*
When hose valves for fire department use are attached to wet pipe sprinkler system risers in accordance with 16.15.2, the following shall apply:
(1) The sprinkler system demand shall not be required to be added to standpipe demand as determined from NFPA 14.

(2) Where the combined sprinkler system demand and hose stream allowance of Table 19.3.3.1.2 exceeds the requirements of NFPA 14, this higher demand shall be used.

(3) For partially sprinklered buildings, the sprinkler demand, not including hose stream allowance, as indicated in Figure 19.3.3.1.1 shall be added to the requirements given in NFPA 14.

19.2.7* High Volume Low Speed (HVLS) Fans.
The installation of HVLS fans in buildings equipped with sprinklers, including ESFR sprinklers, shall comply with the following:
(1) The maximum fan diameter shall be 24 ft (7.3 m).

(2) The HVLS fan shall be centered approximately between four adjacent sprinklers.

(3) The vertical clearance from the HVLS fan to sprinkler deflector shall be a minimum of 3 ft (0.9 m).

(4) All HVLS fans shall be interlocked to shut down immediately upon a waterflow alarm. Where the building is protected with a fire alarm system, this interlock shall be in accordance with the requirements of *NFPA 72*.

19.3 Occupancy Hazard Fire Control Approach for Spray Sprinklers.

19.3.1 General.

19.3.1.1*

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The water demand requirements shall be determined by either the pipe schedule method in accordance with 19.3.2 or the hydraulic calculation method in accordance with 19.3.3.

19.3.1.2 Occupancy Classifications.

19.3.1.2.1
Occupancy classifications for this standard shall relate to sprinkler installations and their water supplies only.

19.3.1.2.2
Occupancy classifications shall not be used as a general classification of occupancy hazards.

19.3.1.2.3
Occupancies or portions of occupancies shall be classified according to the quantity and combustibility of contents, the expected rates of heat release, the total potential for energy release, the heights of stockpiles, and the presence of flammable and combustible liquids, using the definitions contained in Section 4.3.2 through Section 4.3.7.

19.3.1.2.4
Classifications shall be as follows:
(1) Light hazard

(2) Ordinary hazard (Groups 1 and 2)

(3) Extra hazard (Groups 1 and 2)

(4) Special occupancy hazard *(see Chapter 22)*

19.3.2 Water Demand Requirements — Pipe Schedule Method.

19.3.2.1
Table 19.3.2.1 shall be used in determining the minimum water supply requirements for light and ordinary hazard occupancies protected by systems with pipe sized according to the pipe schedules of Section 19.9.

Table 19.3.2.1 Water Supply Requirements for Pipe Schedule Sprinkler Systems

Occupancy Classification	Minimum Residual Pressure Required		Acceptable Flow at Base of Riser (Including Hose Stream Allowance)		Duration (minutes)
	psi	bar	gpm	L/min	
Light hazard	15	1	500–750	1900-2850	30–60
Ordinary hazard	20	1.4	850–1500	3200-5700	60–90

19.3.2.2
Pressure and flow requirements for extra hazard occupancies shall be based on the hydraulic calculation methods of 19.3.3.

19.3.2.3
The pipe schedule method shall be permitted as follows:
(1) Additions or modifications to existing pipe schedule systems sized according to the pipe schedules of Section 19.9

(2) Additions or modifications to existing extra hazard pipe schedule systems

(3) New systems of 5000 ft^2 (465 m^2) or less

(4) New systems exceeding 5000 ft^2 (465 m^2) where the flows required in Table 19.3.2.1 are available at a minimum residual pressure of 50 psi (3.4 bar) at the highest elevation of sprinkler

19.3.2.4

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Table 19.3.2.1 shall be used in determining the minimum water supply requirements.

19.3.2.5
The lower duration value of Table 19.3.2.1 shall be acceptable only where the sprinkler system waterflow alarm device(s) and supervisory device(s) are electrically supervised and such supervision is monitored at an approved, constantly attended location.

19.3.2.6* Residual Pressure.

19.3.2.6.1
The residual pressure requirement of Table 19.3.2.1 shall be met at the elevation of the highest sprinkler.

19.3.2.6.2 Friction Loss Due to Backflow Prevention Valves.

19.3.2.6.2.1
When backflow prevention valves are installed on pipe schedule systems, the friction losses of the device shall be accounted for when determining acceptable residual pressure at the top level of sprinklers.

19.3.2.6.2.2
The friction loss of this device [in psi (bar)] shall be added to the elevation loss and the residual pressure at the top row of sprinklers to determine the total pressure needed at the water supply.

19.3.2.7
The lower flow figure of Table 19.3.2.1 shall be permitted only where the building is of noncombustible construction or the potential areas of fire are limited by building size or compartmentation such that no open areas exceed 3000 ft^2 (280 m^2) for light hazard or 4000 ft^2 (370 m^2) for ordinary hazard.

19.3.3 Water Demand Requirements — Hydraulic Calculation Methods.

19.3.3.1 General.

19.3.3.1.1
The water demand for sprinklers shall be determined only from one of the following, at the discretion of the designer:
(1) Density/area curves of Figure 19.3.3.1.1 in accordance with the density/area method of

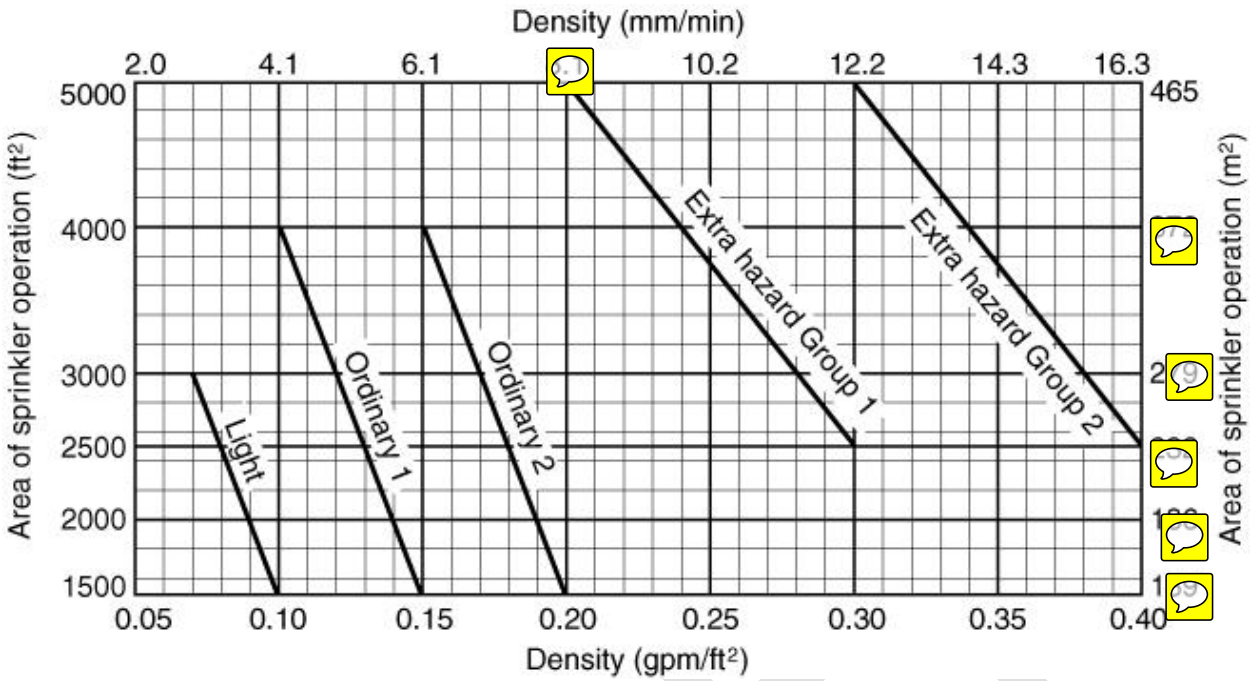
19.3.3.2

(2) The room that creates the greatest demand in accordance with the room design method of 19.3.3.3

(3) Special design areas in accordance with 19.3.3.4

Figure 19.3.3.1.1 Density/Area Curves.

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19.3.3.1.2
The minimum water supply shall be available for the minimum duration specified in Table 19.3.3.1.2.

Table 19.3.3.1.2 Hose Stream Allowance and Water Supply Duration Requirements for Hydraulically Calculated Systems

Occupancy	Inside Hose		Total Combined Inside and Outside Hose		Duration (minutes)
	gpm	L/min	gpm	L/min	
Light hazard	0, 50, or 100	0, 190, or 380	100	380	30
Ordinary hazard	0, 50, or 100	0, 190, or 380	250	950	60–90
Extra hazard	0, 50, or 100	0, 190, or 380	500	1900	90–120

19.3.3.1.2.1
The maximum design area for miscellaneous and low-piled storage shall be 3000 ft² (279 m²).

19.3.3.1.3
The lower duration values in Table 19.3.3.1.2 shall be permitted where the sprinkler system waterflow alarm device(s) and supervisory device(s) are electrically supervised and such supervision is monitored at an approved, constantly attended location.

19.3.3.1.4 Restrictions.
When either the density/area method or room design method is used, the following shall apply:
(1) *For areas of sprinkler operation less than 1500 ft² (139 m²) used for light and ordinary hazard occupancies, the density for 1500 ft² (139 m²) shall be used.

(2) For areas of sprinkler operation less than 2500 ft² (232 m²) for extra hazard occupancies, the density for 2500 ft² (232 m²) shall be used.

19.3.3.1.5 Unsprinklered Combustible Concealed Spaces.

19.3.3.1.5.1*
When using the density/area or room design method, unless the requirements of 19.3.3.1.5.2 are met for buildings having unsprinklered combustible concealed spaces, as described in 9.2.1 and 9.3.19, the minimum area of sprinkler operation for that portion of the building shall be 3000 ft^2 (280 m^2).

(A)
The design area of 3000 ft^2 (280 m^2) shall be applied only to the sprinkler system or portions of the sprinkler system that are adjacent to the qualifying combustible concealed space.

(B)
The term *adjacent* shall apply to any sprinkler system protecting a space above, below, or next to the qualifying concealed space except where a barrier with a fire resistance rating at least equivalent to the water supply duration completely separates the concealed space from the sprinklered area.

19.3.3.1.5.2
The following unsprinklered concealed spaces shall not require a minimum area of sprinkler operation of 3000 ft^2 (279 m^2):
(1) Noncombustible and limited-combustible concealed spaces with minimal combustible loading having no access. The space shall be considered a concealed space even with small openings such as those used as return air for a plenum.

(2) Noncombustible and limited-combustible concealed spaces with limited access and not permitting occupancy or storage of combustibles. The space shall be considered a concealed space even with small openings such as those used as return air for a plenum.

(3) Combustible concealed spaces filled entirely with noncombustible insulation.

(4) *Light or ordinary hazard occupancies where noncombustible or limited-combustible ceilings are directly attached to the bottom of solid wood joists or solid limited-combustible construction or noncombustible construction so as to create enclosed joist spaces 160 ft^3 (4.5 m^3) or less in volume, including space below insulation that is laid directly on top or within the ceiling joists in an otherwise sprinklered concealed space.

(5) Concealed spaces where rigid materials are used and the exposed surfaces comply with one of the following in the form in which they are installed in the space:
(a) The surface materials have a flame spread index of 25 or less and the materials have been demonstrated to not propagate fire more than 10.5 ft (3.2 m) when tested in accordance with ASTM E84, *Standard Test Method for Surface Burning Characteristics of Building Materials,* or ANSI/UL 723, *Standard for Test for Surface Burning Characteristics of Building Materials*, extended for an additional 20 minutes in the form in which they are installed in the space or

(b) The surface materials comply with the requirements of ASTM E2768, *Standard Test Method for Extended Duration Surface Burning Characteristics of Building Materials (30 min Tunnel Test)*.

(6) Concealed spaces in which the exposed materials are constructed entirely of fire-retardant-treated wood as defined by NFPA 703.

(7) Concealed spaces over isolated small rooms not exceeding 55 ft^2 (5.1 m^2) in area.

(8) Vertical pipe chases under 10 ft^2 (0.9 m^2), provided that in multifloor buildings the chases are firestopped at each floor using materials equivalent to the floor construction, and where such pipe chases contain no sources of ignition, piping shall be noncombustible, and pipe penetrations at each floor shall be properly sealed.

(9) Exterior columns under 10 ft^2 (0.9 m^2) in area formed by studs or wood joists, supporting exterior canopies that are fully protected with a sprinkler system.

(10) *Light or ordinary hazard occupancies where noncombustible or limited-combustible ceilings are attached to the bottom of composite wood joists either directly or on to metal channels not exceeding 1 in. (25 mm) in depth, provided the adjacent joist channels are firestopped into volumes not exceeding 160 ft^3

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(4.5 m^3) using materials equivalent to ½ in. (13 mm) gypsum board, and at least 3½ in. (90 mm) of batt insulation is installed at the bottom of the joist channels when the ceiling is attached utilizing metal channels.

(11) Cavities within unsprinklered wall spaces.

19.3.3.2 Density/Area Method.

19.3.3.2.1 Water Supply.

19.3.3.2.1.1
The water supply requirement for sprinklers only shall be calculated from the density/area curves of Figure 19.3.3.1.1 or from Chapter 22 where density/area criteria are specified for special occupancy hazards.

19.3.3.2.1.2
When using Figure 19.3.3.1.1, the calculations shall satisfy any single point on the appropriate density/area curve.

19.3.3.2.1.3
When using Figure 19.3.3.1.1, it shall not be necessary to meet all points on the selected curves.

19.3.3.2.2 Sprinklers.

19.3.3.2.2.1
The densities and areas provided in Figure 19.3.3.1.1 shall be for use only with spray sprinklers.

19.3.3.2.2.2
Quick-response sprinklers shall not be permitted for use in extra hazard occupancies or other occupancies where there are substantial amounts of flammable liquids or combustible dusts.

19.3.3.2.2.3
For extended coverage sprinklers, the minimum design area shall be that corresponding to the hazard in Figure 19.3.3.1.1 or the area protected by five sprinklers, whichever is greater.

19.3.3.2.2.4
Extended coverage sprinklers shall be listed with and designed for the minimum flow corresponding to the density for the hazard as specified in Figure 19.3.3.1.1.

19.3.3.2.3 Quick-Response Sprinklers.

19.3.3.2.3.1
Where listed quick-response sprinklers, including extended coverage quick-response sprinklers, are used throughout a system or portion of a system having the same hydraulic design basis, the system area of operation shall be permitted to be reduced without revising the density as indicated in Figure 19.3.3.2.3.1 when all of the following conditions are satisfied:

(1) Wet pipe system

(2) Light hazard or ordinary hazard occupancy

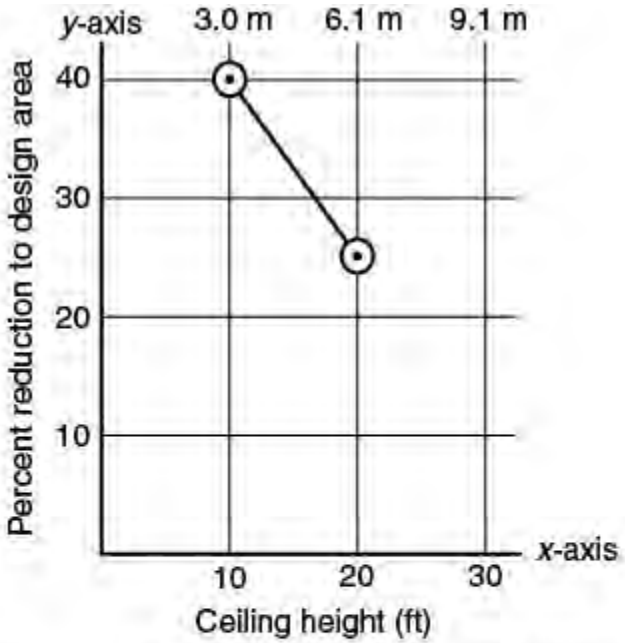
(3) 20 ft (6.1 m) maximum ceiling height

(4) No unprotected ceiling pockets as allowed by 10.2.9 and 11.2.7 exceeding 32 ft^2 (3.0 m^2)

(5) No unprotected areas above cloud ceilings as allowed by 9.2.7

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Figure 19.3.3.2.3.1 Design Area Reduction for Quick-Response Sprinklers.



Note: $y = \frac{-3x}{2} + 55$ for U.S. Customary Units

Note: $y = -4.8x + 54.6$ for S.I. Units

For ceiling height ≥10 ft and □20 ft, $y = \frac{-3x}{2} + 55$

For ceiling height <10 ft, $y = 40$

For ceiling height >20, $y = 0$

For SI units, 1 ft = 0.31 m.

19.3.3.2.3.2
The number of sprinklers in the design area shall never be less than five.

19.3.3.2.3.3
Where quick-response sprinklers are used on a sloped ceiling or roof, the maximum ceiling or roof height shall be used for determining the percent reduction in design area.

19.3.3.2.4 Sloped Ceilings.
The system area of operation shall be increased by 30 percent without revising the density when the following types of sprinklers are used on sloped ceilings with a pitch exceeding 1 in 6 (a rise of 2 units in a run of 12 units, a roof slope of 16.7 percent) in nonstorage applications:
(1) Spray sprinklers, including extended coverage sprinklers listed in accordance with 11.2.1(4), and quick-response sprinklers

(2) CMSA sprinklers

19.3.3.2.5* Dry Pipe and Double Interlock Preaction Systems.
For dry pipe systems and double interlock preaction systems, the area of sprinkler operation shall be increased by 30 percent without revising the density.

19.3.3.2.6 High-Temperature Sprinklers.
Where high-temperature sprinklers are used for extra hazard occupancies, the area of sprinkler operation shall be permitted to be reduced by 25 percent without revising the density, but not to less than 2000 ft^2 (186 m^2).

19.3.3.2.7
Where K-11.2 (160) or larger sprinklers are used with EH1 or EH2 design curves from Figure 13.2.1, the design area shall be permitted to be reduced by 25 percent but not below 2000 ft^2 (186 m^2), regardless of temperature rating.

19.3.3.2.8* Multiple Adjustments.

19.3.3.2.8.1
Where multiple adjustments to the area of operation are required to be made in accordance with 19.3.3.2.3, 19.3.3.2.4, 19.3.3.2.5, or 19.3.3.2.6, these adjustments shall be compounded based on the area of operation originally selected from Figure 19.3.3.1.1.

19.3.3.2.8.2
If the building has unsprinklered combustible concealed spaces, the rules of 19.3.3.1.4 shall be applied after all other modifications have been made.

19.3.3.3 Room Design Method.

19.3.3.3.1*
The water supply requirements for sprinklers only shall be based upon the room that creates the greatest demand.

19.3.3.3.2
The density selected shall be that from Figure 19.3.3.1.1 corresponding to the occupancy hazard classification and room size.

19.3.3.3.3
To utilize the room design method, all rooms shall be enclosed with walls having a fire-resistance rating equal to the water supply duration indicated in Table 19.3.3.1.2.

19.3.3.3.4
If the room is smaller than the area specified in Figure 19.3.3.1.1, the provisions of 19.3.3.1.4(1) and 19.3.3.1.4(2) shall apply.

19.3.3.3.5
Minimum protection of openings shall be as follows:
(1) Light hazard — Nonrated automatic or self-closing doors.

(2) Light hazard with no opening protection — Where openings are not protected, calculations shall include the sprinklers in the room plus two sprinklers in the communicating space nearest each such unprotected opening unless the communicating space has only one sprinkler, in which case calculations shall be extended to the operation of that sprinkler. The selection of the room and communicating space sprinklers to be calculated shall be that which produces the greatest hydraulic demand. For light hazard occupancies with unprotected openings in walls, a minimum lintel of depth of 8 in. (200 mm) is required for openings and the opening shall not exceed 8 ft (2.4 m) in width. It shall be permitted to have a single opening of 36 in. (900 mm) or less without a lintel, provided there are no other openings to adjoining spaces.

(3) Ordinary and extra hazard — Automatic or self-closing doors with appropriate fire resistance ratings for the enclosure.

19.3.3.3.6
Where the room design method is used and the area under consideration is a corridor protected by a single row of sprinklers with protected openings in accordance with 19.3.3.3.5, the maximum number of sprinklers that needs to be calculated is five or, when extended coverage sprinklers are installed, all sprinklers contained within 75 linear feet (23 linear meters) of the corridor.

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19.3.3.3.7
Where the area under consideration is a corridor protected by a single row of sprinklers with unprotected openings, in a light hazard occupancy, the design area shall include all sprinklers in the corridor to a maximum of five or, when extended coverage sprinklers are installed, all sprinklers within 75 linear feet (23 linear meters) of the corridor.

19.3.3.4 Special Design Areas.

19.3.3.4.1
Where the design area consists of a building service chute supplied by a separate riser, the maximum number of sprinklers that needs to be calculated is three, each with a minimum discharge of 15 gpm (57 L/min).

19.3.3.4.2*
Where an area is to be protected by a single line of sprinklers, the design area shall include all sprinklers on the line up to a maximum of seven.

19.3.3.4.3
Sprinklers in ducts as described in Section 8.9 and 9.3.9 shall be hydraulically designed to provide a discharge pressure of not less than 7 psi (0.5 bar) at each sprinkler with all sprinklers within the duct flowing.

19.3.3.4.4 Stair Towers.
Stair towers, or other construction with incomplete floors, if piped on independent risers, shall be treated as one area with reference to pipe sizes.

19.4 Special Design Approaches.

19.4.1 Residential Sprinklers.

19.4.1.1*
The design area shall be the area that includes the four adjacent sprinklers that produce the greatest hydraulic demand.

19.4.1.2*
Unless the requirements of 19.3.3.1.5.2 are met for buildings having unsprinklered combustible concealed spaces, as described in 9.2.1 and 9.3.19, the minimum design area of sprinkler operation for that portion of the building shall be eight sprinklers.

19.4.1.2.1*
The design area of eight sprinklers shall be applied only to the portion of the residential sprinklers that are adjacent to the qualifying combustible concealed space.

19.4.1.2.2
The term *adjacent* shall apply to any sprinkler system protecting a space above, below, or next to the qualifying concealed space except where a barrier with a fire resistance rating at least equivalent to the water supply duration completely separates the concealed space from the sprinklered area.

19.4.1.3
Unless the requirements of 19.4.1.4 are met, the minimum required discharge from each design area sprinkler shall be the greater of the following:
(1) In accordance with minimum flow rates indicated in the sprinkler listings

(2) In rooms or compartments greater than 800 ft² (74.3 m²), calculated based on delivering a minimum of 0.1 gpm/ft² (4.1 mm/min) over the design area in accordance with the provisions of 9.5.2.1

(3) In rooms or compartments 800 ft² (74.3 m²) or less calculated based on delivering a minimum of 0.1 gpm/ft² (4.1 mm/min) over the room or the compartment using the area of the room divided by the number of sprinklers in the room

19.4.1.4

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For modifications or additions to existing systems equipped with residential sprinklers, the listed discharge criteria less than 0.1 gpm/ft^2 (4.1 mm/min) shall be permitted to be used.

19.4.1.4.1
Where replacing residential sprinklers manufactured prior to 2003 that are no longer available from the manufacturer and that are installed using a design density less than 0.05 gpm/ft^2 (2.04 mm/min), a residential sprinkler with an equivalent K-factor (± 5 percent) shall be permitted to be used provided the currently listed coverage area for the replacement sprinkler is not exceeded.

19.4.1.5
Where areas such as attics, basements, or other types of occupancies are outside of dwelling units but within the same structure, these areas shall be protected as a separate design basis in accordance with Section 19.2.

19.4.1.6
Hose stream allowance and water supply duration requirements shall be in accordance with those for light hazard occupancies in Table 19.3.3.1.2.

19.4.2 Exposure Protection.

19.4.2.1*
Piping shall be hydraulically calculated in accordance with Section 19.6 to furnish a minimum of 7 psi (0.5 bar) at any sprinkler with all sprinklers facing the exposure operating.

19.4.2.2
Where the water supply feeds other fire protection systems, it shall be capable of furnishing total demand for such systems as well as the exposure system demand.

19.4.3 Water Curtains.

19.4.3.1
Sprinklers in a water curtain such as described in 9.3.5 or 9.3.13.2 shall be hydraulically designed to provide a discharge of 3 gpm per lineal foot (37 L/min per lineal meter) of water curtain, with no sprinklers discharging less than 15 gpm (57 L/min).

19.4.3.2
For water curtains employing automatic sprinklers, the number of sprinklers calculated in this water curtain shall be the number in the length corresponding to the length parallel to the branch lines in the area determined by 19.6.4.2.

19.4.3.3
For a deluge system water curtain providing proscenium opening protection in accordance with 19.15.17.2, the water curtain shall be calculated to supply all of the open sprinklers attached thereto.

19.4.3.4 Sprinklers Under Roof or Ceiling in Combustible Concealed Spaces of Wood Joist or Wood Truss Construction with Members 3 ft (0.9 m) or Less on Center and Slope Having Pitch of 4 in 12 or Greater.

19.4.3.4.1
Where sprinkler spacing does not exceed 8 ft (2.4 m) measured perpendicular to the slope, the minimum sprinkler discharge pressure shall be 7 psi (0.5 bar).

19.4.3.4.2
Where sprinkler spacing exceeds 8 ft (2.4 m) measured perpendicular to the slope, the minimum sprinkler discharge pressure shall be 20 psi (1.4 bar).

19.4.3.4.3
Hose stream allowance and water supply duration requirements shall be in accordance with those for light hazard occupancies in Table 19.3.3.1.2.

19.4.3.5

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If a single fire can be expected to operate sprinklers within the water curtain and within the design area of a hydraulically calculated system, the water supply to the water curtain shall be added to the water demand of the hydraulic calculations and shall be balanced to the calculated area demand.

19.4.4 Sprinkler-Protected Glazing.
Where the sprinkler-protected glazing is required to comply with 9.3.15, the water supply duration for the design area that includes the window sprinklers shall be not less than the required rating of the assembly.

19.4.4.1
For sprinkler-protected glazing, the number of sprinklers calculated for the glazing shall be the number in the length corresponding to the length parallel to the branch lines in the area determined by 19.6.4.2.

19.4.4.2
If a single fire can be expected to operate sprinklers for the sprinkler-protected glazing and within the design area of a hydraulically calculated system, the water supply to the sprinkler-protected glazing shall be added to the water demand of the hydraulic calculations and shall be balanced to the calculated area demand.

19.4.4.3
Hydraulic design calculations shall include a design area selected to include ceiling sprinklers adjacent to the sprinkler-protected glazing.

19.5 Deluge Systems.
Open sprinkler and deluge systems shall be hydraulically calculated according to applicable standards.

19.6 Hydraulic Calculation Procedures.

19.6.1* General.

19.6.1.1
A calculated system for a building, or a calculated addition to a system in an existing sprinklered building, shall supersede the rules in this standard governing pipe schedules, except that all systems shall continue to be limited by area.

19.6.1.2
Pipe sizes shall be no less than 1 in. (25 mm) nominal for black or galvanized steel piping and ¾ in. (20 mm) nominal for copper tubing or brass, stainless steel, or nonmetallic piping listed for fire sprinkler service unless permitted by 28.5 and 28.6.

19.6.1.3
The size of pipe, number of sprinklers per branch line, and number of branch lines per cross main shall otherwise be limited only by the available water supply.

19.6.1.4*
Unless required by other NFPA standards, the velocity of water flow shall not be limited when hydraulic calculations are performed using the Hazen–Williams or Darcy Weisbach formulas.

19.6.1.5
However, sprinkler spacing and all other rules covered in this and other applicable standards shall be observed.

19.6.1.6
Hydraulic calculations shall extend to the effective point of the water supply where the characteristics of the water supply are known.

19.6.2 Formulas.

19.6.2.1 Friction Loss Formula.

19.6.2.1.1
Pipe friction losses shall be determined on the basis of the Hazen–Williams formula, as follows:

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$$p = \frac{4.52Q^{1.85}}{C^{1.85}d^{4.87}}$$ **[19.4.2.1.1]**

where:

p = frictional resistance (psi/ft of pipe)

Q = flow (gpm)

C = friction loss coefficient

d = actual internal diameter of pipe (in.)

19.6.2.1.2

For SI units, the following equation shall be used:

$$p_m = 6.05\left(\frac{Q_m^{1.85}}{C^{1.85}d_m^{4.87}}\right)10^5$$ **[19.4.2.1.2]**

where:

p_m = frictional resistance (bar/m of pipe)

Q_m = flow (L/min)

C = friction loss coefficient

d_m = actual internal diameter (mm)

19.6.2.1.3

For antifreeze systems greater than 40 gal (150 L) in size, the friction loss shall also be calculated using the Darcy–Weisbach formula:

$$\Delta P = 0.000216 f \frac{l\rho Q^2}{d^5}$$ **[19.4.2.1.3]**

where:

ΔP = friction loss (psi)

f = friction loss factor from Moody diagram

l = length of pipe or tube (ft)

ρ = density of fluid (lb/ft^3)

Q = flow in pipe or tube (gpm)

d = inside diameter of tube (in.)

19.6.2.2 Velocity Pressure Formula.

Velocity pressure shall be determined on the basis of the following formula:

$$P_v = \frac{0.001123Q^2}{D^4}$$ **[19.4.2.2]**

where:

P_v = velocity pressure (psi) (SI, 1 psi = 0.0689 bar)

Q = flow (gpm) (SI, 1 gal = 3.785 L)

D = inside diameter (in.) (SI, 1 in. = 25.4 mm)

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19.6.2.3 Normal Pressure Formula.
Normal pressure (P_n) shall be determined on the basis of the following formula:

$$P_n = P_t - P_v \quad \textbf{[19.4.2.3]}$$

where:

P_n = normal pressure

P_t = total pressure [psi (bar)]

P_v = velocity pressure [psi (bar)]

19.6.2.4 Hydraulic Junction Points.

19.6.2.4.1
Pressures at hydraulic junction points shall balance within 0.5 psi (0.03 bar).

19.6.2.4.2
The highest pressure at the junction point, and the total flows as adjusted, shall be carried into the calculations.

19.6.2.4.3
Pressure balancing shall be permitted through the use of a K-factor developed for branch lines or portions of systems using the formula in 19.6.2.5.

19.6.2.5 K-Factor Formula.
K-factors, flow from an orifice, or pressure from an orifice shall be determined on the basis of the following formula:

$$K_n = \frac{Q}{\sqrt{P}} \quad \textbf{[19.4.2.5]}$$

where:

K_n = equivalent K at a node

Q = flow at the node

P = pressure at the node

19.6.3 Equivalent Pipe Lengths of Valves and Fittings.

19.6.3.1 Pipe and Fittings.

19.6.3.1.1
Table 19.6.3.1.1 shall be used to determine the equivalent length of pipe for fittings and devices unless manufacturer's test data indicate that other factors are appropriate.

Table 19.6.3.1.1 Equivalent Schedule 40 Steel Pipe Length Chart

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Fittings and Valves	Fittings and Valves Expressed in Equivalent Feet (Meters) of Pipe														
	½ in. (15 mm)	¾ in. (20 mm)	1 in. (25 mm)	1¼ in. (32 mm)	1½ in. (40 mm)	2 in. (50 mm)	2½ in. (65 mm)	3 in. (80 mm)	3½ in. (90 mm)	4 in. (100 mm)	5 in. (125 mm)	6 in. (150 mm)	8 in. (200 mm)	10 in. (250 mm)	12 in. (300 mm)
45° elbow	—	1 (0.3)	1 (0.3)	1 (0.3)	2 (0.6)	2 (0.6)	3 (0.9)	3 (0.9)	3 (0.9)	4 (1.2)	5 (1.5)	7 (2.1)	9 (2.7)	11 (3.3)	13 (4)
90° standard elbow	1 (0.3)	2 (0.6)	2 (0.6)	3 (0.9)	4 (1.2)	5 (1.5)	6 (1.8)	7 (2.1)	8 (2.4)	10 (3)	12 (3.7)	14 (4.3)	18 (5.5)	22 (6.7)	27 (8.2)
90° long-turn elbow	0.5 (0.2)	1 (0.3)	2 (0.6)	2 (0.6)	2 (0.6)	3 (0.9)	4 (1.2)	5 (1.5)	5 (1.5)	6 (1.8)	8 (2.4)	9 (2.7)	13 (4)	16 (4.9)	18 (5.5)
Tee or cross (flow turned 90°)	3 (0.9)	4 (1.2)	5 (1.5)	6 (1.8)	8 (2.4)	10 (3)	12 (3.7)	15 (4.6)	17 (5.2)	20 (6.1)	25 (7.6)	30 (9.1)	35 (10.7)	50 (15.2)	60 (18.3)
Butterfly valve	—	—	—	—	—	6 (1.8)	7 (2.1)	10 (3)	—	12 (3.7)	9 (2.7)	10 (3)	12 (3.7)	19 (5.8)	21 (6.4)
Gate valve	—	—	—	—	—	1 (0.3)	1 (0.3)	1 (0.3)	1 (0.3)	2 (0.6)	2 (0.6)	3 (0.9)	4 (1.2)	5 (1.5)	6 (1.8)
Vane type flow switch			6 (1.8)	9 (2.7)	10 (3)	14 (4.3)	17 (5.2)	22 (6.7)	—	30 (9.1)	—	16 (4.9)	22 (6.7)	29 (8.8)	36 (11)
Swing check*	—	—	5 (1.5)	7 (2.1)	9 (2.7)	11 (3.3)	14 (4.3)	16 (4.9)	19 (5.8)	22 (6.7)	27 (8.2)	3[illegible] (9.1)	4[illegible] (13.7)	55 (16.8)	65 (19.8)

Note: Information on ½ in. pipe is included in this table only because it is allowed under 8.15.19.4 and 8.15.19.5.

*Due to the variation in design of swing check valves, the pipe equivalents indicated in this table are considered average.

19.6.3.1.2

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For saddle-type fittings having friction loss greater than that shown in Table 19.6.3.1.1, the increased friction loss shall be included in hydraulic calculations.

19.6.3.1.3 Equivalent Length Modifier.

19.6.3.1.3.1
For internal pipe diameters different from Schedule 40 steel pipe [Schedule 30 for pipe diameters 8 in. (200 mm) and larger], the equivalent length shown in Table 19.6.3.1.1 shall be multiplied by a factor derived from the following formula:

$$\left(\frac{\text{Actual inside diameter}}{\text{Schedule 40 steel pipe inside diameter}}\right)^{4.87} = \text{Factor} \qquad \textbf{[19.4.3.1.3.1]}$$

19.6.3.1.3.2
The factor thus obtained shall be further modified as required by Table 19.6.3.1.1. This table shall apply to other types of pipe listed in Table 19.6.3.1.1 only where modified by factors from 19.6.3.1.1 and 19.6.3.2.

19.6.3.2 *C* Factors.
Table 19.6.3.1.1 shall be used with a Hazen–Williams *C* factor of 120 only.

19.6.3.2.1
For other values of *C*, the values in Table 19.6.3.1.1 shall be multiplied by the factors indicated in Table 19.6.3.2.1.

Table 19.6.3.2.1 *C* Value Multiplier

Value of *C*	100	130	140	150
Multiplying factor	0.713	1.16	1.33	1.51

Note: These factors are based upon the friction loss through the fitting being independent of the *C* factor available to the piping.

19.6.3.3 Valves.
Specific friction loss values or equivalent pipe lengths for alarm valves, dry pipe valves, deluge valves, strainers, and other devices shall be made available to the authority having jurisdiction.

19.6.3.4
Hydraulic design calculations shall include a design area selected to include ceiling sprinklers adjacent to the water curtain.

19.6.3.5 Differing Values.
Specific friction loss values or equivalent pipe lengths for listed fittings not in Table 7.4.1 shall be used in hydraulic calculations where these losses or equivalent pipe lengths are different from those shown in Table 19.6.3.1.1.

19.6.4* Calculation Procedure.

19.6.4.1*
For all systems the design area shall be the hydraulically most demanding based on the criteria of Chapter 11, Chapter 12, or the special design approaches in accordance with the requirements of Chapter 22.

19.6.4.1.1 Room Design Method.
Where the design is based on the room design method, the calculation shall be based on the room and communicating space, if any, that is hydraulically the most demanding.

19.6.4.2 Density/Area Method.

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19.6.4.2.1*
Where the design is based on the density/area method, the design area shall be a rectangular area having a dimension parallel to the branch lines at least 1.2 times the square root of the area of sprinkler operation *(A)* used, which shall permit the inclusion of sprinklers on both sides of the cross main.

19.6.4.2.2
Any fractional sprinkler shall be carried to the next higher whole sprinkler.

19.6.4.2.3
In systems having branch lines with an insufficient number of sprinklers to fulfill the 1.2 requirement, the design area shall be extended to include sprinklers on adjacent branch lines supplied by the same cross main.

19.6.4.2.4*
Where the available floor area for a specific area/density design criteria, including any extension of area as required by 19.2.2 and Section 20.10, is less than the required minimum design area, the design area shall be permitted to only include those sprinklers within the available design area.

19.6.4.2.5
Where the total design discharge from these operating sprinklers is less than the minimum required discharge determined by multiplying the required design density times the required minimum design area, an additional flow shall be added at the point of connection of the branch line to the cross main furthest from the source to increase the overall demand, not including hose stream allowance, to the minimum required discharge.

19.6.4.3 CMSA Sprinkler Method.

19.6.4.3.1
For CMSA sprinklers, the design area shall be a rectangular area having a dimension parallel to the branch lines at least 1.2 times the square root of the area protected by the number of sprinklers to be included in the design area. The design area protected by the number of sprinklers to be used by the 1.2 rule shall be based on the maximum allowable area per sprinkler.

19.6.4.3.2
Any fractional sprinkler shall be carried to the next higher whole sprinkler.

19.6.4.3.3
In systems having branch lines with an insufficient number of sprinklers to fulfill the 1.2 requirement, the design area shall be extended to include sprinklers on adjacent branch lines supplied by the same cross main.

19.6.4.4 ESFR Sprinkler Method.
For ESFR sprinklers, the design area shall consist of the most hydraulically demanding area of 12 sprinklers, consisting of four sprinklers on each of three branch lines, unless other specific numbers of design sprinklers are required in other sections of this standard.

19.6.4.5* Gridded Systems.

19.6.4.5.1
For gridded systems, the designer shall verify that the hydraulically most demanding area is being used.

19.6.4.5.2
A minimum of two additional sets of calculations shall be submitted to demonstrate peaking of demand area friction loss when compared to areas immediately adjacent on either side along the same branch lines, unless the requirements of 19.6.4.5.3 are met.

19.6.4.5.3
Computer programs that show the peaking of the demand area friction loss shall be acceptable based on a single set of calculations.

19.6.4.6 Design Densities.

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19.6.4.6.1*
System piping shall be hydraulically designed using design densities and areas of operation in accordance with 19.3.3.2 or Chapter 12 as required for the occupancies or hazards involved.

19.6.4.6.2*
The density shall be calculated on the basis of floor area of sprinkler operation. Where sprinklers are installed under a sloped ceiling, the area used for this calculation shall be the horizontal plane below the sprinklers.

19.6.4.6.3
The area covered by any sprinkler used in hydraulic design and calculations shall be the horizontal distances measured between the sprinklers on the branch line and between the branch lines in accordance with 9.5.2.

19.6.4.6.4
Where sprinklers are installed above and below a ceiling or in a case where more than two areas are supplied from a common set of branch lines, the branch lines and supplies shall be calculated to supply the largest water demand.

19.6.4.6.5*
For sloped ceiling applications, the area of sprinkler application for density calculations shall be based upon the projected horizontal area.

19.6.4.7* Design Area Sprinklers.

19.6.4.7.1
Each sprinkler in the design area and the remainder of the hydraulically designed system shall discharge at a flow rate at least equal to the stipulated minimum water application rate (density) multiplied by the area of sprinkler operation.

19.6.4.7.1.1
Where sprinklers are required to discharge a specific flow or pressure rather than a density, each sprinkler in the design area shall discharge at a flow or pressure at least equal to the minimum required.

19.6.4.7.2*
Where the design area is equal to or greater than the area in Table 19.6.4.7.2 for the hazard being protected by the sprinkler system, the discharge for sprinklers protecting small compartments 55 ft^2 (5.1 m^2) or less, such as closets, washrooms, and similar compartments that are in the design area, shall be permitted to be omitted from the hydraulic calculations.

Table 19.6.4.7.2 Minimum Design Area

Occupancy Hazard Classification	Minimum Design Area to Omit Discharge from Sprinklers in Small Compartments in Design Area [ft^2 (m^2)])
Light hazard–wet pipe system	1500 (139)
Light hazard–dry pipe system	1950 (181)
Ordinary hazard–wet pipe system	1500 (139)
Ordinary hazard–dry pipe system	1950 (181)
Extra hazard–wet pipe system	2500 (232)
Extra hazard–dry pipe system	3250 (300)

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19.6.4.7.2.1
The sprinklers in these small compartments shall be capable of discharging the minimum density appropriate for the hazard they protect in accordance with Figure 19.3.3.1.1.

19.6.4.7.2.2
The requirements of 19.6.4.7.2 shall only apply where the area of application is equal to or greater than the area shown in Table 19.6.4.7.2 for the appropriate hazard classification (including a 30 percent increase for dry pipe systems).

19.6.4.7.3
The requirements of 19.6.4.7.1.1 to include every sprinkler in the design area shall not apply where sprinklers are provided above and below obstructions such as wide ducts or tables.

19.6.4.7.3.1
Sprinklers under the obstruction shall not be required to be included in the hydraulic calculation of the ceiling sprinklers.

19.6.4.7.3.2
Where the piping to sprinklers under obstructions follows the same sizing pattern as the branch lines, no additional hydraulic calculations shall be required for sprinklers under obstructions.

19.6.4.7.4
Water demand of sprinklers installed in concealed spaces shall not be required to be added to the ceiling demand.

19.6.4.7.5
Calculations shall begin at the hydraulically most remote sprinkler.

19.6.4.7.6
The calculated pressure at each sprinkler shall be used to determine the discharge flow rate for that particular sprinkler.

19.6.4.7.7
Where sprinklers are installed under a sloped ceiling, the area shall be calculated on a horizontal plane below the sprinklers.

19.6.4.8 Friction Loss.

19.6.4.8.1
Pipe friction loss shall be calculated in accordance with the Hazen–Williams formula with *C* values from Table 19.6.4.8.1, as follows:
(1) Pipe, fittings, and devices such as valves, meters, flow switches in pipes 2 in. (50 mm) or less in size, and strainers shall be included, and elevation changes that affect the sprinkler discharge shall be calculated.

(2) Tie-in drain piping shall not be included in the hydraulic calculations.

(3) The loss for a tee or a cross shall be calculated where flow direction change occurs based on the equivalent pipe length of the piping segment in which the fitting is included.

(4) The tee at the top of a riser nipple shall be included in the branch line, the tee at the base of a riser nipple shall be included in the riser nipple, and the tee or cross at a cross main–feed main junction shall be included in the cross main.

(5) Fitting loss for straight-through flow in a tee or cross shall not be included.

(6) The loss of reducing elbows based on the equivalent feet value of the smallest outlet shall be calculated.

(7) The equivalent feet value for the standard elbow on any abrupt 90-degree turn, such as the screw-type pattern shall be used.

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(8) The equivalent feet value for the long-turn elbow on any sweeping 90-degree turn, such as a flanged, welded, or mechanical joint-elbow typeshall be used. *(See Table 19.6.3.1.1.)*

(9) Friction loss shall be excluded for the fitting directly connected to a sprinkler.

(10) Losses through a pressure-reducing valve shall be included based on the normal inlet pressure condition. Pressure loss data from the manufacturer's literature shall be used.

Table 19.6.4.8.1 Hazen–Williams *C* Values

Pipe or Tube	*C* Value*
Unlined cast or ductile iron	100
Black steel (dry systems including preaction)	100
Black steel (wet systems including deluge)	120
Galvanized steel (dry systems including preaction)	100
Galvanized steel (wet systems including deluge)	120
Plastic (listed) all	150
Cement-lined cast- or ductile iron	140
Copper tube, brass or stainless steel	150
Asbestos cement	140
Concrete	140

*The authority having jurisdiction is permitted to allow other *C* values.

19.6.4.8.2*
For antifreeze systems greater than 40 gal (150 L) in size, the pipe friction loss shall be calculated using the Darcy-Weisbach equation shown in 19.6.2.1.3 using a Moody diagram and ε-factors that are representative of aged pipe otherwise following the methodology presented in 19.6.4.8.1.

19.6.4.9* Orifice Plates.

19.6.4.9.1
Orifice plates shall not be used for balancing the system.

19.6.4.9.2
Unless the requirements of 19.6.4.9.3 or 19.6.4.9.4 are met, mixing of sprinklers of different K-factors by reducing the K-factor of adjacent sprinklers on the same branch line leading back to the main for the purpose of minimizing sprinkler over discharge shall not be permitted.

19.6.4.9.3
Sprinklers with different K-factors shall be acceptable for special use such as exposure protection, small rooms or enclosures, or directional discharge. *(See 3.3.196 for definition of small rooms.)*

19.6.4.9.4
Extended-coverage and residential sprinklers with a different K-factor shall be acceptable for part of the protection area where installed in accordance with their listing.

19.6.4.10* Pressures.

19.6.4.10.1
When calculating flow from an orifice, the total pressure *(P_t)* shall be used, unless the calculation method of 19.6.4.10.2 is utilized.

19.6.4.10.2

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Use of the normal pressure *(P_n)* calculated by subtracting the velocity pressure from the total pressure shall be permitted. Where the normal pressure is used, it shall be used on all branch lines and cross mains where applicable.

19.6.4.10.3
Flow from a sprinkler shall be calculated using the nominal K-factor except that the manufacturer's adjusted K-factors shall be utilized for dry-type sprinklers.

19.6.4.11 Minimum Operating Pressure.

19.6.4.11.1
Minimum operating pressure of any sprinkler shall be 7 psi (0.5 bar).

19.6.4.11.2
Where a higher minimum operating pressure for the desired application is specified in the listing of the sprinkler, this higher pressure shall be required.

19.6.4.12 Maximum Operating Pressure.
For extra hazard occupancies, palletized, solid-piled, bin box, back-to-back shelf storage, shelf storage, or rack storage, the maximum operating pressure of any sprinkler shall be 175 psi (12 bar).

19.6.5 In-Rack Sprinklers.

19.6.5.1
Pipes to in-rack sprinklers shall be sized by hydraulic calculations.

19.6.5.2
Water demand of sprinklers installed in racks or water curtains shall be added to the ceiling sprinkler water demand at the point of connection. Demands shall be balanced to the higher pressure. *(See Chapter 8.)*

19.7 Hose Allowance.
Water allowance for outside hose shall be added to the sprinkler and inside hose requirement at the connection to the city water main or a yard hydrant, whichever is closer to the system riser.

19.8 Hydraulic Calculation Forms.

19.8.1 General.
Hydraulic calculations shall be prepared on form sheets that include a summary sheet, detailed worksheets, and a graph sheet. *[See Figure A.19.8.2(a), Figure A.19.8.3, and Figure A.19.8.4 for copies of typical forms.]*

19.8.2* Summary Sheet.
The summary sheet shall contain the following information, where applicable:
(1) Date

(2) Location

(3) Name of owner and occupant

(4) Building number or other identification

(5) Description of hazard (for storage applications, the commodity classification, storage height, and rack configuration shall be included)

(6) Name and address of contractor or designer

(7) Name of approving agency

(8) System design requirements, as follows:
(a) Design area of water application, ft^2 (m^2).

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(b) Minimum rate of water application (density), gpm/ft^2 (mm/min). Where sprinklers are listed with minimum water application in gpm (L/min) or pressure in psi (bar), the minimum rate of water application shall be indicated in gpm (L/min) or pressure, psi (bar).

(c) Area per sprinkler, ft^2 (m^2).

(9) Total water requirements as calculated, including allowance for inside hose, outside hydrants, and water curtain and exposure sprinklers

(10) Allowance for in-rack sprinklers, gpm (L/min)

(11) Limitations (dimension, flow, and pressure) on extended coverage or other listed special sprinklers

19.8.3* Detailed Worksheets.
Detailed worksheets or computer printout sheets shall contain the following information:
(1) Sheet number

(2) Sprinkler description and discharge constant *(K)*

(3) Hydraulic reference points

(4) Flow in gpm (L/min)

(5) Pipe size

(6) Pipe lengths, center-to-center of fittings

(7) Equivalent pipe lengths for fittings and devices

(8) Friction loss in psi/ft (bar/m) of pipe

(9) Total friction loss between reference points

(10) In-rack sprinkler demand balanced to ceiling demand

(11) Elevation head in psi (bar) between reference points

(12) Required pressure in psi (bar) at each reference point

(13) Velocity pressure and normal pressure if included in calculations

(14) Notes to indicate starting points or reference to other sheets or to clarify data shown

(15) *Diagram to accompany gridded system calculations to indicate flow quantities and directions for lines with sprinklers operating in the remote area

(16) Combined K-factor calculations for sprinklers on drops, armovers, or sprigs where calculations do not begin at the sprinkler

19.8.4* Graph Sheet.
A graphic representation of the complete hydraulic calculation shall be plotted on semiexponential graph paper ($Q^{1.85}$) and shall include the following:
(1) Water supply curve

(2) Sprinkler system demand

(3) Hose allowance (where applicable)

(4) In-rack sprinkler demand (where applicable)

19.8.5 Hydraulic Reports.

19.8.5.1* General.

19.8.5.1.1
Hydraulic calculations shall be prepared on form sheets that include a summary sheet, a graph sheet, a water supply analysis, a node analysis, and detailed worksheets.

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19.8.5.1.2
The data shall be presented in the order shown in Figure 19.8.5.1.2(a) through Figure 19.8.5.1.2(d).

Figure 19.8.5.1.2(a) Summary Sheet.

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HYDRAULIC CALCULATIONS
for

Project name: _____

Location: _____

Drawing no.: _____ Date: _____

Design

Remote area number: _____

Remote area location: _____

Occupancy classification: _____

Density: _____ gpm/ft^2 (mm/min)

Area of application: _____ ft^2 (m^2)

Coverage per sprinkler: _____ ft^2 (m^2)

Type of sprinklers calculated: _____

No. of sprinklers calculated: _____

In-rack demand: _____

Hose streams: _____

Total water required (including hose streams): _____ gpm (mm/min) @ _____ psi (bar)

Type of system: _____

Volume of dry or preaction system: _____ gal (l)

Water supply information

Date: _____

Location: _____

Source: _____

Name of contractor: _____

Address: _____

Phone number: _____

Name of designer: _____

Authority having jurisdiction: _____

Notes: (Include peaking information or gridded systems here.) _____

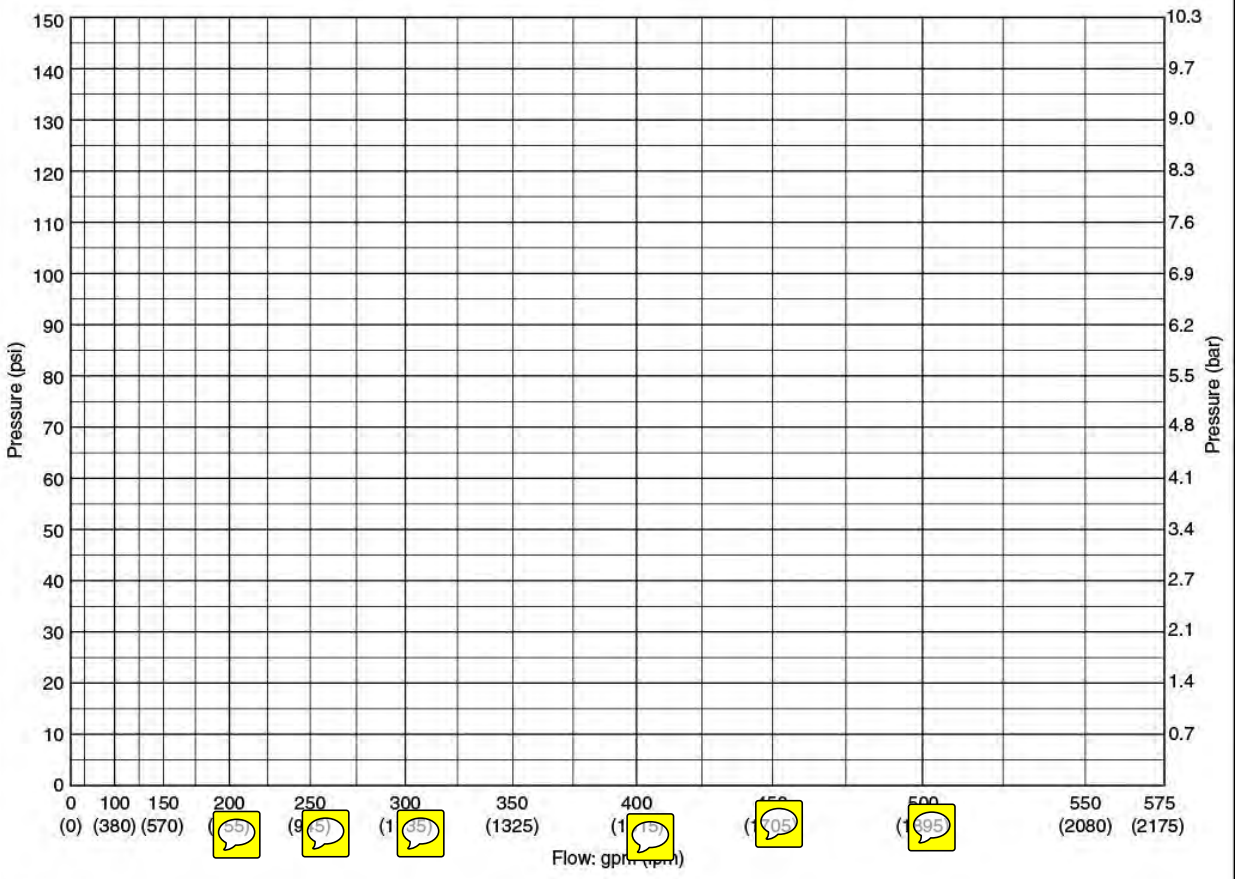
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Figure 19.8.5.1.2(b) Graph Sheet.

FLOW TEST SUMMARY SHEET

$N^{1.85}$

Contract name and number: _____



Notes: _____

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Figure 19.8.5.1.2(c) Supply and Node Analysis Sheet.

SUPPLY ANALYSIS

Node at Source	Static Pressure	Residual Pressure	Flow	Available Pressure	Total Demand	Required Pressure
Data	Data	Data	Data	Data	Data	Data

NODE ANALYSIS

Node Tag	Elevation	Node Type	Pressure at Node	Discharge at Node	Notes
Data	Data	Data	Data	Data	Data
Data	Data	Data	Data	Data	Data
Data	Data	Data	Data	Data	Data
Data	Data	Data	Data	Data	Data
Data	Data	Data	Data	Data	Data
Data	Data	Data	Data	Data	Data
Data	Data	Data	Data	Data	Data
Data	Data	Data	Data	Data	Data
Data	Data	Data	Data	Data	Data
Data	Data	Data	Data	Data	Data
Data	Data	Data	Data	Data	Data
Data	Data	Data	Data	Data	Data
Data	Data	Data	Data	Data	Data
Data	Data	Data	Data	Data	Data

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Figure 19.8.5.1.2(d) Detailed Worksheet.

Job name: _____ Sheet number: _____

PIPE INFORMATION

Node 1 / Node 2	Elev 1 (ft) (m)	K-Factor	Flow added — this step (q) / Total flow (Q)	Nominal ID / Actual ID	Fittings — quantity and length	L ft (m) / F ft (m) / T ft (m)	C Factor / P_f per foot (m) (psi) (bar)	total (P_t) / elev (P_e) / frict (P_f)	Notes
data 1	data 1	data 1	data 1	data	data	data	data	data 1	data
					data	data	data	data	
data 2	data 2		data	data	data	data		data	
data 1	data 1	data 1	data 1	data	data	data	data	data 1	data
					data	data	data	data	
data 2	data 2		data	data	data	data		data	
data 1	data 1	data 1	data 1	data	data	data	data	data 1	data
					data	data	data	data	
data 2	data 2		data	data	data	data		data	
data 1	data 1	data 1	data 1	data	data	data	data	data 1	data
					data	data	data	data	
data 2	data 2		data	data	data	data		data	
data 1	data 1	data 1	data 1	data	data	data	data	data 1	data
					data	data	data	data	
data 2	data 2		data	data	data	data		data	
data 1	data 1	data 1	data 1	data	data	data	data	data 1	data
					data	data	data	data	
data 2	data 2		data	data	data	data		data	
data 1	data 1	data 1	data 1	data	data	data	data	data 1	data
					data	data	data	data	
data 2	data 2		data	data	data	data		data	

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19.8.5.2 Summary Sheet.
The summary sheet as shown in Figure 19.8.5.1.2(a) shall contain the following information, where applicable:
(1) Project name and date

(2) Location (including street address)

(3) Owner or expected occupant of space being designed

(4) Name, address, and phone number of installing contractor

(5) Name and phone number of designer

(6) Authority having jurisdiction

(7) Standard or document system is being designed to, including the edition of the document

(8) Design area number and location

(9) Drawing or sheet number where design area is located

(10) Occupancy or commodity classification and information

(11) For storage applications (including miscellaneous), additional information including storage height, ceiling height, storage configuration, aisle width, orientation of upright or pendent, sprinkler K-factor and sprinkler temperature, and the table and or curve utilized in the design

(12) System type, including the system volume with type of protection system indicated in the notes

(13) Sprinkler type, including coverage and response type

(14) Slope of roof or ceiling within the design area

(15) System design requirements, as follows:
(a) Design area of application, ft^2 (m^2)

(b) Minimum rate of water application (density), gpm/ft^2 (mm/min)

(c) Area per sprinkler, ft^2 (m^2)

(d) Number of sprinklers calculated

(16) Total water requirements as calculated, including allowance for inside hose, outside hydrants, water curtain, and exposure sprinklers, and allowance for in-rack sprinklers, gpm (L/min)

(17) Ceiling height if used for quick response sprinkler reduction

(18) Elevation of highest calculated sprinkler

(19) Water supply information, including the following:
(a) Date and time of test

(b) Location of the test and flow hydrant(s)

(c) Source of the water for the flow test

(d) Elevation of the test hydrant relative to the finished floor

(e) Size of fire pump, gpm @ psi

(f) Size of on-site water tank

(20) Notes that include peaking information for calculations performed by a computer program, type of preaction system, limitations (dimension, flow, and pressure) on extended-coverage or other listed special sprinklers, system type, including the system volume

19.8.5.3 Graph Sheet.

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A graphic representation of the complete hydraulic calculation shall be plotted on semiexponential graph paper ($Q^{1.85}$) as shown in Figure 19.8.5.1.2(b) and shall include the following:

(1) Water supply curve

(2) Sprinkler system demand

(3) Hose demand (where applicable)

(4) In-rack sprinkler demand (where applicable)

(5) Additional pressures supplied by a fire pump or other source (when applicable)

19.8.5.4 Supply Analysis.

Information summarized from the graph sheet as shown in Figure 19.8.5.1.2(c) shall include the following:

(1) Node tag at the source

(2) Static pressure [psi (bar)] available at the source

(3) Residual pressure [psi (bar)] available at the source

(4) Total flow [gpm (L/min)] available at the source

(5) Available pressure [psi (bar)] at the source when the total calculated demand is flowing

(6) Total calculated demand [gpm (L/min)] at the source

(7) Required pressure [psi (bar)] when flowing total calculated demand

19.8.5.5 Node Analysis.

Organized information as shown in Figure 19.8.5.1.2(c) regarding the node tags given to each hydraulic reference point on the system as indicated on the shop drawings shall include the following information:

(1) Node tag for each specific point on the system used in the hydraulic calculations

(2) Elevation in ft (m) of each node tag

(3) K-factor of flowing nodes (such as sprinklers)

(4) Hose allowance in gpm (L/min) requirements for the node tag

(5) Pressure in psi (bar) at the node

(6) Discharge in gpm (L/min) calculated at the node

(7) Notes that indicate any special requirements for the node

19.8.5.6 Detailed Worksheets.

Detailed worksheets as shown in Figure 19.8.5.1.2(d) or computer printout sheets shall contain the following information:

(1) Sheet number

(2) Hydraulic reference points used in each step

(3) Elevation in ft (m) at each hydraulic reference point

(4) Sprinkler description and discharge constant (K) for the flowing reference point

(5) Flow in gpm (L/min) for the flowing reference point (when applicable)

(6) Total flow in gpm (L/min) through each step

(7) Nominal pipe size in in. (mm)

(8) Actual internal diameter of pipe in in. (mm)

(9) Quantity and length in ft (m) of each type of fitting and device

(10) Pipe lengths in ft (m), center-to-center of fittings

(11) Equivalent pipe lengths in ft (m) of fittings and devices for the step

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(12) Total equivalent length in ft (m) of pipes and fitting for the step

(13) C-factor used in each step

(14) Friction loss in psi/ft (bar/m) of pipe

(15) Sum of the pressures from the previous step (starting pressure at beginning)

(16) Elevation head in psi (bar) between reference points

(17) Total friction loss in psi (bar) between reference points

(18) Required pressure in psi (bar) at each reference point

(19) Notes and other information shall include the following:

(a) Velocity pressure and normal pressure if included in calculations

(b) In-rack sprinkler demand balanced to ceiling demand

(c) Notes to indicate starting points or reference to other sheets or to clarify data shown

(d) Diagram to accompany gridded system calculations to indicate flow quantities and directions for lines with sprinklers operating in the remote area

(e) Combined K-factor calculations for sprinklers on drops, armovers, or sprigs where calculations do not begin at the sprinkler

(f) The pressure [psi/(bar)] loss assigned the backflow device when included on a system

(g) Friction factor and Reynolds number when the Darcy–Weisbach equation is used

19.9 Pipe Schedules.

Pipe schedules shall not be used, except in existing systems and in new systems or extensions to existing systems described in Chapter 11. Water supplies shall conform to 19.3.2.

19.9.1* General.

19.9.1.1

The pipe schedule sizing provisions shall not apply to hydraulically calculated systems.

19.9.1.2

Sprinkler systems having sprinklers with K-factors other than 5.6 nominal, listed piping material other than that covered in Table 7.3.1.1, extra hazard Group 1 and Group 2 systems, and exposure protection systems shall be hydraulically calculated.

19.9.1.3

The number of automatic sprinklers on a given pipe size on one floor shall not exceed the number given in 19.9.2, 19.9.3, or 19.9.4 for a given occupancy.

19.9.1.4* Size of Risers.

Each system riser shall be sized to supply all sprinklers on the riser on any one floor as determined by the standard schedules of pipe sizes in 19.9.2, 19.9.3, or 19.9.4.

19.9.1.5 Slatted Floors, Large Floor Openings, Mezzanines, and Large Platforms.

Buildings having slatted floors or large unprotected floor openings without approved stops shall be treated as one area with reference to pipe sizes, and the feed mains or risers shall be of the size required for the total number of sprinklers.

19.9.1.6 Stair Towers.

Stair towers, or other construction with incomplete floors, if piped on independent risers, shall be treated as one area with reference to pipe sizes.

19.9.2 Schedule for Light Hazard Occupancies.

19.9.2.1 Branch Lines.

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19.9.2.1.1
Unless permitted by 19.9.2.1.2 or 19.9.2.1.3, branch lines shall not exceed eight sprinklers on either side of a cross main.

19.9.2.1.2
Where more than eight sprinklers on a branch line are necessary, lines shall be permitted to be increased to nine sprinklers by making the two end lengths 1 in. (25 mm) and 1¼ in. (32 mm), respectively, and the sizes thereafter standard.

19.9.2.1.3
Ten sprinklers shall be permitted to be placed on a branch line, making the two end lengths 1 in. (25 mm) and 1¼ in. (32 mm), respectively, and feeding the tenth sprinkler by a 2½ in. (65 mm) pipe.

19.9.2.2 Pipe Sizes.

19.9.2.2.1
Pipe sizes shall be in accordance with Table 19.9.2.2.1.

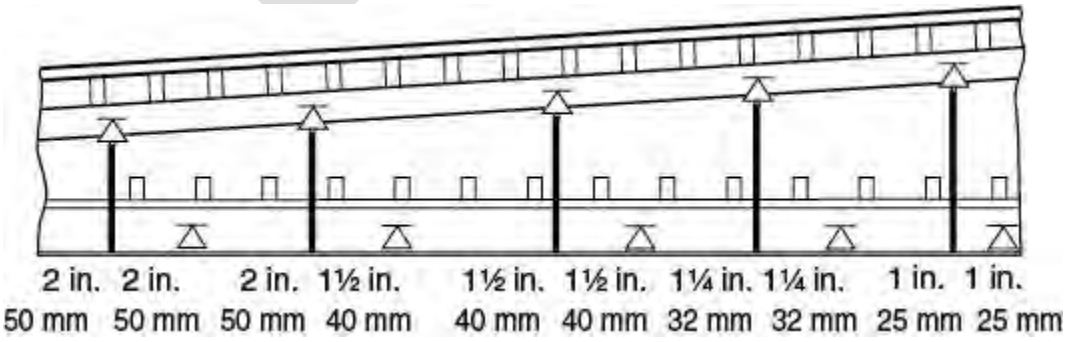
Table 19.9.2.2.1 Light Hazard Pipe Schedules

Steel		Copper	
1 in. (25 mm)	2 sprinklers	1 in.(25 mm)	2 sprinklers
1¼ in. (32 mm)	3 sprinklers	1¼ in. (32 mm)	3 sprinklers
1½ in. (40 mm)	5 sprinklers	1½ in. (40 mm)	5 sprinklers
2 in. (50 mm)	10 sprinklers	2 in. (50 mm)	12 sprinklers
2½ in. (65 mm)	30 sprinklers	2½ in. (65 mm)	40 sprinklers
3 in. (80 mm)	60 sprinklers	3 in. (80 mm)	65 sprinklers
3½ in. (90 mm)	100 sprinklers	3½ in. (90 mm)	115 sprinklers
4 in. (100 mm)	See Section 8.2	4 in. (100 mm)	See Section 8.2

19.9.2.2.2
Each area requiring more sprinklers than the number specified for 3½ in. (90 mm) pipe in Table 19.9.2.2.1 and without subdividing partitions (not necessarily fire walls) shall be supplied by mains or risers sized for ordinary hazard occupancies.

19.9.2.3
Where sprinklers are installed above and below ceilings in accordance with Figure 19.9.2.3(a) through Figure 19.9.2.3(c), and such sprinklers are supplied from a common set of branch lines or separate branch lines from a common cross main, such branch lines shall not exceed eight sprinklers above and eight sprinklers below any ceiling on either side of the cross main.

Figure 19.9.2.3(a) Arrangement of Branch Lines Supplying Sprinklers Above and Below Ceiling.



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Figure 19.9.2.3(b) Sprinkler on Riser Nipple from Branch Line in Lower Fire Area.

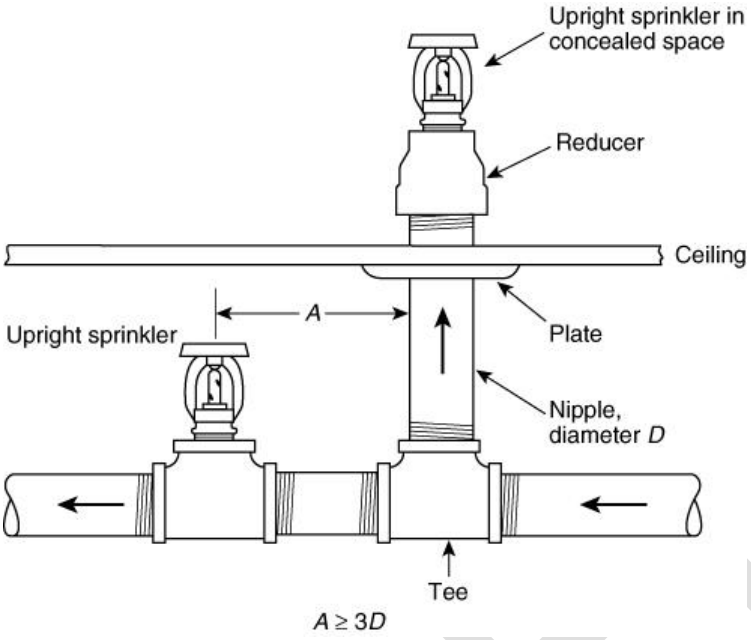
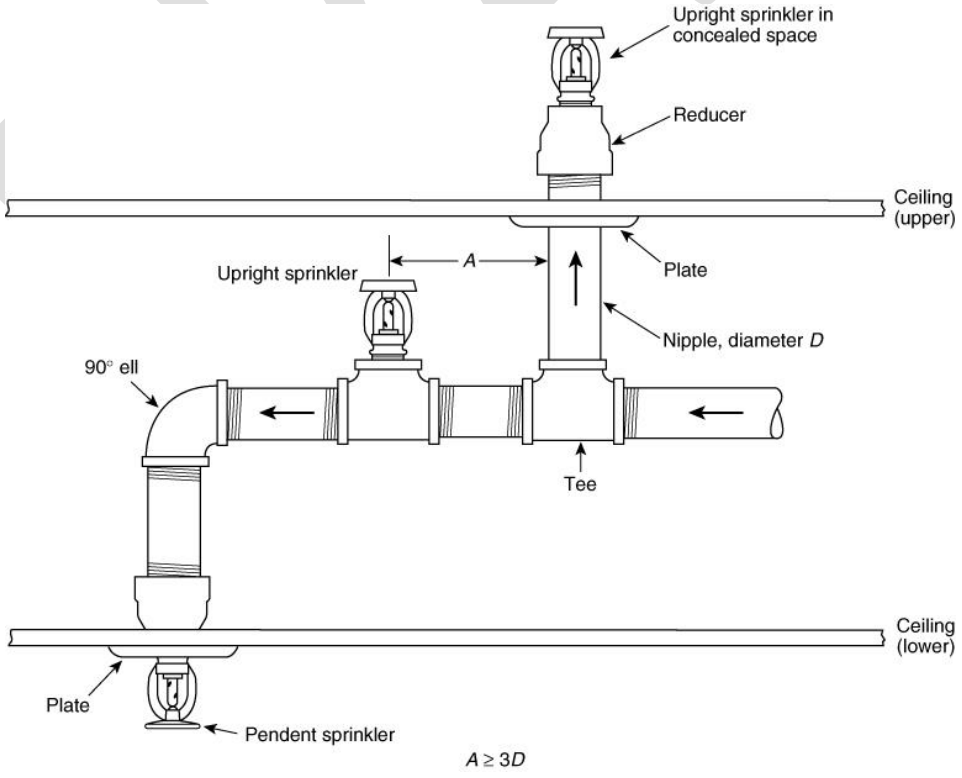


Figure 19.9.2.3(c) Arrangement of Branch Lines Supplying Sprinklers Above, Between, and Below Ceilings.



19.9.2.4
Unless the requirements of 19.9.2.5 are met, pipe sizing up to and including 2 ½ in. (65 mm) shall be as shown in Table 19.9.2.4 utilizing the greatest number of sprinklers to be found on any two adjacent levels.

Table 19.9.2.4 Number of Sprinklers Above and Below Ceiling

Steel		Copper	
1 in. (25 mm)	2 sprinklers	1 in. (25 mm)	2 sprinklers
1¼ in. (32 mm)	4 sprinklers	1¼ in. (32 mm)	4 sprinklers
1½ in. (40 mm)	7 sprinklers	1½ in. (40 mm)	7 sprinklers
2 in. (50 mm)	15 sprinklers	2 in. (50 mm)	18 sprinklers
2½ in. (65 mm)	50 sprinklers	2½ in. (65 mm)	65 sprinklers

19.9.2.5
Branch lines and cross mains supplying sprinklers installed entirely above or entirely below ceilings shall be sized in accordance with Table 19.9.2.2.1.

19.9.2.6*
Where the total number of sprinklers above and below a ceiling exceeds the number specified in Table 19.9.2.4 for 2½ in. (65 mm) pipe, the pipe supplying such sprinklers shall be increased to 3 in. (75 mm) and sized thereafter according to the schedule shown in Table 19.9.2.2.1 for the number of sprinklers above or below a ceiling, whichever is larger.

19.9.3 Schedule for Ordinary Hazard Occupancies.

19.9.3.1
Unless permitted by 19.9.3.2 or 19.9.3.3, branch lines shall not exceed eight sprinklers on either side of a cross main.

19.9.3.2
Where more than eight sprinklers on a branch line are necessary, lines shall be permitted to be increased to nine sprinklers by making the two end lengths 1 in. (25 mm) and 1¼ in. (32 mm), respectively, and the sizes thereafter standard.

19.9.3.3
Ten sprinklers shall be permitted to be placed on a branch line, making the two end lengths 1 in. (25 mm) and 1¼ in. (32 mm), respectively, and feeding the tenth sprinkler by a 2½ in. (65 mm) pipe.

19.9.3.4
Pipe sizes shall be in accordance with Table 19.9.3.4.

Table 19.9.3.4 Ordinary Hazard Pipe Schedule

Steel		Copper	
1 in. (25 mm)	2 sprinklers	1 in. (25 mm)	2 sprinklers
1¼ in. (32 mm)	3 sprinklers	1¼ in. (32 mm)	3 sprinklers
1½ in. (40 mm)	5 sprinklers	1½ in. (40 mm)	5 sprinklers
2 in. (50 mm)	10 sprinklers	2 in. (50 mm)	12 sprinklers
2½ in. (65 mm)	20 sprinklers	2½ in. (65 mm)	25 sprinklers
3 in. (80 mm)	40 sprinklers	3 in. (80 mm)	45 sprinklers
3½ in .(90 mm)	65 sprinklers	3½ in. (90 mm)	75 sprinklers
4 in. (100 mm)	100 sprinklers	4 in. (100 mm)	115 sprinklers

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Steel		Copper	
5 in. (125 mm)	160 sprinklers	5 in. (125 mm)	180 sprinklers
6 in. (150 mm)	275 sprinklers	6 in. (150 mm)	300 sprinklers
8 in. (200 mm)	See Section 8.2	8 in. (200 mm)	See Section 8.2

19.9.3.5
Where the distance between sprinklers on the branch line exceeds 12 ft (3.7 m) or the distance between the branch lines exceeds 12 ft (3.7 m), the number of sprinklers for a given pipe size shall be in accordance with Table 19.9.3.5.

Table 19.9.3.5 Number of Sprinklers — Greater Than 12 ft (3.7 m) Separations

Steel		Copper	
2½ in. (65 mm)	15 sprinklers	2½ in. (65 mm)	20 sprinklers
3 in. (80 mm)	30 sprinklers	3 in. (80 mm)	35 sprinklers
3½ in. (90 mm)	60 sprinklers	3½ in. (90 mm)	65 sprinklers

Note: For other pipe and tube sizes, see Table 22.5.3.4.

19.9.3.6
Where sprinklers are installed above and below ceilings and such sprinklers are supplied from a common set of branch lines or separate branch lines supplied by a common cross main, such branch lines shall not exceed eight sprinklers above and eight sprinklers below any ceiling on either side of the cross main.

19.9.3.7
Pipe sizing up to and including 3 in. (76 mm) shall be as shown in Table 19.9.3.7 in accordance with Figure 19.9.2.3(a), Figure 19.9.2.3(b), and Figure 19.9.2.3(c) utilizing the greatest number of sprinklers to be found on any two adjacent levels.

Table 19.9.3.7 Number of Sprinklers Above and Below a Ceiling

Steel		Copper	
1 in. (25 mm)	2 sprinklers	1 in. (25 mm)	2 sprinklers
1¼ in. (32 mm)	4 sprinklers	1¼ in. (32 mm)	4 sprinklers
1½ in. (40 mm)	7 sprinklers	1½ in. (40 mm)	7 sprinklers
2 in. (50 mm)	15 sprinklers	2 in. (50 mm)	18 sprinklers
2½ in. (65 mm)	30 sprinklers	2½ in. (65 mm)	40 sprinklers
3 in. (80 mm)	60 sprinklers	3 in. (80 mm)	65 sprinklers

19.9.3.8
Branch lines and cross mains supplying sprinklers installed entirely above or entirely below ceilings shall be sized in accordance with Table 19.9.3.4 or Table 19.9.3.5.

19.9.3.9*
Where the total number of sprinklers above and below a ceiling exceeds the number specified in Table 19.9.3.7 for 3 in. (80 mm) pipe, the pipe supplying such sprinklers shall be increased to 3½ in. (90 mm) or larger and sized thereafter according to the schedule shown in Table 19.9.2.2.1 or Table 19.9.3.4 for the number of sprinklers above or below a ceiling, whichever is larger.

19.9.3.10
Where the distance between the sprinklers protecting the occupied area exceeds 12 ft (3.7 m) or the distance between the branch lines exceeds 12 ft (3.7 m), the branch lines shall be sized in accordance

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with either Table 19.9.3.5, taking into consideration the sprinklers protecting the occupied area only, or Table 19.9.3.7, whichever requires the greater size of pipe.

19.9.4* Extra Hazard Occupancies.
Extra hazard occupancies shall be hydraulically calculated.

Chapter 20 General Requirements for Storage

20.1 General.
This chapter shall provide the necessary steps for identifying commodity, storage arrangements, storage heights, and clearances as well as general protection criteria for storage conditions relative to Chapters 21 to 24.

20.1.1
Miscellaneous and low-piled storage, meeting the criteria of Chapter 4, shall be protected in accordance with the relative occupancy hazard criteria reference in that section.

20.2
Protection of storage shall follow the following criteria:
(1) Identify the storage commodity class in accordance with Sections 20.3 and 20.4.

(2) Identify the method of storage in accordance with Section 20.5.

(3) Establish storage height, building height, and associated clearances in accordance with Section 20.6.

(4) Define the general protection criteria that are common to all storage protection options in accordance with Sections 20.7 through 20.15.

(5) Select the appropriate system/sprinkler technology for protection criteria (Chapters 21 through 24).

(6) Design and install system in accordance with the remainder of this document.

20.3* Classification of Commodities.

20.3.1
Commodity classification and the corresponding protection requirements shall be determined based on the makeup of individual storage units, pallet load, or module held together in some manner and normally transported by material-handling equipment.

20.3.1.1
The type and amount of materials used as part of the product and its primary packaging as well as the storage pallet shall be considered in the classification of the commodity.

20.3.1.2
When specific test data of commodity classification by a nationally recognized testing agency are available, the data shall be permitted to be used in determining classification of commodities.

20.3.2 Pallet Types.

20.3.2.1 General.
When loads are palletized, the use of wood or metal pallets, or listed pallets equivalent to wood, shall be assumed in the classification of commodities.

20.3.2.2 Plastic Pallet.
A pallet having any portion of its construction consisting of a plastic material that has not been listed as equivalent to wood shall increase the class of commodity determined for a storage load in accordance with 20.3.2.2.1 or 20.3.2.2.2.

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20.3.2.2.1* Unreinforced Plastic Pallets.
Plastic pallets that have no secondary reinforcing shall be treated as unreinforced plastic pallets.

20.3.2.2.1.1
For Class I through Class IV commodities, when unreinforced polypropylene or unreinforced high-density polyethylene plastic pallets are used, the classification of the commodity unit shall be increased one class.

20.3.2.2.1.2
Unreinforced polypropylene or unreinforced high-density polyethylene plastic pallets shall be marked with a permanent symbol to indicate that the pallet is unreinforced.

20.3.2.2.2 Reinforced Plastic Pallet.
A plastic pallet incorporating a secondary reinforcing material (such as steel or fiberglass) within the pallet shall be considered a reinforced plastic pallet.

20.3.2.2.2.1*
For Class I through Class IV commodities, when reinforced polypropylene or reinforced high-density polyethylene plastic pallets are used, the classification of the commodity unit shall be increased two classes except for Class IV commodity, which shall be increased to a cartoned nonexpanded Group A plastic commodity.

20.3.2.2.2.2
Pallets shall be assumed to be reinforced if no permanent marking or manufacturer's certification of nonreinforcement is provided.

20.3.2.2.3
No increase in the commodity classification shall be required for Group A plastic commodities stored on plastic pallets.

20.3.2.2.4
For ceiling-only sprinkler protection, the requirements of 20.3.2.2.1 and 20.3.2.2.2.1 shall not apply where plastic pallets are used and where the sprinkler system uses spray sprinklers with a minimum K-factor of K-16.8 (240).

20.3.2.3
The requirements of 20.3.2.2.1 through 20.3.2.4 shall not apply to nonwood pallets that have demonstrated a fire hazard that is equal to or less than wood pallets and are listed as such.

20.3.2.4
For Class I through Class IV commodities stored on plastic pallets when other than wood, metal, or polypropylene or high-density polyethylene plastic pallets are used, the classification of the commodity unit shall be determined by specific testing conducted by a national testing laboratory or shall be increased two classes.

20.3.2.5 Slave Pallet.
Where solid, flat-bottom, combustible pallets are used in combination with CMDA sprinklers, Section 20.xxxx shall apply. *(See Figure A.3.9.1.10.)*

20.3.3 Open-Top Container.
A container of any shape that is entirely or partially open on the top and arranged so as to allow for the collection of discharging sprinkler water cascading through the storage array shall be considered outside the protection criteria of rack storage protection outlined in Chapters 21 through 24.

20.3.4 Solid Unit Load of Unexpanded Plastic (Either Cartoned or Exposed).
A load that does not have voids (air) within the load and that burns only on the exterior of the load and that water from sprinklers will reach most surfaces available to burn shall allow a reduction in design density of CMDA sprinklers. *[See Table 15.2.2.5(a)(2).]*

20.3.5 Encapsulation.

20.4* Commodity Classes.

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20.4.1* Class I.
A Class I commodity shall be defined as a noncombustible product that meets one of the following criteria:
(1) Placed directly on wood pallets

(2) Placed in single-layer corrugated cartons, with or without single-thickness cardboard dividers, with or without pallets

(3) Shrink-wrapped or paper-wrapped as a unit load with or without pallets

20.4.2* Class II.
A Class II commodity shall be defined as a noncombustible product that is in slatted wooden crates, solid wood boxes, multiple-layered corrugated cartons, or equivalent combustible packaging material, with or without pallets.

20.4.3* Class III.

20.4.3.1
A Class III commodity shall be defined as a product fashioned from wood, paper, natural fibers, or Group C plastics with or without cartons, boxes, or crates and with or without pallets.

20.4.3.2
A Class III commodity shall be permitted to contain a limited amount (5 percent or less by weight of nonexpanded plastic or 5 percent or less by volume of expanded plastic) of Group A or Group B plastics.

20.4.3.3
Class III commodities containing a mix of both Group A expanded and nonexpanded plastics shall comply with Figure 20.4.3.3(a) where they are within cartons, boxes, or crates or with Figure 20.4.3.3(b) where they are exposed.

Figure 20.4.3.3(a) Commodities Containing a Mixture of Expanded and Nonexpanded Group A Plastics.

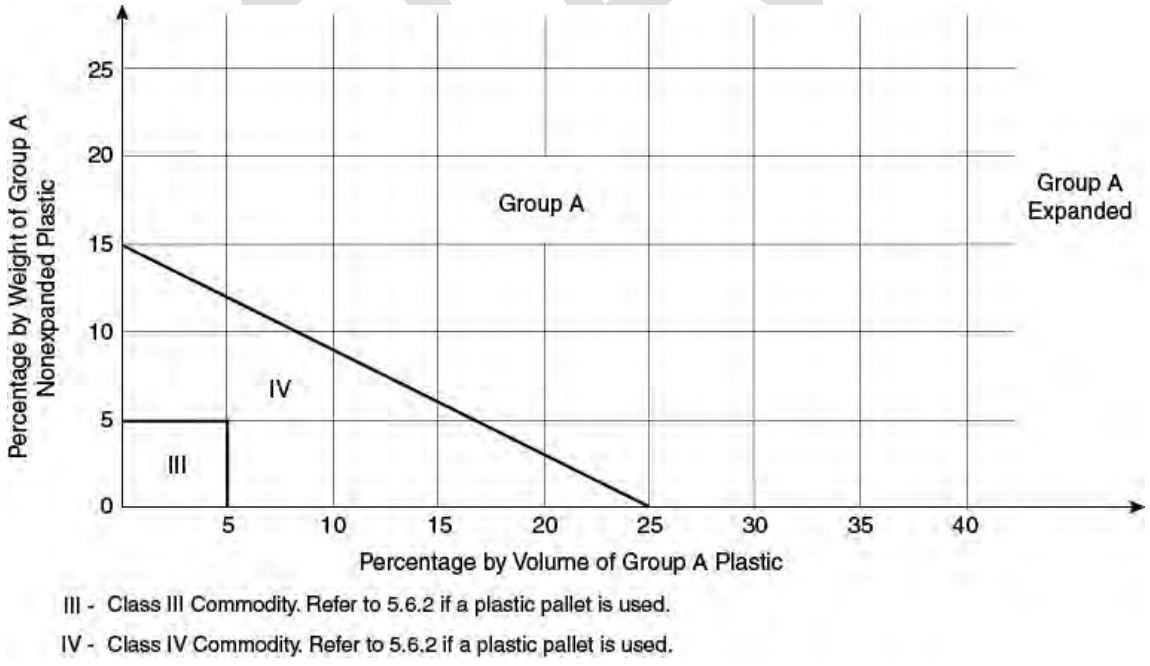
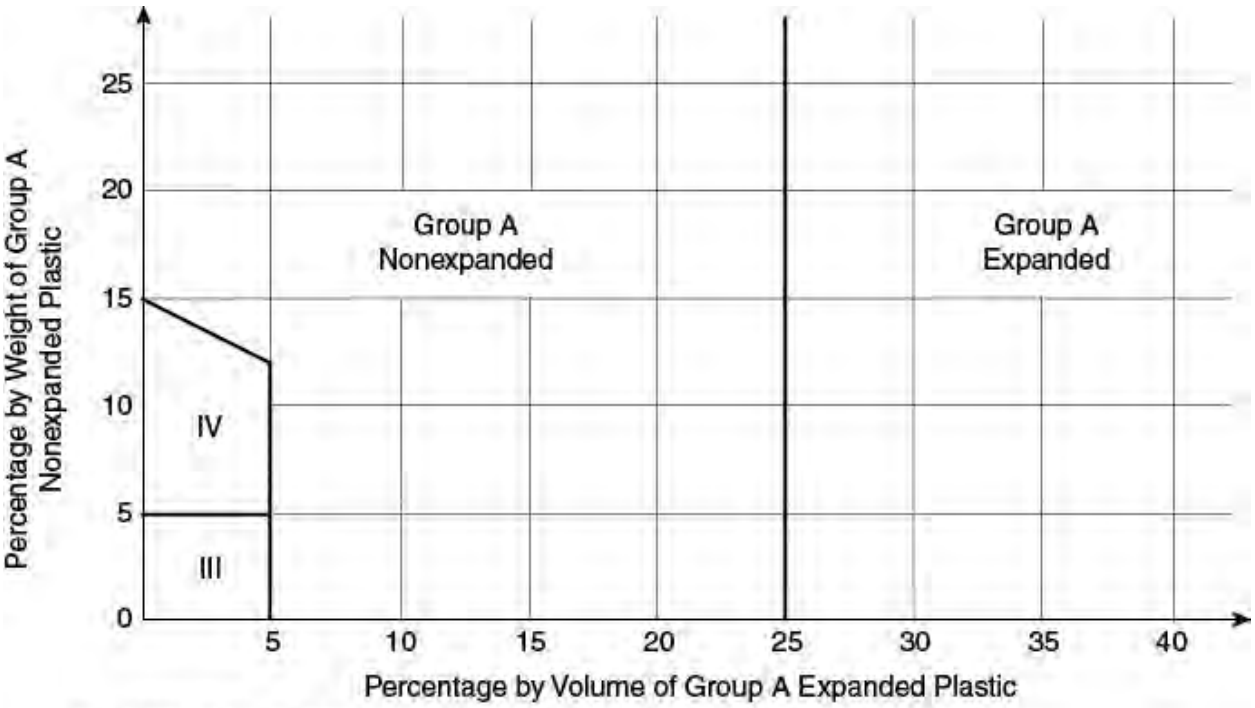


Figure 20.4.3.3(b) Exposed Commodities Containing a Mixture of Expanded and Nonexpanded Group A Plastics.



III - Class III Commodity. Refer to 5.6.2 if a plastic pallet is used.

IV - Class IV Commodity. Refer to 5.6.2 if a plastic pallet is used.

20.4.4* Class IV.

20.4.4.1
A Class IV commodity shall be defined as a product, with or without pallets, that meets one of the following criteria:

(1) Constructed partially or totally of Group B plastics

(2) Consists of free-flowing Group A plastic materials

(3) Cartoned, or within a wooden container, that contains greater than 5 percent and up to 15 percent by weight of Group A unexpanded plastic

(4) Cartoned, or within a wooden container, that contains greater than 5 percent and up to 25 percent by volume of expanded Group A plastics

(5) Cartoned, or within a wooden container, that contains a mix of Group A expanded and unexpanded plastics and complies with Figure 20.4.3.3(a)

(6) Exposed, that contains greater than 5 percent and up to 15 percent by weight of Group A unexpanded plastic

(7) Exposed, that contains a mix of Group A expanded and unexpanded plastics and complies with Figure 20.4.3.3(b)

20.4.4.2
The remaining materials shall be permitted to be metal, wood, paper, natural or synthetic fibers, or Group B or Group C plastics.

20.4.5* Classification of Plastics, Elastomers, and Rubber.
Plastics, elastomers, and rubber shall be classified as Group A, Group B, or Group C.

20.4.5.1* Group A.

The following materials shall be classified as Group A:
(1) ABS (acrylonitrile-butadiene-styrene copolymer)

(2) Acetal (polyformaldehyde)

(3) Acrylic (polymethyl methacrylate)

(4) Butyl rubber

(5) Cellulosics (cellulose acetate, cellulose acetate butyrate, ethyl cellulose)

(6) EPDM (ethylene-propylene rubber)

(7) FRP (fiberglass-reinforced polyester)

(8) Natural rubber

(9) Nitrile-rubber (acrylonitrile-butadiene-rubber)

(10) Nylon (nylon 6, nylon 6/6)

(11) PET (thermoplastic polyester)

(12) Polybutadiene

(13) Polycarbonate

(14) Polyester elastomer

(15) Polyethylene

(16) Polypropylene

(17) Polystyrene

(18) Polyurethane

(19) PVC (polyvinyl chloride — highly plasticized, with plasticizer content greater than 20 percent) (rarely found)

(20) PVF (polyvinyl fluoride)

(21) SAN (styrene acrylonitrile)

(22) SBR (styrene-butadiene rubber)

20.4.5.2*
Group A plastics shall be further subdivided as either expanded or nonexpanded.

20.4.5.3
A Group A expanded plastic commodity shall be defined as a product, with or without pallets, that meets one of the following criteria:
(1) Cartoned, or within a wooden container, that contains greater than 40 percent by volume of Group A expanded plastic

(2) Exposed, that contains greater than 25 percent by volume of Group A expanded plastic

20.4.5.4
A Group A nonexpanded plastic commodity shall be defined as a product, with or without pallets, that meets one of the following criteria:
(1) Cartoned, or within a wooden container, that contains greater than 15 percent by weight of Group A unexpanded plastic

(2) Cartoned, or within a wooden container, that contains greater than 25 percent and up to 40 percent by volume of Group A expanded plastic

(3) Cartoned, or within a wooden container, that contains a mix of Group A unexpanded and expanded plastics, in compliance with Figure 20.4.3.3(a)

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(4) Exposed, that contains greater than 15 percent by weight of Group A unexpanded plastic

(5) Exposed, that contains greater than 5 percent and up to 25 percent by volume of Group A expanded plastic

(6) Exposed, that contains a mix of Group A unexpanded and expanded plastics, in compliance with Figure 20.4.3.3(b)

20.4.5.5
The remaining materials shall be permitted to be noncombustible, wood, paper, natural or synthetic fibers, or Group A, Group B, or Group C plastics.

20.4.6 Group B.
The following materials shall be classified as Group B:
(1) Chloroprene rubber

(2) Fluoroplastics (ECTFE — ethylene-chlorotrifluoro-ethylene copolymer; ETFE — ethylene-tetrafluoroethylene-copolymer; FEP — fluorinated ethylene-propylene copolymer)

(3) Silicone rubber

20.4.7 Group C.
The following materials shall be classified as Group C:
(1) Fluoroplastics (PCTFE — polychlorotrifluoroethylene; PTFE — polytetrafluoroethylene)

(2) Melamine (melamine formaldehyde)

(3) Phenolic

(4) PVC (polyvinyl chloride — flexible — PVCs with plasticizer content up to 20 percent)

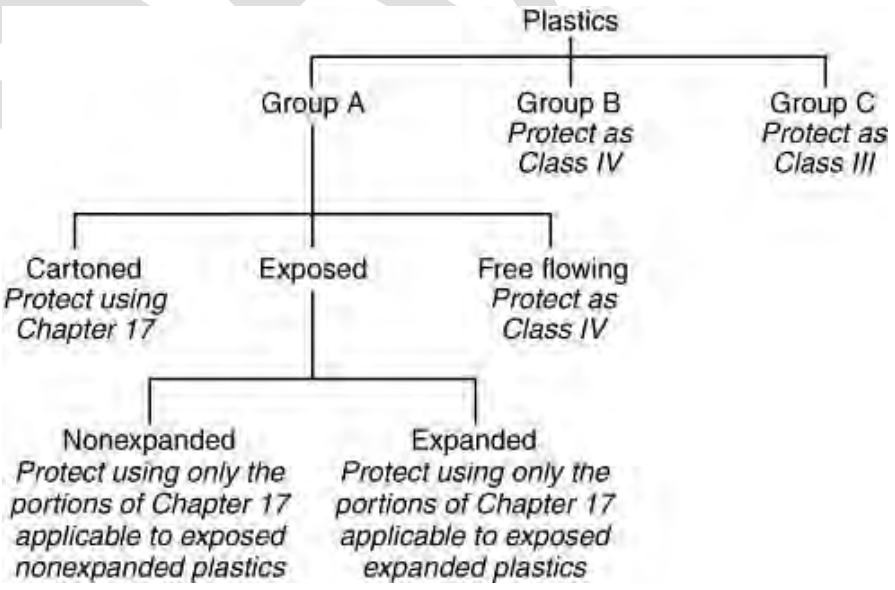
(5) PVDC (polyvinylidene chloride)

(6) PVDF (polyvinylidene fluoride)

(7) Urea (urea formaldehyde)

20.4.8*
Plastic commodities shall be protected in accordance with Figure 20.4.8. *(See Section C.21.)*

Figure 20.4.8 Decision Tree.



20.4.8.1
Group B plastics and free-flowing Group A plastics shall be protected the same as Class IV commodities.

20.4.8.2
Group C plastics shall be protected the same as Class III commodities.

20.4.9 Rubber Tires.
Pneumatic tires for passenger automobiles, aircraft, light and heavy trucks, trailers, farm equipment, construction equipment (off-the-road), and buses shall be protected as rubber tire storage in accordance with Chapters 20 through 24.

20.4.10* Classification of Rolled Paper Storage.
For the purposes of this standard, the classifications of paper described in 20.4.10.1 through 20.4.10.4 shall apply and shall be used to determine the sprinkler system design criteria in accordance with Chapters 20 through 24.

20.4.10.1 Heavyweight Class.
Heavyweight class shall be defined so as to include paperboard and paper stock having a basis weight [weight per 1000 ft^2 (92.9 m^2)] of 20 lb (9.1 kg).

20.4.10.2 Mediumweight Class.
Mediumweight class shall be defined so as to include all the broad range of papers having a basis weight [weight per 1000 ft^2 (92.9 m^2)] of 10 lb to 20 lb (4.5 kg to 9.1 kg).

20.4.10.3 Lightweight Class.
Lightweight class shall be defined so as to include all papers having a basis weight [weight per 1000 ft^2 (92.9 m^2)] of 10 lb (4.5 kg).

20.4.10.4 Tissue.

20.4.10.4.1
Tissue shall be defined so as to include the broad range of papers of characteristic gauzy texture, which, in some cases, are fairly transparent.

20.4.10.4.2
For the purposes of this standard, tissue shall be defined as the soft, absorbent type, regardless of basis weight — specifically, crepe wadding and the sanitary class including facial tissue, paper napkins, bathroom tissue, and toweling.

20.4.11* Plastic Motor Vehicle Components.
Group A plastic automotive components and associated packaging material consisting of exposed, expanded Group A plastic dunnage, instrument panels, and plastic bumper fascia shall be permitted to be protected as defined in Chapter 23.

20.4.12 Retail Display/Storage of Up to Cartoned Group A Plastics.
Group A plastics combined with Class I through IV in a retail/storage environment (big box retail) that combines customer picking areas with storage above within the retail area shall be permitted to be protected in accordance with retail display/storage of up to cartoned group A plastics in Chapters 20 to 23.

20.4.12.1 Baled Cotton.
A natural seed fiber wrapped and secured in industry-accepted materials, usually consisting of burlap, woven polypropylene, or sheet polyethylene, and secured with steel, synthetic or wire bands, or wire; also includes linters (lint removed from the cottonseed) and motes (residual materials from the ginning process) shall be protected as baled cotton in accordance with Chapter 21. *(See Table A.3.9.6.1.)*

20.4.13 Carton Records Storage.
A Class III commodity consisting predominantly of paper records in cardboard cartons shall be permitted to be protected as cartoned record storage in accordance with Chapters 21 or 23.

20.4.14 Mixed Commodities.
20.4.14.1
Protection requirements shall not be based on the overall commodity mix in a fire area.

20.4.14.2

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Unless the requirements of 20.4.14.3 or 20.4.14.4 are met, mixed commodity storage shall be protected by the requirements for the highest classified commodity and storage arrangement.

20.4.14.3
The protection requirements for the lower commodity class shall be permitted to be utilized where all of the following are met:
(1) Up to 10 pallet loads of a higher hazard commodity, as described in 20.4 and 20.4.5, shall be permitted to be present in an area not exceeding 40,000 ft^2 (3720 m^2).

(2) The higher hazard commodity shall be randomly dispersed with no adjacent loads in any direction (including diagonally).

(3) Where the ceiling protection is based on Class I or Class II commodities, the allowable number of pallet loads for Class IV or Group A plastics shall be reduced to five.

20.4.14.4 Mixed Commodity Segregation.
The protection requirements for the lower commodity class shall be permitted to be utilized in the area of lower commodity class, where the higher hazard material is confined to a designated area and the area is protected to the higher hazard in accordance with the requirements of this standard.

20.5 Storage Arrangement.

20.5.1
General storage arrangements defined in this section shall be used to select the appropriate protection criteria in Chapters 21 through 24.

20.5.1.1
Other storage arrangements not covered by this section shall be considered outside the scope of this standard.

20.5.2 Palletized Storage.
On floor storage of commodities on pallets or other storage aids that form horizontal spaces between tiers of storage shall be considered as palletized storage.

20.5.2.1 Closed Array.
Where the vertical flues between pallet loads are 6 in. (152 mm) or less, the arrangement shall be considered closed array.

20.5.2.2 Open Array.
Where the vertical flues between pallet loads are greater than 6 in. (152 mm), the arrangement shall be considered open array.

20.5.2.3 Pile Stability, Stable Piles.
Those arrays where collapse, spillage of contents, or leaning of stacks across flue spaces is not likely to occur soon after initial fire development shall be considered as stable piles.

20.5.2.4* Pile Stability, Unstable Piles.
Those arrays where collapse, spillage of contents, or leaning of stacks across flue spaces occurs soon after initial fire development shall be considered as unstable piles.

20.5.3 Solid-Piled Storage.
Storage of commodities stacked on each other shall be considered as solid piled storage.

20.5.3.1 Closed Array.
Where solid piled storage has vertical flues between the piles of 6 in. (152 mm) or less, the storage arrangement shall be considered as closed array.

20.5.3.2 Open Array.
Where solid piled storage has vertical flues between the piles that are greater than 6 in. (152 mm), the storage arrangement shall be considered as open array.

20.5.3.3 Pile Stability, Stable Piles.

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Those arrays where collapse, spillage of content, or leaning of stacks across flue spaces is not likely to occur soon after initial fire development shall be considered as stable piles.

20.5.3.4* Pile Stability, Unstable Piles.
Those arrays where collapse, spillage of contents, or leaning of stacks across flue spaces occurs soon after initial fire development shall be considered as unstable piles.

20.5.4 Bin Box Storage.
Storage in five-sided wood, metal, or cardboard boxes with open face on the aisles in which boxes are self-supporting or supported by a structure so designed that little or no horizontal or vertical space exists around boxes shall be considered as bin box storage.

20.5.5 Shelf Storage.
Storage on structures up to and including 30 in. (0.76 m) deep and separated by aisles at least 30 in. (0.76 m) wide shall be considered as shelf storage.

20.5.6 Back-to-Back Shelf Storage.
Two solid or perforated shelves up to 30 in. (0.76 m) in depth each, not exceeding a total depth of 60 in. (1.52 m), separated by a longitudinal vertical barrier such as plywood, particleboard, sheet metal, or equivalent, with a maximum 0.25 in. (6.4 mm) diameter penetrations and no longitudinal flue space and a maximum storage height of 15 ft (4.57 m) shall be considered as back-to-back storage.

20.5.7 Movable Racks.
Racks on fixed rails or guides that can be moved back and forth only in a horizontal, two-dimensional plane shall be protected as movable racks.

20.5.7.1
Rack storage in movable racks shall be protected in the same manner as multiple-row racks.

20.5.8* Rack Storage.
General rack storage shall include any combination of vertical, horizontal, and diagonal members that supports stored materials in accordance with 20.5.7.

20.5.8.1 Open Rack.
Racks without shelving or with shelving in racks that are fixed in place with shelves having a solid surface and a shelf area equal to or less than 20 ft^2 (1.9 m^2) or with shelves having a wire mesh, slatted surface, or other material with openings representing at least 50 percent of the shelf area, including the horizontal area of rack members and where the flue spaces are maintained, shall be protected as open rack.

20.5.8.2 Shelving.

20.5.8.2.1 Rack Shelf Area.
The area of the horizontal surface of a shelf in a rack defined by perimeter aisle(s) or nominal 6 in. (152 mm) flue spaces on all four sides, or by the placement of loads that block openings that would otherwise serve as the required flue spaces, shall be considered to determine the rack shelf area.

20.5.8.2.2 Slatted Shelf Rack.
A rack where shelves are fixed in place with a series of narrow individual solid supports used as the shelf material and spaced apart with regular openings shall be protected as a slatted shelf rack.

20.5.8.2.3 Solid Shelf Rack.
A rack that is not defined as an open rack where shelves are fixed in place with a solid, slatted, or wire mesh barrier used as the shelf material and having limited openings in the shelf area shall be protected as a solid shelf rack.

20.5.8.2.4 Solid Shelving.
The area of a shelf shall be measured by perimeter aisle or flue space on all four sides or by the placement of loads that block openings that would otherwise serve as the required flue spaces.

20.5.8.2.4.1

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Shelving material that is less than 50 percent open, or placement of loads that block openings that would otherwise serve as the required flue spaces, greater than 20 ft^2 (1.9 m^2) in area shall be treated as solid shelf racks.

20.5.8.2.4.2
Where multiple-row racks of any height have no longitudinal flue or where double-row racks with storage up 25 ft (7.6 m) in height have no longitudinal flue, the situation shall not be considered solid shelves where transverse flues exist at maximum 5 ft (1.5 m) intervals, and additional in-rack sprinklers shall not be required in accordance with 16.1.6.1 and 16.1.6.2.

20.5.8.3 Aisles.

20.5.8.3.1
Aisles required by Chapters 21 through 25 shall not be obstructed unless Chapters 21 through 25 include specific guidance allowing obstructions over the aisle.

20.5.8.3.2 Aisle Width.
The horizontal dimension between the face of the loads in racks under consideration shall determine the aisle width for protection criteria.

20.5.8.4 Flues.

20.5.8.4.1 Longitudinal Flue Space.
The space between rows of storage perpendicular to the direction of loading with a width not exceeding 24 in. (610 mm) between storage shall be considered as the longitudinal flue.

20.5.8.4.1.1
For Class I through IV and Group A plastic in double-row and multiple-row open racks, a longitudinal flue space shall not be required for storage up to and including 25 ft (7.6 m). *(See Section C.13.)*

20.5.8.4.1.2
For Class I through IV and Group A plastic nominal 6 in. (152.4 mm) longitudinal flue spaces shall be provided in double-row racks for storage over 25 ft (7.6 m).

20.5.8.4.2 Transverse Flue Space.
The space between rows of storage parallel to the direction of loading shall be considered as the transverse flue. *(See Figure A.3.9.3.6.)*

20.5.8.4.2.1
Nominal 6 in. (150 mm) transverse flue spaces between loads and at rack uprights shall be maintained in single-row, double-row, and multiple-row racks.

20.5.8.4.2.2
Random variations in the width of flue spaces or in their vertical alignment shall be permitted.

20.5.8.5 Bulkhead.
A vertical barrier across the rack shall be considered a bulkhead.

20.5.8.6 Horizontal Barrier.
A solid barrier in the horizontal position covering the entire rack, including all flue spaces at certain height increments, to prevent vertical fire spread shall be considered a horizontal barrier.

20.5.8.7 Single-Row Racks.
Racks that have no longitudinal flue space and that have a depth up to 6 ft (1.8 m) with aisles having a width of at least 3.5 ft (1.1 m) between loads on racks shall be protected as single-row racks.

20.5.8.8 Double-Row Racks.
Racks less than or equal to 12 ft (3.7 m) in depth or single-row racks placed back to back having an aggregate depth up to 12 ft (3.7 m), with aisles having an aisle width of at least 3.5 ft (1.1 m) between loads on racks shall be protected as double-row racks.

20.5.8.9 Multiple-Row Racks.

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Racks greater than 12 ft (3.7 m) in depth or single- or double-row racks separated by aisles less than 3.5 ft (1.1 m) wide having an overall width greater than 12 ft (3.7 m) shall be protected as multiple-row racks.

20.5.8.10 Movable Racks.
Racks on fixed rails or guides that can be moved back and forth only in a horizontal, two-dimensional plane shall be protected as movable racks.

20.5.8.11 Portable Racks.
Racks that are not fixed in place and can be arranged in any number of configurations shall be protected as portable racks.

20.5.9 Rubber Tires.
Paragraphs **20.5.9.1** through **20.5.9.7** cover the general terms of rubber tire storage that identify which type of protection criteria shall be used in Chapters 21 to 24.

20.5.9.1 Banded Tires.
When tires are strapped together, they shall be considered as banded.

20.5.9.2 Horizontal Channel.
Any uninterrupted space in excess of 5 ft (1.5 m) in length between horizontal layers of stored tires shall be considered as the horizontal channel.

20.5.9.3 Laced Tire Storage.
Tires stored where the sides of the tires overlap, creating a woven or laced appearance, shall be considered as laced tire storage. *[See Figure A.3.9.4.9(g).]*

20.5.9.4 On-Side Tire Storage.
Tires stored horizontally or flat shall be considered as on-side storage.

20.5.9.5 On-Tread Tire Storage.
Tires stored vertically or on their treads shall be considered as on-tread storage.

20.5.9.6 Palletized Tire Storage.
Storage on portable racks of various types utilizing a conventional pallet as a base shall be considered as palletized storage.

20.5.9.7 Pyramid Tire Storage.
On-floor storage in which tires are formed into a pyramid to provide pile stability shall be considered as pyramid storage.

20.5.9.8 Water Supplies.
Total water supplies shall be capable of providing flow for automatic sprinklers, hose streams, and foam systems (if provided) for the duration required in Table 20.12.2.6.

20.5.10 Roll Paper.
Paragraphs 20.5.9.1 through 20.5.9.11 cover the general terms of roll paper that identify which type of protection criteria shall be used in Chapters 21 through 24.

20.5.10.1 Paper.
Storage of all kinds of felted sheets made from natural fibrous materials, usually vegetable but sometimes mineral or animal, and formed on a fine wire screen from water suspension, where stored in rolled form shall be protected as roll paper storage.

20.5.10.2 Closed Array (Paper).
Where a vertical storage arrangement in which the distances between columns in both directions are short [not more than 2 in. (50 mm) in one direction and 1 in. (25 mm) in the other], the storage array shall be considered as closed array.

20.5.10.3 Open Array (Paper).
Where a vertical storage arrangement in which the distance between columns in both directions is lengthy (all vertical arrays other than closed or standard), the storage array shall be considered as open array.

20.5.10.4 Standard Array (Paper).

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Where a vertical storage arrangement in which the distance between columns in one direction is short [1 in. (25 mm) or less] and is in excess of 2 in. (50 mm) in the other direction, the storage array shall be considered as standard array.

20.5.10.5 Banded Roll Paper Storage.
Where rolls are provided with a circumferential steel strap [⅜ in. (9.5 mm), or wider] at each end of the roll, the rolls shall be considered banded.

20.5.10.6 Column.
A single vertical stack of rolls shall be considered a column.

20.5.10.7 Core.
The central tube around which paper is wound to form a roll shall be considered as the core.

20.5.10.8 Horizontal Roll Paper Storage.
Rolls stored with the cores in the horizontal plane (on-side storage) shall be considered as horizontal storage.

20.5.10.9 Vertical Roll Paper Storage.
Rolls stored with the cores in the vertical plane (on-end storage) shall be considered as vertical storage.

20.5.10.10 Wrapped Roll Paper Storage.
Rolls provided with a complete heavy kraft covering around both sides and ends shall be considered as wrapped storage.

20.5.10.11 Roll Paper Storage Height.
The maximum vertical distance above the floor at which roll paper is normally stored shall be considered as the storage height.

20.5.10.12 Protection Criteria for Roll Paper Storage.

20.5.10.13
Wet pipe systems shall be used in tissue storage areas.

20.5.10.13.1
The water supply design shall include the demand of the automatic sprinkler system plus the hose stream allowance plus, where provided, the high-expansion foam system for the duration specified in Table 20.12.2.6.

20.5.10.14
Horizontal storage of heavyweight or mediumweight paper shall be protected as a closed array.

20.5.10.15
Mediumweight paper shall be permitted to be protected as heavyweight paper where wrapped completely on the sides and both ends, or where wrapped on the sides only with steel bands. Wrapping material shall be either a single layer of heavyweight paper with a basis weight of 40 lb (18.1 kg) or two layers of heavyweight paper with a basis weight of less than 40 lb (18.1 kg).

20.5.10.16
Lightweight paper or tissue paper shall be permitted to be protected as mediumweight paper where wrapped completely on the sides and both ends, or where wrapped on the sides only with steel bands. Wrapping material shall be either a single layer of heavyweight paper with a basis weight of 40 lb (18.1 kg) or two layers of heavyweight paper with a basis weight of less than 40 lb (18.1 kg).

20.5.10.17
For purposes of sprinkler system design criteria, lightweight class paper shall be protected as tissue.

20.5.11 Plastic Motor Vehicle Components.
Group A plastic automotive components and associated packaging material consisting of exposed, expanded Group A plastic dunnage, instrument panels, and plastic bumper fascia shall be permitted to be protected as defined in Chapter 23.

20.5.11.1

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Automotive components covered in this section shall not include the storage of air bags, tires, and seats on portable racks. Paragraphs 20.5.11.1 through 20.5.11.3 cover the general terms of plastic motor vehicle components that identify which protection criteria shall be used in Chapter 23.

20.5.11.2 Automotive Components on Portable Racks.
Instrument panels, windshields, metal and plastic gasoline tanks, heater housings, door panels, interior trim, bumper fascia, wiring harnesses, sheet metal, body components, engines, driveline components, steering mechanisms, auxiliary motors, and lighting, all with or without expanded Group A plastic dunnage, shall be permitted to be protected as automotive components in Chapter 23.

20.5.11.3 Closed Array.
Where portable racks have vertical flues between the racks that are 6 in. (152 mm) or less, the storage arrangement shall be considered as closed array.

20.5.12 Retail Display/Storage.
Paragraph **20.5.7.1** covers the general terms of retail display/storage that identify which type of protection criteria shall be used in Chapters 21 through 24.

20.5.13 Baled Cotton Storage.
Paragraph **20.5.13.1** covers the general terms of baled cotton storage that identify which type of protection criteria shall be used in Chapter 21.

20.5.13.1 Tiered Storage.
An arrangement in which bales are stored directly on the floor, two or more bales high, shall be considered as tiered storage.

20.5.14 Cartoned Record Storage.
Paragraphs 20.5.14.1 and 20.5.14.2 cover the general terms of cartoned record storage that identify which type of rack and shelving criteria shall be used in Chapters 21 through 24.

20.5.14.1 Cartoned Records Storage.
The protection criteria in Chapter 21 for cartoned records storage shall be based on a Class III commodity consisting predominantly of paper records in cardboard cartons.

20.5.14.2* Catwalk.
For the purposes of cartoned records storage, catwalks shall be considered a storage aid consisting of either open metal grating or solid horizontal barriers supported from a rack storage system that is utilized as a walkway for access to storage at elevated levels.

20.6 Building Construction and Storage: Heights and Clearance.

20.6.1 Ceiling Slope.
The sprinkler system criteria specified in Chapter 12 and Chapters 14 through 20 are intended to apply to buildings with ceiling slopes not exceeding 2 in 12 (16.7 percent) unless modified by a specific section in Chapter 12 and Chapters 14 through 20.

20.6.2* Building and Storage Height.

20.6.2.1
The maximum building height shall be measured to the underside of the roof deck or ceiling in the storage area or in accordance with 20.13.1.1 through 20.6.2.4.2.

20.6.2.2
For corrugated metal deck roofs up to 3 in. (75 mm) in depth, the maximum roof height shall be measured from floor to the bottom of the deck.

20.6.2.3
For decks deeper than 3 in. (75 mm), the maximum roof height shall be measured to the highest point on the deck.

20.6.2.4

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For ceilings that have insulation installed directly against underside of the ceiling or roof structure, the maximum roof height shall be measured to the bottom of insulation and shall be in accordance with 20.13.1.3.1 or 20.13.1.3.2.

20.6.2.4.1
For insulation that is installed directly against the ceiling or roof structure and is installed flat and parallel to the ceiling or roof structure, the maximum roof height shall be measured to the underside of the insulation.

20.6.2.4.2
For insulation that is installed in a manner that causes it to deflect or sag down from the ceiling or roof structure, the maximum roof height shall be measured as half of the distance of the deflection from the insulation high point to the insulation low point. If the deflection or sag in the insulation exceeds 6 in. (150 mm), the maximum roof height shall be measured to the high point of the insulation.

20.6.2.5*
Where the building height changes within a compartment, the sprinklers directly over the storage shall be capable of protecting storage directly beneath.

20.6.2.5.1
Where a barrier to heat and smoke in accordance with 20.10.1(2) or 20.10.1(3) is not present, the sprinkler criteria 15 ft (4.6 m) into the perimeter of the lower ceiling area shall be the same as the sprinkler protection for the high ceiling area.

20.6.2.6
ESFR sprinklers shall be used only in buildings equal to, or less than, the height of the building for which they have been listed.

20.6.3 Storage Height.

20.6.3.1
The sprinkler system design shall be based on the storage height that routinely or periodically exists in the building and creates the greatest water demand.

20.6.3.2
Where storage is placed above doors, the storage height shall be calculated from the base of storage above the door.

20.6.4 Clearance to Ceiling.

20.6.4.1*
The clearance to ceiling shall be measured in accordance with 20.6.4.1.1 through 20.6.4.1.3.

20.6.4.1.1
For corrugated metal deck roofs up to 3 in. (75 mm) in depth, the clearance to ceiling shall be measured from the top of storage to the bottom of the deck.

20.6.4.1.2
For corrugated metal deck roofs deeper than 3 in. (75 mm), the clearance to ceiling shall be measured to the highest point on the deck.

20.6.4.1.3
For ceilings that have insulation attached directly to underside of the ceiling or roof structure, the clearance to ceiling shall be measured from the top of storage to the bottom of the insulation and shall be in accordance with 20.6.4.1.3(A) or 20.6.4.1.3(B).

(A)
For insulation that is attached directly to the ceiling or roof structure and is installed flat and parallel to the ceiling or roof structure, the clearance to ceiling shall be measured from the top of storage to the underside of the insulation.

(B)

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For insulation that is installed in a manner that causes it to deflect or sag down from the ceiling or roof structure, the clearance to ceiling shall be measured from the top of storage to a point half of the distance of the deflection from the insulation high point to the insulation low point. If the deflection or sag in the insulation exceeds 6 in. (150 mm), the clearance to ceiling shall be measured from the top of storage to the high point of the insulation.

20.6.4.2
Protection of Class I-IV commodities with excessive clearance from the top of storage to the ceiling sprinkler deflectors shall be in accordance with Table 20.6.4.2.

Table 20.6.4.2 Class I Through Class IV Commodities

Storage Configuration	Where the clearance to ceiling exceeds	Protection is based upon the storage height that would result in a clearance to ceiling of…	In-rack Sprinklers*
Palletized, solid-piled, bin box, shelf, or back-to-back shelf storage	20 ft (6.1 m)	20 ft (6.1 m)	N/A
Rack storage up to and including 25 ft (7.6 m) in height	20 ft (6.1 m)	20 ft (6.1 m)	Permitted as alternative to presumed clearance of 20 ft (6.1 m)
Rack storage over 25 ft (7.6 m) in height	10 ft (3.1 m)	10 ft (3.1 m)	Permitted as alternative to presumed clearance of 10 ft (3.1 m)

*When applying the supplemental in-rack sprinkler option, the ceiling density is based upon the given storage height with an assumed acceptable clearance to ceiling. Provide one level of supplemental, quick response in-rack sprinklers located directly below the top tier of storage and at every flue space intersection.

20.6.4.3
Protection of Plastic and Rubber commodities with excessive clearance from the top of storage to the ceiling sprinkler deflectors shall be in accordance with Table 20.6.4.3.

Table 20.6.4.3 Plastics and Rubber Commodities

Storage Configuration	Where the clearance to ceiling exceeds	Protection is based upon the storage height that would result in a clearance to ceiling of…	In-rack Sprinklers*
Palletized, solid-piled, bin box, shelf, or back-to-back shelf storage	20 ft (6.1 m)	20 ft (6.1 m)	N/A
Rack storage up to and including 25 ft (7.6 m) in height	10 ft (3.1 m)	10 ft (3.1 m)	Permitted as alternative to presumed clearance of 10 ft (3.1 m)
Rack storage over 25 ft (7.6 m) in height	10 ft (3.1 m)	N/A	Required

*If in-rack sprinklers are required for the actual storage height with an acceptable clearance to ceiling, in-rack sprinklers are installed as indicated by that criteria. Provide one level of supplemental, quick response in-rack sprinklers located directly below the top tier of storage and at every flue space intersection.

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20.6.4.4
For spray sprinkler CMDA criteria where the clearance to ceiling exceeds those identified in Table 20.6.4.4, the requirements of 20.6.4.5 through 20.6.4.10 shall apply.

Table 20.6.4.4 Maximum Clearance from Top of Storage to Ceiling for CMDA Protection Criteria

Commodity	Class I to IV	Group A Plastic
Palletized, Solid-Piled, Bin Box, Shelf, or Back-to-Back Shelf Storage	20 ft (6.1 m)	20 ft (6.1 m)
Rack Storage up to 25 ft (7.6 m)	20 ft (6.1 m)	10 ft (3.1 m)
Rack Storage > 25 ft (7.6 m)	10 ft (3.1 m)	10 ft (3.1 m)

20.6.4.5
Where the clearance to ceiling exceeds 20 ft (6.1 m) for palletized, solid-piled, bin box, shelf, or back-to-back shelf storage, the protection shall be based on the storage height that would result in a clearance to ceiling of 20 ft (6.1 m).

20.6.4.6
Where the clearance to ceiling exceeds 20 ft (6.1 m) for rack storage of Class I through IV storage up to and including 25 ft (7.6 m) in height, the protection shall be based upon the storage height that would result in a clearance to ceiling of 20 ft (6.1 m) or providing one level of supplemental, quick-response in-rack sprinklers in accordance with Chapter 25.

20.6.4.7
Where the clearance to ceiling exceeds 10 ft (3.0 m) for rack storage of Class I to IV above 25 ft (7.6 m) in height or Group A plastic up to 25 ft (7.6 m) in height, protection shall be based upon the storage height that would result in a clearance to ceiling of 10 ft (3.0 m) or providing one level of supplemental, quick-response in-rack sprinklers in accordance with Chapter 25.

20.6.4.8
Where the clearance exceeds 10 ft (3.0 m) for rack storage of Group A plastic above 25 ft (7.6 m) in height,, protection shall be based on providing one level of supplemental, quick-response in-rack sprinklers in accordance with Chapter 25.

20.6.4.9
When applying the supplemental in-rack sprinkler option, the ceiling density shall be based upon the given storage height with an assumed acceptable clearance to ceiling.

20.6.4.10
If in-rack sprinklers are required for the actual storage height with an acceptable clearance to ceiling, in-rack sprinklers shall be installed as indicated by that criteria.

20.6.5 Roof Vents and Draft Curtains.
See Section C.6.

20.6.6 Clearance from Deflector to Storage.

20.6.6.1
Unless the requirements of 20.6.6.2 through 20.6.6.5 are met, the clearance between the deflector and the top of storage or contents of the room shall be 18 in. (450 mm) or greater.

20.6.6.2*
Manually operated roof vents or automatic roof vents with operating elements that have a higher temperature classification than the automatic sprinklers shall be permitted.

20.6.6.3
Early suppression fast-response (ESFR) sprinklers shall not be used in buildings with automatic heat or smoke vents unless the vents use a high-temperature rated, standard-response operating mechanism.

20.6.6.4
Where other standards specify greater clearance to storage minimums, they shall be followed.

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20.6.6.5
A minimum clearance to storage of 36 in. (900 mm) shall be permitted for special sprinklers.

20.6.6.6*
Draft curtains shall not be used within ESFR sprinkler systems.

20.6.6.6.1
Draft curtains separating ESFR sprinklers at system breaks or from control mode sprinklers or between hazards shall be permitted. *(See 14.2.5.)*

20.6.6.6.2
Where ESFR sprinkler systems are installed adjacent to sprinkler systems with standard-response sprinklers, a draft curtain of noncombustible construction and at least 2 ft (600 mm) in depth shall be required to separate the two areas.

20.6.6.6.3
A clear aisle of at least 4 ft (1.2 m) centered below the draft curtain shall be maintained for separation.

20.6.6.7
A minimum clearance to storage of less than 18 in. (450 mm) between the top of storage and ceiling sprinkler deflectors shall be permitted where proven by successful large-scale fire tests for the particular hazard.

20.6.6.8
The clearance from the top of storage to sprinkler deflectors shall be not less than 36 in. (900 mm) where rubber tires are stored.

20.6.7* High Volume Low Speed (HVLS) Fans.

20.6.7.1
The installation of HVLS fans in buildings equipped with sprinklers, including ESFR sprinklers, shall comply with the following:

(1) The maximum fan diameter shall be 24 ft (7.3 m).

(2) The HVLS fan shall be centered approximately between four adjacent sprinklers.

(3) The vertical clearance from the HVLS fan to sprinkler deflector shall be a minimum of 3 ft (900 mm).

(4) All HVLS fans shall be interlocked to shut down immediately upon a waterflow alarm.

(5) Where the building is protected with a fire alarm system, this interlock shall be in accordance with the requirements of *NFPA 72*.

20.7 Unsprinklered Combustible Concealed Spaces.

20.7.1*
When using the density/area method or room design method, unless the requirements of 20.7.2 are met for buildings having unsprinklered combustible concealed spaces as described in 17.4.1 and 9.3.19, the minimum area of sprinkler operation for that portion of the building shall be 3000 ft^2 (280 m^2).

20.7.1.1
The design area of 3000 ft^2 (280 m^2) shall be applied only to the sprinkler system or portions of the sprinkler system that are adjacent to the qualifying combustible concealed space.

20.7.1.2
The term *adjacent* shall apply to any sprinkler system protecting a space above, below, or next to the qualifying concealed space except where a barrier with a fire resistance rating at least equivalent to the water supply duration completely separates the concealed space from the sprinklered area.

20.7.2
The following unsprinklered combustible concealed spaces shall not require a minimum design area of sprinkler operation of 3000 ft^2 (280 m^2):

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(1) Noncombustible and limited-combustible concealed spaces with minimal combustible loading having no access. The space shall be considered a concealed space even with small openings such as those used as return air for a plenum.

(2) Noncombustible and limited-combustible concealed spaces with limited access and not permitting occupancy or storage of combustibles. The space shall be considered a concealed space even with small openings such as those used as return air for a plenum.

(3) Combustible concealed spaces filled entirely with noncombustible insulation.

(4) Concealed spaces where rigid materials are used and the exposed surfaces have a flame spread index of 25 or less and the materials have been demonstrated to not propagate fire more than 10.5 ft (3.2 m) when tested in accordance with ASTM E 84, *Standard Test Method for Surface Burning Characteristics of Building Materials,* or ANSI/UL 723, *Standard for Test for Surface Burning Characteristics of Building Materials,* extended for an additional 20 minutes in the form in which they are installed in the space.

(5) Concealed spaces in which the exposed materials are constructed entirely of fire retardant–treated wood as defined by NFPA 703.

(6) Concealed spaces over isolated small compartments not exceeding 55 ft^2 (5.1 m^2) in area.

(7) Vertical pipe chases under 10 ft^2 (0.9 m^2), provided that in multifloor buildings the chases are firestopped at each floor using materials equivalent to the floor construction. Such pipe chases shall contain no sources of ignition, piping shall be noncombustible, and pipe penetrations at each floor shall be properly sealed.

(8) Exterior columns under 10 ft^2 (0.9 m^2) in area formed by studs or wood joists, supporting exterior canopies that are fully protected with a sprinkler system.

20.8 Room Design Method.

20.8.1*
The water supply requirements for sprinklers only shall be based upon the room that creates the greatest demand.

20.8.2
To utilize the room design method, all rooms shall be enclosed with walls having a fire resistance rating equal to the required water supply duration.

20.8.2.1
Minimum protection of openings shall include automatic- or self-closing doors with the appropriate fire protection rating for the enclosure.

20.8.3
Where the room design method is used, the density shall correspond to that required for the smallest area acceptable under the density/area method.

20.9* High-Expansion Foam Systems.

20.9.1 General: High Expansion Foam Systems.

20.9.1.1
High-expansion foam systems that are installed in addition to automatic sprinklers shall be installed in accordance with NFPA 11.

20.9.1.2
High-expansion foam systems shall be automatic in operation.

20.9.1.3
High-expansion foam used to protect the idle pallet shall have a maximum fill time of 4 minutes.

20.9.1.4

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Detectors for high-expansion foam systems shall be listed and shall be installed at no more than one-half the listed spacing.

20.9.1.5
The release system for the high expansion foam deluge system shall be designed to operate prior to the sprinklers installed in the area.

20.9.1.5.1
The maximum submergence time for the high-expansion foam shall be 5 minutes for Class I, Class II, or Class III commodities and 4 minutes for Class IV commodities.

20.9.2 High-Expansion Foam: Reduction in Ceiling Density.

20.9.2.1
Using CMDA sprinkler protection criteria for palletized, solid-piled, bin box, shelf, or back-to-back shelf storage of Class I through Class IV commodities, idle pallets, or plastics, where high-expansion foam systems are used in combination with ceiling sprinklers, a reduction in ceiling density to one-half that required for Class I through Class IV commodities, idle pallets, or plastics shall be permitted without revising the design area, but the density shall be no less than 0.15 gpm/ft2 (6.1 mm/min).

20.9.2.2
Using CMDA sprinkler protection criteria for rack storage, where high-expansion foam systems are used in combination with ceiling sprinklers, the minimum ceiling sprinkler design density shall be 0.2 gpm/ft^2 (8.1 mm/min) for Class I, Class II, or Class III commodities and 0.25 gpm/ft^2 (10.2 mm/min) for Class IV commodities for the most hydraulically remote 2000 ft^2 (186 m^2) operating area.

20.9.2.3
Where high-expansion foam systems are used in combination with ceiling sprinklers, the maximum submergence time shall be 7 minutes for Class I, Class II, or Class III commodities and 5 minutes for Class IV commodities.

20.9.2.4
Where high-expansion foam systems are used for rack storage of Class I through IV commodities over 25 ft (7.6 m) high up to and including 35 ft (10.7 m) high, they shall be used in combination with ceiling sprinklers.

20.9.2.5 Reduced-Discharge Density.
Where high-expansion foam systems for rubber tire protection are installed in accordance with NFPA 11, a reduction in sprinkler discharge density to one-half the density specified in Table 21.6.1(a) or 0.24 gpm/ft^2 (9.8 mm/min), whichever is higher, shall be permitted.

20.9.2.6
In-rack sprinklers for the protection of Class I through IV commodities shall not be required where high-expansion foam systems are used in combination with ceiling sprinklers.

20.9.2.7 Detectors for High-Expansion Foam Systems.

20.9.2.7.1
Detectors shall be listed and shall be installed in one of the following configurations:
(1) At the ceiling only where installed at one-half the listed linear spacing [e.g., 15 ft × 15 ft (4.6 m × 4.6 m) rather than at 30 ft × 30 ft (9.1 m × 9.1 m)]; at the ceiling at the listed spacing and in racks at alternate levels

(2) Where listed for rack storage installation and installed in accordance with the listing to provide response within 1 minute after ignition using an ignition source that is equivalent to that used in a rack storage testing program

20.9.2.7.2
Ceiling detectors alone shall not be used where the clearance to ceiling exceeds 10 ft (3.0 m) or the height of the storage exceeds 25 ft (7.6 m).

20.9.2.7.3

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Detectors for preaction systems shall be installed in accordance with 20.9.2.7.

20.10* Adjacent Hazards or Design Methods.

20.10.1
For buildings with two or more adjacent hazards or design methods, the following shall apply:
(1) Where areas are not physically separated by a barrier or partition capable of delaying heat from a fire in one area from fusing sprinklers in the adjacent area, the required sprinkler protection for the more demanding design basis shall extend 15 ft (4.6 m) beyond its perimeter.

(2) The requirements of 20.10.1(1) shall not apply where the areas are separated by a draft curtain or barrier located above an aisle, horizontally a minimum of 2 ft (600 mm) from the adjacent hazard on each side, or a partition that is capable of delaying heat from a fire in one area from fusing sprinklers in the adjacent area.

(3) The requirements of 20.10.1(1) shall not apply to the extension of more demanding criteria from an upper ceiling level to beneath a lower ceiling level where the difference in height between the ceiling levels is at least 2 ft (600 mm), located above an aisle, horizontally a minimum 2 ft (600 mm) from the adjacent hazard on each side.

20.10.2*
Protection criteria for Group A plastics shall be permitted for the protection of the same storage height and configuration of Class I, II, III, and IV commodities.

20.10.3
CMSA and ESFR sprinklers shall be permitted to protect storage of Class I through Class IV commodities, Group A plastic commodities, miscellaneous storage, and other storage as specified in Chapter 12 through Chapter 20 or by other NFPA standards.

20.10.4 Systems with Multiple Hazard Classifications.
For systems with multiple hazard classifications, the hose stream allowance and water supply duration shall be in accordance with Section 20.12.2 as well as one of the following:
(1) The water supply requirements for the highest hazard classification within the system shall be used.

(2) The water supply requirements for each individual hazard classification shall be used in the calculations for the design area for that hazard.

(3) *For systems with multiple hazard classifications where the higher classification only lies within single rooms less than or equal to 400 ft^2 (37.2 m^2) in area with no such rooms adjacent, the water supply requirements for the principal occupancy shall be used for the remainder of the system.

20.11* Hose Connections.

20.11.1 Small [1½ in. (40 mm)] Hose Connections.
See Section C.5.

20.11.1.1 Hose Connection.
Small hose connections [1½ in. (38 mm)] shall be provided where required by the authority having jurisdiction in accordance with Section 16.15 for first-aid, fire-fighting, and overhaul operations.

20.11.1.2
Small hose connections shall not be required for the protection of Class I, II, III, and IV commodities stored 12 ft (3.7 m) or less in height.

20.12 Hose Stream Allowance and Water Supply Duration.

20.12.1
Hose stream allowance and water supply duration for Chapters 20 through 25 shall be in accordance with Section 20.12.

20.12.2 Hose Stream Allowance and Water Supply Duration.

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20.12.2.1*
Tanks shall be sized to supply the equipment that they serve.

20.12.2.2*
Pumps shall be sized to supply the equipment that they serve.

20.12.2.3
Water allowance for outside hose shall be added to the sprinkler requirement at the connection to the city main or a yard hydrant, whichever is closer to the system riser.

20.12.2.4
Where inside hose connections are planned or are required, the following shall apply:
(1) A total water allowance of 50 gpm (190 L/min) for a single hose connection installation shall be added to the sprinkler requirements.

(2) A total water allowance of 100 gpm (380 L/min) for a multiple hose connection installation shall be added to the sprinkler requirements.

(3) The water allowance shall be added in 50 gpm (190 L/min) increments beginning at the most remote hose connection, with each increment added at the pressure required by the sprinkler system design at that point.

20.12.2.5
When hose valves for fire department use are attached to wet pipe sprinkler system risers in accordance with 16.15.2, the following shall apply:
(1) The water supply shall not be required to be added to standpipe demand as determined from NFPA 14.

(2) Where the combined sprinkler system demand and hose stream allowance of Chapter 12 and Chapters 14 through 20 exceeds the requirements of NFPA 14, this higher demand shall be used.

(3) For partially sprinklered buildings, the sprinkler demand, not including hose stream allowance, as indicated in Chapter 12 and Chapters 14 through 20 shall be added to the requirements given in NFPA 14.

20.12.2.6
Unless indicated otherwise, the minimum water supply requirements for a hydraulically designed sprinkler system shall be determined by adding the hose stream allowance from Table 20.12.2.6 to the water demand for sprinklers.

Table 20.12.2.6 Hose Stream Allowance and Water Supply Duration

Commodity	Sprinkler Type	Sprinkler Spacing Type	Number of Ceiling Sprinklers in Design Area[a]	Size of Design Area at Ceiling	Hose Stream Allowance		Water Supply Duration (minutes)
					gpm	L/min	
Class I-IV Commodities, Group A plastics, idle wood pallets, idle plastic pallets and miscellaneous storage	Control mode density/area (CMDA)	Standard and extended-coverage	NA	Up to 1200 ft^2 (110 m^2)	250	950	60
				Over 1200 ft^2 (111 m^2) to 1500 ft^2 (140 m^2)	500	1900	90
				Over 1500 ft^2 (139 m^2) to 2600 ft^2 (240 m^2)	500	1900	120
				Over 2600 ft^2 (240 m^2)	500	1900	150
		Standard	Up to 12	NA	250	950	60

Commodity	Sprinkler Type	Sprinkler Spacing Type	Number of Ceiling Sprinklers in Design Area[a]	Size of Design Area at Ceiling	Hose Stream Allowance		Water Supply Duration (minutes)
					gpm	L/min	
	Control Mode Specific Application (CMSA)		Over 12 to 15	NA	500	1900	90
			Over 15 to 25	NA	500	1900	120
			Over 25	NA	500	1900	150
		Extended-coverage	Up to 6	NA	250	950	60
			Up to 8[b]	NA	250	950	60
			Over 6 to 8	NA	500	1900	90
			Over 8 to 12	NA	500	1900	120
			Over 12	NA	500	1900	150
	Early Suppression Fast Response (ESFR)	Standard	Up to 12	NA	250	950	60
			Over 12 to 15	NA	500	1900	90
			Over 15 to 25	NA	500	1900	120
			Over 25	NA	500	1900	150
On-floor rubber tire storage up to 5 ft (1.5 m) in height	CMDA & CMSA	Standard and extended-coverage	Any	Any	250	950	120
Rubber tire storage	CMDA	Standard and extended-coverage	NA	Up to 5000 ft^2 (372 m^2)	750	2850	180
	CMSA	Standard	Up to 15	NA	500	1900	180
	ESFR	Standard	Up to 12	NA	250	950	60
			Over 12 to 20	NA	500	1900	120[c]
Roll paper	CMDA	Standard	NA	Up to 4000 ft^2 (372 m^2)	500	1900	120
	CMSA	Standard	Up to 25	NA	500	1900	120
	ESFR	Standard	Up to 12	NA	250	950	120
Alternative Protection per 16.1.2.4 or 17.1.2.9	NA	NA	NA	NA	500	1900	120

NA: Not applicable.

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[a]For CSMA and ESFR sprinklers, the additional sprinklers included in the design area for obstructions do not need to be considered in determining the total number of sprinklers in this column.

[b]Limited to a maximum of 144 ft^2 (13.4 m^2) per sprinkler.

[c]For storage on-tread, on-side, and laced tires in open portable steel racks or palletized portable racks, with pile height up to 25 ft (7.6 m) and building height up to 30 ft (9.1 m) with K-14.0 (K-200) or K16.8 (K-240) ESFR sprinklers, the water supply duration is 180 minutes.

20.12.2.7
For the protection of baled cotton, the total water supply available shall be sufficient to provide the recommended sprinkler discharge density over the area to be protected, plus a minimum of 500 gpm (1900 L/min) for hose streams.

20.12.2.7.1
Water supplies shall be capable of supplying the total demand for sprinklers and hose streams for not less than 2 hours.

20.12.3
The minimum water supply requirements shall be determined by adding the hose stream allowance from Section 20.12.2 to the water supply for sprinklers as determined by Chapter 12 through Chapter 20.

20.12.4
The minimum water supply requirements determined from 20.12.3 shall be available for the minimum duration specified in Section 20.12.2.

20.12.5
Total system water supply requirements shall be determined in accordance with the hydraulic calculation procedures of Chapter 23.

20.13 Discharge Considerations: General.

20.13.1 Multiple Adjustments.

20.13.1.1
Where multiple adjustments to the area of operation are required to be made, these adjustments shall be compounded based on the area of operation originally selected.

20.13.1.2
If the building has unsprinklered combustible concealed spaces, the rules of Section **20.7** shall be applied after all other modifications have been made.

20.13.2* Wet Pipe Systems.

20.13.2.1
Sprinkler systems shall be wet pipe systems.

20.13.2.2*
In areas that are subject to freezing or where special conditions exist, dry pipe systems and preaction systems shall be permitted to protect storage occupancies.

20.13.3 Dry Pipe and Preaction Systems.
For dry pipe systems and preaction systems using control mode density/area (CMDA) criteria, the area of sprinkler operation shall be increased by 30 percent without revising the density.

20.14* Protection of Idle Pallets.

20.14.1 Wood Pallets.

20.14.1.1*
Wood pallets shall be permitted to be stored in the following arrangements:
(1) Stored outside

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(2) Stored in a detached structure

(3) Stored indoors where arranged and protected in accordance with 20.14.1.2

20.14.1.2
Wood pallets, where stored indoors, shall be protected in accordance with one of the following:
(1) Control mode density/area sprinkler protection as specified in Table 20.14.1.2(a).

(2) CMSA sprinkler protection in accordance with Table 20.14.1.2(b).

(3) ESFR sprinkler protection in accordance with Table 20.14.1.2(c).

(4) Control mode density/area sprinkler protection in accordance with the OH2 curve of Figure 13.2.1 existing with a hose stream demand of at least 250 gpm (950 L/min) for a duration of at least 60 minutes when pallets are stored no higher than 6 ft (1.8 m) and each pile of no more than four stacks is separated from other pallet piles by at least 8 ft (2.4 m) of clear space or 25 ft (7.6 m) of commodity. The maximum clearance to ceiling of 20 ft (6.1 m) specified in 20.6.4 shall not apply to arrangement 20.14.1.2(4).

Table 20.14.1.2(a) Control Mode Density/Area Sprinkler Protection for Indoor Storage of Idle Wood Pallets

Type of Sprinkler	Location of Storage	Nominal K-Factor	Maximum Storage Height		Maximum Ceiling/Roof Height		Sprinkler Density		Areas of Operation	
			ft	m	ft	m	gpm/ft²	mm/min	ft²	m²
Control mode density/area	On floor	8 (115) or larger	Up to 6	Up to 1.8	20	6.1	0.20	8.1	3000*	280*
	On floor	11.2 (160) or larger	Up to 8	Up to 2.4	30	9.1	0.45	18.3	2500	230
	On floor or rack without solid shelves	11.2 (160) or larger	8 to 12	2.4 to 3.7	30	9.1	0.6	24.4	3500	325
			12 to 20	3.7 to 6.1	30	9.1	0.6	24.4	4500	420
	On floor	16.8 (240) or larger	Up to 20	Up to 6.1	30	9.1	0.6	24.4	2000	185

*The area of sprinkler operation should be permitted to be reduced to 2000 ft² (186 m²) when sprinklers having a nominal K-factor of 11.2 or larger are used or if high temperature–rated sprinklers with a nominal K-factor of 8.0 are used.

Table 20.14.1.2(b) CMSA Sprinkler Protection for Indoor Storage of Idle Wood Pallets

Storage Arrangement	Commodity Class	Maximum Storage Height		Maximum Ceiling/Roof Height		K-Factor/ Orientation	Type of System	Number of Design Sprinklers	Minimum Operating Pressure	
		ft	m	ft	m				psi	bar
On floor	Idle wood pallets	20	6.1	30	9.1	11.2 (160) Upright	Wet	15	25	1.7
							Dry	25	25	1.7
						16.8 (240) Upright	Wet	15	15	1.0
							Dry	25	15	1.0

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Storage Arrangement	Commodity Class	Maximum Storage Height		Maximum Ceiling/Roof Height		K-Factor/ Orientation	Type of System	Number of Design Sprinklers	Minimum Operating Pressure	
		ft	m	ft	m				psi	bar
						19.6 (280) Pendent	Wet	15	16	1.1
				35	11	19.6 (280) Pendent	Wet	15	25	1.7
				40	12	19.6 (280) Pendent	Wet	15	30	2.1

Table 20.14.1.2(c) ESFR Sprinkler Protection for Indoor Storage of Idle Wood Pallets

Type of Sprinkler (Orientation)	Location of Storage	Nominal K-Factor	Maximum Storage Height		Maximum Ceiling/ Roof Height		Minimum Operating Pressure	
			ft	m	ft	m	psi	bar
ESFR (pendent)	On floor or rack without solid shelves	14.0 (200)	25	7.6	30	9.1	50	3.4
			25	7.6	32	10	60	4.1
		16.8 (240)	25	7.6	30	9.1	35	2.4
			25	7.6	32	10	42	2.9
			35	11	40	12	52	3.6
		22.4 (320)	25	7.6	30	9.1	25	1.7
			30	9.1	35	11	35	2.4
			35	11	40	12	40	2.7
		25.2 (360)	25	7.6	30	9.1	15	1.0
			30	9.1	35	11	20	1.4
			35	11	40	12	25	1.7
ESFR (upright)	On floor	14.0 (200)	20	6.1	30	9.1	50	3.4
			20	6.1	35	11	75	5.2
		16.8 (240)	20	6.1	30	9.1	35	2.4
			20	6.1	35	11	52	3.6

20.14.1.2.1
The maximum clearance to ceiling of 20 ft (6.1 m) specified in 20.6.4 shall not apply to arrangement 20.14.1.2(4).

20.14.1.3
Idle wood pallets shall not be stored in racks unless they are protected in accordance with the appropriate requirements of Table 20.14.1.2(a) or Table 20.14.1.2(c). *(See Section C.7.)*

20.14.2 Plastic Pallets.

20.14.2.1
Plastic pallets shall be permitted to be stored in the following manner:

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(1) Plastic pallets shall be permitted to be stored outside.

(2) Plastic pallets shall be permitted to be stored in a detached structure.

(3) Plastic pallets shall be permitted to be stored indoors where arranged and protected in accordance with the requirements of 20.14.2.2.

20.14.2.2 Protection Criteria for Plastic Pallets Stored Indoors.

20.14.2.2.1
Plastic pallets having a demonstrated fire hazard that is equal to or less than idle wood pallets and is listed for such equivalency shall be permitted to be protected in accordance with 20.14.1.

20.14.2.2.2
When specific test data are available, the data shall take precedence in determining the required protection of idle plastic pallets.

20.14.2.2.3
Protection with ESFR sprinklers shall be in accordance with the requirements of Table 20.14.2.2.3.

Table 20.14.2.2.3 ESFR Sprinkler Protection for Indoor Storage of Idle Plastic Pallets

Type of Sprinkler (Orientation)	Location of Storage	Nominal K-Factor	Maximum Storage Height		Maximum Ceiling/Roof Height		Minimum Operating Pressure	
			ft	m	ft	m	psi	bar
ESFR (pendent)	On floor or rack without solid shelves	14.0	25	7.6	30	9.1	50	3.4
			25	7.6	32	10	60	4.1
		(200)	25	7.6	30	9.1	35	2.4
		16.8	25	7.6	32	10	42	2.9
		(240)	35	11	40	12	52	3.6

20.14.2.2.4
Protection with spray sprinklers shall be in accordance with one of the scenarios in 20.14.2.2.4.1 through 20.14.2.2.4.3.

20.14.2.2.4.1
Where plastic pallets are stored in cutoff rooms, the following shall apply:
(1) The cutoff rooms shall have at least one exterior wall.

(2) The plastic pallet storage shall be separated from the remainder of the building by 3 hour–rated fire walls.

(3) The storage shall be protected by sprinklers designed to deliver 0.6 gpm/ft^2 (24.4 mm/min) for the entire room or by high-expansion foam and sprinklers designed to deliver 0.3 gpm/ft^2 (12.2 mm/min) for the entire room.

(4) The storage shall be piled no higher than 12 ft (3.7 m).

(5) Any steel columns shall be protected by 1-hour fireproofing or a sidewall sprinkler directed to one side of the column at the top or at the 15 ft (4.6 m) level, whichever is lower. Flow from these sprinklers shall be permitted to be omitted from the sprinkler system demand for hydraulic calculations.

20.14.2.2.4.2
Where plastic pallets are stored without cutoffs from other storage, the following shall apply:
(1) Maximum storage height of 10 ft (3.0 m)

(2) Maximum ceiling height of 30 ft (9.1 m)

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(3) Sprinkler density 0.6 gpm/ft^2 over 2000 ft^2 (24.4 mm/min over 186 m^2)

(4) Minimum sprinkler K-factor of 16.8 (240)

20.14.2.2.4.3
Plastic pallets shall have no impact on the required sprinkler protection when stored as follows:
(1) Storage shall be piled no higher than 4 ft (1.2 m).

(2) Sprinkler protection shall employ high temperature–rated sprinklers.

(3) Each pallet pile of no more than two stacks shall be separated from other pallet piles by at least 8 ft (2.4 m) of clear space or 25 ft (7.6 m) of stored commodity.

(4) Minimum ceiling design of OH2 shall be used.

20.14.2.3
Idle plastic pallets shall be stored only in racks where protected in accordance with the requirements of Table 20.14.2.2.3.

20.14.2.3.1
When specific test data and a product listing are available, the data shall take precedence in determining the required protection of idle plastic pallets stored in racks.

20.14.3 Idle Pallets Stored on Racks, on Shelves, and Above Doors.

20.14.3.1
Idle pallets shall not be stored on racks or shelves, except where permitted in 20.14.1.3, 20.14.2.3, and 20.14.3.2.

20.14.3.2
Idle pallets shall be permitted to be stored on the lowest level of storage only where no storage or shelves are located above the stored pallets and the applicable protection criteria referenced for on-floor storage in Section 20.14 are applied.

20.14.3.3
Where idle pallet storage is above a door, the idle pallet storage height and ceiling height shall be calculated from the base of storage above the door using the applicable protection criteria referenced in Section 20.14.

20.15 Column Protection: Rack Storage and Rubber Tire Storage.

20.15.1*
Where fireproofing of building columns is not provided and storage heights are in excess of 15 ft (4.6 m), protection of building columns located wholly or partially within the rack footprint inclusive of flue spaces or within 12 in. (300 mm) of the footprint shall be protected in accordance with one of the following:
(1) In-rack sprinklers

(2) Sidewall sprinklers at the 15 ft (4.6 m) elevation, pointed toward one side of the steel column

(3) Provision of ceiling sprinkler density for a minimum of 2000 ft^2 (186 m^2) with ordinary 165°F (74°C) or high-temperature 286°F (140°C) rated sprinklers as shown in Table 20.15.1 for storage heights above 15 ft (4.6 m), up to and including 20 ft (6.1 m)

(4) Provision of CMSA or ESFR ceiling sprinkler protection

Table 20.15.1 Ceiling Sprinkler Densities for Protection of Steel Building Columns

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Commodity Classification	Aisle Width			
	4 ft (1.2 m)		8 ft (2.4 m)	
	gpm/ft^2	(L/min)/m^2	gpm/ft^2	(L/min)/m^2
Class I	0.37	15.1	0.33	13.4
Class II	0.44	17.9	0.37	15.1
Class III	0.49	20.0	0.42	17.1
Class IV	0.68	27.7	0.57	23.2

20.15.1.1
Where storage heights are in excess of 15 ft (4.6 m) and vertical rack members support the building structure, the vertical rack members shall be protected in accordance with one of the options in 20.15.1.

20.15.1.2
The flow from a column sprinkler(s) shall be permitted to be omitted from the sprinkler system hydraulic calculations.

20.15.2 Columns Within Rubber Tire Storage.

20.15.2.1
Where fireproofing is not provided, steel columns shall be protected as follows:
(1) Storage exceeding 15 ft through 20 ft (4.6 m through 6.1 m) in height — one sidewall sprinkler directed to one side of the column at a 15 ft (4.6 m) level

(2) Storage exceeding 20 ft (6.1 m) in height — two sidewall sprinklers, one at the top of the column and the other at a 15 ft (4.6 m) level, both directed to the side of the column

20.15.2.2
The flow from a column sprinkler(s) shall be permitted to be omitted from the sprinkler system hydraulic calculations.

20.15.2.3
The protection specified in 20.15.2.1(1) and 20.15.2.1(2) shall not be required where storage in fixed racks is protected by in-rack sprinklers.

20.15.2.4
The protection specified in 20.15.2.1 shall not be required where ESFR or CMSA sprinkler systems that are approved for rubber tire storage are installed.

20.15.2.5
The rate of water supply shall be sufficient to provide the required sprinkler discharge density over the required area of application plus provision for generation of high-expansion foam and in-rack sprinklers where used.

20.16 Alternative Protection Scheme A.
Class I, II, III, IV commodities requiring a greater level of protection than is available from the overhead sprinkler system shall be permitted to be protected in accordance with 20.16.1.1 through 20.16.1.7.

20.16.1
Class I, II, III, IV, and Group A plastic commodities requiring a greater level of protection than is available from the overhead sprinkler system shall be permitted to be protected in accordance with 20.16.1.1 through 20.16.1.7.

20.16.1.1
Where the storage rack will not be solely dedicated to the storage of commodities requiring a greater level of protection than is available from the overhead sprinkler system, either of the following shall apply:
(1) Extend the protection prescribed by Section 20.16 horizontally one pallet load in all directions beyond the commodity storage area requiring the higher level of protection.

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(2) Install a vertical barrier to segregate the commodities requiring the higher level of protection from any adjacent commodities.

20.16.1.2
Commodities that can be protected by the ceiling-level sprinkler system shall be permitted to be stored vertically above and horizontally adjacent to the portions of the storage rack equipped as prescribed by Section **20.16**.

20.16.1.3 Horizontal Barriers.
Horizontal barriers shall be installed at every tier level of the dedicated storage rack where the rack is equipped with solid shelves.

20.16.1.3.1
Where the dedicated storage rack is open-frame, horizontal barriers shall be installed at vertical increments not exceeding 12 ft (3.6 m).

20.16.1.3.2
The barriers shall span horizontally so that all flue spaces within the rack bay are covered.

20.16.1.3.3
A maximum 3 in. (75 mm) wide gap shall be permitted at rack uprights.

20.16.1.3.4
The solid barrier shall be installed on a horizontal plane within a rack, beneath which in-rack sprinklers shall be installed, as follows:
(1) The barrier shall be constructed of minimum 22 gauge (0.7 [illegible]) sheet metal or of minimum ⅜ in. (10 mm) plywood.

(2) The barrier shall extend to both aisle faces of the racks, covering up both the longitudinal and the transverse flue spaces of the rack bays in which they are installed.

(3) The barrier shall be fitted to within 3 in. (75 mm) of any vertical rack member or other equipment that would create an opening, such as vertical in-rack sprinkler pipe drops.

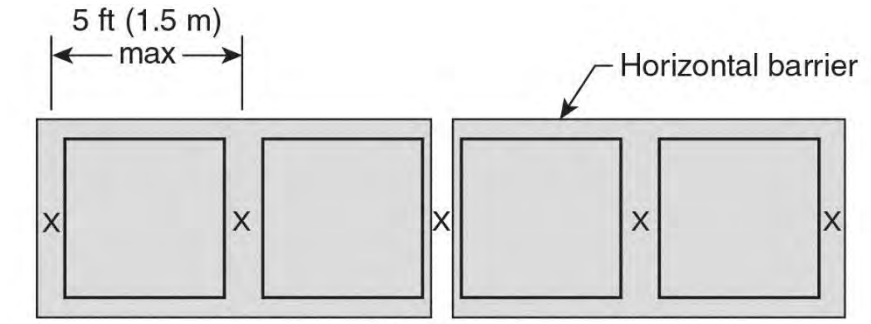
20.16.1.4 In-Rack Sprinklers.
Minimum K-8.0 (K-115) quick-response sprinklers (ceiling-level or in-rack) shall be installed beneath each horizontal barrier. The deflector of the sprinkler shall be located as close to the underside of the horizontal barrier as possible.

20.16.1.4.1 Single-Row Racks.

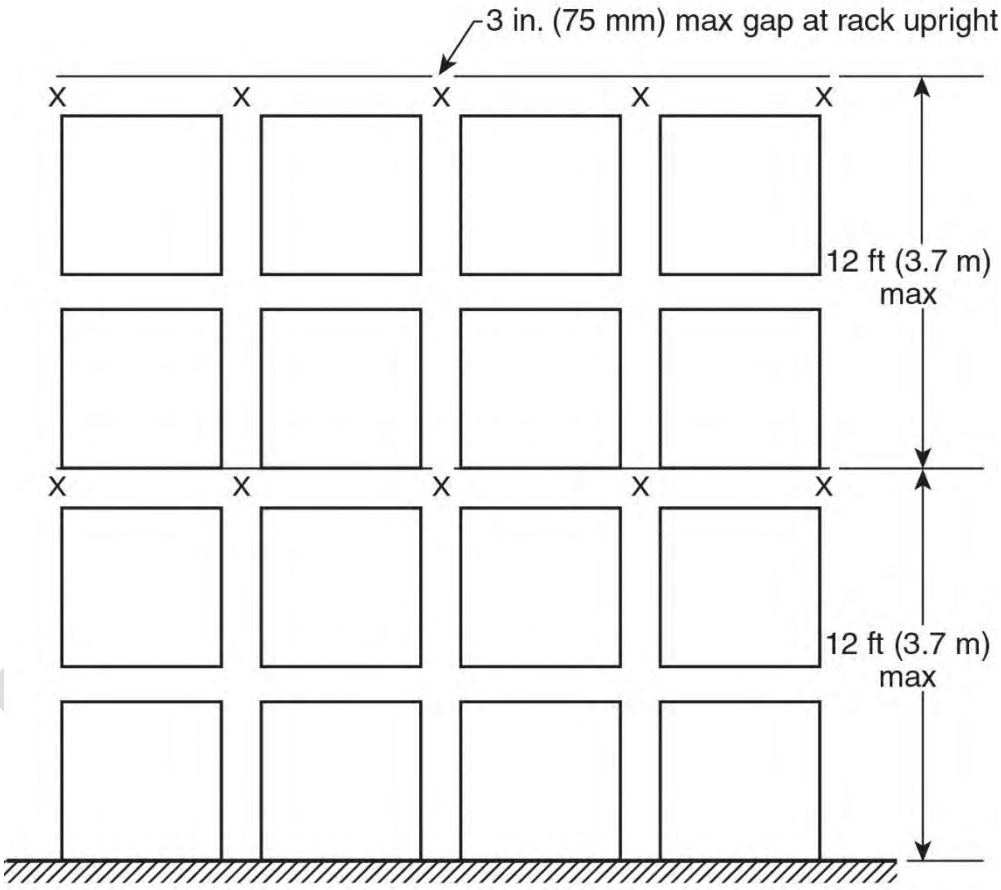
(A)
For single-row racks, sprinklers shall be installed at each rack upright and at each rack mid-bay as shown in Figure 20.16.1.4.1(A).

Figure 20.16.1.4.1(A) Alternative Protection for Single-Row Racks.

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Plan View



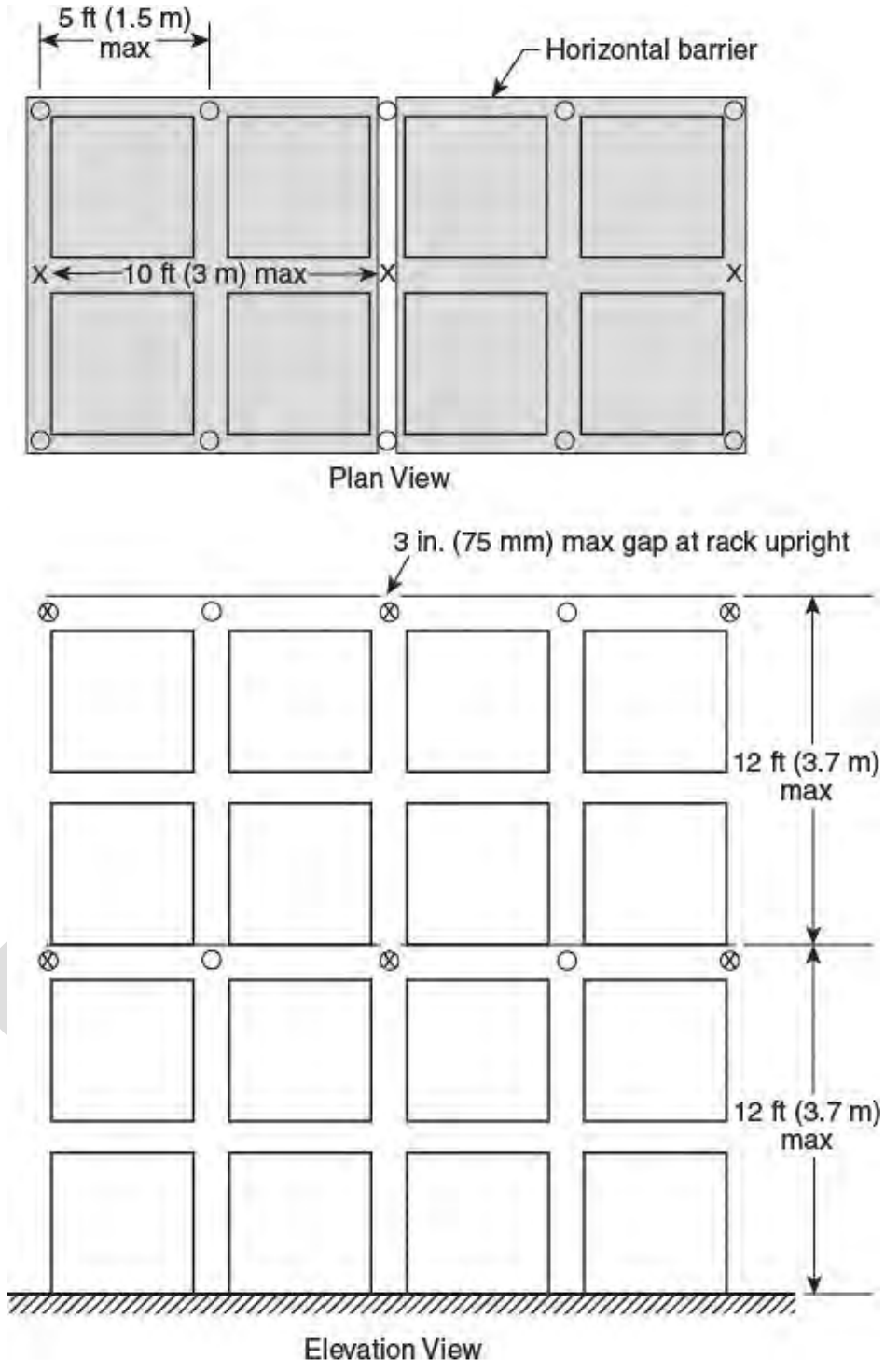
Elevation View

(B)
The maximum linear spacing between sprinklers shall not exceed 5 ft (1.5 m).

20.16.1.4.2 Double-Row Racks.

(A)
For double-row racks, sprinklers shall be installed at each rack upright within the longitudinal flue space and at the face of the rack and at the mid-bay face of each rack bay as shown in Figure 20.16.1.4.2(A).

Figure 20.16.1.4.2(A) Alternative Protection for Double-Row Racks.



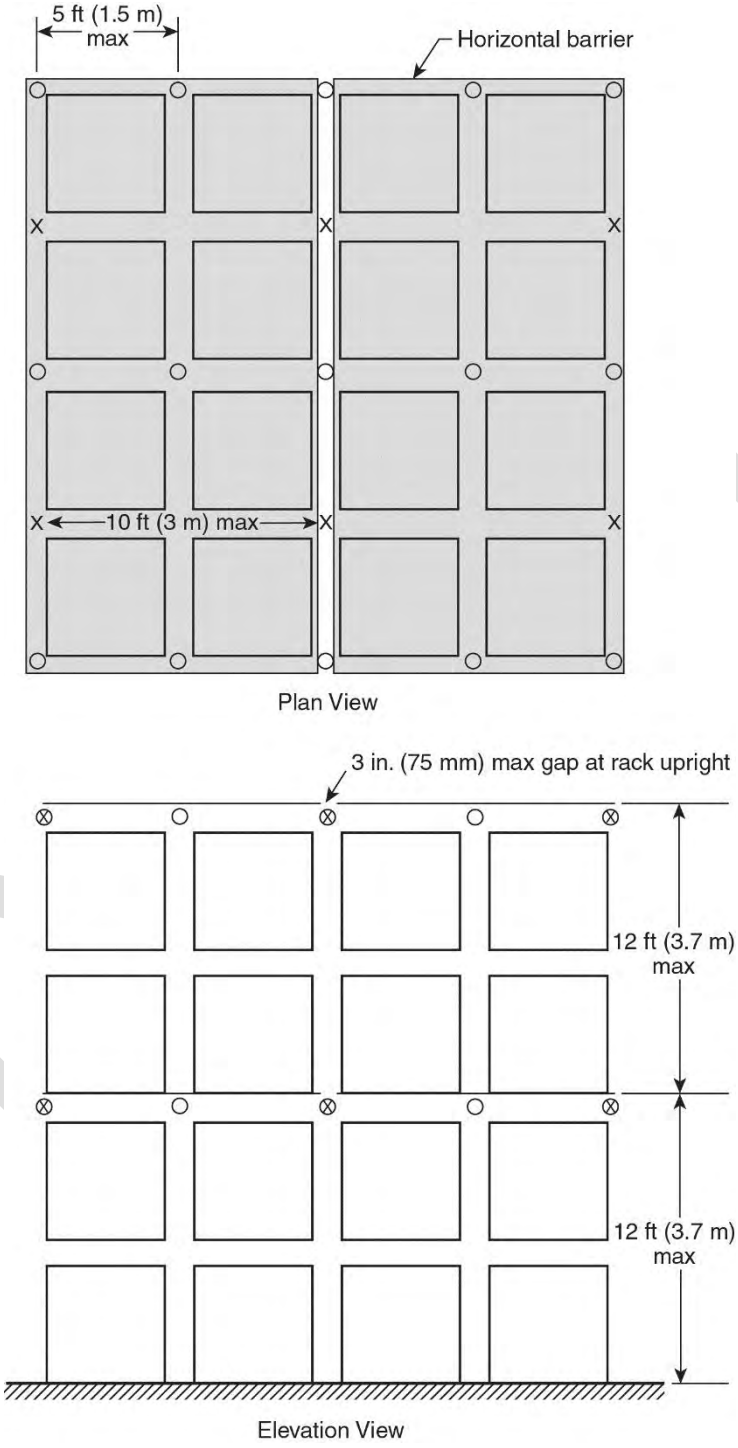
(B)
The maximum linear spacing between sprinklers shall not exceed 5 ft (1.5 m) at the rack face and 10 ft (3.0 m) within the longitudinal flue space.

20.16.1.4.3 Multiple-Row Racks.

(A)

For multiple-row racks, an alternating sprinkler arrangement shall be installed within adjacent transverse flue spaces as shown in Figure 20.16.1.4.3(A), with sprinklers at the face of each flue space.

Figure 20.16.1.4.3(A) Alternative Protection for Multiple-Row Racks.



(B)
The maximum linear spacing between sprinklers at the face and at each alternating bay shall not exceed 5 ft (1.5 m) and shall not exceed 10 ft (3.0 m) between sprinklers at every other bay.

20.16.1.5
The design of an in-rack sprinkler system shall be based on a minimum flow of 60 gpm (230 L/min) from the most remote six sprinklers for single-row racks or the most remote eight sprinklers for both double-row and multiple-row racks.

20.16.1.6
The in-rack sprinkler demand shall not be required to be hydraulically balanced with the ceiling-level sprinkler system.

20.16.1.7 Ceiling Sprinkler System.
The ceiling-level sprinkler system shall be designed based on the highest commodity hazard not protected by the criteria prescribed by 20.16.

Chapter 21 Protection of High Piled Storage Using Control Mode Density Area (CMDA) Sprinklers

21.1 General.

21.1.1
The criteria in Chapter 20 shall apply to storage protected with CMDA sprinklers.

21.1.2*
For storage applications with densities of 0.2 gpm/ft² (8.1 mm/min) or less, standard-response sprinklers with a K-factor of K-5.6 (80) or larger shall be permitted.

21.1.3
For general storage applications, rack storage, rubber tire storage, roll paper storage, and baled cotton storage being protected with upright and pendent spray sprinklers with required densities of greater than 0.2 gpm/ft² to 0.34 gpm/ft² (8.1 mm/min to 13.9 mm/min), standard-response sprinklers with a nominal K-factor of K-8.0 (115) or larger shall be used.

21.1.4
For general storage applications, rack storage, rubber tire storage, roll paper storage, and baled cotton storage being protected with upright and pendent spray sprinklers with required densities greater than 0.34 gpm/ft² (13.9 mm/min), standard-response spray sprinklers with a K-factor of K-11.2 (161) or larger that are listed for storage applications shall be used.

21.1.5*
Unless the requirements of 21.1.6 are met, the requirements of 21.1.3 and 21.1.4 shall not apply to modifications to existing storage application systems, using sprinklers with K-factors of K-8.0 (115) or less.

21.1.6
Where applying the requirements of Figure 21.5.1(b) and Figure 21.5.1(c) utilizing the design criteria of 0.6 gpm/ft² per 2000 ft² (24.4 mm/min per 186 m²) to existing storage applications, the requirements of 21.1.4 shall apply.

21.1.7
The use of quick-response spray sprinklers for storage applications shall be permitted when listed for such use.

21.1.8
The design figures indicate water demands for ordinary-temperature-rated and nominal high-temperature-rated sprinklers at the ceiling.

21.1.8.1
The ordinary-temperature design densities correspond to ordinary-temperature-rated sprinklers and shall be used for sprinklers with ordinary- and intermediate-temperature classification.

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21.1.8.2
The high-temperature design densities correspond to high-temperature-rated sprinklers and shall be used for sprinklers having a high-temperature rating.

21.1.9
Ordinary- and intermediate-temperature sprinklers with K-factors of K-11.2 (161) or larger, where listed for storage, shall be permitted to use the densities for high-temperature sprinklers.

21.1.10 Discharge Considerations.

21.1.10.1
The water supply for sprinklers only shall be determined either from the density/area requirements of Chapter 12 through Chapter 20 or shall be based upon the room design method in accordance with Section 20.8, at the discretion of the designer.

21.1.10.2
The calculations shall satisfy any single point on appropriate density/area curves.

21.1.10.3
When using the density/area method, the design area shall meet the requirements of 19.6.4.2.1.

21.1.10.4
The minimum design density shall be not less than 0.15 gpm/ft^2 (6.1 mm/min) after all adjustments are made.

21.2* Control Mode Density/Area Sprinkler Protection Criteria for Palletized, Solid-Piled, Bin Box, Shelf, or Back-to-Back Shelf Storage of Class I Through Class IV Commodities.

21.2.1
Protection for Class I through Class IV commodities in the following configurations shall be provided in accordance with this section:
(1) Nonencapsulated commodities that are solid-piled, palletized, or bin box storage up to 30 ft (9.1 m) in height

(2) Nonencapsulated commodities on shelf storage up to 15 ft (4.6 m) in height

(3) *Encapsulated commodities that are solid-piled, palletized, bin box, or shelf storage up to 15 ft (4.6 m) in height

(4) Back-to-back shelf storage up to 15 ft (4.6 m) in height

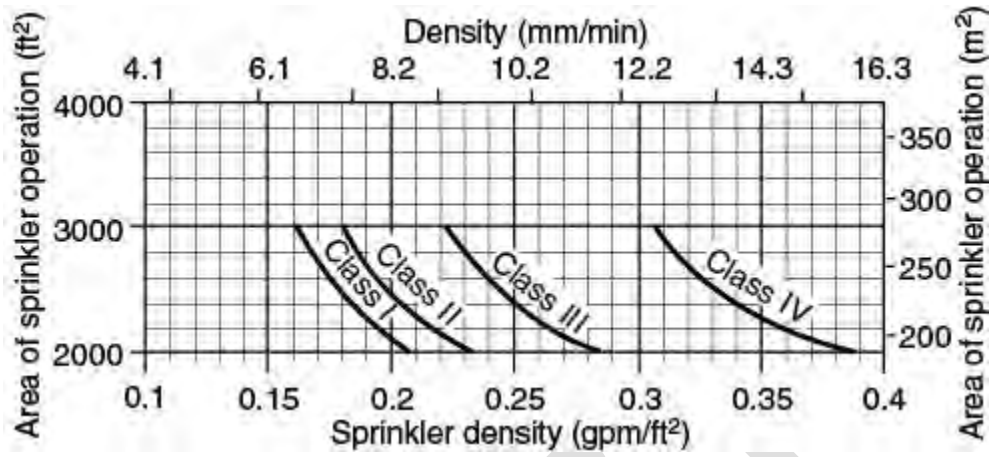
(5) Encapsulated storage of solid-piled and palletized Class I through IV commodities permitted in accordance with 21.2.3 for storage heights over 15 ft (4.6 m) up to and including 20 ft (6.1 m)

21.2.2 Protection Criteria for Palletized, Solid-Piled, Bin Box, Shelf, or Back-to-Back Shelf Storage of Class I Through Class IV Commodities Stored Over 12 ft (3.7 m) in Height.

21.2.2.1
Where using ordinary temperature–rated sprinklers, a single point shall be selected from the appropriate commodity curve on Figure 21.2.2.1.

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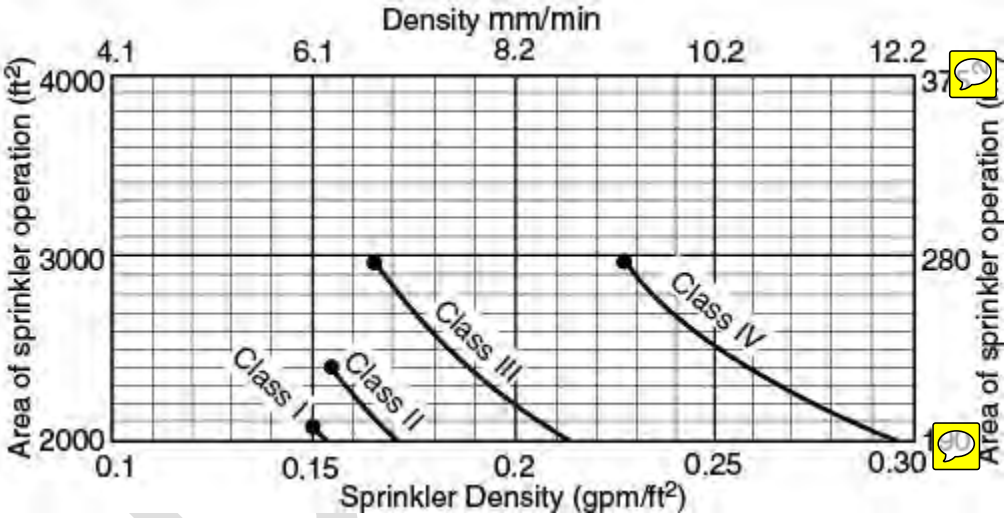
Figure 21.2.2.1 Sprinkler System Design Curves for 20 ft (6.1 m) High Storage — Ordinary Temperature–Rated Sprinklers.



21.2.2.2

Where using high temperature–rated sprinklers, a single point shall be selected from the appropriate commodity curve on Figure 21.2.2.2.

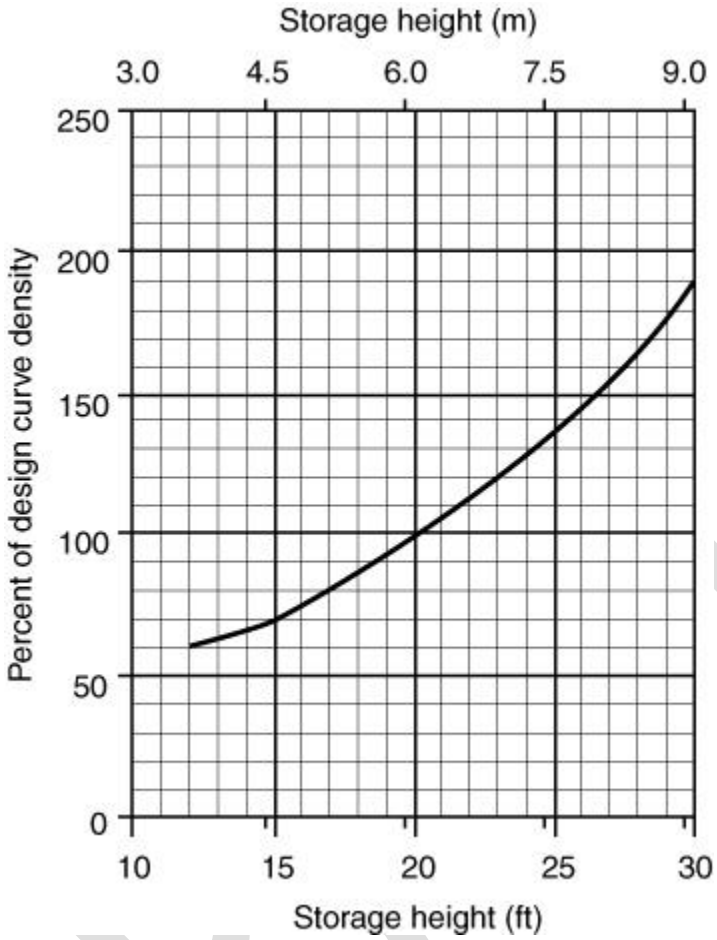
Figure 21.2.2.2 Sprinkler System Design Curves for 20 ft (6.1 m) High Storage — High Temperature–Rated Sprinklers.



21.2.2.3

The densities selected in accordance with 21.2.2.1 or 21.2.2.2 shall be modified in accordance with Figure 21.2.2.3 without revising the design area.

Figure 21.2.2.3 Ceiling Sprinkler Density vs. Storage Height.



21.2.2.4
In the case of metal bin boxes with face areas not exceeding 16 ft^2 (1.5 m^2) and metal closed shelves with face areas not exceeding 16 ft^2 (1.5 m^2), the area of application shall be permitted to be reduced by 33 percent, provided the minimum requirements of 21.2.2.5 and 21.2.2.6 are met.

21.2.2.5
For storage greater than 12 ft (3.7 m), the design density shall not be less than 0.15 gpm/ft^2 (6.1 mm/min), and the design area shall not be less than 2000 ft^2 (186 m^2) for wet systems or 2600 ft^2 (242 m^2) for dry systems for any commodity, class, or group.

21.2.2.6
For storage greater than 12 ft (3.7 m), the sprinkler design density for any given area of operation for a Class III or Class IV commodity, calculated in accordance with 21.2.2, shall not be less than the density for the corresponding area of operation for ordinary hazard Group 2.

21.2.2.7
For back-to-back shelf storage, the design density shall be taken from Figure 21.2.2.1 for storage greater than 12 ft (3.7 m) and up to 15 ft (4.6 m) with no reduction for design density referenced in Figure 21.2.2.3.

21.2.3 Encapsulated Storage Over 15 ft (4.6 m) in Height Up to and Including 20 ft (6.1 m) in Height.

21.2.3.1

Encapsulated storage over 15 ft (4.6 m) in height up to and including 20 ft (6.1 m) in height shall be limited to solid-piled and palletized storage.

21.2.3.2
Encapsulated storage over 15 ft (4.6 m) in height up to and including 20 ft (6.1 m) in height shall be protected by sprinklers with a K-factor of 11.2 (160) or larger.

21.2.3.3
Encapsulated storage over 15 ft (4.6 m) in height up to and including 20 ft (6.1 m) in height of Class I commodity shall be protected with a density/area of at least 0.46 gpm/ft^2 over 2000 ft^2 (18.7 mm/min over 186 m^2).

21.2.3.4
Encapsulated storage over 15 ft (4.6 m) in height up to and including 20 ft (6.1 m) in height of Class II commodity shall be protected with a density/area of at least 0.53 gpm/ft^2 over 2000 ft^2 (21.6 mm/min over 186 m^2).

21.2.3.5
Encapsulated storage over 15 ft (4.6 m) in height up to and including 20 ft (6.1 m) in height of Class III and Class IV commodity shall be protected with a density/area of at least 0.6 gpm/ft^2 over 2000 ft^2 (24.4 mm/min over 186 m^2).

21.2.4 Special Design for Palletized, Solid-Piled, Bin Box, or Shelf Storage of Class I Through Class IV Commodities.

21.2.4.1 Bin Box and Shelf Storage.

21.2.4.1.1
Bin box and shelf storage that is over 12 ft (3.7 m) but not in excess of the height limits of 21.2.1 and that is provided with walkways at vertical intervals of not over 12 ft (3.7 m) shall be protected with automatic sprinklers under the walkway(s).

21.2.4.1.2
Protection shall be as follows:
(1) Ceiling design density shall be based on the total height of storage within the building.

(2) Automatic sprinklers under walkways shall be designed to maintain a minimum discharge pressure of 15 psi (1.0 bar) for the most hydraulically demanding six sprinklers on each level. Walkway sprinkler demand shall not be required to be added to the ceiling sprinkler demand. Sprinklers under walkways shall not be spaced more than 8 ft (2.4 m) apart horizontally.

21.3 Control Mode Density/Area Sprinkler Protection Criteria for Palletized, Solid-Piled, Bin Box, Shelf, or Back-to-Back Shelf Storage of Plastic and Rubber Commodities.

21.3.1
Protection for plastic and rubber commodities shall be in accordance with Section 21.3. The decision tree shown in Figure 21.3.1 shall be used to determine the protection in each specific situation, subject to the following limitations:
(1) Commodities that are stored palletized, solid piled, or in bin boxes up to 25 ft (7.6 m) in height.

(2) Commodities that are stored in shelf storage up to 15 ft (4.6 m) in height.

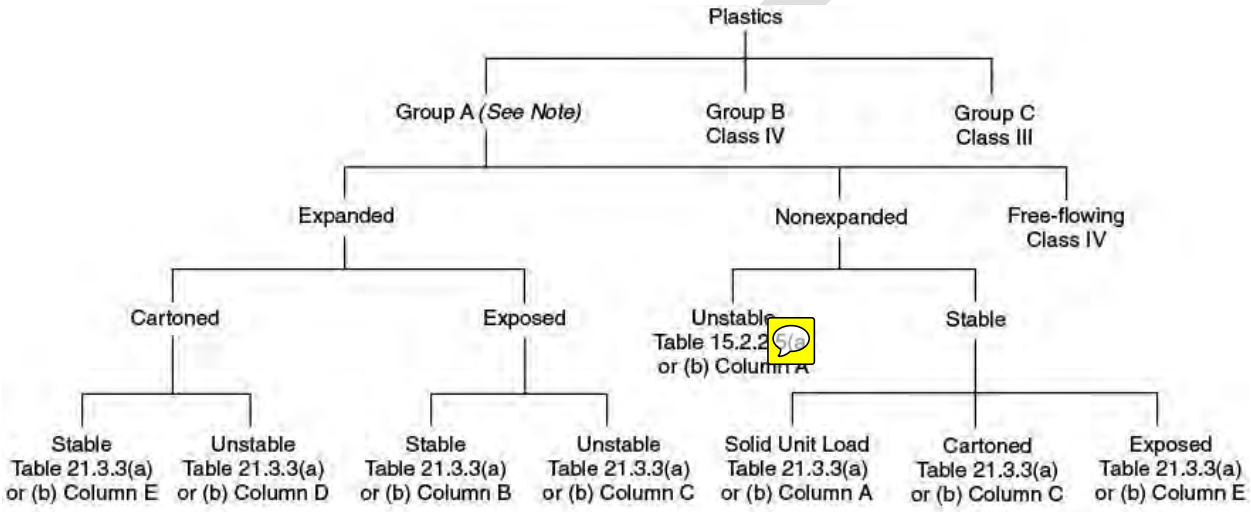
(3) Commodities that are stored using back-to-back shelf storage up to 15 ft (4.6 m) in height. The minimum aisle width shall be 60 in. (1.5 m). The design criteria shall be in accordance with Table 21.3.1. The back-to-back shelf shall have a full height solid vertical transverse barrier of ⅜ in. (10 mm) plywood or particleboard, 22 gauge sheet metal, or equivalent, from face of aisle to face of aisle, spaced at a maximum 45 ft (14 m) interval. The transverse barrier shall be permitted to terminate at the longitudinal barrier.

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Table 21.3.1 Back-to-Back Shelf Storage of Cartoned Nonexpanded Group A Plastics

Storage Height		Ceiling Height		Protection	
ft	m	ft	m		
Over 5 up to 8	1.5/2.4	Up to 14	4.3	Ordinary Hazard Group 2	
Up to 12	3.7	Up to 15	4.6	0.45 gpm/ft^2 over 2500 ft^2	18.3 mm/min/232 m^2
Up to 12	3.7	Up to 30	9.1	0.6 gpm/ft^2 over 2500 ft^2	24.4 mm/min/232 m^2
Up to 15	4.6	Up to 30	9.1	0.7 gpm/ft^2 over 2500 ft^2	28.5 mm/min/232 m^2

Figure 21.3.1 Decision Tree.



Note: Cartons that contain Group A plastic material are permitted to be treated as Class IV commodities under either of the following conditions:

(1) There are multiple layers of corrugation or equivalent outer material that would significantly delay fire involvement of the Group A plastic.

(2) The amount and arrangement of Group A plastic material within a carton with a single layer of corrugation would not be expected to significantly increase the fire hazard.

21.3.2*

Factors affecting protection requirements such as closed/open array, clearance to ceiling, and stable/unstable piles shall be applicable only to storage of Group A plastics. This decision tree also shall be used to determine protection for commodities that are not wholly Group A plastics but contain such quantities and arrangements of the same that they are deemed more hazardous than Class IV commodities.

21.3.3*

Design areas and densities for the appropriate storage configuration shall be selected from Table 21.3.3(a) or Table 21.3.3(b) as appropriate.

Table 21.3.3(a) Design Densities for Palletized, Solid-Piled, Bin Box, or Shelf Storage of Group A Plastic Commodities (U.S. Customary Units)

Maximum Storage Height (ft)	Roof/Ceiling Height (ft)	Density (gpm/ft^2)				
		A	B	C	D	E
>5 to ≤12	Up to 15	0.2	EH2	0.3	EH1	EH2

Maximum Storage Height (ft)	Roof/Ceiling Height (ft)	Density (gpm/ft²)				
		A	B	C	D	E
	>15 to 20	0.3	0.6	0.5	EH2	EH2
	>20 to 32	0.4	0.8	0.6	0.45	0.7
15	Up to 20	0.3	0.6	0.5	0.4	0.45
	>20 to 25	0.4	0.8	0.6	0.45	0.7
	>25 to 35	0.45	0.9	0.7	0.55	0.85
20	Up to 25	0.4	0.8	0.6	0.45	0.7
	>25 to 30	0.45	0.9	0.7	0.55	0.85
	>30 to 35	0.6	1.2	0.85	0.7	1.1
25	Up to 30	0.45	0.9	0.7	0.55	0.85
	>30 to 35	0.6	1.2	0.85	0.7	1.1

Notes:

(1) Minimum clearance between sprinkler deflector and top of storage shall be maintained as required.

(2) Column designations correspond to the configuration of plastics storage as follows:

A: (1) Nonexpanded, unstable

(2) Nonexpanded, stable, solid unit load

B: Expanded, exposed, stable

C: (1) Expanded, exposed, unstable

(2) Nonexpanded, stable, cartoned

D: Expanded, cartoned, unstable

E: (1) Expanded, cartoned, stable

(2) Nonexpanded, stable, exposed

(3) EH1 = Density required by Figure 13.2.1 for Curve EH1

EH2 = Density required by Figure 13.2.1 for Curve EH2

(4) Roof/ceiling height >35 ft is not permitted.

Table 21.3.3(b) Design Densities for Palletized, Solid-Piled, Bin Box, or Shelf Storage of Group A Plastic Commodities (S.I. Units)

Maximum Storage Height (m)	Roof/Ceiling Height (m)	Density (mm/min)				
		A	B	C	D	E
>1.5 to ≤3.6	Up to 4.6	8.1	EH2	12.2	EH1	EH2
	>4.6 to 6.1	12.2	24.4	20.4	EH2	EH2
	>6.1 to 9.7	16.3	32.6	24.4	18.3	28.5
4.6	Up to 6.1	12.2	24.4	20.4	16.3	18.3
	>6.1 to 7.6	16.3	32.6	24.4	18.3	28.5
	>7.6 to 11	18.3	36.7	28.5	22.4	34.6

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Maximum Storage Height (m)	Roof/Ceiling Height (m)	Density (mm/min)				
		A	B	C	D	E
6.1	Up to 7.6	16.3	32.6	24.4	18.3	28.5
	>7.6 to 9.1	18.3	36.7	28.5	22.4	34.6
	>9.1 to 11	24.4	48.9	34.6	28.5	44.8
7.6	Up to 9.1	18.3	36.7	28.5	22.4	34.6
	>9.1 to 11	24.4	48.9	34.6	28.5	44.8

Notes:

(1) Minimum clearance between sprinkler deflector and top of storage shall be maintained as required.

(2) Column designations correspond to the configuration of plastics storage as follows:

A: (1) Nonexpanded, unstable

(2) Nonexpanded, stable, solid unit load

B: Expanded, exposed, stable

C: (1) Expanded, exposed, unstable

(2) Nonexpanded, stable, cartoned

D: Expanded, cartoned, unstable

E: (1) Expanded, cartoned, stable

(2) Nonexpanded, stable, exposed

(3) EH1 = Density required by Figure 13.2.1 for Curve EH1

EH2 = Density required by Figure 13.2.1 for Curve EH2

(4) Roof/ceiling height >35 ft not permitted.

21.3.4
The ceiling-only protection criteria specified in Chapter 17 for rack storage of Group A plastic commodities shall be permitted to be used for solid-piled and palletized storage of the same commodity at the same height and clearance to ceiling.

21.3.5*
For Table 21.3.3(a) and Table 21.3.3(b), the design areas shall be as follows:
(1) The area shall be a minimum of 2500 ft^2 (232 m^2).

(2) Where Table 21.3.3(a) and Table 21.3.3(b) allow densities and areas to be selected in accordance with Curve EH1 and Curve EH2 of Figure 13.2.1, any density/area from the curves in Figure 13.2.1 shall be permitted. When selecting a point from the EH1 or EH2 density/area curves of Figure 13.2.1, the following area reductions shall be permitted:
(a) For K-8.0 (115) sprinklers used with Curve EH1, the design area shall be permitted to be reduced by 25 percent, but not below 2000 ft^2 (186 m^2), where high temperature sprinklers are used.

(b) For K-11.2 (160) or larger sprinklers, the design area shall be permitted to be reduced by 25 percent, but not below 2000 ft^2 (186 m^2), regardless of temperature rating.

(3) For closed arrays, the area shall be permitted to be reduced to 2000 ft^2 (186 m^2).

21.3.6*
Interpolation of densities between storage heights shall be permitted.

21.3.6.1

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Densities shall be based on the 2500 ft² (232 m²) design area.

21.3.6.2
Interpolation of ceiling/roof heights shall not be permitted.

21.3.7
For storage of Group A plastics between 5 ft (1.5 m) and 12 ft (3.7 m) in height, the installation requirements for extra hazard systems shall apply.

21.4 Control Mode Density/Area Sprinkler Protection Criteria for Rack Storage of Class I Through Class IV Commodities.

21.4.1 Protection Criteria for Rack Storage of Class I Through Class IV Commodities Stored Over 12 ft (3.7 m) Up to and Including 25 ft (7.6 m) in Height.

21.4.1.1*
Ceiling sprinkler water demand shall be determined in accordance with 21.4.1.2 for single- and double-row racks or 21.4.1.3 for multiple-row racks. *(See Section C.14.)*

21.4.1.2*
For single- or double-row racks for Class I, Class II, Class III, or Class IV commodities, encapsulated or nonencapsulated in single- or double-row racks, ceiling sprinkler water demand in terms of density [gpm/ft² (mm/min)] and area of sprinkler operation [ft² (m²) of ceiling or roof] shall be selected from the density/area curves of Figure 21.4.1.2(a) through Figure 21.4.1.2(e)that are appropriate for each commodity and configuration as shown in Table 21.4.1.2 and shall be modified as appropriate by 21.4.1.4. These requirements shall apply to portable racks arranged in the same manner as single- or double-row racks.

Figure 21.4.1.2(a) Sprinkler System Design Curves — 20 ft (6.1 m) High Rack Storage — Class I Nonencapsulated Commodities — Conventional Pallets

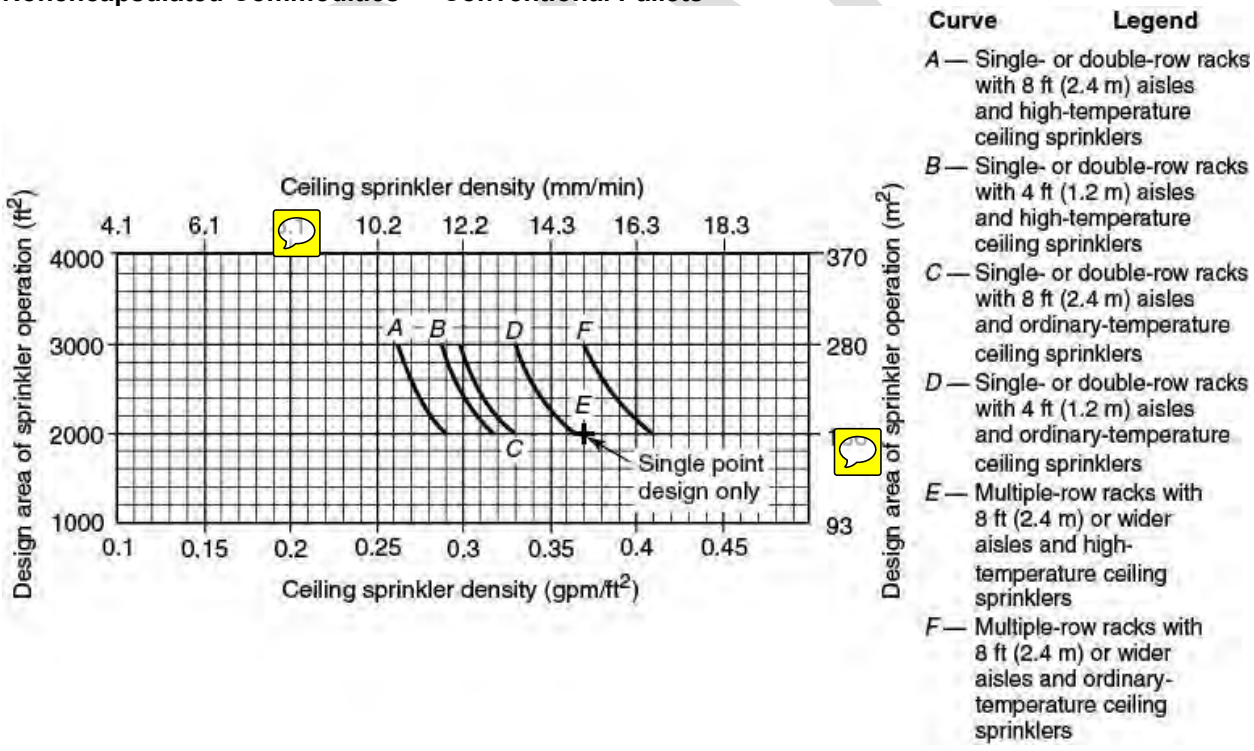


Figure 21.4.1.2(b) Sprinkler System Design Curves — 20 ft (6.1 m) High Rack Storage — Class II Nonencapsulated Commodities — Conventional Pallets.

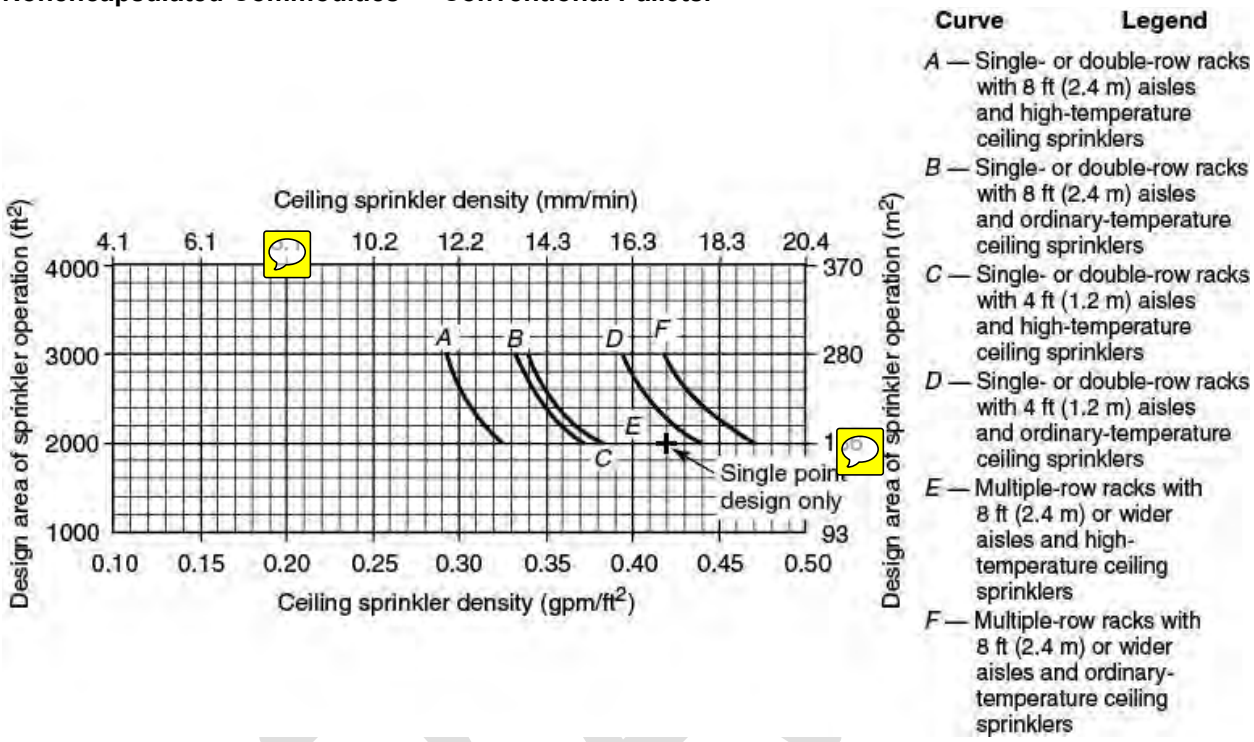


Figure 21.4.1.2(c) Sprinkler System Design Curves — 20 ft (6.1 m) High Rack Storage — Class III Nonencapsulated Commodities — Conventional Pallets.

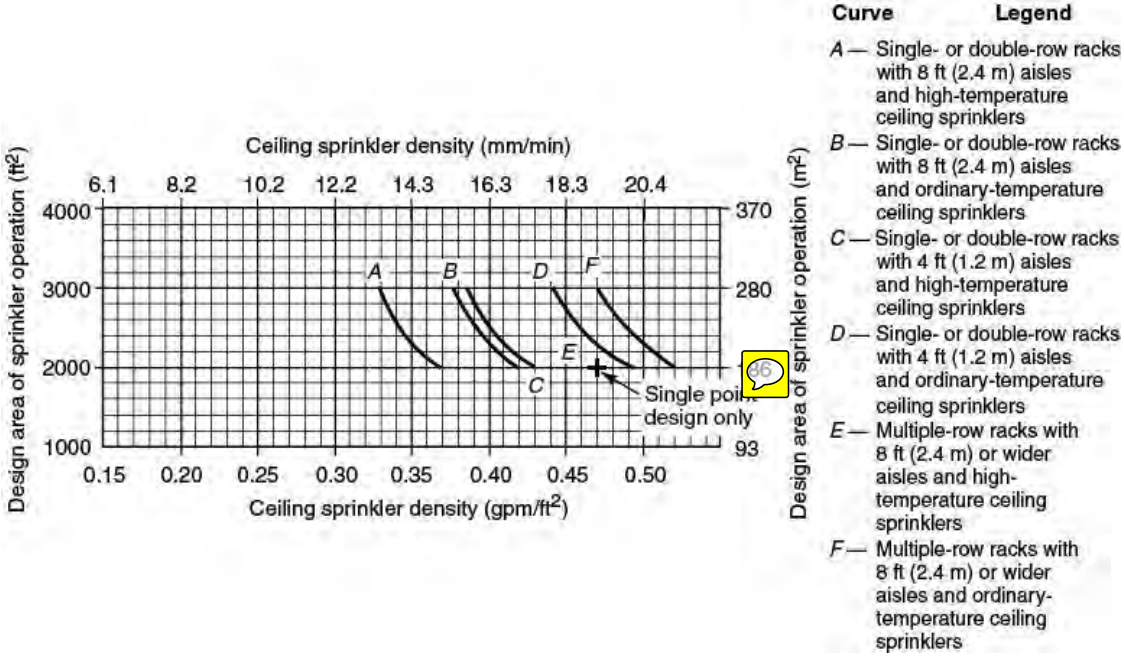
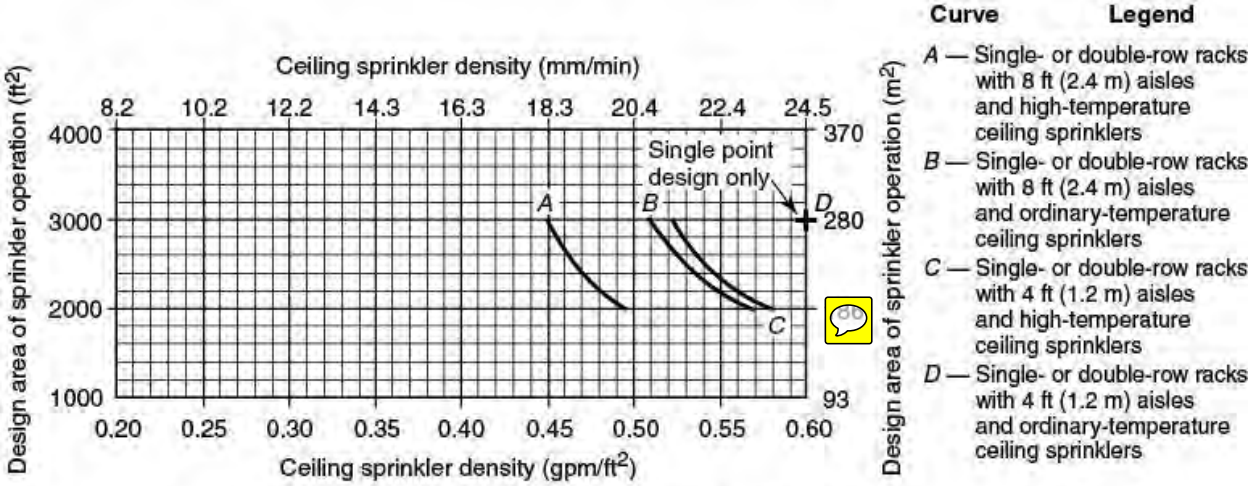


Figure 21.4.1.2(d) Sprinkler System Design Curves — 20 ft (6.1 m) High Rack Storage — Class IV Nonencapsulated Commodities — Conventional Pallets.



Note: Curves *C* and *D* also apply to ceiling sprinklers only for multiple-row rack storage up to and including 15 ft (4.6 m) high, and Figure 16.2.1.3.4.1 shall not be applied.

Figure 21.4.1.2(e) Single- or Double-Row Racks — 20 ft (6.1 m) High Rack Storage — Sprinkler System Design Curves — Class I and Class II Encapsulated Commodities — Conventional Pallets.

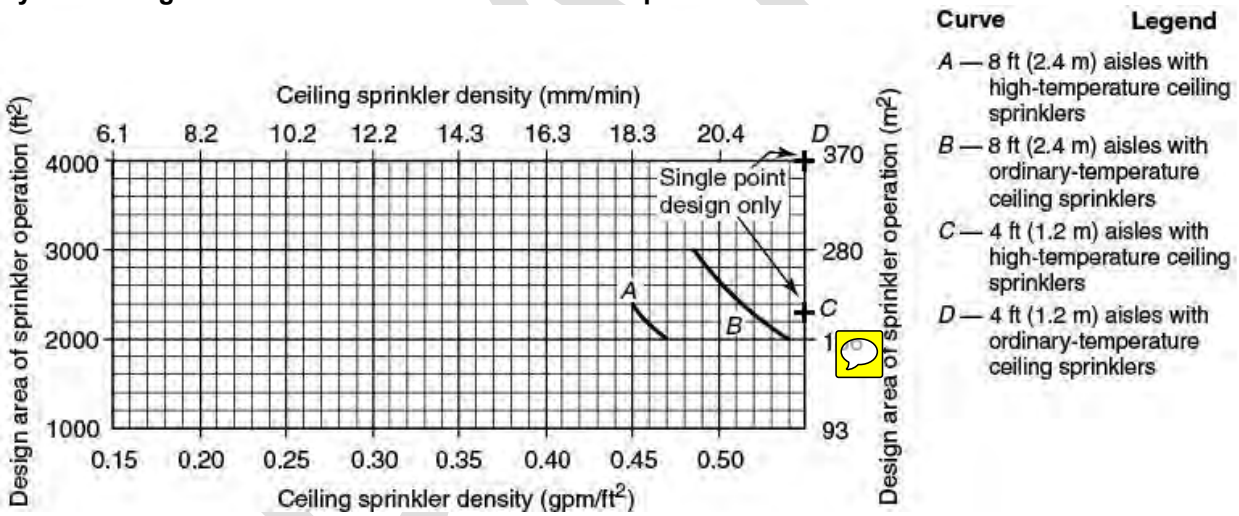


Table 21.4.1.2 Single- or Double-Row Racks — Storage Height Over 12 ft (3.7 m) Up to and Including 25 ft (7.6 m)

Height	Commodity Class	Encapsulated	Aisles*		Sprinklers Mandatory In-Rack	Ceiling Sprinkler Water Demand					
						With In-Rack Sprinklers			Without In-Rack Sprinklers		
			ft	m		Figure	Curves	Apply Figure 16.2.1.3.4.1	Figure	Curves	Apply Figure 16.2.1.3.4.1
Over 12 ft (3.7 m) up to and including 20 ft (6.1 m)	I	No	4	1.2	No	16.2.1.3.2(a)	C and D	Yes	16.2.1.3.2(a)	F and H	Yes
			8	2.4			A and B			E and G	
		Yes	4	1.2	No	16.2.1.3.2(e)	C and D		16.2.1.3.2(e)	G and H	Yes
			8	2.4			A and B			E and F	
	II	No	4	1.2	No	16.2.1.3.2(b)	C and D		16.2.1.3.2(b)	G and H	Yes
			8	2.4			A and B			E and F	
		Yes	4	1.2	No	16.2.1.3.2(e)	C and D		16.2.1.3.2(e)	G and H	Yes
			8	2.4			A and B			E and F	
	III	No	4	1.2	No	16.2.1.3.2(c)	C and D		16.2.1.3.2(c)	G and H	Yes
			8	2.4			A and B			E and F	
		Yes	4	1.2	1 level	16.2.1.3.2(f)	C and D		—	—	—
			8	2.4			A and B				

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Height	Commodity Class	Encapsulated	Aisles*		Sprinklers Mandatory In-Rack	Ceiling Sprinkler Water Demand					
						With In-Rack Sprinklers			Without In-Rack Sprinklers		
			ft	m		Figure	Curves	Apply Figure 16.2.1.3.4.1	Figure	Curves	Apply Figure 16.2.1.3.4.1
Over 20 ft (6.1 m) up to and including 22 ft (6.7 m)	IV	No	4	1.2	No	16.2.1.3.2(d)	C and D	No	16.2.1.3.2(d)	G and H	Yes
			8	2.4			A and B			E and F	
		Yes	4	1.2	1 level	16.2.1.3.2(g)	C and D		—	—	—
			8	2.4			A and B				
	I	No	4	1.2	No	16.2.1.3.2(a)	C and D		16.2.1.3.2(a)	F and H	Yes
			8	2.4			A and B			E and G	
		Yes	4	1.2	1 level	16.2.1.3.2(e)	C and D		—	—	—
			8	2.4			A and B				
	II	No	4	1.2	No	16.2.1.3.2(b)	C and D		16.2.1.3.2(b)	G and H	Yes
			8	2.4			A and B			E and F	
		Yes	4	1.2	1 level	16.2.1.3.2(e)	C and D		—	—	—
			8	2.4			A and B				
	III	No	4	1.2	No	16.2.1.3.2(c)	C and D		16.2.1.3.2(c)	G and H	Yes

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Height	Commodity Class	Encapsulated	Aisles*		Sprinklers Mandatory In-Rack	Ceiling Sprinkler Water Demand					
						With In-Rack Sprinklers			Without In-Rack Sprinklers		
			ft	m		Figure	Curves	Apply Figure 16.2.1.3.4.1	Figure	Curves	Apply Figure 16.2.1.3.4.1
			8	2.4			A and B			E and F	
		Yes	4	1.2	1 level	16.2.1.3.2(f)	C and D		—	—	—
			8	2.4			A and B				
	IV	No	4	1.2	No	16.2.1.3.2(d)	C and D		16.2.1.3.2(d)	G and H	Yes
			8	2.4			A and B			E and F	
		Yes	4	1.2	1 level	16.2.1.3.2(g)	C and D		—	—	—
			8	2.4			A and B				
Over 22 ft (6.7 m) up to and including 25 ft (7.6 m)	I	No	4	1.2	No	16.2.1.3.2(a)	C and D	No	16.2.1.3.2(a)	F and H	Yes
			8	2.4			A and B			E and G	
		Yes	4	1.2	1 level	16.2.1.3.2(e)	C and D		—	—	—
			8	2.4			A and B				
	II	No	4	1.2	No	16.2.1.3.2(b)	C and D		16.2.1.3.2(b)	G and H	Yes
			8	2.4			A and B			E and F	

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Height	Commodity Class	Encapsulated	Aisles*		Sprinklers Mandatory In-Rack	Ceiling Sprinkler Water Demand					
						With In-Rack Sprinklers			Without In-Rack Sprinklers		
			ft	m		Figure	Curves	Apply Figure 16.2.1.3.4.1	Figure	Curves	Apply Figure 16.2.1.3.4.1
		Yes	4	1.2	1 level	16.2.1.3.2(e)	C and D		—	—	—
			8	2.4			A and B				
	III	No	4	1.2	No	16.2.1.3.2(c)	C and D		16.2.1.3.2(c)	G and H	Yes
			8	2.4			A and B			E and F	
		Yes	4	1.2	1 level	16.2.1.3.2(f)	C and D		—	—	—
			8	2.4			A and B				
	IV	No	4	1.2	1 level	16.2.1.3.2(d)	C and D		—	—	—
			8	2.4			A and B				
		Yes	4	1.2		16.2.1.3.2(g)	C and D		—	—	—
			8	2.4			A and B				

*See 16.2.1.3.2.1 for interpolation of aisle widths.

21.4.1.2.1*
Design densities for single- and double-row racks shall be selected to correspond to aisle width. *(See Section C.15.)*

(A)
For aisle widths between 4 ft (1.2 m) and 8 ft (2.4 m), the rules for 4 ft (1.2 m) aisle width shall be used or direct linear interpolation between the densities shall be permitted.

(B)
The density given for 8 ft (2.4 m) wide aisles shall be applied to aisles wider than 8 ft (2.4 m).

(C)

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The density given for 4 ft (1.2 m) wide aisles shall be applied to aisles more narrow than 4 ft (1.2 m) down to 3½ ft (1.1 m).

(D)
Where aisles are more narrow than 3½ ft (1.1 m), racks shall be considered to be multiple-row racks.

21.4.1.3 Multiple-Row Racks — Storage Height Over 12 ft (3.7 m) Up to and Including 25 ft (7.6 m).

21.4.1.3.1 Multiple-Row Racks — Rack Depth Up to and Including 16 ft (4.9 m) with Aisles 8 ft (2.4 m) or Wider.
For Class I, Class II, Class III, or Class IV commodities, encapsulated or nonencapsulated, ceiling sprinkler water demand in terms of density [gpm/ft^2 (mm/min)] and area of sprinkler operation [ft^2 (m^2) of ceiling or roof] shall be selected from the density/area curves of Figure 21.4.1.2(a) through Figure 21.4.1.2(e) that are appropriate for each commodity and configuration as shown in Table 21.4.1.3.1 and shall be modified as appropriate by 21.4.1.4. The protection criteria shall apply to portable racks arranged in the same manner as multiple-row racks.

Table 21.4.1.3.1 Multiple-Row Racks — Rack Depth Up to and Including 16 ft (4.9 m), Aisles 8 ft (2.4 m) or Wider and Storage Height Over 12 ft (3.7 m) Up to 25 ft (7.6 m)

Height	Commodity Class	Encap-sulated	Sprinklers Mandatory In-Rack	Ceiling Sprinkler Water Demand							
				With In-Rack Sprinklers				Without In-Rack Sprinklers			
				Figure	Curves	Apply Figure 16.2.1.3.4.1	1.25 × Density	Figure	Curves	Apply Figure 16.2.1.3.4.1	1.25 × Density
Over 12 ft (3.7 m) up to and including 15 ft (4.6 m)	I	No	No	16.2.1.3.2(a)	C and D	Yes	No	16.2.1.3.2(a)	I and J	Yes	No
		Yes		16.2.1.3.2(a)			Yes	16.2.1.3.2(a)	I and J		Yes
	II	No		16.2.1.3.2(b)			No	16.2.1.3.2(b)	I and J	Yes	No
		Yes		16.2.1.3.2(b)			Yes	16.2.1.3.2(b)	I and J		Yes
	III	No	No	16.2.1.3.2(c)			No	16.2.1.3.2(c)	I and J	Yes	No
		Yes	1 level	16.2.1.3.2(c)			Yes		NA	NA	NA
	IV	No	No	16.2.1.3.2(d)			No	16.2.1.3.2(d)	C and D	No	No
		Yes	1 level	16.2.1.3.2(d)	A and B		1.50 × density		NA	NA	NA
Over 15 ft (4.6 m) up to	I	No	No	16.2.1.3.2(a)	C and D	Yes	No	16.2.1.3.2(a)	I and J	Yes	No
		Yes		16.2.1.3.2(a)			Yes	16.2.1.3.2(a)	I and J		Yes

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Height	Commodity Class	Encapsulated	Sprinklers Mandatory In-Rack	Ceiling Sprinkler Water Demand							
				With In-Rack Sprinklers				Without In-Rack Sprinklers			
				Figure	Curves	Apply Figure 16.2.1.3.4.1	1.25 × Density	Figure	Curves	Apply Figure 16.2.1.3.4.1	1.25 × Density
and including 20 ft (6.1 m)	II	No		16.2.1.3.2(b)			No	16.2.1.3.2(b)	I and J	Yes	No
		Yes		16.2.1.3.2(b)			Yes	16.2.1.3.2(b)	I and J		Yes
	III	No	No	16.2.1.3.2(c)			No	16.2.1.3.2(c)	I and J	Yes	No
		Yes	1 level	16.2.1.3.2(c)			Yes	NA	NA	NA	NA
	IV	No	1 level	16.2.1.3.2(d)			No				
		Yes		16.2.1.3.2(d)	A nd B		1.50 × density				
Over 20 ft (6.1 m) up to and including 25 ft (7.6 m)	I	No	No	16.2.1.3.2(a)		No	No	16.2.1.3.2(a)	I and J	Yes	No
		Yes	1 level	16.2.1.3.2(a)			Yes	NA	NA	NA	NA
	II	No	1 level	16.2.1.3.2(b)	C and D		No				
		Yes		16.2.1.3.2(b)			Yes				
	III	No		16.2.1.3.2(c)			No				
		Yes		16.2.1.3.2(c)			Yes				
	IV	No	2 levels	16.2.1.3.2(d)			No				
		Yes		16.2.1.3.2(d)	A and B		1.50 × density				

NA: Not applicable.

21.4.1.3.2 Multiple-Row Racks — Rack Depth Over 16 ft (4.9 m) or Aisles More Narrow Than 8 ft (2.4 m).

For Class I, Class II, Class III, or Class IV commodities, encapsulated or nonencapsulated, ceiling sprinkler water demand in terms of density [gpm/ft^2 (mm/min)] and area of sprinkler operation [ft^2 (m^2) of ceiling or roof] shall be selected from the density/area curves of Figure 21.4.1.2(a) through Figure 21.4.1.2(e**)** that are appropriate for each commodity and configuration as shown in Table 21.4.1.3.2 and

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shall be modified as appropriate by 21.4.1.4. The protection criteria shall apply to portable racks arranged in the same manner as multiple-row racks.

Table 21.4.1.3.2 Multiple-Row Racks — Rack Depth Over 16 ft (4.9 m) or Aisles Narrower Than 8 ft (2.4 m), Storage Height Over 12 ft (3.7 m) Up to and Including 25 ft (7.6 m)

Height	Commodity Class	Encap-sulated	Sprinklers Mandatory In-Rack	Ceiling Sprinkler Water Demand							
				With In-Rack Sprinklers				Without In-Rack Sprinklers			
				Figure	Curves	Apply Figure 16.2.1.3.4.1	1.25 × Density	Figure	Curves	Apply Figure 16.2.1.3.4.1	1.25 × Density
Over 12 ft (3.7 m) up to and including 15 ft (4.6 m)	I	No	No	16.2.1.3.2(a)	C and D	Yes	No	16.2.1.3.2(a)	I and J	Yes	No
		Yes		16.2.1.3.2(a)			Yes	16.2.1.3.2(a)	I and J		Yes
	II	No		16.2.1.3.2(b)			No	16.2.1.3.2(b)	I and J	Yes	No
		Yes		16.2.1.3.2(b)			Yes	16.2.1.3.2(b)	I and J		Yes
	III	No		16.2.1.3.2(c)			No	16.2.1.3.2(c)	I and J	Yes	No
		Yes	1 level	16.2.1.3.2(c)			Yes				
	IV	No	No	16.2.1.3.2(d)			No	16.2.1.3.2(d)	C and D	No	No
		Yes	1 level	16.2.1.3.2(d)			1.50 × density				
Over 15 ft (4.6 m) up to and including 20 ft (6.1 m)	I	No	1 level	16.2.1.3.2(a)	C and D	Yes	No	NA	NA	NA	NA
		Yes		16.2.1.3.2(a)			Yes				
	II	No		16.2.1.3.2(b)			No				
		Yes		16.2.1.3.2(b)			Yes				
	III	No		16.2.1.3.2(c)			No				
		Yes		16.2.1.3.2(c)			Yes				
	IV	No		16.2.1.3.2(d)			No				
		Yes		16.2.1.3.2(d)			1.50 ×				

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Height	Commodity Class	Encap-sulated	Sprinklers Mandatory In-Rack	Ceiling Sprinkler Water Demand							
				With In-Rack Sprinklers				Without In-Rack Sprinklers			
				Figure	Curves	Apply Figure 16.2.1.3.4.1	1.25 × Density	Figure	Curves	Apply Figure 16.2.1.3.4.1	1.25 × Density
							density				
Over 20 ft (6.1 m) up to and including 25 ft (7.6 m)	I	No	1 level	16.2.1.3.2(a)	C and D	No	No	NA	NA	NA	NA
		Yes		16.2.1.3.2(a)			Yes				
	II	No		16.2.1.3.2(b)			No				
		Yes		16.2.1.3.2(b)			Yes				
	III	No		16.2.1.3.2(c)			No				
		Yes		16.2.1.3.2(c)			Yes				
	IV	No	2 levels	16.2.1.3.2(d)			No				
		Yes		16.2.1.3.2(d)			1.50 × density				

NA: Not applicable.

21.4.1.3.3
Where Class I, Class II, and Class III commodities are encapsulated, ceiling sprinkler density shall be 25 percent greater than for nonencapsulated.

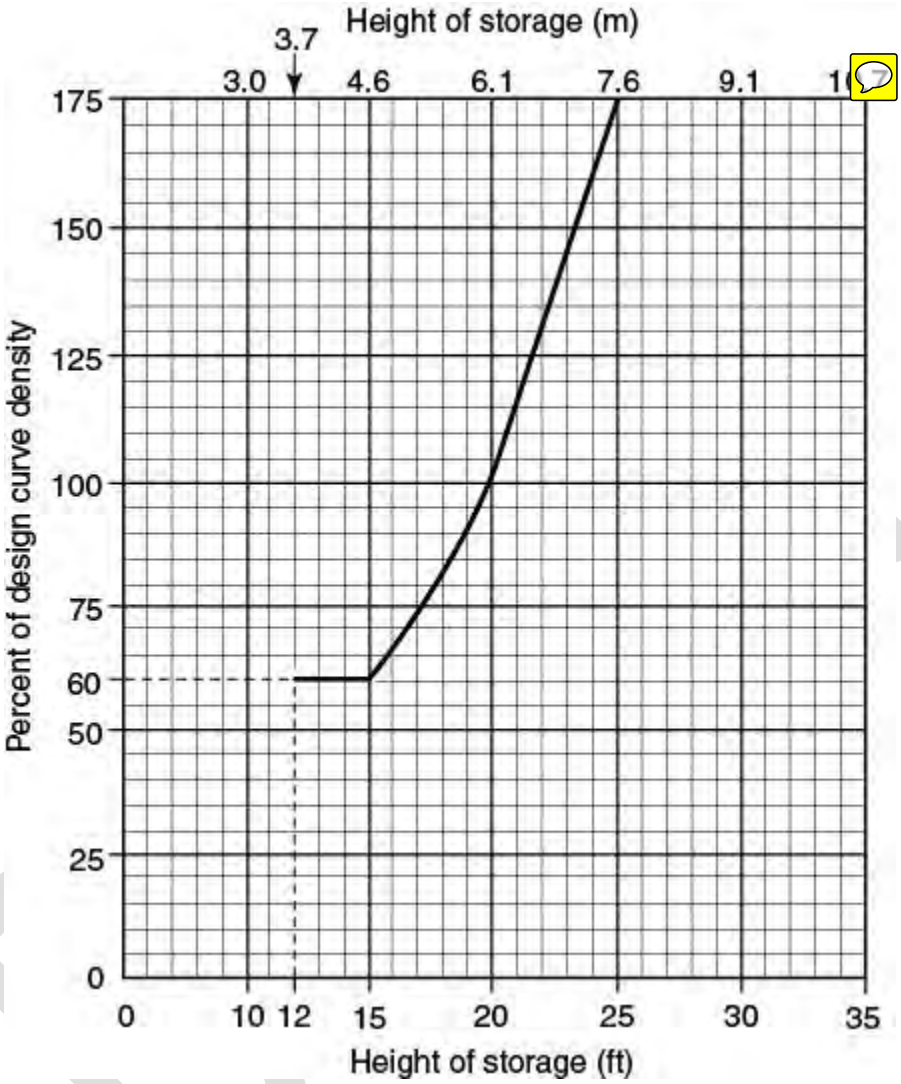
21.4.1.3.4
Where Class IV commodities are encapsulated, ceiling sprinkler density shall be 50 percent greater than for nonencapsulated.

21.4.1.4 Ceiling Sprinkler Density Adjustments.

21.4.1.4.1
For storage height over 12 ft (3.7 m) up to and including 25 ft (7.6 m) protected with ceiling sprinklers only and for storage height over 12 ft (3.7 m) up to and including 20 ft (6.1 m) protected with ceiling sprinklers and minimum required in-rack sprinklers, densities obtained from design curves shall be adjusted in accordance with Figure 21.4.1.4.1.

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Figure 21.4.1.4.1 Ceiling Sprinkler Density vs. Storage Height.



21.4.1.4.2
For storage height over 20 ft (6.1 m) up to and including 25 ft (7.6 m) protected with ceiling sprinklers and minimum required in-rack sprinklers, densities obtained from design curves shall be used. Densities shall not be adjusted in accordance with Figure 21.4.1.4.1.

21.4.1.4.3
For storage height over 12 ft (3.7 m) up to and including 20 ft (6.1 m) protected with ceiling sprinklers and with more than one level of in-rack sprinklers, but not in every tier, densities obtained from design curves and adjusted in accordance with Figure 21.4.1.4.1 shall be permitted to be reduced an additional 20 percent, as indicated in Table 21.4.1.4.3.

Table 21.4.1.4.3 Adjustment to Ceiling Sprinkler Density for Storage Height and In-Rack Sprinklers

Storage Height	In-Rack Sprinklers	Apply Figure 16.2.1.3.4.1 for Storage Height Adjustment	Permitted Ceiling Sprinklers Density Adjustments Where In-Rack Sprinklers Are Installed
Over 12 ft (3.7 m) through 25 ft (7.6 m)	None	Yes	None
Over 12 ft (3.7 m) through 20 ft (6.1 m)	Minimum required	Yes	None
	More than minimum, but not in every tier	Yes	Reduce density 20% from that of minimum in-rack sprinklers
	In every tier except above the top tier	Yes	Reduce density 40% from that of minimum in-rack sprinklers
Over 20 ft (6.1 m) through 25 ft (7.3 m)	Minimum required	No	None
	More than minimum, but not in every tier	No	Reduce density 20% from that of minimum in-rack sprinklers
	In every tier except above the top tier	No	Reduce density 40% from that of minimum in-rack sprinklers

21.4.1.4.4
For storage height over 20 ft (6.1 m) up to and including 25 ft (7.6 m) protected with ceiling sprinklers and with more than the minimum required level of in-rack sprinklers, but not in every tier, densities obtained from design curves shall be permitted to be reduced 20 percent, as indicated in Table 21.4.1.4.3. Densities shall not be adjusted in accordance with Figure 21.4.1.4.1 for storage height.

21.4.1.4.5*
For storage height over 12 ft (3.7 m) up to and including 20 ft (6.1 m) protected with ceiling sprinklers and in-rack sprinklers at each tier, densities obtained from design curves and adjusted in accordance with Figure 21.4.1.4.1 shall be permitted to be reduced an additional 40 percent, as indicated in Table 21.4.1.4.3.

21.4.1.4.6
For storage height over 20 ft (6.1 m) up to and including 25 ft (7.6 m) protected with ceiling sprinklers and in-rack sprinklers at each tier except above the top tier, densities obtained from design curves shall be permitted to be reduced 40 percent, as indicated in Table 21.4.1.4.3. Densities shall not be adjusted in accordance with Figure 21.4.1.4.1 for storage height.

21.4.1.4.7
Where solid, flat-bottom, combustible pallets (slave pallets) are used with storage height up to and including 25 ft (7.6 m), the densities that are indicated in the design curves shown in Figure 21.4.1.2(a) through Figure 21.4.1.2(e**)**, based on conventional pallets, shall be increased 20 percent for the given area.

(A)
The percentage shall be applied to the density determined in accordance with 21.4.1.4.

(B)
The increase in density shall not apply where in-rack sprinklers are utilized in the design.

21.4.2 Control Mode Density/Area Sprinkler Protection Criteria for Rack Storage of Class I Through Class IV Commodities Stored Over 25 ft (7.6 m) in Height.

21.4.2.1*

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For single- and double-row racks, the water demand for nonencapsulated storage separated by aisles at least 4 ft (1.2 m) wide and with a clearance to ceiling up to and including 10 ft (3.0 m) shall be in accordance with Table 21.4.2.1.

Table 21.4.2.1 Single- or Double-Row Racks of Class I Through Class IV Commodities Stored Over 25 ft (7.6 m) in Height with Aisles 4 ft (1.2 m) or More in Width

Commodity Class	In-Rack Sprinklers Approximate Vertical Spacing at Tier Nearest the Vertical Distance and Maximum Horizontal Spacing[a,b,c]		Figure	Maximum Storage Height	Stagger	Ceiling Sprinkler Operating Area		Ceiling Sprinkler Density Clearance to Ceiling Up to 10 ft (3 m)[g]			
								Ordinary Temperature		High Temperature	
	Longitudinal Flue[d]	Face[e,f]				ft^2	m^2	gpm/ft^2	mm/min	gpm/ft^2	mm/min
I	Vertical 20 ft (6.1 m) Horizontal 10 ft (3.0 m) under horizontal barriers	None	16.3.1.3.1.1(A)(a)	30 ft (9.1 m)	No	2000	186	0.25	10.2	0.35	14.2
	Vertical 20 ft (6.1 m) Horizontal 10 ft (3.0 m)	Vertical 20 ft (6.1 m) Horizontal 10 ft (3.0 m)	16.3.1.3.1.1(A)(b)	Higher than 25 ft (7.6 m)	Yes			0.25	10.2	0.35	14.2
I, II, III	Vertical 10 ft (3.0 m) or at 15 ft (4.6 m) and 25 ft (7.6 m)	None	16.3.1.3.1.1(A)(c)	30 ft (9.1 m)	Yes	2000	186	0.3	12.2	0.4	16.3
	Vertical 10 ft (3.0 m m) Horizontal 10 ft (3.0 m m)	Vertical 30 ft (9.1 m) Horizontal 10 ft (3.0 m)	16.3.1.3.1.1(A)(d)	Higher than 25 ft (7.6 m)	Yes			0.3	12.2	0.4	16.3
	Vertical 20 ft (6.1 m) Horizontal 10 ft (3.0 m)	Vertical 20 ft (6.1 m) Horizontal 5 ft (1.5 m)	16.3.1.3.1.1(A)(e)		Yes			0.3	12.2	0.4	16.3

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Commodity Class	In-Rack Sprinklers Approximate Vertical Spacing at Tier Nearest the Vertical Distance and Maximum Horizontal Spacing[a,b,c]		Figure	Maximum Storage Height	Stagger	Ceiling Sprinkler Operating Area		Ceiling Sprinkler Density Clearance to Ceiling Up to 10 ft (3 m)[g]			
								Ordinary Temperature		High Temperature	
	Longitudinal Flue[d]	Face[e,f]				ft²	m²	gpm/ft²	mm/min	gpm/ft²	mm/min
	Vertical 25 ft (7.6 m) Horizontal 5 ft (1.5 m)	Vertical 25 ft (7.6 m) Horizontal 5 ft (1.5 m)	16.3.1.3.1.1(A)(f)		No			0.3	12.2	0.4	16.3
	Horizontal barriers at 20 ft (6.1 m) Vertical intervals — two lines of sprinklers under barriers — maximum horizontal spacing 10 ft (3.0 m), staggered		16.3.1.3.1.1(A)(g)		Yes			0.3	12.2	0.4	16.3
I, II, III, IV	Vertical 15 ft (4.6 m) Horizontal 10 ft (3.1 m)	Vertical 20 ft (6.1 m) Horizontal 10 ft (3.0 m)	16.3.1.3.1.1(A)(h)	Higher than 25 ft (7.6 m)	Yes	2000	186	0.35	14.3	0.45	18.3
	Vertical 20 ft (6.1 m) Horizontal 5 ft (1.5 m)	Vertical 20 ft (6.1 m) Horizontal 5 ft (1.5 m)	16.3.1.3.1.1(A)(i)		No			0.35	14.2	0.45	18.3
	Horizontal barriers at 15 ft (4.6 m) Vertical intervals		16.3.1.3.1.1(A)(j)		Yes			0.35	14.2	0.45	18.3

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Commodity Class	In-Rack Sprinklers Approximate Vertical Spacing at Tier Nearest the Vertical Distance and Maximum Horizontal Spacing[a,b,c]		Figure	Maximum Storage Height	Stagger	Ceiling Sprinkler Operating Area		Ceiling Sprinkler Density Clearance to Ceiling Up to 10 ft (3 m)[g]			
								Ordinary Temperature		High Temperature	
	Longitudinal Flue[d]	Face[e,f]				ft²	m²	gpm/ft²	mm/min	gpm/ft²	mm/min
	— two lines of sprinklers under barriers — maximum horizontal spacing 10 ft (3.0 m), staggered										

[a]Minimum in-rack sprinkler discharge, 30 gpm (114 L/min).

[b]Water shields required.

[c]All in-rack sprinkler spacing dimensions start from the floor.

[d]Install sprinklers at least 3 in. (75 mm)from uprights.

[e]Face sprinklers shall not be required for a Class I commodity consisting of noncombustible products on wood pallets (without combustible containers), except for arrays shown in Figure 16.3.1.3.1.1(A)(g) and Figure 16.3.1.3.1.1(A)(j).

[f]In Figure 16.3.1.3.1.1(A)(a) through Figure 16.3.1.3.1.1(A)(j), each square represents a storage cube that measures 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. to 10 ft (450 mm to 3.0 m). Therefore, there can be one load to six or seven loads between in-rack sprinklers that are spaced 10 ft (3.0 m) apart vertically.

[g]For encapsulated commodity, increase density 25 percent.

21.4.2.1.1
Where storage as described in 21.4.2.1 is encapsulated, ceiling sprinkler density shall be 25 percent greater than for nonencapsulated storage.

21.4.2.2
For multiple-row racks, the water demand for nonencapsulated storage separated by aisles at least 4 ft (1.2 m) wide and with a clearance to ceiling up to and including 10 ft (3.0 m) shall be in accordance with Table 21.4.2.2.

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Table 21.4.2.2 Multiple-Row Racks of Class I Through Class IV Commodities Stored Over 25 ft (7.6 m) in Height

Commodity Class	Encapsulated	In-Rack Sprinklers[a,b,c]						Height Limit (ft)	Stagger	Figure	Maximum Spacing from Top of Storage to Highest In-Rack Sprinklers		Ceiling Sprinkler Operating Area		Ceiling Sprinklers Density Clearance to Ceiling Up to 10 ft			
		Maximum Vertical Spacing		Maximum Horizontal Spacing in A Flue		Maximum Horizontal Spacing across Flue									165°F (74°C) Rating		286°F (141°C) Rating	
		ft	m	ft	m	ft	m				ft	m	ft²	m²	gpm/ft²	mm/min	gpm/ft²	mm/min
I	No	20	6.1	12	3.7	10	3.0	None	Between adjacent flues	16.3.1.3.1.3(A)(a)	10	3.0	2000	186	0.25	10.2	0.35	14.3
	Yes														0.31	12.6	0.44	17.9
I, II, and III	No	15	4.6	10	3.0	10	3.0			16.3.1.3.1.3(A)(b)	10	3.0			0.30	12.2	0.40	16.3
	Yes														0.37	15.1	0.50	20.4
I, II, III, and IV	No	10	3.1	10	3.0	10	3.0			16.3.1.3.1.3(A)(c)	5	1.5			0.35	14.2	0.45	18.3
	Yes														0.44	17.9	0.56	22.8

For SI units, °C = 5/9 (°F-32); 1 gpm/ft² = 40.746 mm/min.

[a]All four rack faces shall be protected by sprinklers located within the racks and no more than 18 in. (450 mm) from the faces, as indicated in Figure 16.3.1.3.1.3(A)(a) through Figure 16.3.1.3.1.3(A)(c). It shall not be required for each sprinkler level to protect all faces.

[b]All in-rack sprinkler spacing dimensions start from the floor.

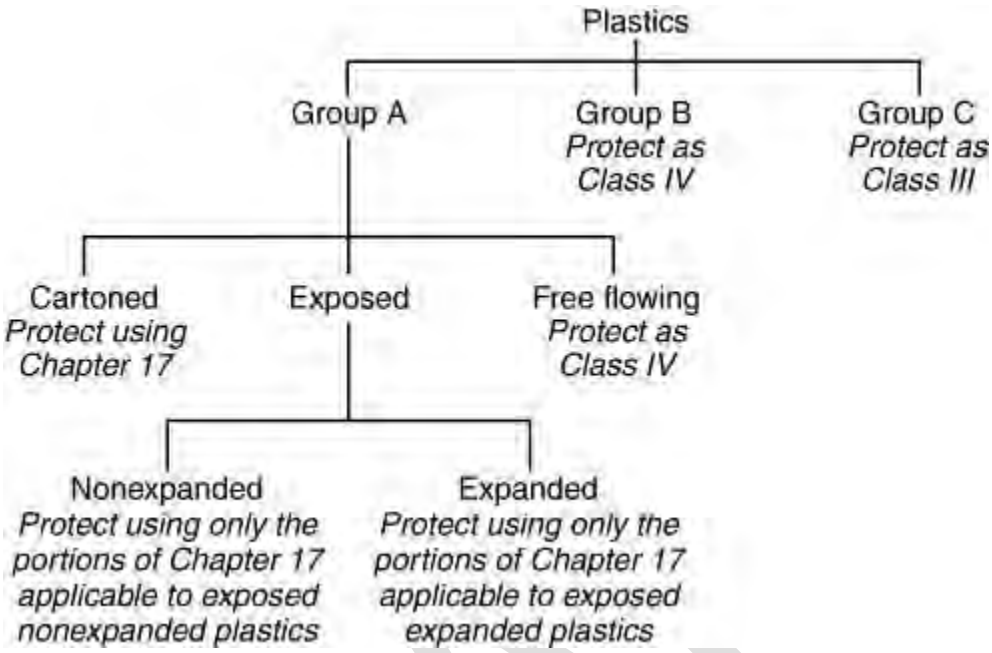
[c]In Figure 16.3.1.3.1.3(A)(a) through Figure 16.3.1.3.1.3(A)(c), each square represents a storage cube measuring 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. to 10 ft (450 mm to 3.0 m). Therefore, there could be as few as one load or as many as six or seven loads between in-rack sprinklers that are spaced 10 ft (3.1 m) apart vertically.

21.4.2.2.1
Where such storage is encapsulated, ceiling sprinkler density shall be 25 percent greater than for nonencapsulated storage.

21.5 Control Mode Density/Area Sprinkler Protection Criteria for Single-, Double-, and Multiple-Row Racks for Group A Plastic Commodities Stored Up to and Including 25 ft (7.6 m) in Height.

21.5.1
Plastic commodities shall be protected in accordance with Figure 21.5.1. *(See Section C.21.)*.

Figure 21.5.1 Decision Tree.



21.5.1.1

For Group A plastic commodities in cartons, encapsulated or nonencapsulated in single-, double-, and multiple-row racks and with a clearance to ceiling up to and including 10 ft (3.1 m), ceiling sprinkler water demand in terms of density [gpm/ft^2 (mm/min)] and area of operation [ft^2 (m^2)] shall be selected from Table 21.5.1.1.

Table 21.5.1.1 Control Mode Density/Area Sprinkler Protection Criteria for Single-, Double-, and Multiple-Row Racks for Group A Plastic Commodities Stored Up to and Including 25 ft (7.6 m) in Height

Commodity	Storage height	Maximum Clearance from Top of Storage to Ceiling	Maximum Ceiling Height	In-Racks Requirements	Ceiling Sprinklers Density Clearance to Ceiling Up to 10 ft	Ceiling Sprinkler Operating Area
	ft (m)	ft (m)	ft (m)		gpm/ft^2(mm/min)	ft^2 (m^2)
Group A plastic commodities in cartons, encapsulated	5 ft to 10 ft (1.5 m to 3.1	<5 ft (1.5 m)	<15 ft (3.1 m)	Not Required	0.30 gpm/ft^2 (12.2 mm/min)	2000 ft^2 (186 m^2)
		5 ft to 10 ft (1.5 m to 3.1 m)	20 ft (6.1 m)	Not Required	0.45 gpm/ft^2 (18.3 mm/min)	
	15 ft (4.6 m),	5 ft (1.5 m) and up	22 ft (6.7 m)	Not Required	0.45 gpm/ft^2 (18.3 mm/min)	
		Up to 10 ft (3.1 m)	25 ft (7.6 m)	Not Required	0.60 gpm/ft^2 (24.5 mm/min)	
				Figure 25.9.3.2(a)	0.30 gpm/ft^2 (12.2 mm/min)	

Commodity	Storage height	Maximum Clearance from Top of Storage to Ceiling	Maximum Ceiling Height	In-Racks Requirements	Ceiling Sprinklers Density Clearance to Ceiling Up to 10 ft	Ceiling Sprinkler Operating Area
	ft (m)	ft (m)	ft (m)		gpm/ft^2(mm/min)	ft^2 (m^2)
	20 ft (6.1 m)	<5 ft (1.5 m)	<25 ft (7.6 m)	Not Required 1,2	0.60 gpm/ft^2 (24.5 mm/min)	
				Figure 25.9.3.2(b)	0.45 gpm/ft^2 (18.3 mm/min)	
				Figure 25.9.3.2(c)	0.30 gpm/ft^2 (12.2 mm/min)	
		5 ft to 10 ft (1.5 m to 3.1 m)	27 ft (8.2 m).	Not Required 1	0.60 gpm/ft^2 (24.5 mm/min)	
			30 ft (9.1 m)	Figure 25.9.3.2(d)	0.45 gpm/ft^2 (18.3 mm/min)	
				Figure 25.9.3.2(e)	0.30 gpm/ft^2 (12.2 mm/min)	
				Figure 25.9.3.2(f)	0.30 gpm/ft^2 (12.2 mm/min)	
				Figure 25.9.3.2(g)	0.30 gpm/ft^2 (12.2 mm/min)	
	25 ft (7.6 m)	<5 ft (1.5 m)	30 ft (9.1 m)	Not Required 2	0.8 gpm/ft^2 (32.6 mm/min)	
				Figure 25.9.3.2(h)	0.45 gpm/ft^2 (18.3 mm/min)	
				Figure 25.9.3.2(i)	0.30 gpm/ft^2 (12.2 mm/min)	
		5 ft to 10 ft (1.5 m to 3.1 m)	35 ft (10.7 m)	Figure 25.9.3.2(j)	0.30 gpm/ft^2 (12.2 mm/min)	

Notes

(1) Ceiling-only protection is not permitted for this storage configuration except where K-11.2 or larger spray sprinklers listed for storage use are installed.

(2) For the protection of Single and Double Row rack only

(3) Ceiling-only protection shall not be permitted for this storage configuration except where K-16.8 spray sprinklers listed for storage use are installed

21.5.1.2
Linear interpolation of design densities and areas of application shall be permitted between storage heights with the same clearance to ceiling.

21.5.1.3
No interpolation between clearance to ceiling shall be permitted.

21.5.1.4*
An option shall be selected from Table 25.1.1 given the storage height and clearance being protected.

21.5.1.4.1

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The density/area criteria shall be applied to the ceiling sprinklers and the in-rack sprinklers shown in the option (if any) shall be provided.

21.5.1.4.2
Options that do not show multiple-row racks in the figures shall not be permitted to protect multiple-row rack storage.

21.5.1.4.3
Notes in each figure shall be permitted to clarify options or to present additional options not shown in the figures.

21.5.2
For storage of Group A plastics between 5 ft and 12 ft (1.5 m and 3.7 m) in height, the installation requirements for extra hazard systems shall apply.

21.5.3*
Exposed nonexpanded Group A plastics protected with control mode density/area sprinklers shall be protected in accordance with Table 21.5.3.
Table 21.5.3 Control Mode Density/Area Sprinkler Protection Criteria for Exposed Unexpanded Group A Plastics

Commodity	Storage height	Maximum Ceiling Height	In-Racks Requirements	Ceiling Sprinklers Density Clearance to Ceiling Up to 10 ft	Ceiling Sprinkler Operating Area
	ft (m)	ft (m)		gpm/ft^2 (mm/min)	ft^2 (m^2)
Exposed Unexpanded Group A plastic	10 ft (3.1 m)	20 ft (6.1 m)	Not Required	0.80 gpm/ft^2 (32.6 mm/min)	2500 ft^2 (232 m^2)
			Figure 25.9.3.2(a)	0.45 gpm/ft^2 (18.3 mm/min)	2000 ft^2 (186 m^2)
			Figure 25.9.3.2(b)	0.30 gpm/ft^2 (12.2 mm/min)	
	15 ft (4.6 m)	25 ft (7.6 m)	Figure 25.9.3.2(c)	0.45 gpm/ft^2 (18.3 mm/min)	
			Figure 25.9.3.2(d)	0.30 gpm/ft^2 (12.2 mm/min)	
	20 ft (6.1 m)	25 ft (7.6 m)	Figure 25.9.3.2(e)	0.60 gpm/ft^2 (24.5 mm/min)	
			Figure 25.9.3.2(f)	0.45 gpm/ft^2 (18.3 mm/min)	
		30 ft (9.1 m)	Figure 25.9.3.2(g)	0.80 gpm/ft^2 (32.6 mm/min)	1500 ft^2 (139 m^2)
			Figure 25.9.3.2(h)	0.60 gpm/ft^2 (24.5 mm/min)	
			Figure 25.9.3.2(i)	0.30 gpm/ft^2 (12.2 mm/min)	2000 ft^2 (186 m^2)
	25 ft (7.6 m)	35 ft (10.7 m)	Figure 25.9.3.2(j)	0.80 gpm/ft^2 (32.6 mm/min)	1500 ft^2 (139 m^2)
			Figure 25.9.3.2(k)	0.30 gpm/ft^2 (12.2 mm/min)	2000 ft^2 (186 m^2)

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21.5.4 Control Mode Density/Area Sprinkler Protection Criteria for Rack Storage of Group A Plastic Commodities Stored Over 25 ft (7.6 m) in Height for Single-, Double-, and Multiple-Row Racks.

21.5.4.1
Protection of Group A plastics in cartons, expanded or nonexpanded, whether encapsulated or nonencapsulated and with a clearance to ceiling up to and including 10 ft (3.1 m), shall be permitted using control mode density/area sprinklers in accordance with 21.5.4.

21.5.4.2
Protection of Group A plastics that are exposed and nonexpanded, whether encapsulated or nonencapsulated racks and with a clearance to ceiling up to and including 10 ft (3.1 m), shall be permitted only using in-rack sprinkler arrangements that are specifically permitted to be used with exposed unexpanded plastics.

21.5.4.3* Ceiling Sprinkler Water Demand.
For Group A plastic commodities, encapsulated or nonencapsulated, ceiling sprinkler water demand in terms of density [gpm/ft^2 (mm/min)] and area of operation [ft^2 (m^2)] shall be selected from Table 21.5.4.3 where in-rack sprinklers are installed per Chapter 25.

Table 21.5.4.3 Control Mode Density/Area Sprinkler Discharge Criteria for Single-, Double-, and Multiple-Row Racks of Group A Plastic Commodities with Storage Over 25 ft (7.6 m) in Height

Commodity	**Rack Type**	**Storage height above top level of in-rack sprinklers**	**In-Racks Requirements**	**Ceiling Sprinklers Density Clearance to Ceiling Up to 10 ft**	**Ceiling Sprinkler Operating Area**
	ft (m)	**ft (m)**		**gpm/ft^2 (mm/min)**	**ft2 (m^2)**
Cartoned Unexpanded and Expanded Group A plastic	Single Row and Double Row Racks	up to 5 ft (1.5 m)	Figure 21.5.5.5(a) to (c) or Figure 21.5.5.7	0.30 gpm/ft^2 (12.2 mm/min)	2000 ft^2 (186 m^2)
	Single Row and Double Row Racks	>5 ft up to 10 ft (>1.5 m up to 3.1 m)	21.5.5.5(a) to (c) or Figure 21.5.5.7	0.45 gpm/ft^2 (18.3 mm/min)	2000 ft^2 (186 m^2)
	Multiple Row Racks	up to 5 ft (1.5 m)	Figure 21.5.5.8(a) to (f)	0.30 gpm/ft^2 (12.2 mm/min)	2000 ft^2 (186 m^2)
		up to and including 10 ft (3.1 m)		0.45 gpm/ft^2 (18.3 mm/min)	2000 ft^2 (186 m^2)
Exposed Unexpanded Group A Plastic	Single Row and Double Row Racks	up to and including 10 ft (3.1 m)	Figure 21.5.5.7	0.45 gpm/ft^2 (18.3 mm/min)	2000 ft^2 (186 m^2)
		up to 5 ft (1.5m)	Figure 21.5.5.8(a) to (f)	0.30 gpm/ft^2 (12.2 mm/min)	2000 ft^2 (186 m^2)

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Commodity	Rack Type	Storage height above top level of in-rack sprinklers	In-Racks Requirements	Ceiling Sprinklers Density Clearance to Ceiling Up to 10 ft	Ceiling Sprinkler Operating Area
	ft (m)	ft (m)		gpm/ft² (mm/min)	ft2 (m²)
	Multiple Row Racks	up to and including 10 ft (3.1 m)		0.45 gpm/ft² (18.3 mm/min)	2000 ft² (186 m²)

21.5.4.4
The minimum water supply requirements for a hydraulically designed occupancy hazard fire control sprinkler system shall be determined by adding the hose stream allowance from Table 21.5.4.4 to the water supply for sprinklers determined in Section 17.3.

Table 21.5.4.4 Hose Stream Allowance and Water Supply Duration Requirements for Rack Storage of Group A Plastic Commodities Stored Over 25 ft (7.6 m) in Height

Commodity Classification	Storage Height		Inside Hose		Total Combined Inside and Outside Hose		Duration (minutes)
	ft	m	gpm	L/min	gpm	L/min	
Plastic	>25	>7.6	0, 50, or 100	0, 190, or 380	500	1900	120

21.6* Control Mode Density/Area Sprinkler Protection Criteria for Rack Storage Rubber Tires.

21.6.1 Ceiling Systems.
Protection of rubber tire storage shall be selected from Table 21.6.1(a) or Table 21.6.1(b).

Table 21.6.1(a) Protection Criteria for Rubber Tire Storage Using Control Mode Density/Area Sprinklers

Piling Method	Pile Height [ft (m)]	Sprinkler Discharge Density [gpm/ft² over mm/min over m²)] *(see Note 1)*	Areas of Application [ft²(m²)] *(see Note 1)*	
			Ordinary Temperature	High Temperature *(see Note 1)*
(1) On-floor storage	Up to 5 (1.5)	0.19 (0.72)	2000 (186)	2000 (186)
(a) Pyramid piles, on-side	Over 5 (1.5) to 12 (3.7)	0.30 (1.1)	2500 (232)	2500 (232)
(b) Other arrangements such that no horizontal channels are formed *(see Note 2)*	Over 12 (3.7) to 18 (5.5)	0.60 (2.3)	Not allowed	2500 (232)
(2) On-floor storage	Up to 5 (1.5)	0.19 (0.72)	2000 (186)	2000 (186)

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Piling Method	Pile Height [ft (m)]	Sprinkler Discharge Density [gpm/ft² over ft² mm/min over m²)] *(see Note 1)*	Areas of Application [ft²(m²)] *(see Note 1)*	
			Ordinary Temperature	High Temperature *(see Note 1)*
Tires, on-tread	Over 5 (1.5) to 12 (3.7)	0.30 (1.1)	2500 (232)	2500 (232)
(3) Palletized portable rack storage	Up to 5 (1.5)	0.19 (0.72)	2000 (186)	2000 (186)
On-side or on-tread	Over 5 (1.5) to 20 (6.1)	See Table 18.4(b)	—	—
	Over 20 (6.1) to 30 (9.1)	0.30 (1.1) plus high-expansion foam	3000 (280)	3000 (280)
(4) Palletized portable rack storage, on-side	Up to 5 (1.5)	0.19 (0.72)	2000 (186)	2000 (186)
	Over 5 (1.5) to 20 (6.1)	See Table 18.4(b)	—	—
	Over 20 (6.1) to 25 (7.6)	0.60 (2.2) and 0.90 (3.4) *(see Note 3)* or	Not allowed	5000 (465)
		0.75 (2.8) with 1-hour fire-resistive rating of roof and ceiling assembly	Not allowed	3000 (280)
			Not allowed	4000 (370)
(5) Open portable rack storage, on-side or on-tread	Up to 5 (1.5)	0.19 (0.72)	2000 (186)	2000 (186)
	Over 5 (1.5) to 12 (3.7)	0.60 (2.2)	5000 (465)	3000 (280)
	Over 12 (3.7) to 20 (6.1)	0.60 (2.2) and 0.90 (3.4) *(see Note 3)* or	Not allowed	5000 (465)
			Not allowed	3000 (280)
		0.30 (1.1) plus high-expansion foam	3000 (280)	3000 (280)
(6) Open portable rack storage, laced	Over 12 (3.7) to 20 (6.1)	0.60 (2.2) and 0.90 (3.4) *(see Notes 3 and 5)*	Not allowed	5000 (465)
			Not allowed	3000 (280)
(7) Single-, double-, and multiple-row fixed rack storage on pallets,	Up to 5 (1.5)	0.19 (0.72)	2000 (186)	2000 (186)

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Piling Method	Pile Height [ft (m)]	Sprinkler Discharge Density [gpm/ft^2 over ft^2 mm/min over m^2)] *(see Note 1)*	Areas of Application [ft^2(m^2)] *(see Note 1)*	
			Ordinary Temperature	High Temperature *(see Note 1)*
on-side, or on-tread without shelves	Over 5 (1.5) to 20 (6.1)	See Table 18.4(b) or 0.40 (1.5) plus one level in-rack sprinklers or	3000 (280)	3000 (280)
		0.30 (1.1) plus high-expansion foam	3000 (280)	3000 (280)
	Over 20 (6.1) to 30 (9.1)	0.30 (1.1) plus high-expansion foam	Not allowed	3000 (280)
(8) Single-, double-, and multiple-row fixed rack storage without pallets or shelves, on-side or on-tread	Up to 5 (1.5)	0.19 (0.72)	2000 (186)	2000 (186)
	Over 5 (1.5) to 12 (3.7)	0.60 (2.2)	5000 (465)	3000 (280)
		0.40 (1.5) plus one level in-rack sprinklers	3000 (280)	3000 (280)
		0.60 (2.2) and	Not allowed	5000 (465)
		0.90 (3.4) *(see Note 3)* or	Not allowed	3000 (280)
	Over 12 (3.7) to 20 (6.1)	0.40 (1.5) plus one level in-rack sprinklers or	3000 (280)	3000 (280)
		0.30 (1.1) plus high-expansion foam	3000 (280)	3000 (280)
	Over 20 (6.1) to 30 (9.1)	0.30 (1.1) plus high-expansion foam	Not allowed	3000 (280)

Notes:

(1) Sprinkler discharge densities and areas of application are based on a maximum clearance to ceiling of 10 ft (3.0 m) with the maximum height of storage anticipated.

(2) Laced tires on-floor, vertical stacking on-side (typical truck tires), and off-road tires. Laced tires are not stored to a significant height by this method due to the damage inflicted on the tire (i.e., bead).

(3) Water supply shall fulfill both requirements.

(4) Shelf storage of rubber tires shall be protected as solid rack shelving.

(5) This protection scheme is for use with K-16.8 (240) or larger control mode sprinklers only. Maximum clearance to ceiling can be increased to 14 ft (4.3 m) with this scheme.

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Table 21.6.1(b) Control Mode Density/Area Sprinklers System Density (gpm/ft² over ft², for Palletized Portable Rack Storage and Fixed Rack Storage of Rubber Tires with Pallets Over 5 ft (1.5 m) to 20 ft (3.7 m) in Height

Storage Height [ft (m)]	Sprinkler Temperature	
	High Temperature	Ordinary Temperature
>5 to 10 (1.5 to 3.0)	0.32/2000 (1.2/186)	0.32/2000 (1.2/186)
>10 to 12 (3.0 to 3.7)	0.39/2000 (1.5/186)	0.39/2600 (1.5/241)
>12 to 14 (3.7 to 4.3)	0.45/2000 (1.7/186)	0.45/3200 (1.7/300)
>14 to 16 (4.3 to 4.9)	0.5/2300 (1.9/214)	0.5/3700 (1.9/345)
>16 to 18 (4.9 to 5.5)	0.55/2600 (2.1/241)	0.55/4400 (2.1/410)
>18 to 20 (5.5 to 6.1)	0.6/3000 (2.3/280)	0.6/5000 (2.3/465)

21.7 Control Mode Density/Area Sprinkler Protection Criteria for Roll Paper Storage.

21.7.1
Storage of heavyweight or mediumweight classes of rolled paper up to 10 ft (3.0 m) in height shall be protected by sprinklers designed for ordinary hazard Group 2 densities.

21.7.2
Storage of tissue and lightweight classes of paper up to 10 ft (3.0 m) in height shall be protected by sprinklers in accordance with extra hazard Group 1 densities.

21.7.3
Sprinkler design criteria for storage of roll paper 10 ft (3.0 m) high and higher in buildings or structures with roof or ceilings up to 30 ft (9.1 m) shall be in accordance with Table 21.7.3(a) and Table 21.7.3(b).

Table 21.7.3(a) Control Mode Density/Area Sprinkler Protection Criteria for Roll Paper Storage for Buildings or Structures with Roof or Ceilings Up to 30 ft (Discharge Densities are gpm/ft² over ft²)

Storage Height (ft)	Ceiling (ft)	Heavyweight					Mediumweight				Tissue All Storage Arrays
		Closed Array Banded or Unbanded	Standard Array		Open Array		Closed Array Banded or Unbanded	Standard Array		Open Array Banded or Unbanded	
			Banded	Unbanded	Banded	Unbanded		Banded	Unbanded		
10	≤5	0.3/2000	0.3/2000	0.3/2000	0.3/2000	0.3/2000	0.3/2000	0.3/2000	0.3/2000	0.3/2000	0.45/2000
10	>5	0.3/2000	0.3/2000	0.3/2000	0.3/2000	0.3/2000	0.3/2000	0.3/2000	0.3/2000	0.3/2000	0.45/2500
15	≤5	0.3/2000	0.3/2000	0.3/2000	0.3/2500	0.3/3000	0.3/2000	0.3/2000	0.45/2500	0.45/2500	0.60/2000
15	>5	0.3/2000	0.3/2000	0.3/2000	0.3/3000	0.3/3500	0.3/2000	0.3/2500	0.45/3000	0.45/3000	0.60/3000
20	≤5	0.3/2000	0.3/2000	0.3/2500	0.45/3000	0.45/3500	0.3/2000	0.45/2500	0.6/2500	0.6/2500	0.75/2500
20	>5	0.3/2000	0.3/2500	0.3/3000	0.45/3500	0.45/4000	0.3/2500	0.45/3000	0.6/3000	0.6/3000	0.75/3000

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Storage Height (ft)	Ceiling (ft)	Heavyweight					Mediumweight				Tissue All Storage Arrays
		Closed Array Banded or Unbanded	Standard Array		Open Array		Closed Array Banded or Unbanded	Standard Array		Open Array Banded or Unbanded	
			Banded	Unbanded	Banded	Unbanded		Banded	Unbanded		
25	≤5	0.45/2500	0.45/3000	0.45/3500	0.6/2500	0.6/3000	0.45/3000	0.6/3000	0.75/2500	0.75/2500	*see Note 1*

Notes:

(1) Sprinkler protection requirements for tissue stored above 20 ft have not been determined.

(2) Densities or areas, or both, shall be permitted to be interpolated between any 5 ft storage height increment.

Table 21.7.3(b) Control Mode Density/Area Sprinkler Protection Criteria for the Protection of Roll Paper Storage for Buildings or Structures with Roof or Ceilings Up to 9.1 m (Discharge Densities are mm/min over m^2)

Storage Height (m)	Ceiling (m)	Heavyweight					Mediumweight				Tissue All Storage Arrays
		Closed Array Banded or Unbanded	Standard Array		Open Array		Closed Array Banded or Unbanded	Standard Array		Open Array Banded or Unbanded	
			Banded	Unbanded	Banded	Unbanded		Banded	Unbanded		
3.0	≤1.5	12.2/186	12.2/186	12.2/186	12.2/186	12.2/186	12.2/186	12.2/186	12.2/186	12.2/186	18.3/186
3.0	>1.5	12.2/186	12.2/186	12.2/186	12.2/186	12.2/186	12.2/186	12.2/186	12.2/186	12.2/186	18.3/232
4.6	≤1.5	12.2/186	12.2/186	12.2/186	12.2/232	12.2/280	12.2/186	12.2/186	18.3/232	18.3/232	24.5/186
4.6	>1.5	12.2/186	12.2/186	12.2/186	12.2/280	12.2/335	12.2/186	12.2/232	18.3/280	18.3/280	24.5/280
6.1	≤1.5	12.2/186	12.2/186	12.2/232	18.3/280	18.3/325	12.2/186	18.3/232	24.5/232	24.5/232	30.6/232
6.1	>1.5	12.2/186	12.2/186	12.2/280	18.3/325	18.3/372	12.2/232	18.3/280	24.5/280	24.5/280	30.6/280
7.6	≤1.5	18.3/232	18.3/280	18.3/325	24.5/232	24.5/280	18.3/280	24.5/280	30.6/232	30.6/232	*see Note 1*

Notes:

(1) Sprinkler protection requirements for tissue stored above 6.1 m have not been determined.

(2) Densities or areas, or both, shall be permitted to be interpolated between any 1.5 m storage height increment.

21.7.4*
High-temperature sprinklers shall be used for installations protecting roll paper stored 15 ft (4.6 m) or higher.

21.7.5

The protection area per sprinkler shall not exceed 100 ft² (9.3 m²) or be less than 70 ft² (6.5 m²).

21.7.6
Where high-expansion foam systems are installed in heavyweight class and mediumweight class storage areas, sprinkler discharge design densities shall be permitted to be reduced to not less than 0.24 gpm/ft² (9.8 mm/min) with a minimum operating area of 2000 ft² (186 m²).

21.7.7
Where high-expansion foam systems are installed in tissue storage areas, sprinkler discharge densities and areas of application shall not be reduced below those provided in Table 21.7.3(a) and Table 21.7.3(b).

21.8 Special Design for Rack Storage of Class I Through Class IV Commodities and Group A Plastics Stored Up to and Including 25 ft (7.6 m) in Height.

21.8.1 Slatted Shelves.

21.8.1.1*
Slatted rack shelves shall be considered equivalent to solid rack shelves where the shelving is not considered open rack shelving or where the requirements of 21.8.1.2 are not met. *(See Section C.20.)*

21.8.1.2
A wet pipe system that is designed to provide a minimum of 0.6 gpm/ft² (24.4 mm/min) density over a minimum area of 2000 ft² (186 m²) shall be permitted to protect single-row and double-row racks with slatted rack shelving where all of the following conditions are met:
(1) Sprinklers shall be K-11.2 (160), K-14.0 (200), or K-16.8 (240) orifice spray sprinklers with a temperature rating of ordinary, intermediate, or high and shall be listed for storage occupancies.

(2) The protected commodities shall be limited to Class I through Class IV, Group B plastics, Group C plastics, cartoned (expanded and nonexpanded) Group A plastics, and exposed (nonexpanded) Group A plastics.

(3) Slats in slatted rack shelving shall be a minimum nominal 2 in. (50 mm) thick by maximum nominal 6 in. (150 mm) wide, with the slats held in place by spacers that maintain a minimum 2 in. (50 mm) opening between each slat.

(4) Where K-11.2 (160), K-14.0 (200), or K-16.8 (240) orifice sprinklers are used, there shall be no slatted shelf levels in the rack above 12 ft (3.7 m). Open rack shelving using wire mesh shall be permitted for shelf levels above 12 ft (3.7 m).

(5) Transverse flue spaces at least 3 in. (75 mm) wide shall be provided at least every 10 ft (3.0 m) horizontally.

(6) The aisle widths shall be at least 7½ ft (2.3 m).

(7) The maximum roof height shall be 27 ft (8.2 m).

(8) The maximum storage height shall be 20 ft (6.1 m).

(9) Solid plywood or similar materials shall not be placed on the slatted shelves so that they block the 2 in. (50 mm) spaces between slats, nor shall they be placed on wire mesh shelves.

21.8.1.3 Reduced-Discharge Density.
Where high-expansion foam systems are installed in accordance with NFPA 11, a reduction in sprinkler discharge density to one-half the density specified in Table 21.6.1(a) or 0.24 gpm/ft² (9.8 mm/min), whichever is higher, shall be permitted.

21.9 Sprinkler Design Criteria for Storage and Display of Class I Through Class IV Commodities, Cartoned Nonexpanded Group A Plastics and Nonexpanded Exposed Group A Plastics in Retail Stores.

21.9.1

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A wet pipe system designed to meet two separate design points — 0.6 gpm/ft² (24.4 mm/min) density over 2000 ft² (186 m²) and 0.7 gpm/ft² (28.5 mm/min) density for the four hydraulically most demanding sprinklers with 500 gpm (1900 L/min) hose stream allowance for a 2-hour duration — shall be permitted to protect single- and double-row slatted shelf racks when the following conditions are met:
(1) An extended coverage sprinkler with a nominal K-factor of K-25.2 (360) listed for storage occupancies shall be provided.

(2) Shelves shall be either open shelving or slatted using a 2 in. (50 mm) thick by maximum 6 in. (150 mm) wide slat held in place by spacers that maintain a minimum 2 in. (50 mm) opening between each slat.

(3) There shall be no slatted shelf levels in the rack above nominal 12 ft (3.7 m) level. Wire mesh (greater than 50 percent opening) shall be permitted for shelf levels above 12 ft (3.7 m).

(4) A single level of solid shelving (3½ ft × 8 ft 3 in.) (1.1 m × 2.5 m) shall be permissible at an elevation of not more than 5 ft (1.5 m).

(5) Perforated metal (open area of 40 percent or more) shall be permitted over either the open shelving or the slatted shelves up to the 60 in. (1.5 m) level.

(6) Other than what is allowed in this section, solid plywood or similar materials shall not be placed on the slatted shelves.

(7) Solid displays shall be permissible, provided that all flues are maintained and only one display is installed per bay.

(8) Maximum roof height shall be 30 ft (9.1 m) in the protected area.

(9) Maximum storage height shall be 22 ft (6.7 m).

(10) Aisle widths shall be a minimum of 8 ft (2.4 m).

(11) Minimum transverse flue spaces of 3 in. every 10 ft (75 mm every 3.0 m) horizontally shall be provided.

(12) Minimum longitudinal flue spaces of 6 in. (150 mm) shall be provided for double-row racks.

(13) Storage in the aisle shall be permissible, provided the aisle storage is no more than 4 ft (1.2 m) high and a minimum clear aisle of 4 ft (1.2 m) is maintained.

21.9.2
A wet pipe system designed to meet two separate design points — 0.425 gpm/ft² (17.3 mm/min) density over 2000 ft² (186 m²) and 0.50 gpm/ft² (20.4 mm/min) density for the four hydraulically most demanding sprinklers with 500 gpm (1900 L/min) hose stream allowance for a 2-hour duration — shall be permitted in solid steel cantilever-style retail shelving racks (gondola racks) when the following conditions are met:
(1) An extended coverage sprinkler with a nominal K-factor of K-25.2 (360) listed for storage occupancies shall be provided.

(2) The storage height shall not exceed 12 ft (3.7 m).

(3) The ceiling height shall not exceed 22 ft (6.7 m) in the protected area.

(4) Gondola rack structure shall not exceed 48 in. (1.2 m) in aggregate depth or 78 in. (2 m) in height.

(5) A minimum aisle of 5 ft (1.5 m) between storage shall be maintained.

(6) Rack lengths shall be no more than 70 ft (21 m).

21.9.3
A wet system designed to meet two separate design points — 0.425 gpm/ft² (17.3 mm/min) density over 2000 ft² (186 m²) and 0.50 gpm/ft² (20.4 mm/min) density for the four hydraulically most demanding sprinklers with 500 gpm (1900 L/min) hose stream allowance for a 2-hour duration — shall be permitted in solid steel cantilever-style retail shelving racks (gondola racks) when the following conditions are met:
(1) An extended coverage sprinkler with a nominal K-factor of K-25.2 (360) listed for storage occupancies shall be provided.

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(2) Storage height shall not exceed 15 ft (4.6 m).

(3) Ceiling height shall not exceed 25 ft (7.6 m) in the protected area.

(4) Gondola rack structure shall not exceed 60 in. (1.5 m) aggregate depth or 8 ft (2.4 m) in height.

(5) A perforated metal deck at the 8 ft (2.4 m) level shall be permissible with storage placed on top with or without flue spaces to a maximum height from floor of 15 ft (4.6 m).

(6) Rack lengths shall not exceed 70 ft (21 m).

(7) A minimum aisle space of 6 ft (1.8 m) shall be provided.

21.9.4

A wet pipe system designed to meet two separate design points — 0.45 gpm/ft^2 (18.3 mm/min) density over 2000 ft^2 (186 m^2) and 0.55 gpm/ft^2 (22.4 mm/min) density for the four hydraulically most demanding sprinklers with 500 gpm (1900 L/min) hose stream allowance for a 2-hour duration — shall be permitted without the use of in-rack sprinklers when the following conditions are met:

(1) An extended coverage sprinkler with a nominal K-factor of K-25.2 (360) listed for storage occupancies shall be provided.

(2) Storage height shall not exceed 15 ft (4.6 m).

(3) Ceiling height shall not exceed 25 ft (7.6 m).

(4) Shelving structure shall not exceed 48 in. (1.2 m) aggregate depth or 12 ft (3.7 m) in height.

(5) Shelving shall be permitted to be made of solid particleboard.

(6) A minimum aisle space of 3 ft (900 mm) shall be maintained.

(7) Shelving length shall be a maximum of 70 ft (21 m).

21.9.5

A wet pipe system designed to meet two separate design points — 0.38 gpm/ft^2 (15.5 mm/min) density over 2000 ft^2 (186 m^2) and 0.45 gpm/ft^2 (18.3 mm/min) density for the four hydraulically most demanding sprinklers with 500 gpm (1900 L/min) hose stream allowance for a 2-hour duration — shall be permitted without the use of in-rack sprinklers in steel retail sales floor shelving racks where the following conditions are met:

(1) An extended coverage sprinkler with a nominal K-factor of K-25.2 (360) listed for storage occupancies shall be provided.

(2) Storage height shall not exceed 14 ft (4.3 m).

(3) Ceiling height shall not exceed 20 ft (6.1 m).

(4) Solid metal shelving shall be permissible up to the 72 in. (1.8 m) level and wire shelving shall be permissible up to the 10 ft (3.0 m) level.

(5) The solid metal shelving shall not exceed 66 in. (1.7 m) in aggregate depth with a 6 in. (150 mm) longitudinal flue between two 30 in. (750 mm) deep shelves.

(6) A minimum aisle space of 5 ft (1.5 m) shall be maintained.

(7) A minimum longitudinal flue of 6 in. (150 mm) shall be maintained.

(8) Rack length shall be a maximum of 70 ft (21 m).

21.9.6

A wet pipe system designed to meet two separate design points — 0.49 gpm/ft^2 (20 mm/min) density over 2000 ft^2 (186 m^2) and 0.55 gpm/ft^2 (22.4 mm/min) density for the four hydraulically most demanding sprinklers with 500 gpm (1900 L/min) hose stream allowance for a 2-hour duration — shall be permitted without the use of in-rack sprinklers in retail solid shelved steel rack structure when the following conditions are met:

(1) An extended coverage sprinkler with a nominal K-factor of K-25.2 (360) listed for storage occupancies shall be provided.

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(2) Storage height shall not exceed 16.5 ft (5 m).

(3) Ceiling height shall not exceed 22 ft (6.7 m).

(4) Shelving structure shall not exceed 51 in. (1.3) aggregate depth or 148 in. (3.7) in height.

(5) The intersection of perpendicular steel racks shall be permissible as long as no storage is placed within the void space at the junction of the racks.

(6) The top shelf shall be wire mesh.

(7) A minimum aisle width of 4 ft (1.2 m) shall be maintained between shelf units and other displays.

21.10 Control Mode Density/Area Sprinkler Protection Criteria for Baled Cotton Storage.

21.10.1
For tiered or rack storage up to a nominal 15 ft (4.6 m) in height, sprinkler discharge densities and areas of application shall be in accordance with Table 21.10.1.

Table 21.10.1 Baled Cotton Storage Up to and Including 15 ft (4.6 m)

System Type	Discharge Density per Area [gpm/ft^{2}over (ft^2 (mm/min over m^2)]		
	Tiered Storage	Rack Storage	Untiered Storage
Wet	0.25/3000 (0.95/ 0)	0.33/3000 (1.2/2)	0.15/3000 (0.57/2)
Dry	0.25/3900 (0.95/360	0.33/3900 (1.2/360	0.15/3900 (0.57/360

21.10.2
Where roof or ceiling heights would prohibit storage above a nominal 10 ft (3 m), the sprinkler discharge density shall be permitted to be reduced by 20 percent of that indicated in **Table 21.10.1** but shall not be reduced to less than 0.15 gpm/ft^2 (6.1 mm/min).

21.11 Control Mode Density/Area Sprinkler Protection Criteria for Carton Records Storage with Catwalk Access.

21.11.1
Carton records storage shall be permitted to be protected in accordance with the succeeding subsections of Section **21.11**.

21.11.2
Carton records storage shall be permitted to be supported on shelving that is a minimum of 50 percent open from approved flue space to approved flue space.

21.11.2.1
Transverse flue spaces of a nominal 6 in. (150 mm) width shall be located at each rack upright.

21.11.2.2
Rack uprights shall be installed on a maximum of 10 ft 6 in. (3.2 m) centers.

21.11.2.3
Longitudinal flues shall not be required.

21.11.3
The storage rack structure for carton records storage shall consist of either of the following:
(1) A single-row rack not greater than 72 in. (1.8 m) deep

(2) Double-row racks having a total depth of not greater than 102 in. (2.6 m) face to aisle

21.11.3.1

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Each storage rack shall be separated from other storage racks by aisles that are not less than 30 in. (750 mm) and not more than 36 in. (900 mm) in width.

21.11.3.2
Aisles used for ingress and egress shall be permitted to be up to 44 in. (1.1 m) wide when solid decking is used.

21.11.4
Catwalk aisles between racks shall be constructed of open metal grating that is at least 50 percent open.

21.11.4.1
Catwalk aisles at the ends of racks shall be permitted to be constructed of solid materials.

21.11.5
Catwalks shall be installed at a maximum of 12 ft (3.7 m) apart vertically.

21.11.6 Sprinkler Criteria.

21.11.6.1
Cartoned record storage in racks with access utilizing catwalks shall be protected in accordance with this subsection.

21.11.6.2
The design criteria for the ceiling sprinkler system shall be in accordance with Table 21.11.6.2.

Table 21.11.6.2 Ceiling Sprinkler Design Criteria for Carton Record Storage

	Up to 25 ft (7.6 m) High Storage		Over 25 ft (7.6 m) High Storage	
	Ordinary Temperature	**High Temperature**	**Ordinary Temperature**	**High Temperature**
Density				
gpm/ft^2	0.33	0.29	0.3	0.4
mm/min	13.4	11.8	12.2	16.3
Area ft^2	2000	2000	2000	2000
m^2	186	186	186	186
Hose Allowance				
(gpm)	500	500	500	500
L/m	1900	1900	1900	1900
Duration				
(hours)	2	2	2	2

21.11.6.2.1
Ceiling sprinklers spaced to cover a maximum of 100 ft^2 (9.3 m^2) shall be standard-response spray sprinklers with K-factors per Section 12.6.

21.11.6.3
Intermediate-level sprinklers shall be installed at each catwalk level in accordance with 21.11.6.3.1 through 21.11.6.3.4 and shall be quick-response, ordinary temperature, nominal K-5.6 (80), K-8.0 (115), or K-11.2 (160).

21.11.6.3.1
Intermediate-level sprinklers shall be installed in the center ±4 in. (100 mm) of each aisle below each catwalk level.

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21.11.6.3.2
Intermediate-level sprinklers shall be installed a minimum 6 in. (150 mm) above the top of storage.

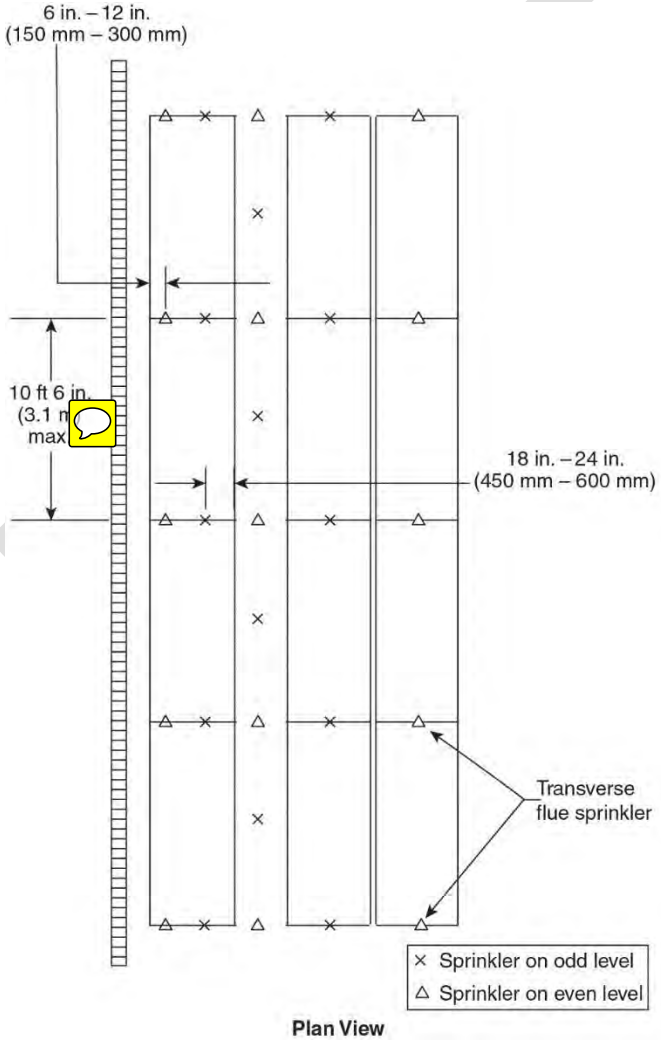
21.11.6.3.3
Sprinklers shall be supplied from the in-rack sprinkler system.

21.11.6.3.4
Spacing of sprinklers within the aisles shall be located so as to align with the transverse flues and the center of the storage unit when staggered and shall not exceed 10 ft 6 in. (3.2 m) on center.

21.11.6.3.5*
Sprinklers installed below each catwalk level shall be staggered vertically and horizontally. *[See Figure A.21.11.6.3.5(a) and Figure A.21.11.6.3.5(b).]*

21.11.6.4
Sprinklers shall be provided in transverse flue spaces in accordance with 21.11.6.4.1 through 21.11.6.4.3.1 and Figure 21.11.6.4.

Figure 21.11.6.4 Sprinkler Location and Spacing in Transverse Flues.



21.11.6.4.1
For double- and multiple-row racks, in-rack sprinklers shall be installed in the transverse flues at each catwalk level and shall be staggered vertically. For single-row racks, in-rack sprinklers shall be installed in the transverse flue at each catwalk level.

21.11.6.4.2
For double- and multiple-row racks sprinklers installed in the transverse flues shall be located not less than 18 in. (450 mm) but not greater than 24 in. (600 mm) from the face of the rack on the catwalk side.

21.11.6.4.3
For single-row racks, sprinklers installed in the transverse flues shall be staggered horizontally such that the sprinkler at first level is not less than 18 in. (450 mm) but not greater than 24 in. (600 mm m) from the face of the rack on the catwalk side.

21.11.6.4.3.1
At the next level the sprinkler in the transverse flue shall be located not less than 6 in. (150 mm) but not greater than 12 in. (300 mm) from the back face of the rack. This staggering shall be repeated throughout all catwalk levels.

21.11.6.4.4
In-rack sprinklers shall be installed a minimum 6 in. (150 mm) above the top of storage.

21.11.6.4.5
Transverse flue sprinklers shall be quick-response, ordinary temperature, nominal K-5.6 (80), K-8.0 (115), or K-11.2 (160) and installed in accordance with Figure A.21.11.6.3.5(a) and Figure A.21.11.6.3.5(b).

21.11.6.5
For multiple-level catwalk systems, a minimum of 10 sprinklers, five on each of the top two levels, shall be calculated with a minimum flow rate of 30 gpm (115 L/min) per sprinkler. Calculated sprinklers shall be the hydraulically most demanding on each level.

21.11.6.5.1
For single-level catwalks, a minimum of six sprinklers shall be calculated with a minimum flow rate at 30 gpm (115 L/min) per sprinkler. Calculated sprinklers shall be the hydraulically most demanding.

21.11.6.5.2
The in-rack sprinkler system shall be balanced in with the ceiling system.

21.12 Control Mode Density/Area Sprinkler Protection Criteria for Compact Storage of Commodities Consisting of Paper Files, Magazines, Books, and Similar Documents in Folders and Miscellaneous Supplies with No More Than 5 Percent Plastics Up to 8 ft (2.4 m) High.

21.12.1*
Compact storage modules up to 8 ft (2.4 m) high storing commodities consisting of paper files, magazines, books, and similar documents in folders and miscellaneous supplies with no more than 5 percent plastics shall be permitted to be classified as light hazard.

21.12.2
The top of the compact storage module shall be at least 18 in. (450 mm) below the sprinkler deflector.

21.12.3
Sprinklers shall be ordinary temperature, quick-response, standard spray upright or pendent.

21.12.4
The compact storage module shall be provided with minimum solid steel 24 gauge (0.63 mm) metal longitudinal barriers installed every third carriage.

21.12.5*
Solid 24 (0.63 mm) gauge metal transverse barriers shall be spaced not more than 4 ft (1.2 m) apart.

21.12.6
Compact storage module sizes shall not exceed 250 ft^2 (23.2 m^2).

21.12.6.1
The size of a module shall be defined as the area of compact storage bound by the length of the carriages times the distance between longitudinal barriers or to the outward edge of a fixed storage unit in the module, including the width of the aisle in the module.

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21.12.6.2
The lengths of the carriages shall be measured to the end of the carriages enclosed by solid metal transverse panels and separated by a minimum 28 in. (700 mm) aisle to a storage unit perpendicular to the carriage.

Chapter 22 CMSA Requirements for Storage Applications

22.1 General.

The criteria in Chapter 20 shall apply to storage protected with CMSA sprinklers.

22.1.1
Quick-response CMSA sprinklers designed to meet any criteria in Chapter 20 through Chapter 25 shall be permitted to protect any of the following:
(1) Light hazard occupancies

(2) Ordinary hazard occupancies

22.1.2
Standard-response CMSA sprinklers designed to meet any criteria in Chapter 20 through Chapter 25 shall be permitted to protect ordinary hazard occupancies.

22.1.3
When using CMSA, the design area shall meet the requirements of 23.4.4.3.1.

22.1.4
Protection shall be provided as specified in Table 22.4 or appropriate NFPA standards in terms of minimum operating pressure and the number of sprinklers to be included in the design area.

22.1.5 Open Wood Joist Construction.

22.1.5.1
Where CMSA sprinklers are installed under open wood joist construction, one of the following shall be provided:
(1) A minimum pressure of 50 psi (3.4 bar) for K-11.2 (160) sprinklers

(2) A minimum pressure of 22 psi (1.5 bar) for K-16.8 (240) sprinklers

(3) The pressure from Table 22.4 for K-19.6 (280) or larger sprinkler.

(4) The pressure from Table 22.4 for K-11.2 (160) or K-16.8 (240) where each joist channel is fully separated with material equal to the joist material to its full depth at intervals not exceeding 20 ft (6.1 m).

22.1.5.2 Preaction Systems.

22.1.5.2.1
For the purpose of using Table 22.2, preaction systems shall be classified as dry pipe systems.

22.1.5.3
Building steel shall not require special protection where Table 22.2 are applied as appropriate for the storage configuration.

22.1.5.4* Storage Conditions.
The design of the sprinkler system shall be based on those conditions that routinely or periodically exist in a building and create the greatest water demand, which include the following:
(1) Pile height

(2) Clearance to ceiling

(3) Pile stability

(4) Array

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22.1.6*
The ceiling design criteria for single-, double-, and multiple-row racks in Chapter **16** shall be based on open rack configurations as defined in 3.3.141.

22.1.7
CMSA sprinklers shall not be permitted to protect storage on solid shelf racks unless the solid shelf racks are protected with in-rack sprinklers in accordance with 16.1.6.

22.1.7.1
Where solid shelves are used, in-rack sprinklers shall be installed in every level below the highest solid shelf.

22.1.8*
Protection criteria for Group A plastics shall be permitted for the protection of the same storage height and configuration of Class I, II, III, and IV commodities.

22.2
Protection of palletized and solid-piled storage of Class I through Class IV commodities shall be in accordance with Table 22.2.

Table 22.2 CMSA Sprinkler Design Criteria for Palletized and Solid-Piled Storage of Class I Through Class IV Commodities (Encapsulated and Nonencapsulated)

Configuration	Commodity Class	Maximum Storage Height		Maximum Ceiling/Roof Height		K-Factor/ Orientation	Type of System	Number of Design Sprinklers	Minimum Operating Pressure	
		ft	m	ft	m				psi	bar
Palletized	Class I or II	20	6.1	30	9.1	25.2 (360) Pendent	Wet	15	10	0.7
				40	12.1	25.2 (360) Pendent	Wet	15	23	1.6
		25	7.6	30	9.1	11.2 (160) Upright	Wet	15	25	1.7
							Dry	25	25	1.7
						16.8 (240) Upright	Wet	15	10	0.7
							Dry	25	15	1.0
						19.6 (280) Pendent	Wet	15	16	1.1
						25.2 (360) Pendent	Wet	15	10	0.7
				35	11	11.2 (160) Upright	Wet	15	25	1.7
							Dry	25	25	1.7
						16.8 (240) Upright	Wet	15	15	1.0
							Dry	25	15	1.0
				40	12.1	25.2 (360) Pendent	Wet	15	23	1.6
		30	9.1	35	11	19.6 (280) Pendent	Wet	15	25	1.7
				40	12.1	25.2 (360) Pendent	Wet	15	23	1.6

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Configuration	Commodity Class	Maximum Storage Height		Maximum Ceiling/Roof Height		K-Factor/ Orientation	Type of System	Number of Design Sprinklers	Minimum Operating Pressure	
		ft	m	ft	m				psi	bar
		35	11	40	12	19.6 (280) Pendent	Wet	15	30	2.1
						25.2 (360) Pendent	Wet	15	23	1.6
	Class III	20	6.1	30	9.1	25.2 (360) Pendent	Wet	15	10	0.7
				40	12	25.2 (360) Pendent	Wet	15	23	1.6
		25	7.6	30	9.1	11.2 (160) Upright	Wet	15	25	1.7
							Dry	25	25	1.7
						16.8 (240) Upright	Wet	15	15	1.0
							Dry	25	15	1.0
						19.6 (280) Pendent	Wet	15	16	1.1
						25.2 (360) Pendent	Wet	15	16	1.1
				35	11	11.2 (160) Upright	Wet	15	25	1.7
							Dry	25	25	1.7
						16.8 (240) Upright	Wet	15	15	1.0
							Dry	25	15	1.0
				40	12	25.2 (360) Pendent	Wet	15	23	1.6
		30	9.1	35	11	19.6 (280) Pendent	Wet	15	25	1.7
				40	12	25.2 (360) Pendent	Wet	15	23	1.6
		35	11	40	12	19.6 (280) Pendent	Wet	15	30	2.1
				40	12	25.2 (360) Pendent	Wet	15	23	1.6
	Class IV	20	6.1	30	9.1	11.2 (160) Upright	Wet	20	25	1.7
								15	50	3.4
						16.8 (240) Upright	Wet	20	15	1.0
								15	22	1.5
						19.6 (280) Pendent	Wet	15	16	1.1

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Configuration	Commodity Class	Maximum Storage Height		Maximum Ceiling/Roof Height		K-Factor/ Orientation	Type of System	Number of Design Sprinklers	Minimum Operating Pressure	
		ft	m	ft	m				psi	bar
						25.2 (360) Pendent	Wet	15	10	0.7
				40	12	25.2 (360) Pendent	Wet	15	23	1.6
		25	7.6	30	9.1	16.8 (240) Upright	Wet	15	22	1.5
						19.6 (280) Pendent	Wet	15	16	1.1
						25.2 (360) Pendent	Wet	15	10	0.7
				40	12	25.2 (360) Pendent	Wet	15	23	1.6
		30	9.1	35	11	19.6 (280) Pendent	Wet	15	25	1.7
				40	12	25.2 (360) Pendent	Wet	15	23	1.6
		35	11	40	12	19.6 (280) Pendent	Wet	15	30	2.1
						25.2 (360) Pendent	Wet	15	23	1.6
Solid piled	Class I or II	20	6.1	30	9.1	11.2 (160) Upright	Wet	15	25	1.7
							Dry	25	25	1.7
						16.8 (240) Upright	Wet	15	10	0.7
							Dry	25	15	1.0
						19.6 (280) Pendent	Wet	15	16	1.1
						25.2 (360) Pendent	Wet	15	10	0.7
				40	12	25.2 (360) Pendent	Wet	15	23	1.6
		25	7.6	30	9.1	16.8 (240) Upright	Wet	15	10	0.7
						19.6 (280) Pendent	Wet	15	16	1.1
						25.2 (360) Pendent	Wet	15	10	0.7
				40	12	25.2 (360) Pendent	Wet	15	23	1.6

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Configuration	Commodity Class	Maximum Storage Height		Maximum Ceiling/Roof Height		K-Factor/ Orientation	Type of System	Number of Design Sprinklers	Minimum Operating Pressure	
		ft	m	ft	m				psi	bar
		30	9.1	35	11	19.6 (280) Pendent	Wet	15	25	1.7
				40	12	25.2 (360) Pendent	Wet	15	23	1.6
		35	11	40	12	19.6 (280) Pendent	Wet	15	30	2.1
						25.2 (360) Pendent	Wet	15	23	1.6
	Class III	20	6.1	30	9.1	11.2 (160) Upright	Wet	15	25	1.7
							Dry	25	25	1.7
						16.8 (240) Upright	Wet	15	15	1.0
							Dry	25	15	1.0
						19.6 (280) Pendent	Wet	15	16	1.1
						25.2 (360) Pendent	Wet	15	10	0.7
				40	12	25.2 (360) Pendent	Wet	15	23	1.6
		25	7.6	30	9.1	16.8 (240) Upright	Wet	15	22	1.5
						19.6 (280) Pendent	Wet	15	16	1.1
						25.2 (360) Pendent	Wet	15	10	0.7
				40	12	25.2 (360) Pendent	Wet	15	23	1.6
		30	9.1	35	11	19.6 (280) Pendent	Wet	15	25	1.7
				40	12	25.2 (360) Pendent	Wet	15	23	1.6
		35	11	40	12	19.6 (280) Pendent	Wet	15	30	2.1
						25.2 (360) Pendent	Wet	15	23	1.6
	Class IV	20	6.1	30	9.1	11.2 (160) Upright	Wet	15	50	3.4
						16.8 (240) Upright	Wet	15	22	1.5

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Configuration	Commodity Class	Maximum Storage Height		Maximum Ceiling/Roof Height		K-Factor/ Orientation	Type of System	Number of Design Sprinklers	Minimum Operating Pressure	
		ft	m	ft	m				psi	bar
						19.6 (280) Pendent	Wet	15	16	1.1
						25.2 (360) Pendent	Wet	15	10	0.7
				40	12	25.2 (360) Pendent	Wet	15	23	1.6
		25	7.6	30	9.1	16.8 (240) Upright	Wet	15	22	1.5
						19.6 (280) Pendent	Wet	15	16	1.1
						25.2 (360) Pendent	Wet	15	10	0.7
				40	12	25.2 (360) Pendent	Wet	15	23	1.6
		30	9.1	35	11	19.6 (280) Pendent	Wet	15	25	1.7
				40	12	25.2 (360) Pendent	Wet	15	23	1.6
		35	11	40	12	19.6 (280) Pendent	Wet	15	30	2.1
						25.2 (360) Pendent	Wet	15	23	1.6

22.3
Protection of palletized and solid-piled storage of nonexpanded and expanded Group A plastic commodities shall be in accordance with Table 22.3.

Table 22.3 CMSA Sprinkler Design Criteria for Palletized and Solid-Piled Storage of Group A Plastic Commodities

Storage Arrangement	Commodity Class	Maximum Storage Height		Maximum Ceiling/Roof Height		K-Factor/Orientation	Type of System	Number of Design Sprinklers	Minimum Operating Pressure	
		ft	m	ft	m				psi	bar
Palletized	Cartoned nonexpanded plastics	20	6.1	30	9.1	11.2 (160) Upright	Wet	25	25	1.7
						16.8 (240) Upright	Wet	15	22	1.5
						19.6 (280) Pendent	Wet	15	16	1.1
						25.2 (360) Pendent	Wet	15	10	0.7

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Storage Arrangement	Commodity Class	Maximum Storage Height		Maximum Ceiling/Roof Height		K-Factor/Orientation	Type of System	Number of Design Sprinklers	Minimum Operating Pressure	
		ft	m	ft	m				psi	bar
Solid piled	Cartoned nonexpanded plastics			40	12	25.2 (360) Pendent	Wet	15	23	1.6
		25	7.6	30	9.1	16.8 (240) Upright	Wet	15	22	1.5
						19.6 (280) Pendent	Wet	15	16	1.1
						25.2 (360) Pendent	Wet	15	10	0.7
				40	12	25.2 (360) Pendent	Wet	15	23	1.6
		30	9.1	35	11	19.6 (280) Pendent	Wet	15	25	1.7
				40	12.1	25.2 (360) Pendent	Wet	15	23	1.6
		35	11	40	12	19.6 (280) Pendent	Wet	15	30	2.1
						25.2 (360) Pendent	Wet	15	23	1.6
		20	6.1	30	9.1	11.2 (160) Upright	Wet	15	50	3.4
						16.8 (240) Upright	Wet	15	22	1.5
						19.6 (280) Pendent	Wet	15	16	1.1
						25.2 (360) Pendent	Wet	15	10	0.7
				40	12	25.2 (360) Pendent	Wet	15	23	1.6
		25	7.6	30	9.1	16.8 (240) Upright	Wet	15	22	1.5
						19.6 (280) Pendent	Wet	15	16	1.1
						25.2 (360) Pendent	Wet	15	10	0.7
				40	12	25.2 (360) Pendent	Wet	15	23	1.6
		30	9.1	35	11	19.6 (280) Pendent	Wet	15	25	1.7
				40	12	25.2 (360) Pendent	Wet	15	23	1.6
		35	11	40	12	19.6 (280) Pendent	Wet	15	30	2.1

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Storage Arrangement	Commodity Class	Maximum Storage Height		Maximum Ceiling/Roof Height		K-Factor/Orientation	Type of System	Number of Design Sprinklers	Minimum Operating Pressure	
		ft	m	ft	m				psi	bar
						25.2 (360) Pendent	Wet	15	23	1.6
Palletized	Exposed nonexpanded plastics	20	6.1	30	9.1	11.2 (160) Upright	Wet	25	25	1.7
						16.8 (240) Upright	Wet	15	22	1.5
		25	7.6	30	9.1	16.8 (240) Upright	Wet	15	22	1.5
	Cartoned or exposed expanded plastics	18	5.5	26	7.9	11.2 (160) Upright	Wet	15	50	3.4
						16.8 (240) Upright	Wet	15	22	1.5
Solid piled	Cartoned or exposed nonexpanded plastics	20	6.1	30	9.1	11.2 (160) Upright	Wet	15	50	3.4
		25	7.6	30	9.1	16.8 (240) Upright	Wet	15	22	1.5

22.4
Protection of single-, double-, and multiple-row rack storage for Class I through Class IV commodities shall be in accordance with Table 22.4.

Table 22.4 CMSA Sprinkler Design Criteria for Rack Storage of Class I Through Class IV Commodities (Encapsulated and Nonencapsulated)

Storage Arrangement	Commodity Class	Maximum Storage Height		Maximum Ceiling/Roof Height		K-Factor/ Orientation	Type of System	Number of Design Sprinklers	Minimum Operating Pressure	
		ft	m	ft	m				psi	bar
Single-, double-, and multiple-row racks (no open-top containers)	Class I or II	20	6.1	30	9.1	11.2 (160) Upright	Wet	15	25	1.7
							Dry	25	25	1.7
						16.8 (240) Upright	Wet	15	10	0.7
							Dry	25	15	1.0
						19.6 (280) Pendent	Wet	15	16	1.1
						25.2 (360) Pendent	Wet	15	10	0.7
				40	12.1	25.2 (360) Pendent	Wet	15	23	1.6
		25	7.6	30	9.1	11.2 (160) Upright	Wet	20	25	1.7
							Dry	30	25	1.7
						16.8 (240) Upright	Wet	15	10	0.7
							Dry	30	15	1.0

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Storage Arrangement	Commodity Class	Maximum Storage Height		Maximum Ceiling/Roof Height		K-Factor/ Orientation	Type of System	Number of Design Sprinklers	Minimum Operating Pressure	
		ft	m	ft	m				psi	bar
						19.6 (280) Pendent	Wet	15	16	1.1
						25.2 (360) Pendent	Wet	15	10	0.7
				40	12.1	25.2 (360) Pendent	Wet	15	23	1.6
	Class III	20	6.1	30	9.1	11.2 (160) Upright	Wet	15	25	1.7
							Dry	25	25	1.7
						16.8 (240) Upright	Wet	15	15	1.0
							Dry	25	15	1.0
						19.6 (280) Pendent	Wet	15	16	1.1
						25.2 (360) Pendent	Wet	15	10	0.7
				40	12.1	25.2 (360) Pendent	Wet	15	23	1.6
		25	7.6	30	9.1	11.2 (160) Upright	Wet	15 + 1 level of in-rack	25	1.7
							Dry	25 + 1 level of in-rack	25	1.7
						16.8 (240) Upright	Wet	15	22	1.5
							Dry	25 + 1 level of in-rack	15	1.0
						19.6 (280) Pendent	Wet	15	16	1.1
						25.2 (360) Pendent	Wet	15	10	0.7
				35	10.7	11.2 (160) Upright	Wet	15 + 1 level of in-rack	25	1.7
							Dry	25 + 1 level of in-rack	25	1.7
						16.8 (240) Upright	Wet	15 + 1 level of in-rack	15	1.0

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Storage Arrangement	Commodity Class	Maximum Storage Height		Maximum Ceiling/Roof Height		K-Factor/ Orientation	Type of System	Number of Design Sprinklers	Minimum Operating Pressure	
		ft	m	ft	m				psi	bar
							Dry	25 + 1 level of in-rack	15	1.0
						19.6 (280) Pendent	Wet	15	25	1.7
				40	12.2	19.6 (280) Pendent	Wet	15	30	2.1
						25.2 (360) Pendent	Wet	15	23	1.6
	Class IV	20	6.1	25	7.6	11.2 (160) Upright	Wet	15	50	3.4
						16.8 (240) Upright	Wet	15	22	1.5
						19.6 (280) Pendent	Wet	15	16	1.1
				30	9.1	11.2 (160) Upright	Wet	20	50	3.4
								15	75	5.2
						16.8 (240) Upright	Wet	15	22	1.5
						19.6 (280) Pendent	Wet	15	16	1.1
						25.2 (360) Pendent	Wet	15	10	0.7
				40	12.1	25.2 (360) Pendent	Wet	15	23	1.6
		25	7.6	30	9.1	11.2 (160) Upright	Wet	15 + 1 level of in-rack	50	3.4
						16.8 (240) Upright	Wet	15	22	1.5
						19.6 (280) Pendent	Wet	15	16	1.1
						25.2 (360) Pendent	Wet	15	10	0.7
				35	10.7	11.2 (160) Upright	Wet	20 + 1 level of in-rack	50	3.4
								15 + 1 level of in-rack	75	5.2

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Storage Arrangement	Commodity Class	Maximum Storage Height		Maximum Ceiling/Roof Height		K-Factor/ Orientation	Type of System	Number of Design Sprinklers	Minimum Operating Pressure	
		ft	m	ft	m				psi	bar
						16.8 (240) Upright	Wet	20 + 1 level of in-rack	22	1.5
								15 + 1 level of in-rack	35	2.4
						19.6 (280) Pendent	Wet	15	25	1.7
				40		19.6 (280) Pendent	Wet	15	30	2.1
						25.2 (360) Pendent	Wet	15	23	1.6

22.5
Protection of single-, double-, and multiple-row rack storage for nonexpanded Group A plastic commodities shall be in accordance with Table 22.5.

Table 22.5 CMSA Sprinkler Design Criteria for Single-, Double-, and Multiple-Row Racks of Group A Plastic Commodities Stored Up and Including 25 ft (7.6 m) in Height

Storage Arrangement	Commodity Class	Maximum Storage Height		Maximum Ceiling/Roof Height		K-Factor/ Orientation	Type of System	Number of Design Sprinklers	Minimum Operating Pressure	
		ft	m	ft	m				psi	bar
Single-, double-, and multiple-row racks (no open-top containers)	Cartoned nonexpanded plastics	20	6.1	25	7.6	11.2 (160) Upright	Wet	15	50	3.4
						16.8 (240) Upright	Wet	15	22	1.5
						19.6 (280) Pendent	Wet	15	16	1.1
				30	9.1	11.2 (160) Upright	Wet	30	50	3.4
							Wet	20	75	5.2
						16.8 (240) Upright	Wet	15*	22	1.5
						19.6 (280) Pendent	Wet	15	16	1.1
		25	7.6	30	9.1	11.2 (160) Upright	Wet	15 + 1 level of in-rack	50	3.4
						16.8 (240) Upright	Wet	15*	22	1.5
						19.6 (280) Pendent	Wet	15	16	1.1

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Storage Arrangement	Commodity Class	Maximum Storage Height		Maximum Ceiling/Roof Height		K-Factor/ Orientation	Type of System	Number of Design Sprinklers	Minimum Operating Pressure	
		ft	m	ft	m				psi	bar
	Exposed nonexpanded plastics	25	7.6	35	11	11.2 (160) Upright	Wet	30 + 1 level of in-rack	50	3.4
							Wet	20 + 1 level of in-rack	75	5.2
						16.8 (240) Upright	Wet	30 + 1 level of in-rack	22	1.5
							Wet	20 + 1 level of in-rack	35	2.4
						19.6 (280) Pendent	Wet	15	25	1.7
		20	6.1	25	7.6	11.2 (160) Upright	Wet	15	50	3.4
						16.8 (240) Upright	Wet	15	22	1.5
		20	6.1	30	9.1	11.2 (160) Upright	Wet	30	50	3.4
							Wet	20	75	5.2
						16.8 (240) Upright	Wet	15*	22	1.5
		25	7.6	30	9.1	11.2 (160) Upright	Wet	15 + 1 level of in-rack	50	3.4
						16.8 (240) Upright	Wet	15*	22	1.5
		25	7.6	35	11	11.2 (160) Upright	Wet	30 + 1 level of in-rack	50	3.4
							Wet	20 + 1 level of in-rack	75	5.2
						16.8 (240) Upright	Wet	30 + 1 level of in-rack	22	1.5
							Wet	20 + 1 level of in-rack	35	2.4

*Minimum 8 ft (2.4 m) aisle.

22.6 Rubber Tires.

Protection of rubber tires with CMSA sprinklers shall be in accordance with Table 22.6.

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22.7 Roll Paper Storage.
Protection of roll paper storage with CMSA sprinklers shall be in accordance withTable 22.7.

Table 22.7 Protection of Roll Paper Storage [Number of Sprinklers at Operating Pressure, psi (bar)]

Storage Height		Maximum Building Height		Nominal K-Factor	Type of System	Heavyweight					Mediumweight					Tissue All Storage Arrays
						Closed Array	Standard Array		Open Array		Closed Array	Standard Array		Open Array		
ft	m	ft	m			Banded or Unbanded	Banded	Unbanded	Banded	Unbanded	Banded or Unbanded	Banded	Unbanded	Banded	Unbanded	
20	6.1	30	9.1	11.2 (160)	Wet	15 at 50(3.4)	15 at 50(3.4)	15 at 50(3.4)	15 at 50(3.4)	NA	15 at 50(3.4)	15 at 50(3.4)	15 at 50(3.4)	NA	NA	See Note
20	6.1	30	9.1	11.2 (160)	Dry	25 at 50(3.4)	25 at 50(3.4)	25 at 50(3.4)	NA	NA	25 at 50(3.4)	25 at 50(3.4)	25 at 50(3.4)	NA	NA	NA
26	7.9	60	18	11.2 (160)	Wet	15 at 50(3.4)	15 at 50(3.4)	15 at 50(3.4)	15 at 50(3.4)	NA	NA	NA	NA	NA	NA	NA
20	6.1	30	9.1	16.8 (240)	Wet	15 at 22(1.5)	15 at 22(1.5)	15 at 22(1.5)	15 at 22(1.5)	NA	15 at 22(1.5)	15 at 22(1.5)	15 at 22(1.5)	NA	NA	See Note
20	6.1	30	9.1	16.8 (240)	Dry	25 at 22(1.5)	25 at 22(1.5)	25 at 22(1.5)	NA	NA	25 at 22(1.5)	25 at 22(1.5)	25 at 22(1.5)	NA	NA	NA
26	7.9	60	18	16.8 (240)	Wet	15 at 22(1.5)	15 at 22(1.5)	15 at 22(1.5)	15 at 22(1.5)	NA	NA	NA	NA	NA	NA	NA

Note: Base design on 25 AS at 75 psi (5.2 bar) for K-11.2 (160) sprinklers or 25 AS at 35 psi (240) for K-16.8 (240) sprinklers when storage is in closed or standard array; other arrays NA.

NA: Not applicable.

Chapter 23 ESFR Requirements for Storage Applications

23.1 General.
The criteria in Chapter 20 shall apply to storage protected with ESFR sprinklers.

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23.1.1
ESFR sprinklers designed to meet any criteria in this chapter shall be permitted to protect any of the following:
(1) Light hazard occupancies

(2) Ordinary hazard occupancies

(3) Any storage arrangement OH1, OH2, EH1, and EH2 design criteria

23.1.2 Draft Curtains.

23.1.2.1
Where ESFR sprinkler systems are installed adjacent to sprinkler systems with standard-response sprinklers, a draft curtain of noncombustible construction and at least 2 ft (600 mm) in depth shall be required to separate the two areas.

23.1.2.2
A clear aisle of at least 4 ft (1.2 m) centered below the draft curtain shall be maintained for separation.

23.1.2.3 Temperature Ratings.
Sprinkler temperature ratings for ESFR sprinklers shall be ordinary unless 8.3.2 requires intermediate- or high-temperature ratings.

23.1.3
ESFR sprinkler systems shall be designed such that the minimum operating pressure is not less than that indicated in Table 23.3.1 for commodity, storage height, and building height involved.

23.1.4
The ceiling design criteria for single-, double-, and multiple-row racks in Chapter 23 shall be based on open rack configurations as defined in 3.9.3.7.4.

23.1.4.1
ESFR sprinklers shall not be permitted to protect storage on solid shelf racks unless the solid shelf racks are protected with in-rack sprinklers in accordance with Chapter 25.

23.1.4.2
ESFR sprinklers shall not be permitted to protect storage on solid shelf racks unless the solid shelf racks are protected with in-rack sprinklers in accordance with 16.1.6.

23.1.4.2.1
Where solid shelves are used, in-rack sprinklers shall be installed in every level below the highest solid shelf.

23.1.4.3
ESFR sprinklers shall not be permitted to protect storage with open top containers.

23.1.4.4
ESFR sprinkler systems shall be designed such that the minimum operating pressure is not less than that indicated in Table 23.5.1 for type of storage, commodity, storage height, and building height involved.

23.2 ESFR Design Criteria.
ESFR design criteria shall be selected from Section 23.3 through Section 23.13.

23.3 Early Suppression Fast-Response (ESFR) Sprinklers for Palletized or Solid-Piled Storage of Class I Through Class IV Commodities.

23.3.1
Protection of palletized and solid-piled storage of Class I through Class IV commodities shall be in accordance with Table 23.3.1.

Table 23.3.1 ESFR Protection of Palletized and Solid-Piled Storage of Class I Through Class IV Commodities

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Commodity	Maximum Storage Height		Maximum Ceiling/Roof Height		Nominal K-Factor	Orientation	Minimum Operating Pressure	
	ft	m	ft	m			psi	bar
Class I, II, III, or IV, encapsulated and nonencapsulated (no open-top containers)	20	6.1	25	7.6	14.0 (200)	Upright/ pendent	50	3.4
					16.8 (240)	Upright/ pendent	35	2.4
					22.4 (320)	Pendent	25	1.7
					25.2 (360)	Pendent	15	1.0
	25	7.6	30	9.1	14.0 (200)	Upright/ pendent	50	3.4
					16.8 (240)	Upright/ pendent	35	2.4
					22.4 (320)	Pendent	25	1.7
					25.2 (360)	Pendent	15	1.0
			32	10	14.0 (200)	Upright/ pendent	60	4.1
					16.8 (240)	Upright/pendent	42	2.9
	30	9.1	35	11	14.0 (200)	Upright/ pendent	75	5.2
					16.8 (240)	Upright/ pendent	52	3.6
					22.4 (320)	Pendent	35	2.4
					25.2 (360)	Pendent	20	1.4
	35	11	40	12	16.8 (240)	Pendent	52	3.6
					22.4 (320)	Pendent	40	2.7
					25.2 (360)	Pendent	25	1.7
	35	11	45	14	22.4 (320)	Pendent	40	2.7
					25.2 (360)	Pendent	40	2.7
	40	12	45	14	22.4 (320)	Pendent	40	2.7
					25.2 (360)	Pendent	40	2.7

23.4 Early Suppression Fast-Response (ESFR) Sprinklers for Palletized or Solid-Piled Storage of Group A Plastic Commodities.

23.4.1* Storage Conditions.
The design of the sprinkler system shall be based on those conditions that routinely or periodically exist in a building and create the greatest water demand, which include the following:

(1) Pile height

(2) Clearance to ceiling

(3) Pile stability

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(4) Array

23.4.2
Protection of palletized and solid-piled storage of cartoned or exposed nonexpanded plastic and cartoned expanded or exposed expanded plastic shall be in accordance with Table 23.4.2.

Table 23.4.2 ESFR Protection of Palletized and Solid-Piled Storage of Group A Plastic Commodities

Storage Arrangement	Commodity	Maximum Storage Height		Maximum Ceiling/Roof Height		Nominal K-Factor	Orientation	Minimum Operating Pressure	
		ft	m	ft	m			psi	bar
Palletized and solid-piled storage (no open-top containers)	Cartoned nonexpanded plastic	20	6.1	25	7.6	14.0 (200)	Upright/ pendent	50	3.4
						16.8 (240)	Upright/ pendent	35	2.4
						22.4 (320)	Pendent	25	1.7
						25.2 (360)	Pendent	15	1.0
				30	9.1	14.0 (200)	Upright/ pendent	50	3.4
						16.8 (240)	Upright/ pendent	35	2.4
						22.4 (320)	Pendent	25	1.7
						25.2 (360)	Pendent	15	1.0
				35	11	14.0 (200)	Upright/ pendent	75	5.2
						16.8 (240)	Upright/ pendent	52	3.6
						22.4 (320)	Pendent	35	2.4
						25.2 (360)	Pendent	20	1.4
				40	12	16.8 (240)	Pendent	52	3.6
						22.4 (320)	Pendent	40	2.7
						25.2 (360)	Pendent	25	1.7
				45	14	22.4 (320)	Pendent	40	2.7

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Storage Arrangement	Commodity	Maximum Storage Height		Maximum Ceiling/Roof Height		Nominal K-Factor	Orientation	Minimum Operating Pressure	
		ft	m	ft	m			psi	bar
						25.2 (360)	Pendent	40	2.7
		25	7.6	30	9.1	14.0 (200)	Upright/ pendent	50	3.4
						16.8 (240)	Upright/ pendent	35	2.4
						22.4 (320)	Pendent	25	1.7
						25.2 (360)	Pendent	15	1.0
				32	10	14.0 (200)	Upright/ pendent	60	4.1
						16.8 (240)	Upright/ pendent	42	2.9
				35	11	14.0 (200)	Upright or pendent	75	5.2
						16.8 (240)	Upright/ pendent	52	3.6
						22.4 (320)	Pendent	35	2.4
						25.2 (360)	Pendent	20	1.4
				40	12	16.8 (240)	Pendent	52	3.6
						22.4 (320)	Pendent	40	2.7
						25.2 (360)	Pendent	25	1.7
				45	14	22.4 (320)	Pendent	40	2.7
						25.2 (360)	Pendent	40	2.7
		30	9.1	35	11	14.0 (200)	Upright/ pendent	75	5.2
						16.8 (240)	Upright/ pendent	52	3.6
						22.4 (320)	Pendent	35	2.4

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Storage Arrangement	Commodity	Maximum Storage Height		Maximum Ceiling/Roof Height		Nominal K-Factor	Orientation	Minimum Operating Pressure	
		ft	m	ft	m			psi	bar
						25.2 (360)	Pendent	20	1.4
				40	12	16.8 (240)	Pendent	52	3.6
						22.4 (320)	Pendent	40	2.7
						25.2 (360)	Pendent	25	1.7
				45	14	22.4 (320)	Pendent	40	2.7
						25.2 (360)	Pendent	40	2.7
		35	10.7	40	12	16.8 (240)	Pendent	52	3.6
						22.4 (320)	Pendent	40	2.7
						25.2 (360)	Pendent	25	1.7
				45	14	22.4 (320)	Pendent	40	2.7
						25.2 (360)	Pendent	40	2.7
		40	12.2	45	14	22.4 (320)	Pendent	40	2.7
						25.2 (360)	Pendent	40	2.7
	Exposed nonexpanded plastic	20	6.1	25	7.6	14.0 (200)	Pendent	50	3.4
						16.8 (240)	Pendent	35	2.4
				30	9.1	14.0 (200)	Pendent	50	3.4
						16.8 (240)	Pendent	35	2.4
				35	11	14.0 (200)	Pendent	75	5.2
						16.8 (240)	Pendent	52	3.6

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Storage Arrangement	Commodity	Maximum Storage Height		Maximum Ceiling/Roof Height		Nominal K-Factor	Orientation	Minimum Operating Pressure	
		ft	m	ft	m			psi	bar
				40	12	16.8 (240)	Pendent	52	3.6
		25	7.6	30	9.1	14.0 (200)	Pendent	50	3.4
						16.8 (240)	Pendent	35	2.4
				32	9.7	14.0 (200)	Pendent	60	4.1
						16.8 (240)	Pendent	42	2.9
				35	11	14.0 (200)	Pendent	75	5.2
						16.8 (240)	Pendent	52	3.6
				40	12	16.8 (240)	Pendent	52	3.6
						22.4 (320)	Pendent	50	3.4
						25.2 (360)	Pendent	50	3.4
		30	9.1	35	11	14.0 (200)	Pendent	75	5.2
						16.8 (240)	Pendent	52	3.6
				40	12	16.8 (240)	Pendent	52	3.6
						22.4 (320)	Pendent	50	3.4
						25.2 (360)	Pendent	50	3.4
		35	11	40	12	16.8 (240)	Pendent	52	3.6
						22.4 (320)	Pendent	50	3.4
						25.2 (360)	Pendent	50	3.4
		20	6.1	25	7.6	14.0 (200)	Upright/ pendent	50	3.4

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Storage Arrangement	Commodity	Maximum Storage Height		Maximum Ceiling/Roof Height		Nominal K-Factor	Orientation	Minimum Operating Pressure	
		ft	m	ft	m			psi	bar
	Cartoned expanded plastic					16.8 (240)	Upright/ pendent	35	2.4
				30	9.1	14.0 (200)	Upright/ pendent	50	3.4
						16.8 (240)	Upright/ pendent	35	2.4
		25	7.6	30	9.1	14.0 (200)	Upright/ pendent	50	3.4
						16.8 (240)	Upright/ pendent	35	2.4
				32	10	14.0 (200)	Pendent	60	4.1
						16.8 (240)	Upright/ pendent	42	2.9
	Exposed* expanded plastic	25	7.6	40	12	25.2 (360)	Pendent	60	4.1

*Applies to closed array storage only.

23.5 Early Suppression Fast-Response (ESFR) Sprinklers for Rack Storage of Class I Through Class IV Commodities.

23.5.1
Protection of single-, double-, and multiple-row rack storage of Class I through Class IV commodities shall be in accordance with Table 23.5.1.

Table 23.5.1 ESFR Sprinkler Protection of Rack Storage of Class I Through Class IV Commodities

Storage Arrangement	Commodity	Maximum Storage Height		Maximum Ceiling/Roof Height		Nominal K-Factor	Orientation	Minimum Operating Pressure		In-Rack Sprinkler Requirements
		ft	m	ft	m			psi	bar	
Single-row, double-row, and multiple-row racks (no open-top containers)	Class I, II, III, or IV, encapsulated or nonencapsultated	20	6.1	25	7.6	14 (200)	Upright/ pendent	50	3.4	No
						16.8 (240)	Upright/ pendent	35	2.4	No
						22.4 (320)	Pendent	25	1.7	No
						25.2 (360)	Pendent	15	1	No

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Storage Arrangement	Commodity	Maximum Storage Height		Maximum Ceiling/Roof Height		Nominal K-Factor	Orientation	Minimum Operating Pressure		In-Rack Sprinkler Requirements
		ft	m	ft	m			psi	bar	
				30	9.1	14 (200)	Upright/ pendent	50	3.4	No
						16.8 (240)	Upright/ pendent	35	2.4	No
						22.4 (320)	Pendent	25	1.7	No
						25.2 (360)	Pendent	15	1	No
				35	10.7	14 (200)	Upright/ pendent	75	5.2	No
						16.8 (240)	Upright/ pendent	52	3.6	No
						22.4 (320)	Pendent	35	2.4	No
						25.2 (360)	Pendent	20	1.4	No
				40	12.2	16.8 (240)	Pendent	52	3.6	No
						22.4 (320)	Pendent	40	2.8	No
						25.2 (360)	Pendent	25	1.7	No
				45	13.7	14 (200)	Pendent	90	6.2	Yes
						16.8 (240)	Pendent	63	4.4	Yes
						22.4 (320)	Pendent	40	2.8	No
						25.2 (360)	Pendent	40	2.8	No
		25	7.6	30	9.1	14 (200)	Upright/ pendent	50	3.4	No
						16.8 (240)	Upright/ pendent	35	2.4	No
						22.4 (320)	Pendent	25	1.7	No
						25.2 (360)	Pendent	15	1.0	No

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Storage Arrangement	Commodity	Maximum Storage Height		Maximum Ceiling/Roof Height		Nominal K-Factor	Orientation	Minimum Operating Pressure		In-Rack Sprinkler Requirements
		ft	m	ft	m			psi	bar	
				32	9.8	14 (200)	Upright/ pendent	60	4.1	No
						16.8 (240)	Upright/ pendent	42	2.9	No
				35	10.7	14 (200)	Upright/ pendent	75	5.2	No
						16.8 (240)	Upright/ pendent	52	3.6	No
						22.4 (320)	Pendent	35	2.4	No
						25.2 (360)	Pendent	20	1.4	No
				40	12.2	16.8 (240)	Pendent	52	3.6	No
						22.4 (320)	Pendent	40	2.8	No
						25.2 (360)	Pendent	25	1.7	No
				45	13.7	14 (200)	Pendent	90	6.2	Yes
						16.8 (240)	Pendent	63	4.3	Yes
						22.4 (320)	Pendent	40	2.8	No
						25.2 (360)	Pendent	40	2.8	No
Single-, double-, and multiple-row rack (no open-top containers)	Class I, II, III, or IV, encapsulated or nonencapsulated	30	9.1	35	10.7	14 (200)	Upright/pendent	75	5.2	No
						16.8 (240)	Upright/ pendent	52	3.6	No
						22.4 (320)	Pendent	35	2.4	No
						25.2 (360)	Pendent	20	1.4	No
				40	12.2		Pendent	52	3.6	No

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Storage Arrangement	Commodity	Maximum Storage Height		Maximum Ceiling/Roof Height		Nominal K-Factor	Orientation	Minimum Operating Pressure		In-Rack Sprinkler Requirements
		ft	m	ft	m			psi	bar	
						16.8 (240)				
						22.4 (320)	Pendent	40	2.8	No
						25.2 (360)	Pendent	25	1.7	No
				45	[illegible]	14 (200)	Pendent	90	6.2	Yes
						16.8 (240)	Pendent	63	4.3	Yes
						22.4 (320)	Pendent	40	2.8	No
						25.2 (360)	Pendent	40	2.8	No
				40	12.2	16.8 (240)	Pendent	52	3.6	No
						22.4 (320)	Pendent	40	2.8	No
						25.2 (360)	Pendent	25	1.7	No
		35	10.7	45	13.7	14 (200)	Pendent	90	6.2	Yes
						16.8 (240)	Pendent	63	4.3	Yes
						22.4 (320)	Pendent	40	2.8	No
						25.2 (360)	Pendent	40	2.8	No
		40	12	45	[illegible]	16.8 (240)	Pendent	63	4.3	Yes
							Pendent	40	2.8	No

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Storage Arrangement	Commodity	Maximum Storage Height		Maximum Ceiling/Roof Height		Nominal K-Factor	Orientation	Minimum Operating Pressure		In-Rack Sprinkler Requirements
		ft	m	ft	m			psi	bar	
						22.4 (320)				
						25.2 (360)	Pendent	40	2.8	No

23.6 Early Suppression Fast-Response (ESFR) Sprinklers for Rack Storage of Group A Plastic Commodities.

23.6.1
Protection of single-, double-, and multiple-row rack storage of cartoned or exposed nonexpanded Group A plastic and cartoned expanded Group A plastic shall be in accordance with Table 23.6.1.

Table 23.6.1 ESFR Protection of Rack Storage of Group A Plastic Commodities

Storage Arrangement	Commodity	Maximum Storage Height		Maximum Ceiling/Roof Height		Nominal K-Factor	Orientation	Minimum Operating Pressure		In-Rack Sprinkler Requirements
		ft	m	ft	m			psi	bar	
Single-, double-, and multiple-row racks (no open-top containers)	Cartoned unexpanded	20	6.1	25	7.6	14 (200)	Upright/ pendent	50	3.4	No
						16.8 (240)	Upright/ pendent	35	2.4	No
						22.4 (320)	Pendent	25	1.7	No
						25.2 (360)	Pendent	15	1	No
				30	9.1	14 (200)	Upright/ pendent	50	3.4	No
							Upright/	35	2.4	No

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Storage Arrangement	Commodity	Maximum Storage Height		Maximum Ceiling/Roof Height		Nominal K-Factor	Orientation	Minimum Operating Pressure		In-Rack Sprinkler Requirements
		ft	m	ft	m			psi	bar	
						16.8 (240)	pendent			
						22.4 (320)	Pendent	25	1.7	No
						25.2 (360)	Pendent	15	1	No
				35	11	14 (200)	Upright/ pendent	75	5.2	No
						16.8 (240)	Upright/ pendent	52	3.6	No
						22.4 (320)	Pendent	35	2.4	No
						25.2 (360)	Pendent	20	1.4	No
				40	12	16.8 (240)	Pendent	52	3.6	No
						22.4 (320)	Pendent	40	2.7	No
						25.2 (360)	Pendent	25	1.7	No
				45	14	14 (200)	Pendent	90	6.2	Yes
						16.8 (240)	Pendent	63	4.3	Yes
						22.4 (320)	Pendent	40	2.7	No
						25.2 (360)	Pendent	40	2.7	No
		25	7.6	30	9.1	14 (200)	Upright/pendent	50	3.4	No
						16.8 (240)	Upright/ pendent	35	2.4	No

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Storage Arrangement	Commodity	Maximum Storage Height		Maximum Ceiling/Roof Height		Nominal K-Factor	Orientation	Minimum Operating Pressure		In-Rack Sprinkler Requirements
		ft	m	ft	m			psi	bar	
						22.4 (320)	Pendent	25	1.7	No
						25.2 (360)	Pendent	15	1	No
				32	10	14 (200)	Upright/ pendent	60	4.1	No
						16.8 (240)	Upright/ pendent	42	2.9	No
				35	11	14 (200)	Upright/ pendent	75	5.2	No
						16.8 (240)	Upright/ pendent	52	3.6	No
						22.4 (320)	Pendent	35	2.4	No
						25.2 (360)	Pendent	20	1.4	No
				40	12	16.8 (240)	Pendent	52	3.6	No
						22.4 (320)	Pendent	40	2.7	No
						25.2 (360)	Pendent	25	1.7	No
				45	14	14 (200)	Pendent	90	6.2	Yes
						16.8 (240)	Pendent	63	4.3	Yes
						22.4 (320)	Pendent	40	2.7	No
						25.2 (360)	Pendent	40	2.7	No
		30	9.1	35	11	14 (200)	Upright/ pendent	75	5.2	No

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Storage Arrangement	Commodity	Maximum Storage Height		Maximum Ceiling/Roof Height		Nominal K-Factor	Orientation	Minimum Operating Pressure		In-Rack Sprinkler Requirements
		ft	m	ft	m			psi	bar	
		35	11			16.8 (240)	Upright/ pendent	52	3.6	No
						22.4 (320)	Pendent	35	2.4	No
						25.2 (360)	Pendent	20	1.4	No
				40	12	16.8 (240)	Pendent	52	3.6	No
						22.4 (320)	Pendent	40	2.7	No
						25.2 (360)	Pendent	25	1.7	No
				45	14	14 (200)	Pendent	90	6.2	Yes
						16.8 (240)	Pendent	63	4.3	Yes
						22.4 (320)	Pendent	40	2.7	No
						25.2 (360)	Pendent	40	2.7	No
		40	12	40	12	16.8 (240)	Pendent	52	3.6	No
						25.2 (360)	Pendent	25	1.7	No
				45	14	14 (200)	Pendent	90	6.2	Yes
						16.8 (240)	Pendent	63	4.3	Yes
						22.4 (320)	Pendent	40	2.7	No
						25.2 (360)	Pendent	40	2.7	No

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Storage Arrangement	Commodity	Maximum Storage Height		Maximum Ceiling/Roof Height		Nominal K-Factor	Orientation	Minimum Operating Pressure		In-Rack Sprinkler Requirements
		ft	m	ft	m			psi	bar	
		40	12	45	14	14 (200)	Pendent	90	6.2	Yes
						16.8 (240)	Pendent	63	4.3	Yes
						22.4 (320)	Pendent	40	2.7	No
						25.2 (360)	Pendent	40	2.7	No
	Cartoned Expanded	20	6.1	25	7.6	14 (200)	Upright/ pendent	50	3.4	No
						16.8 (240)	Upright/ pendent	35	2.4	No
				30	9.1	14 (200)	Upright/ pendent	50	3.4	No
						16.8 (240)	Upright/ pendent	35	2.4	No
		25	7.6	30	9.1	14 (200)	Upright/ pendent	50	3.4	No
						16.8 (240)	Upright/ pendent	35	2.4	No
				32	10	14 (200)	Pendent	60	4.1	No
						16.8 (240)	Upright/ pendent	42	2.9	No
	Exposed unexpanded	20	6.1	25	7.6	14 (200)	Pendent	50	3.4	No
						16.8 (240)	Pendent	35	2.4	No
				30	9.1	14 (200)	Pendent	50	3.4	No
						16.8 (240)	Pendent	35	2.4	No
				35	11		Pendent	75	5.2	No

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Storage Arrangement	Commodity	Maximum Storage Height		Maximum Ceiling/Roof Height		Nominal K-Factor	Orientation	Minimum Operating Pressure		In-Rack Sprinkler Requirements
		ft	m	ft	m			psi	bar	
						14 (200)				
						16.8 (240)	Pendent	52	3.6	No
				40	12	16.8 (240)	Pendent	52	3.6	No
				45	14	14 (200)	Pendent	90	6.2	Yes
						16.8 (240)	Pendent	63	4.3	Yes
		25	7.6	30	9.1	14 (200)	Pendent	50	3.4	No
						16.8 (240)	Pendent	35	2.4	No
				32	10	14 (200)	Pendent	60	4.1	No
						16.8 (240)	Pendent	42	2.9	No
				35	11	14 (200)	Pendent	75	5.2	No
						16.8 (240)	Pendent	52	3.6	No
				40	12	16.8 (240)	Pendent	52	3.6	No
						22.4 (320)	Pendent	50	3.4	No
						25.2 (360)	Pendent	50	3.4	No
				45	14	14 (200)	Pendent	90	6.2	Yes
						16.8 (240)	Pendent	63	4.3	Yes

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Storage Arrangement	Commodity	Maximum Storage Height		Maximum Ceiling/Roof Height		Nominal K-Factor	Orientation	Minimum Operating Pressure		In-Rack Sprinkler Requirements
		ft	m	ft	m			psi	bar	
		30	9.1	35	10.7	14 (200)	Pendent	75	5.2	No
						16.8 (240)	Pendent	52	3.6	No
				40	11	16.8 (240)	Pendent	52	3.6	No
						22.4 (320)	Pendent	50	3.4	No
						25.2 (360)	Pendent	50	3.4	No
				45	12	14 (200)	Pendent	90	6.2	Yes
						16.8 (240)	Pendent	63	4.3	Yes
		35	11	40	12	16.8 (240)	Pendent	52	3.6	No
						22.4 (320)	Pendent	50	3.4	No
						25.2 (360)	Pendent	50	3.4	No
				45	14	14 (200)	Pendent	90	6.2	Yes
						16.8 (240)	Pendent	63	4.3	Yes
		40	12	45	14	14 (200)	Pendent	90	6.2	Yes
						16.8 (240)	Pendent	63	4.3	Yes

23.6.1.1
ESFR protection as defined shall not apply to the following:
(1) Rack storage involving solid shelves, except as permitted by 23.6.1.2

(2) Rack storage involving open-top cartons or containers

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23.6.1.2
ESFR sprinklers shall not be permitted to protect storage on solid shelf racks unless the solid shelf racks are protected with in-rack sprinklers in accordance with 17.1.5.

23.6.1.2.1
Where solid shelves are used, in-rack sprinklers shall be installed in every level below the highest solid shelf.

23.6.2
ESFR sprinkler systems shall be designed such that the minimum operating pressure is not less than that indicated in Table 23.6.1 for type of storage, commodity, storage height, and building height involved.

23.6.3
The design area shall consist of the most hydraulically demanding area of 12 sprinklers, consisting of four sprinklers on each of three branch lines.

23.6.4 In-Rack Sprinkler Requirements Where ESFR Sprinklers Are Used at Ceiling.

23.6.4.1
Where required by Table 23.6.1, in-rack sprinklers shall be installed at the first tier level at or above one-half of the storage height.

23.6.4.2
In-rack sprinklers shall be K-8.0 (115) or K-11.2 (160) quick-response, ordinary-temperature sprinklers.

23.6.4.3
The minimum of 6 in. (150 mm) vertical clear space shall be maintained between the sprinkler deflectors and the top of a tier of storage.

(A)
Sprinkler discharge shall not be obstructed by horizontal rack members.

23.6.4.4
The maximum horizontal distance between in-rack sprinklers shall be 5 ft (1.5 m).

23.6.4.5
In-rack sprinklers shall be located at an intersection of transverse and longitudinal flues while not exceeding the maximum spacing rules.

23.6.4.6
Where distances between transverse flues exceed the maximum allowable distances, sprinklers shall be installed at the intersection of the transverse and longitudinal flues, and additional sprinklers shall be installed between transverse flues to meet the maximum distance rules.

23.6.4.7
Where no transverse flues exist, in-rack sprinklers shall not exceed the maximum spacing rules.

23.6.4.8
The water demand for sprinklers installed in racks shall be based on simultaneous operation of the most hydraulically remote eight sprinklers.

23.6.4.9
Each of the in-rack sprinklers described in 23.6.4.8 shall discharge at a minimum of 60 gpm (227 L/min).

23.7* Protection of Exposed Expanded Group A Plastics.

23.7.1
Protection of single-, double-, and multiple-row rack storage of exposed expanded Group A plastics shall be permitted to be in accordance with 23.7.2 through 23.7.8.

23.7.2
The maximum storage height shall be 35 ft (10.7 m).

23.7.3

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The maximum ceiling height shall be 40 ft (12.2 m).

23.7.4
Sprinklers shall be intermediate temperature–rated ESFR pendent sprinklers with a nominal K-factor of K-25.2 (360).

23.7.4.1
The maximum sprinkler deflector distance below the ceiling shall be 14 in. (350 mm).

23.7.5
The design area shall consist of the most hydraulically demanding area of 12 sprinklers.

23.7.6
The minimum operating pressure shall be either 30 psi (2.0 bar) or 60 psi (4.1 bar) based upon the applicable storage and ceiling height for the installation as follows:
(1) 30 psi (2.0 bar) for storage heights up to 25 ft (7.6 m) with a maximum ceiling height of 30 ft (9.1 m)
(2) 60 psi (4.1 bar) for storage heights up to 25 ft (7.6 m) with a maximum ceiling height of 40 ft (12.2 m)

23.7.7
The minimum aisle width shall be 8 ft (2.4 m).

23.7.8
The rack shall have a solid vertical barrier of ⅜ in. (9.5 mm) plywood or particleboard, 22 gauge sheet metal, or equivalent, from face of rack to face of rack, spaced at a maximum of 16.5 ft (5.0 m) intervals.

23.7.8.1
The vertical barrier shall extend from a maximum of 4 in. (102 mm) above the floor to the maximum storage height.

23.7.8.2
The plan area of storage between vertical barriers and aisles shall not exceed 124 ft² (11.5 m²).

23.7.8.3
The vertical barrier shall extend across the longitudinal flue.

23.7.8.4
Commodity shall be permitted to extend a nominal 4 in. (102 mm) beyond the vertical barrier at the aisle.

23.8 ESFR Protection of Rack Storage of Rubber Tires.
Sprinkler discharge and area of application shall be in accordance with Table 23.8.

Table 23.8 Early Suppression Fast-Response (ESFR) Sprinklers for Protection of Rubber Tires (see Note 1)

Piling Method	Pile Height	Maximum Building Height		Nominal K-factor	Orientation	Number of Sprinklers	Minimum Operating Pressure *(see Note 2)*	
		ft	m				psi	bar
Rubber tire storage, on-side or on-tread, in palletized portable racks, open portable racks, or fixed racks without solid shelves	Up to 25 ft (7.6 m)	30	9.1	14.0 (200)	Upright/ pendent	12 *(see Note 2)*	50	3.4
				16.8 (240)	Upright/ pendent	12 *(see Note 2)*	35	2.4
				22.4 (320)	Pendent	12 *(see Note 2)*	25	1.7

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Piling Method	Pile Height	Maximum Building Height		Nominal K-factor	Orientation	Number of Sprinklers	Minimum Operating Pressure *(see Note 2)*	
		ft	m				psi	bar
				25.2 (360)	Pendent	12 *(see Note 2)*	15	1.0
Rubber tire storage, on-side, in palletized portable racks, open portable racks, or fixed racks without solid shelves	Up to 25 ft (7.6 m)	35	11	14.0 (200)	Upright/ pendent	12 *(see Note 2)*	75	5.2
				16.8 (240)	Pendent	12 *(see Note 2)*	52	3.6
				22.4 (320)	Pendent	12 *(see Note 2)*	35	2.4
				25.2 (360)	Pendent	12 *(see Note 2)*	25	1.7
On-tread, on-side, and laced tires in open portable steel racks or palletized portable racks	Up to 25 ft (7.6 m)	30	9.1	14.0 (200)	Pendent	20 *(see Notes 3 and 4)*	75	5.2
				16.8 (240)	Pendent	20 *(see Notes 3 and 4)*	52	3.6
Rubber tire storage, on-side, in palletized portable racks	Up to 25 ft (7.6 m)	40	12					
				16.8 (240)	Pendent	12	52	3.6
Rubber tire storage, on-tread, or laced in open portable steel racks	Up to 25 ft (7.6 m)	40	12	25.2 (360)	Pendent	12	40	2.8
On-tread, on-side, and laced tires in open portable steel racks or palletized portable racks	Up to 30 ft (9.1 m)	40	12	25.2 (360)	Pendent	12	75	5.2

Notes:

(1) Wet systems only.

(2) The shape of the design area shall be in accordance with 14.4.3.

(3) Where used in this application, ESFR protection is expected to control rather than to suppress the fire.

(4) The design area shall consist of the most hydraulically demanding area of 20 sprinklers, consisting of five sprinklers on each of four branch lines. The design shall include a minimum operating area of 1600 ft^2 (149 m^2).

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23.9 Early Suppression Fast-Response (ESFR) Sprinklers for Protection of Roll Paper Storage.
Where automatic sprinkler system protection utilizes ESFR sprinklers, hydraulic design criteria shall be as specified in Table 23.9. Design discharge pressure shall be applied to 12 operating sprinklers.

Table 23.9 ESFR Sprinklers for Protection of Roll Paper Storage (Maximum Height of Storage Permitted)

ESFR K-Factor	Orientation	System Type	Pressure		Building Height		Heavyweight						Mediumweight						Tissue All Arrays
							Closed		Standard		Open		Closed		Standard		Open		
			psi	bar	ft	m	ft	m	ft	m	ft	m	ft	m	ft	m	ft	m	
14.0 (201)	Upright/ pendent	Wet	50	3.4	30	9.1	25	7.6	25	7.6	25	7.6	25	7.6	25	7.6	25	7.6	NA
16.8 (242)	Upright/ pendent	Wet	35	2.4															
22.4 (322)	Pendent	Wet	25	1.7															
25.2 (363)	Pendent	Wet	15	1.0															
14.0 (201)	Upright/ pendent	Wet	75	5.2	35	11	30	9.1	30	9.1	30	9.1	NA		NA		NA		NA
16.8 (242)	Upright/ pendent	Wet	52	3.6															
					40	12	30	9.1	30	9.1	30	9.1	NA		NA		NA		NA
16.8 (242)	Pendent	Wet	52	3.6															
22.4 (322)	Pendent	Wet	40	2.7															
25.2 (363)	Pendent	Wet	25	1.7															
22.4 (322)	Pendent	Wet	50	3.4	45	14	30	9.1	30	9.1	30	9.1	NA		NA		NA		NA
25.2 (363)	Pendent	Wet	50	3.4															

NA: Not applicable.

23.10 Plastic Motor Vehicle Components.
Group A plastic automotive components and associated packaging material shall be permitted to be protected in accordance with Table 23.10.

Table 23.10 ESFR Sprinkler Design Criteria K-25.2 (360) for Portable Racks (Closed Array[a]) Without Solid Shelves Containing Automotive Components

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Commodity	Maximum Storage Height		Maximum Ceiling/Roof Height		Type of System	Maximum Sprinkler Spacing[b]		Number of Design Sprinklers by Minimum Operating Pressure[c]		Maximum Deflector Distance Below Ceiling[d]		Hose Stream Allowance		Water Supply Duration (hours)
	ft	m	ft	m		ft^2	m^2	psi	bar	in.	mm	gpm	L/min	
Automotive components and associated packaging material	25	7.6	35	11	Wet	100	9.3	16 at 37 psi	16 at 2.5 bar	18	450	500	1900	2

[a]Portable rack array shall be tightly nested without any flue spaces.

[b]Sprinkler spacing can exceed 100 ft^2 (9.3 m^2) where sprinklers are listed for larger spacing.

[c]System hydraulic design shall also be capable of delivering a discharge density of 0.60 gpm/ft^2 (24.4 mm/min) over the most hydraulically remote 4000 ft^2 (370 m^2) area.

[d]Maximum deflector distance below ceiling shall be permitted to exceed 18 in. (450 mm) where sprinklers are listed for greater distances.

23.11 Sprinkler Design Criteria for Storage and Display of Class I Through Class IV Commodities, Cartoned Nonexpanded Group A Plastics and Nonexpanded Exposed Group A Plastics in Retail Stores.

23.11.1
A sprinkler system with K-25.2 (360) ESFR sprinklers operating at a minimum pressure of 15 psi (1 bar) shall be permitted to protect single- and double-row racks with solid displays without the use of in-rack sprinklers in retail sales floors where the following conditions are met:

(1) Storage height shall not exceed 20 ft (6.1 m).

(2) Solid veneered particleboard/plywood displays shall be permissible, provided that all flues are maintained and only one display is installed per bay.

(3) A single display shall be permitted to have one or two solid horizontal or slanted members, and a solid back.

(4) Maximum roof height shall be 30 ft (9.14 m) in the protected area.

(5) Aisle widths shall be a minimum of 6 ft (1.8 m).

(6) Minimum transverse flue spaces of 3 in. every 10 ft (76 mm every 3.05 m) horizontally shall be provided.

(7) Minimum longitudinal flue spaces of 6 in. (152 mm) shall be provided for double-row racks.

(8) Maximum roof height shall be 30 ft (9.14 m) in the protected area.

(9) Maximum storage height shall be 22 ft (6.71 m).

(10) Aisle widths shall be a minimum of 8 ft (2.44 m).

(11) Minimum transverse flue spaces of 3 in. every 10 ft (76 mm every 3.05 m) horizontally shall be provided.

(12) Minimum longitudinal flue spaces of 6 in. (152 mm) shall be provided for double-row racks.

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(13) Storage in the aisle shall be permissible provided the aisle storage is no more than 4 ft (1.22 m) high and a minimum clear aisle of 4 ft (1.22 m) is maintained.

23.12 Protection of High Bay Records Storage.

23.12.1* Mobile High Bay Records Storage.
The requirements in this section shall be permitted to apply to ceiling-only sprinkler protection of paper products, including paper files, magazines, books, and similar paper documents in corrugated containers either closed or open top, to include corrugated totes, with no more than 5 percent plastics stored in mobile shelving units greater than 12 ft (3.7 m) and up to 34 ft (10 m) high and up to 30 shelving units (storage tiers) high, when the shelving unit structure meets all of the requirements in 23.12.3.

23.12.2 Fixed High Bay Records Storage.
High bay record storage shall be permitted to be fixed in place when meeting the limitations of 23.12.1 and 23.12.3.

23.12.3
A wet pipe sprinkler system with nominal K-25.2 (360) ESFR sprinklers operating at a minimum of 40 psi (2.7 bar) shall be provided. The shelving units shall be subject to the following limitations:
(1) Back-to-back storage shelving units each no greater than 36 in. (900 mm) deep separated by longitudinal flue space not less than 6 in. (150 mm) wide.

(2) Solid steel shelving units not exceeding 54 in. (1.4 m) wide separated by steel barriers mechanically fastened to upright steel framing that forms a transverse flue space not less than 3 in. (75 mm) wide.

(3) Upright steel framing not completely blocking transverse flue space between adjacent shelving units.

(4) Noncombustible shelving backstops and side shelf supports, also referred to as side box guides, projecting not less than 3 in. (75 mm) above the shelves and that prevent stored commodities from encroaching into transverse and longitudinal flue spaces.

(5) Solid steel shelving not greater than 18 in. (450 mm) on centers vertically.

(6) Solid steel tops over top shelving units except at tops of transverse and longitudinal flue spaces.

(7) Open-ended, hollow tubular steel vertical (upright) shelving columns at top of shelving system.

(8) Shelving system framing and power tracks not exceeding 3 in. (75 mm) in width and not less than 1 ft (300 mm) on centers and not less than 6 in. (150 mm) below sprinkler deflectors.

(9) Minimum clearance of 36 in. (900 mm) above top solid steel cover over top storage shelf to the sprinkler deflector.

(10) Mobile shelving systems arranged to shift automatically to a uniform nominal 6 in. (150 mm) clearance clear space between mobile carriages supporting back-to-back shelving units. Systems shall be arranged to initiate the shifting 60 seconds after activation of ceiling-mounted smoke detectors or upon sprinkler flow, whichever is first. Shelving system carriage electrical motors shall be listed and integral to the mobile carriage systems for normal functions and shall not be required to have emergency power back-up.

23.13 Slatted Shelves.

Chapter 24 Alternative Sprinkler System Designs for Chapters 20 Through 25

24.1* General.

24.1.1

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Sprinklers intended to protect storage fire risks shall be permitted to be installed using water supply design criteria that are different from the design criteria specified for the sprinklers described in Chapters 12 through 20 when specifically listed for such use within the limitations described in this chapter.

24.1.2
The requirements of Chapters 12 through 20 shall apply unless modified by this chapter.

24.1.2.1
Sprinklers having standard coverage areas that require up to 20 sprinklers to be included in the hydraulic calculation shall be installed in accordance with 14.2.3, 14.2.4, 14.2.4.1 and 21.12.6.

24.1.2.1.1
Quick-response sprinklers shall also be installed in accordance with 14.2.5.1 and 14.2.5.2.

24.1.2.2
Sprinklers having extended coverage areas that require up to 10 sprinklers to be included in the hydraulic calculation shall be installed in accordance with 14.2.3, 14.2.4, 14.2.4.1 and 21.12.6.

24.1.2.2.1
Quick-response sprinklers shall also be installed in accordance with 14.2.5.1 and 14.2.5.2.

24.1.3
The in-rack protection requirements of Chapters 12 through 20 shall apply when storage racks are equipped with solid shelves and in-rack sprinklers are required per the applicable chapter.

24.1.4
The requirements of the applicable chapter shall apply when ceiling-only protection options are not available per this chapter.

24.1.5
The design criteria in this chapter shall not be used to permit a reduction in the water supply requirements for in-rack sprinkler protection.

24.1.6
A series of large-scale fire tests involving challenging test scenarios that address the range of variables associated with the intended application of the sprinkler shall be conducted to evaluate the ability of the sprinkler to protect storage fire risks that are representative of those described in the manufacturer's installation and design parameter instructions and referenced in the listing.

24.1.7
The manufacturer's installation and design parameter instructions for these sprinklers shall specify in a standardized manner the end-use limitations and sprinkler system design criteria including at least the following:
(1) Commodity or commodities to be protected

(2) Storage arrangements allowed

(3) Installation guidelines including obstruction and ceiling construction limitations

(4) Maximum ceiling and storage heights with associated minimum operating pressures and number of sprinklers required to be included in the hydraulic calculation

(5) Hose stream allowance and duration

24.1.8
The number of sprinklers to be used in the sprinkler system design shall be based on the worst-case result obtained from the full-scale fire test series increased by a minimum 50 percent.

24.1.8.1
Regardless of the number of sprinklers that operated during the worst-case full-scale fire test, the number in the sprinkler system demand shall be no less than one of the following:
(1) Twelve sprinklers for standard coverage sprinklers

(2) Eight sprinklers for extended-coverage sprinklers based on a spacing of 12 ft × 12 ft (3.7 × 3.7 m)

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(3) Six sprinklers for extended-coverage sprinklers based on a spacing of 14 ft × 14 ft (4.3 m × 4.3 m)

24.1.8.2
Once the number of sprinklers for a demand area has been established, the minimum operating area, based on the proposed sprinkler spacing, shall not be less than 768 ft^2 (71 m^2).

24.1.8.3
The design area and number of sprinklers calculated on a branch line shall be in accordance with **19.6.4.2** using an area of sprinkler operation equal to the required number of operating sprinklers and the maximum allowable coverage for the specific design criteria being utilized.

24.1.9
Listed storage sprinklers that are not specifically referenced in Sections 24.2 and 24.3 but are tested in accordance with Chapter 21 with system design criteria based upon Sections 24.1, 24.4, and 24.5 shall be permitted to be used in accordance with their listing limitations, where approved.

24.2* Sprinkler Design Criteria for Palletized and Solid-Piled, Storage of Class I Through Class IV and Plastic Commodities.

24.2.1
Protection of palletized and solid-piled storage of Class I through Class IV and cartoned nonexpanded plastic commodities shall be permitted to be protected in accordance with Table 24.2.1.

Table 24.2.1 Extended Coverage, CMSA [K-factor 25.2 (360)] Sprinkler Design Criteria for Palletized and Solid-Piled Storage of Class I Through Class IV and Cartoned Nonexpanded Plastic Commodities

Storage Arrangement	Commodity Class	Maximum Storage Height		Maximum Ceiling/Roof Height		K-Factor/ Orientation	Type of System	Number of Design Sprinklers	Minimum Operating Pressure	Maximum Coverage Area
		ft	m	ft	m					
Palletized and solid-piled	Class I through Class IV, encapsulated and nonencapsulated, and cartoned nonexpanded plastics	20	6.1	30	9.1	25.2 (360) Upright/ pendent	Wet	6	30 psi (2.1 bar)	12 ft × 12 ft (3.7 m × 3.7 m) 144 ft^2 (13.4 m^2)
		20	6.1	30	9.1	25.2 (360) Upright/ pendent	Wet	6	30 psi (2.1 bar)	14 ft × 14 ft (4.3 m × 4.3 m) 196 ft^2 (18.2 m^2)
		25	7.6	30	9.1	25.2 (360) Upright/ pendent	Wet	6	30 psi (2.1 bar)	12 ft × 12 ft (3.7 m × 3.7 m)

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Storage Arrangement	Commodity Class	Maximum Storage Height		Maximum Ceiling/Roof Height		K-Factor/ Orientation	Type of System	Number of Design Sprinklers	Minimum Operating Pressure	Maximum Coverage Area
		ft	m	ft	m					
										144 ft² (13.4 m²)
		25	7.6	30	9.1	25.2 (360) Upright/ pendent	Wet	6	30 psi (2.1 bar)	14 ft × 14 ft (4.3 m × 4.3 m) 196 ft² (18.2 m²)
		25	7.6	35	11	25.2 (360) Upright/ pendent	Wet	8	40 psi (2.7 bar)	12 ft × 12 ft (3.7 m × 3.7 m) 144 ft² (13.4 m²)
		25	7.6	35	11	25.2 (360) Upright	Wet	8	40 psi (2.8 bar)	14 ft × 14 ft (4.3 m × 4.3 m) 196 ft² (18.2 m²)
		30	9.1	35	11	25.2 (360) Upright/ pendent	Wet	8	40 psi (2.8 bar)	12 ft × 12 ft (3.7 m × 3.7 m) 144 ft² (13.4 m²)
		30	9.1	35	11	25.2 (360) Upright	Wet	8	40 psi (2.8 bar)	14 ft × 14 ft (4.3 m × 4.3 m) 196 ft² (18.2 m²)

24.3* Sprinkler Protection Criteria for Open-Frame Rack Storage of Class I Through Class IV and Plastic Commodities.

24.3.1

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Protection of single-, double-, and multiple-row racks without solid shelves of Class I through Class IV and cartoned nonexpanded plastic commodities shall be permitted to be protected in accordance with Table 24.3.1.

Table 24.3.1 Extended Coverage, CMSA [K-Factor 25.2 (360)] Sprinkler Design Criteria for Single-, Double-, and Multiple-Row Racks Without Solid Shelves of Class I Through Class IV and Cartoned Nonexpanded Plastic Commodities

Storage Arrangement	Commodity Class	Maximum Storage Height		Maximum Ceiling/Roof Height		K-Factor/ Orientation	Type of System	Number of Design Sprinklers	Minimum Operating Pressure	Maximum Coverage Area
		ft	m	ft	m					
Single-, double-, and multiple-row racks without solid shelves (no open-top containers)	Class I through Class IV, encapsulated and nonencapsulated, and cartoned nonexpanded plastics	20	6.1	30	9.1	25.2 (360) Upright/ pendent	Wet	6	30 psi (2.1 bar)	12 ft × 12 ft (3.7 m × 3.7 m) 144 ft^2 (13.4 m^2)
		20	6.1	30	9.1	25.2 (360) Upright/ pendent	Wet	6	30 psi (2.1 bar)	14 ft × 14 ft (4.3 m × 4.3 m) 196 ft^2 (18.2 m^2)
		25	7.6	30	9.1	25.2 (360) Upright/ pendent	Wet	6	30 psi (2.1 bar)	12 ft × 12 ft (3.7 m × 3.7 m) 144 ft^2 (13.4 m^2)
		25	7.6	30	9.1	25.2 (360) Upright/ pendent	Wet	6	30 psi (2.1 bar)	14 ft × 14 ft (4.3 m × 4.3 m) 196 ft^2 (18.2 m^2)
		25	7.6	35	11	25.2 (360) Upright/ pendent	Wet	8	40 psi (2.6 bar)	12 ft × 12 ft (3.7 m × 3.7 m) 144 ft^2 (13.4 m^2)
		25	7.6	35	11	25.2 (360) Upright	Wet	8	40 psi (2.6 bar)	14 ft × 14 ft

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Storage Arrangement	Commodity Class	Maximum Storage Height		Maximum Ceiling/Roof Height		K-Factor/ Orientation	Type of System	Number of Design Sprinklers	Minimum Operating Pressure	Maximum Coverage Area
		ft	m	ft	m					
										(4.3 m × 4.3 m) 196 ft² (18.2 m²)
		30	9.1	35	11	25.2 (360) Upright/ pendent	Wet	8	40 psi (2.7 bar)	12 ft × 12 ft (3.7 m × 3.7 m) 144 ft² (13.4 m²)
		30	9.1	35	11	25.2 (360) Upright	Wet	8	40 psi (2.6 bar)	14 ft × 14 ft (4.3 m × 4.3 m) 196 ft² (18.2 m²)

24.3.2
Protection of Class I through Class IV and cartoned nonexpanded plastic commodities stored on single-, double-, or multiple-row racks without solid shelves or solid-piled, palletized, shelf, or bin-box storage arrangements shall be permitted to be protected in accordance with Table 24.3.2.

Table 24.3.2 CMSA K-25.2 Pendant Standard Coverage Sprinkler Design Criteria for Single-, Double-, and Multiple-Row Racks Without Solid Shelves and Solid-Piled, Palletized Storage Arrangement of Class I Through IV and Cartoned Nonexpanded Plastic Commodities

Storage Arrangement	Commodity Class	Maximum Storage Height		Maximum Ceiling/ Roof Height		K-Factor Orientation	System Type	Number of Design Sprinklers	Minimum Operating Pressure	Sprinkler Linear Spacing		Sprinkler Area Spacing	
		ft	m	ft	m					Min	Max	Min	Max
Solid-piled, palletized, and single-, double-, and multiple-row racks	Class I–IV encapsulated and nonencapsulated, and cartoned nonexpanded plastics	25	7.6	30	9.1	25.2 (360) Pendant	Wet	12	20 psi (1.4 bar)	8 ft (2.4 m)	12 ft (3.6 m)	80 ft² (7.5 m²)	100 ft² (9.0 m²)

Storage Arrangement	Commodity Class	Maximum Storage Height		Maximum Ceiling/ Roof Height		K-Factor Orientation	System Type	Number of Design Sprinklers	Minimum Operating Pressure	Sprinkler Linear Spacing		Sprinkler Area Spacing	
		ft	m	ft	m					Min	Max	Min	Max
without solid shelves (no open top containers)													

24.3.3
Protection of Class I through Class IV and cartoned nonexpanded plastic commodities stored on single-, double-, or multiple-row racks without solid shelves or solid-piled, palletized, shelf, or bin-box storage arrangements shall be permitted to be protected in accordance with Table 24.3.3.

Table 24.3.3 CMSA K-25.2 Pendant Standard Coverage Sprinkler Design Criteria for Single-, Double-, and Multiple-Row Racks Without Solid Shelves and Solid-Piled, Palletized Storage Arrangement of Class I Through IV and Cartoned Nonexpanded Plastic Commodities

Storage Arrangement	Commodity Class	Maximum Storage Height		Maximum Ceiling/ Roof Height		K-Factor Orientation	System Type	Number of Design Sprinklers	Minimum Operating Pressure	Sprinkler Linear Spacing		Sprinkler Area Spacing	
		ft	m	ft	m					Min	Max	Min	Max
Solid-piled, palletized, and single-, double-, and multiple-row racks without solid shelves (no open top containers)	Class I–IV encapsulated and nonencapsulated, and cartoned nonexpanded plastics	25	7.6	30	9.1	25.2 (360) Pendant	Wet	12	15 psi (1.0 bar)	8 ft (2.4 m)	12 ft (3.6 m)	80 ft² (7.5 m²)	100 ft² (9.0 m²)

24.4 Hose Stream Allowance and Water Supply Duration.

24.4.1
The minimum water supply requirements for a hydraulically designed occupancy hazard fire control sprinkler system shall be determined by adding the hose stream allowance from Table 24.4.1 to the water supply for sprinklers obtained from this chapter.

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Table 24.4.1 Hose Stream Allowance and Water Supply Duration

Sprinkler Type	Sprinkler Spacing Type	Number of Sprinklers in Design Area	Hose Stream Allowance		Water Supply Duration (minutes)
			gpm	L/min	
Control mode density/area and CMSA	Standard	Up to 12	250	950	60
		Over 12 to 15	500	1900	90
		Over 15 to 25	500	1900	120
		Over 25	500	1900	150
	Extended coverage	Up to 6	250	950	60
		Up to 8 (144 ft^2)	250	950	60
		Over 6 to 8	500	1900	90
		Over 8 to 12	500	1900	120
		Over 12	500	1900	150
ESFR	Standard	Up to 12	250	950	60
		Over 12 to 15	500	1900	90
		Over 15 to 25	500	1900	120
		Over 25	500	1900	150

24.4.1.1
The water supply requirements for a hydraulically designed occupancy hazard fire control sprinkler system shall be available for the minimum duration specified in Table 24.4.1.

24.5 Minimum Obstruction Criteria.

24.5.1 General.
The installation guidelines for obstructions to ceiling-level sprinklers shall be in accordance with the requirements of Section 24.5 for sprinkler system designs obtained from this chapter.

24.5.2 Standard Coverage Spacing Sprinklers.

24.5.2.1
Sprinklers having standard coverage areas requiring up to 20 sprinklers to be included in the hydraulic calculation shall be installed in accordance with the obstruction criteria described in 14.2.11, unless large-scale fire testing is conducted with a representative obstruction below the sprinkler that demonstrates equivalent performance.

24.5.2.2
Control mode density/area (CMDA) and CMSA sprinklers having standard coverage areas requiring more than 20 sprinklers in the design area shall be installed in accordance with the obstructions to sprinkler discharge criteria described in 13.2.8.

24.5.2.2.1
ESFR sprinklers having standard-coverage areas requiring more than 20 sprinklers in the design area shall be installed in accordance with the obstructions to sprinkler discharge criteria described in 14.2.11.

24.5.2.2.2
Other obstruction criteria shall be acceptable if large-scale fire testing is conducted with a representative obstruction below the sprinkler that demonstrates equivalent performance.

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24.5.3 Extended Coverage Spacing Sprinklers.

24.5.3.1
Sprinklers having extended coverage areas requiring up to 10 sprinklers to be included in the hydraulic calculation shall be installed in accordance with the obstruction criteria described in 11.2.5.1, 14.2.11.2, and 14.2.11.3, unless large-scale fire testing is conducted with a representative obstruction below the sprinkler that demonstrates equivalent performance.

24.5.3.2
CMDA and CMSA sprinklers having extended coverage areas requiring more than 10 sprinklers in the design area shall be installed in accordance with the obstructions to sprinkler discharge criteria described in **13.2.8** and **11.2.5.1**.

24.5.3.2.1
ESFR sprinklers having extended coverage areas requiring more than 10 sprinklers in the design area shall be installed in accordance with the obstructions to sprinkler discharge criteria described in 14.2.11.2 and 14.2.11.3.

24.5.3.2.2
Other obstruction criteria shall be acceptable if large-scale fire testing is conducted with a representative obstruction below the sprinkler that demonstrates equivalent performance.

24.5.3.2.3
When utilizing upright CMSA, CMDA, or ESFR sprinklers, any continuous obstruction 4 in. (100 mm) or less shall be permitted to be ignored.

24.6 In-Rack Sprinkler Protection Criteria for Open-Frame Rack Storage of Class I Through Class IV and Plastic Commodities.

24.6.1
Protection of closed-top Class I through Class IV and plastic commodities stored on single-, double-, or multiple-row racks without solid shelves shall be permitted to be protected in accordance with this section.

24.6.2
In-rack sprinkler systems shall be wet-pipe only.

24.6.3
In-rack sprinklers shall be standard-coverage, quick-response, pendent, and 160ºF (70ºC) nominally rated.

24.6.3.1
Minimum K-14.0 (K-200) sprinklers shall be installed where the minimum required flow is 100 gpm (380 L/min) or less.

24.6.3.2
Minimum K-22.4 (K-320) sprinklers shall be installed where the minimum required flow exceeds 100 gpm (380 L/min).

24.6.4
Depending on the type of storage rack being protected, in-rack sprinklers shall be positioned horizontally in accordance with Figure 24.6.4(a) through Figure 24.6.4(f) and the following:
(1) The minimum horizontal distance between in-rack sprinklers shall be 27 in. (700 mm), with the maximum horizontal distance being 4.5 ft (1.4 m), unless shown otherwise in the applicable figures.

(2) Except as shown in Figure 24.6.4(c), all in-rack sprinklers shall be located within the footprint of the rack structure.

(3) All face sprinklers shall be positioned so that the horizontal distance between the face of the storage rack and the outer edge of storage, if it protrudes into the storage aisle, does not exceed 18 in. (450 mm).

Figure 24.6.4(a) Plan View of In-Rack Sprinkler Arrangement for Open-Frame Single-Row Racks Up to 3 ft (0.9 m) Deep.

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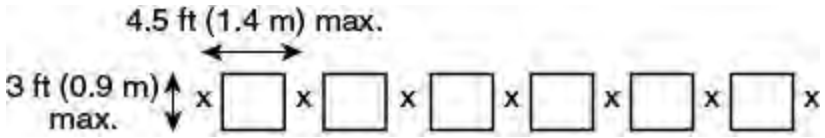


Figure 24.6.4(b) Plan View of In-Rack Sprinkler Arrangement for Open-Frame Single-Row Racks Up to 6 ft (1.8 m) Deep.

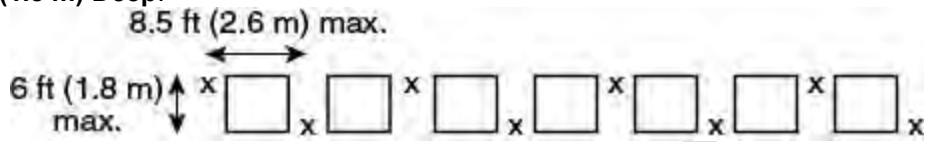


Figure 24.6.4(c) Plan View of In-Rack Sprinkler Arrangement for Open-Frame Single-Row Racks Up to 6 ft (1.8 m) Deep Located Against a Wall.

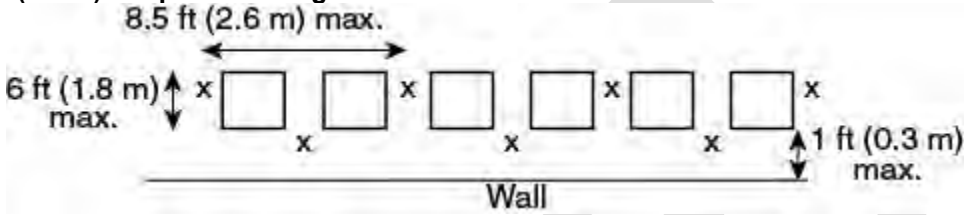


Figure 24.6.4(d) Plan View of In-Rack Sprinkler Arrangement for Open-Frame Double-Row Racks Up to 9 ft (2.7 m) Deep.

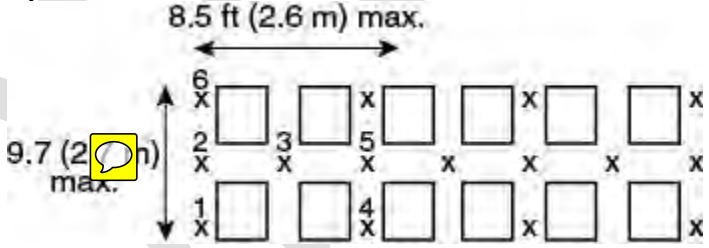


Figure 24.6.4(e) Plan View of In-Rack Sprinkler Arrangement for Open-Frame Double-Row Racks Up to 12 ft (3.7 m) Deep.

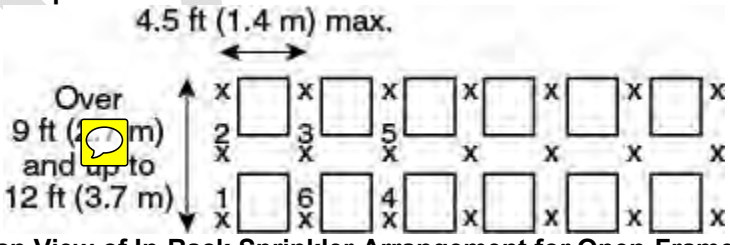
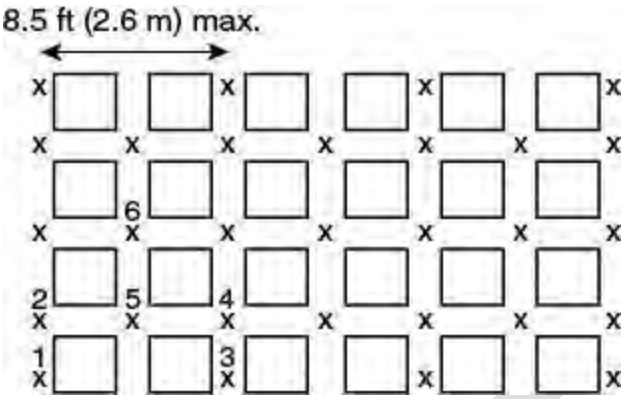


Figure 24.6.4(f) Plan View of In-Rack Sprinkler Arrangement for Open-Frame Multiple-Row Racks.



24.6.5
The maximum allowable vertical distance between in-rack sprinklers for cartoned expanded plastics, exposed nonexpanded plastics, and exposed expanded plastics shall be 30 ft (9.1 m).

24.6.5.1
The maximum allowable vertical distance between in-rack sprinklers for Class I through Class IV and cartoned nonexpanded plastics shall be 40 ft (12.2 m).

24.6.5.2
A minimum 6 in. (150 mm) vertical distance between the top of storage and the in-rack sprinkler deflector shall be maintained.

24.6.6
Regardless of the number of in-rack sprinkler levels installed, the number of sprinkler levels for the in-rack sprinkler system design shall be based on the single most hydraulically remote in-rack sprinkler level and the minimum number of in-rack sprinklers for this level in accordance with Table 24.6.6.

Table 24.6.6 Number of Sprinklers in the In-Rack Sprinkler Design

IRAS Installation Arrangement; Figure	Number of Sprinklers in the In-Rack Design	
	Class I through IV and Cartoned Plastics	Exposed Plastics
Single-row racks uo to 3 ft (0.9 m) Deep; Figure 21.6.4(a)	4	4
Single-row racks up to 6 ft (1.8 m) deep; Figures 21.6.4(b) and 21.6.4(c)	5	5
Double- and multiple-row racks; Figures 21.6.4(e) and 21.6.4(f)	6	6 and 6*

*This represents 6 sprinklers in the most remote rack as well as 6 sprinklers in the nearest adjacent rack. See Figures 21.6.4(d), 21.6.4(e) and 21.6.4(f) to determine which 6 sprinklers to account for in the in-rack sprinkler design for double- and multiple-row racks.

24.6.7
The minimum flow required in the system design shall be from the most remote in-rack sprinkler in accordance with Table 24.6.7.

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Table 24.6.7 Minimum Flow in the In-Rack Sprinkler Design

Maximum Vertical IRAS Installation Increment, ft (m)	Commodity Hazard	Min. K-Factor	Minimum Flow from Most Remote IRAS, gpm (L/min)
30 (9.1)	Class I through IV and cartoned nonexpanded plastic	14.0 (200)	65 (250)
	Cartoned expanded plastic	14.0 (200)	100 (380)
	Exposed plastic	22.4 (320)	120 (455)
40 (12.2)	Class I through IV and cartoned nonexpanded plastic	22.4 (320)	121 (455)

24.6.8
A hose stream allowance of 250 gpm (950 L/min) shall be included as part of the in-rack sprinkler system design obtained from Section 24.6.

24.6.9
The water supply requirements obtained from Section 24.6 shall be available for a minimum of 60 minutes.

24.6.10*
The water supply for the in-rack sprinkler system shall be capable of providing the required in-rack sprinkler system design obtained from Section 24.6 independent of the design requirements of the ceiling sprinkler system protecting this same area.

24.6.11
The ceiling sprinkler system shall be designed and installed in accordance with the guidelines outlined in Chapters 16 or 17, depending on the commodity hazard, except as modified in Section 24.6.

24.6.11.1
Where the in-rack sprinkler system is designed and installed in accordance with Section 24.6, the top level of in-rack sprinklers shall be considered to be a floor for design purposes of the ceiling sprinkler system.

24.6.11.2
As a result, the storage height above the top level of in-rack sprinklers shall be permitted to be in excess of 10 ft (3.0 m).

24.6.12*
The water supply for the ceiling system shall be capable of providing the required ceiling sprinkler system design obtained from either Chapter 16 or Chapter 17 independent of the design requirements of the in-rack sprinkler system obtained from Section 24.6 and protecting this same area.

Chapter 25 Protection of Rack Storage Using In-Rack Sprinklers

25.1 General Requirements of In-Rack Sprinklers.

25.1.1 Scope.
This section shall apply where rack storage of Class I through Class IV commodities, Group A plastic commodities, or rubber tires will be protected with in-rack sprinklers.

25.1.2 Open-Frame Storage Racks.

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25.1.2.1
The in-rack sprinkler arrangements as well as the ceiling and in-rack sprinkler design criteria for rack storage in this chapter shall be based on open-frame rack configurations as defined in 3.3.141 unless indicated otherwise.

25.1.2.2
Where Group A commodities are being stored in racks with aisles less than 3.5 ft (1.1 m) wide, in-rack sprinkler protection shall be in accordance with the guidelines for multiple-row racks.

25.1.2.3
Where open-frame double-row racks with storage up 25 ft (7.6 m) in height have no longitudinal flue, but have transverse flues at maximum 5 ft (1.5 m) intervals, the double-row rack storage arrangement shall be considered open-frame.

25.1.2.4
Where multiple-row racks of any height have no longitudinal flue, but have transverse flues at maximum 5 ft (1.5 m) intervals, the multiple-row rack storage arrangement shall be considered open-frame.

25.1.3 In-Rack Sprinkler System.

25.1.3.1 In-Rack Sprinkler System Size.

25.1.3.1.1
The area protected by a single in-rack sprinkler system shall not exceed 40,000 ft^2 (3720 m^2) of floor area occupied by the racks, including aisles, regardless of the number of in-rack sprinkler levels.

25.1.3.1.2
An in-rack sprinkler system shall be permitted to be supplied from the overhead ceiling sprinkler system where the area of the racks protected by the in-rack sprinklers, including the adjacent aisles, do not exceed 8,000 ft^2 (740 m^2).

25.1.3.2* In-Rack Sprinkler System Control Valves.

25.1.3.2.1
Unless the requirements of 25.1.3.2.2 or 25.1.3.2.3 are met, separate indicating control valves and drains shall be provided and arranged so that ceiling and in-rack sprinkler systems can be controlled independently.

25.1.3.2.2
Installation of 20 or fewer in-rack sprinklers supplied by any one ceiling sprinkler system shall not require a separate indicating control valve.

25.1.3.2.3
The separate indicating valves shall be permitted to be arranged as sectional control valves supplied from the ceiling sprinkler system where in-rack sprinklers are required and the racks including the adjacent aisles occupy 8000 ft^2 (740 m^2) or less of the area protected by the ceiling sprinklers.

25.1.3.3* Sprinkler Waterflow Alarm for In-Rack Sprinklers.
See Section C.4.

25.1.4 Flue Space Requirements for Racks Protected by In-Rack Sprinklers.

25.1.4.1
Where in-rack sprinklers are protecting rack storage, nominal 6 in. (150 mm) transverse flue spaces between loads and at rack uprights shall be maintained.

25.1.4.2
Where in-rack sprinklers are protecting rack storage, random variations in the width of flue spaces or in their vertical alignment shall be permitted.

25.1.4.3

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Where in-rack sprinklers are protecting double- and multiple-row rack storage up to and including 25 ft (7.6 m) in height, a longitudinal (back-to-back clearance between loads) flue space shall not be required.

25.1.4.4
Where in-rack sprinklers are protecting double-row racks over 25 ft (7.6 m) in height, nominal 6 in. (150 mm) longitudinal flue spaces shall be provided.

25.1.5 Building Steel Protection.
Where in-rack sprinklers are installed in accordance with this chapter, building steel shall not require special protection.

25.1.6 Movable Racks.
Rack storage in movable racks shall be protected in the same manner as multiple-row racks.

25.2 Ceiling-Level Sprinkler Design Criteria in Combination with In-Rack Sprinklers.

25.2.1 General.

25.2.1.1*
This section shall apply to storage of materials, such as Class I through Class IV and Group A plastic commodity as well as rubber tires, representing the broad range of combustibles stored in racks that are being protected by in-rack sprinklers. The requirements of Chapter **20** shall apply unless modified by this chapter. *(See Section C.9.)*

25.2.1.2*
Ceiling-level sprinkler design criteria for single-, double-, and multiple-row racks in 25.2 shall be based on open rack configurations as defined in 3.3.141.

25.2.1.3*
Ceiling-level sprinkler design criteria for Group A plastic commodities in this chapter shall be permitted for the protection of the same storage height and configuration of Class I, II, III, and IV commodities.

25.2.1.4
Ceiling-level sprinkler design criteria for single- and double-row rack storage of Group A plastic commodities shall be applicable where aisles are 3.5 ft (1.1 m) or greater in width.

25.2.1.5
Ceiling-level sprinkler design criteria for rack storage of Group A plastic commodities shall be protected as multiple-row racks where aisles are less than 3.5 ft (1.1 m) in width.

25.2.1.6
The minimum water supply requirements for a hydraulically designed occupancy hazard automatic ceiling-level sprinkler system shall be determined by adding the hose stream allowance from Table 20.12.2.6 to the water supply for in-rack sprinklers determined in Section **25.12**, unless indicated otherwise.

25.2.2 Miscellaneous and Low-Piled Storage.

25.2.2.1 Miscellaneous Storage.

25.2.2.1.1
This section shall apply to any of the following situations:
(1) Miscellaneous storage of Class I through Class IV commodities up to and including 12 ft (3.7 m) in height

(2) Miscellaneous storage of Group A plastic commodities up to and including 12 ft (3.7 m) in height

(3) Miscellaneous storage of rubber tires up to and including 12 ft (3.7 m) in height

25.2.2.1.2
Where in-rack sprinklers are installed in accordance with Section 25.4 through Section 25.7 to protect miscellaneous rack storage of Class I through Class IV and Group A plastic commodities, as well as

miscellaneous rack storage of rubber tires, up to and including 12 ft (3.7 m) in height under a maximum 32 ft (10.0 m) high ceiling, the ceiling-level sprinkler design criteria shall be in accordance with Figure 25.2.2.1.2.

Figure 25.2.2.1.2 CMDA Ceiling-Level Sprinkler Design Criteria for Miscellaneous Storage Protected with One Level of In-Rack Sprinklers [missing figure?]

25.2.2.1.3
Installation criteria as permitted by NFPA 13 and design criteria and modifiers as permitted by the density/area method of Section 19.2 for ordinary hazard Group 2 occupancies shall be applicable.

25.2.2.1.4 Hose Connections.
Hose connections shall not be required for the protection of miscellaneous storage.

25.2.2.2 Low-Piled Storage.

25.2.2.2.1
This section shall apply to any of the following situations:
(1) Storage of Class I through Class IV commodities up to 12 ft and including (3.7 m) in height.

(2) *Storage of Group A plastic commodities up to and including 5 ft (1.5 m) in height.

25.2.2.2.2
For low-piled rack storage with solid shelves of Class I through Class IV commodities up to and including 12 ft (3.7 m) in height, in-rack sprinklers shall be provided in accordance with Section 25.6, and the ceiling-level sprinkler design shall be in accordance with Figure 25.2.2.1.2.

25.2.2.2.3
For low-piled rack storage with solid shelves of Group A plastic commodities up to and including 5 ft (1.5 m) in height, in-rack sprinklers shall be provided in accordance with Section 25.6, and the ceiling-level sprinkler design shall be in accordance with Figure 25.2.2.1.2.

25.2.3 CMDA Ceiling Level Sprinkler Design Criteria in Combination with In-Rack Sprinklers.

25.2.3.1 General.

25.2.3.1.1
Ceiling-level sprinkler design criteria for the rack storage of Class I through Class IV commodities shall be in accordance with Section 25.2.3.2 for storage over 12 ft (3.7 m) and up to and including 25 ft (7.6 m) in height and Section 25.2.3.3 for storage over 25 ft (7.6 m) in height.

25.2.3.1.2
Ceiling-level sprinkler design criteria for the rack storage of Group A plastic commodities shall be in accordance with Section 25.2.3.4 for storage over 5 ft (1.5 m) and up to and including 25 ft (7.6 m) in height and Section 25.2.3.5 for storage over 25 ft (7.6 m) in height.

25.2.3.1.3
This chapter also shall be used to determine protection for commodities that are not entirely Group A plastic commodities but contain such quantities and arrangements of Group A plastic commodities that they are deemed more hazardous than Class IV commodities.

25.2.3.2 Rack Storage of Class I Through Class IV Commodities Stored Over 12 ft (3.7 m) and Up to and Including 25 ft (7.6 m) in Height.

25.2.3.2.1* Single- and Double-Row Racks.
For single- or double-row rack storage of Class I through Class IV commodities, encapsulated or nonencapsulated, stored over 12 ft (3.7 m) and up to and including 25 ft (7.6 m) in height, Table

25.2.3.2.1 shall be used to determine the appropriate figure for determining ceiling-level sprinkler design criteria with the provision of one level of in-rack sprinklers.

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Table 25.2.3.2.1 Single- or Double-Row Racks — Storage Height Over 12 ft (3.7 m) Up to and Including 25 ft (7.6 m)

Height	Commodity Class	Encapsulated	Aisles*		Sprinklers Mandatory In-Rack	Ceiling Sprinkler Water Demand					
						With In-Rack Sprinklers			Without In-Rack Sprinklers		
			ft	m		Figure	Curves	Apply Figure 16.2.1.3.4.1	Figure	Curves	Apply Figure 16.2.1.3.4.1
Over 12 ft (3.7 m) up to and including 20 ft (6.1 m)	I	No	4	1.2	No	16.2.1.3.2(a)	C and D	Yes	16.2.1.3.2(a)	F and H	Yes
			8	2.4			A and B			E and G	
		Yes	4	1.2	No	16.2.1.3.2(e)	C and D		16.2.1.3.2(e)	G and H	Yes
			8	2.4			A and B			E and F	
	II	No	4	1.2	No	16.2.1.3.2(b)	C and D		16.2.1.3.2(b)	G and H	Yes
			8	2.4			A and B			E and F	
		Yes	4	1.2	No	16.2.1.3.2(e)	C and D		16.2.1.3.2(e)	G and H	Yes
			8	2.4			A and B			E and F	
	III	No	4	1.2	No	16.2.1.3.2(c)	C and D		16.2.1.3.2(c)	G and H	Yes
			8	2.4			A and B			E and F	
		Yes	4	1.2	1 level	16.2.1.3.2(f)	C and D		—	—	—
			8	2.4			A and B				

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Height	Commodity Class	Encapsulated	Aisles*		Sprinklers Mandatory In-Rack	Ceiling Sprinkler Water Demand					
						With In-Rack Sprinklers			Without In-Rack Sprinklers		
			ft	m		Figure	Curves	Apply Figure 16.2.1.3.4.1	Figure	Curves	Apply Figure 16.2.1.3.4.1
Over 20 ft (6.1 m) up to and including 22 ft (6.7 m)	IV	No	4	1.2	No	16.2.1.3.2(d)	C and D	No	16.2.1.3.2(d)	G and H	Yes
			8	2.4			A and B			E and F	
		Yes	4	1.2	1 level	16.2.1.3.2(g)	C and D		—	—	—
			8	2.4			A and B				
	I	No	4	1.2	No	16.2.1.3.2(a)	C and D		16.2.1.3.2(a)	F and H	Yes
			8	2.4			A and B			E and G	
		Yes	4	1.2	1 level	16.2.1.3.2(e)	C and D		—	—	—
			8	2.4			A and B				
	II	No	4	1.2	No	16.2.1.3.2(b)	C and D		16.2.1.3.2(b)	G and H	Yes
			8	2.4			A and B			E and F	
		Yes	4	1.2	1 level	16.2.1.3.2(e)	C and D		—	—	—
			8	2.4			A and B				
	III	No	4	1.2	No	16.2.1.3.2(c)	C and D		16.2.1.3.2(c)	G and H	Yes

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Height	Commodity Class	Encapsulated	Aisles*		Sprinklers Mandatory In-Rack	Ceiling Sprinkler Water Demand					
						With In-Rack Sprinklers			Without In-Rack Sprinklers		
			ft	m		Figure	Curves	Apply Figure 16.2.1.3.4.1	Figure	Curves	Apply Figure 16.2.1.3.4.1
			8	2.4			A and B			E and F	
		Yes	4	1.2	1 level	16.2.1.3.2(f)	C and D		—	—	—
			8	2.4			A and B				
	IV	No	4	1.2	No	16.2.1.3.2(d)	C and D		16.2.1.3.2(d)	G and H	Yes
			8	2.4			A and B			E and F	
		Yes	4	1.2	1 level	16.2.1.3.2(g)	C and D		—	—	—
			8	2.4			A and B				
Over 22 ft (6.7 m) up to and including 25 ft (7.6 m)	I	No	4	1.2	No	16.2.1.3.2(a)	C and D	No	16.2.1.3.2(a)	F and H	Yes
			8	2.4			A and B			E and G	
		Yes	4	1.2	1 level	16.2.1.3.2(e)	C and D		—	—	—
			8	2.4			A and B				
	II	No	4	1.2	No	16.2.1.3.2(b)	C and D		16.2.1.3.2(b)	G and H	Yes
			8	2.4			A and B			E and F	

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Height	Commodity Class	Encapsulated	Aisles*		Sprinklers Mandatory In-Rack	Ceiling Sprinkler Water Demand					
						With In-Rack Sprinklers			Without In-Rack Sprinklers		
			ft	m		Figure	Curves	Apply Figure 16.2.1.3.4.1	Figure	Curves	Apply Figure 16.2.1.3.4.1
		Yes	4	1.2	1 level	16.2.1.3.2(e)	C and D		—	—	—
			8	2.4			A and B				
	III	No	4	1.2	No	16.2.1.3.2(c)	C and D		16.2.1.3.2(c)	G and H	Yes
			8	2.4			A and B			E and F	
		Yes	4	1.2	1 level	16.2.1.3.2(f)	C and D		—	—	—
			8	2.4			A and B				
	IV	No	4	1.2	1 level	16.2.1.3.2(d)	C and D		—	—	—
			8	2.4			A and B				
		Yes	4	1.2		16.2.1.3.2(g)	C and D		—	—	—
			8	2.4			A and B				

*See 16.2.1.3.2.1 for interpolation of aisle widths.

25.2.3.2.2 Multiple-Row Racks.

25.2.3.2.2.1
For multiple-row racks, having a rack depth up to and including 16 ft (4.9 m) with aisles 8 ft (2.4 m) or wider, storing Class I through Class IV commodities, encapsulated or nonencapsulated, over 12 ft (3.7 m) and up to and including 25 ft (7.6 m) in height, Table 25.2.3.2.2.1 shall be used to determine the appropriate figure for determining ceiling-level sprinkler design criteria with the provision of one level of in-rack sprinklers.

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Table 25.2.3.2.2.1 Multiple-Row Racks — Rack Depth Up to and Including 16 ft (4.9 m), Aisles 8 ft (2.4 m) or Wider and Storage Height Over 12 ft (3.7 m) Up to 25 ft (7.6 m)

Height	Commodity Class	Encapsulated	Sprinklers Mandatory In-Rack	Ceiling Sprinkler Water Demand							
				With In-Rack Sprinklers				Without In-Rack Sprinklers			
				Figure	Curves	Apply Figure 16.2.1.3.4.1	1.25 × Density	Figure	Curves	Apply Figure 16.2.1.3.4.1	1.25 × Density
Over 12 ft (3.7 m) up to and including 15 ft (4.6 m)	I	No	No	16.2.1.3.2(a)	C and D	Yes	No	16.2.1.3.2(a)	I and J	Yes	No
		Yes		16.2.1.3.2(a)			Yes	16.2.1.3.2(a)	I and J		Yes
	II	No		16.2.1.3.2(b)			No	16.2.1.3.2(b)	I and J	Yes	No
		Yes		16.2.1.3.2(b)			Yes	16.2.1.3.2(b)	I and J		Yes
	III	No	No	16.2.1.3.2(c)			No	16.2.1.3.2(c)	I and J	Yes	No
		Yes	1 level	16.2.1.3.2(c)			Yes		NA	NA	NA
	IV	No	No	16.2.1.3.2(d)			No	16.2.1.3.2(d)	C and D	No	No
		Yes	1 level	16.2.1.3.2(d)	A and B		1.50 × density		NA	NA	NA
Over 15 ft (4.6 m) up to and including 20 ft (6.1 m)	I	No	No	16.2.1.3.2(a)	C and D	Yes	No	16.2.1.3.2(a)	I and J	Yes	No
		Yes		16.2.1.3.2(a)			Yes	16.2.1.3.2(a)	I and J		Yes
	II	No		16.2.1.3.2(b)			No	16.2.1.3.2(b)	I and J	Yes	No
		Yes		16.2.1.3.2(b)			Yes	16.2.1.3.2(b)	I and J		Yes
	III	No	No	16.2.1.3.2(c)			No	16.2.1.3.2(c)	I and J	Yes	No
		Yes	1 level	16.2.1.3.2(c)			Yes	NA	NA	NA	NA
	IV	No	1 level	16.2.1.3.2(d)			No				
		Yes		16.2.1.3.2(d)	A nd B		1.50 × density				

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Height	Commodity Class	Encap-sulated	Sprinklers Mandatory In-Rack	Ceiling Sprinkler Water Demand							
				With In-Rack Sprinklers				Without In-Rack Sprinklers			
				Figure	Curves	Apply Figure 16.2.1.3.4.1	1.25 × Density	Figure	Curves	Apply Figure 16.2.1.3.4.1	1.25 × Density
Over 20 ft (6.1 m) up to and including 25 ft (7.6 m)	I	No	No	16.2.1.3.2(a)	C and D	No	No	16.2.1.3.2(a)	I and J	Yes	No
		Yes	1 level	16.2.1.3.2(a)			Yes	NA	NA	NA	NA
	II	No	1 level	16.2.1.3.2(b)			No				
		Yes		16.2.1.3.2(b)			Yes				
	III	No		16.2.1.3.2(c)			No				
		Yes		16.2.1.3.2(c)			Yes				
	IV	No	2 levels	16.2.1.3.2(d)			No				
		Yes		16.2.1.3.2(d)	A and B		1.50 × density				

NA: Not applicable.

25.2.3.2.2.2

For multiple-row racks, having a rack depth up to and including 16 ft (4.9 m) with aisles 8 ft (2.4 m) or wider, storing Class I through Class IV commodities, encapsulated or nonencapsulated, over 12 ft (3.7 m) and up to and including 25 ft (7.6 m) in height, Table 25.2.3.2.2.2 shall be used to determine the appropriate figure for determining ceiling-level sprinkler design criteria with the provision of one level of in-rack sprinklers.

Table 25.2.3.2.2.2 Determining Appropriate Ceiling-Level Protection Criteria Figure for Multiple-Row Racks of Class I through Class IV Commodities — Rack Depth Over 16 ft (4.9 m) or Aisles Narrower Than 8 ft (2.4 m), Storage Height Over 12 ft (3.7 m) Up to and Including 25 ft (7.6 m)

Height	Commodity Class	Encap-sulated	Sprinklers Mandatory In-Rack	Ceiling Sprinkler Water Demand							
				With In-Rack Sprinklers				Without In-Rack Sprinklers			
				Figure	Curves	Apply Figure 16.2.1.3.4.1	1.25 × Density	Figure	Curves	Apply Figure 16.2.1.3.4.1	1.25 × Density
Over 12 ft (3.7 m) up to	I	No	No	16.2.1.3.2(a)	C and D	Yes	No	16.2.1.3.2(a)	I and J	Yes	No
		Yes		16.2.1.3.2(a)			Yes	16.2.1.3.2(a)	I and J		Yes

Height	Commodity Class	Encap-sulated	Sprinklers Mandatory In-Rack	Ceiling Sprinkler Water Demand							
				With In-Rack Sprinklers				Without In-Rack Sprinklers			
				Figure	Curves	Apply Figure 16.2.1.3.4.1	1.25 × Density	Figure	Curves	Apply Figure 16.2.1.3.4.1	1.25 × Density
and including 15 ft (4.6 m)	II	No		16.2.1.3.2(b)			No	16.2.1.3.2(b)	I and J	Yes	No
		Yes		16.2.1.3.2(b)			Yes	16.2.1.3.2(b)	I and J		Yes
	III	No		16.2.1.3.2(c)			No	16.2.1.3.2(c)	I and J	Yes	No
		Yes	1 level	16.2.1.3.2(c)			Yes				
	IV	No	No	16.2.1.3.2(d)			No	16.2.1.3.2(d)	C and D	No	No
		Yes	1 level	16.2.1.3.2(d)			1.50 × density				
Over 15 ft (4.6 m) up to and including 20 ft (6.1 m)	I	No	1 level	16.2.1.3.2(a)	C and D	Yes	No	NA	NA	NA	NA
		Yes		16.2.1.3.2(a)			Yes				
	II	No		16.2.1.3.2(b)			No				
		Yes		16.2.1.3.2(b)			Yes				
	III	No		16.2.1.3.2(c)			No				
		Yes		16.2.1.3.2(c)			Yes				
	IV	No		16.2.1.3.2(d)			No				
		Yes		16.2.1.3.2(d)			1.50 × density				
Over 20 ft (6.1 m) up to and including	I	No	1 level	16.2.1.3.2(a)	C and D	No	No	NA	NA	NA	NA
		Yes		16.2.1.3.2(a)			Yes				
	II	No		16.2.1.3.2(b)			No				

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Height	Commodity Class	Encap-sulated	Sprinklers Mandatory In-Rack	Ceiling Sprinkler Water Demand							
				With In-Rack Sprinklers				Without In-Rack Sprinklers			
				Figure	Curves	Apply Figure 16.2.1.3.4.1	1.25 × Density	Figure	Curves	Apply Figure 16.2.1.3.4.1	1.25 × Density
25 ft (7.6 m)		Yes		16.2.1.3.2(b)			Yes				
	III	No		16.2.1.3.2(c)			No				
		Yes		16.2.1.3.2(c)			Yes				
	IV	No	2 levels	16.2.1.3.2(d)			No				
		Yes		16.2.1.3.2(d)			1.50 × density				

NA: Not applicable.

25.2.3.2.3 Ceiling-Level Protection Criteria Figures.

25.2.3.2.3.1*
The ceiling-level sprinkler design criteria in terms of density [gpm/ft^2 (mm/min)] and are a of sprinkler operation [ft^2 (m^2) of ceiling or roof] obtained from the appropriate density/area curves of Figure 25.2.3.2.3.1(a)through Figure 25.2.3.2.3.1(g) shall be modified as appropriate by 25.2.3.2.4. These requirements shall apply to portable racks arranged in the same manner as single-, double- or multiple-row racks. *(See Section C.14.)*

Figure 25.2.3.2.3.1(a) Sprinkler System Design Curves — 20 ft (6.1 m) High Rack Storage — Class I Nonencapsulated Commodities — Conventional Pallets.

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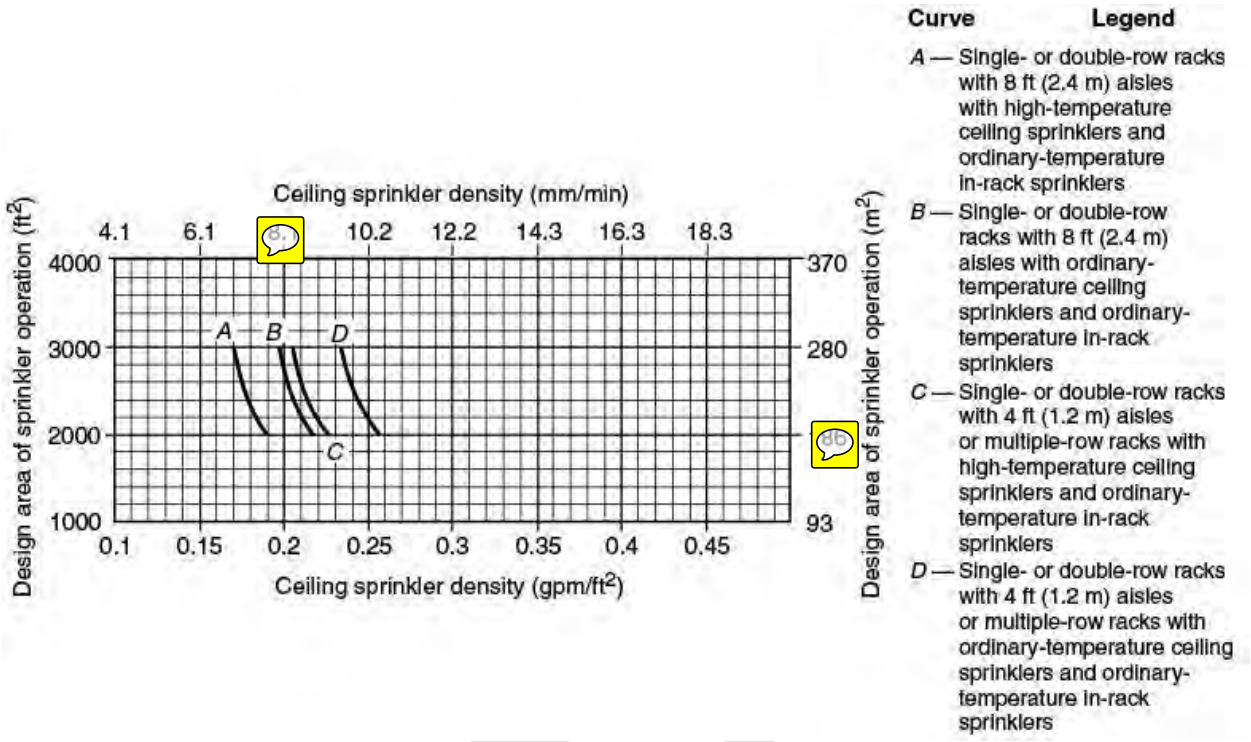


Figure 25.2.3.2.3.1(b) Sprinkler System Design Curves — 20 ft (6.1 m) High Rack Storage — Class II Nonencapsulated Commodities — Conventional Pallets.

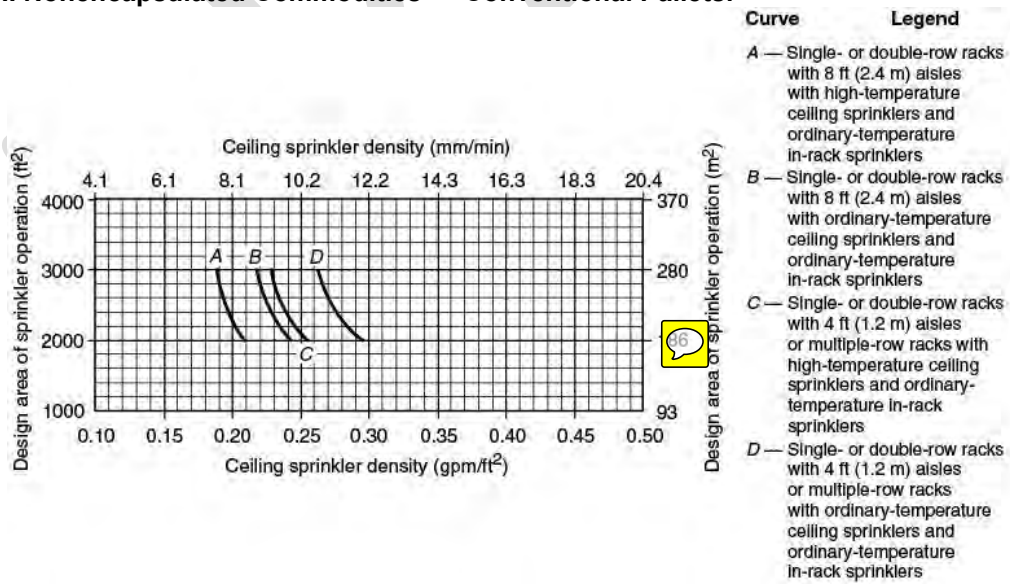


Figure 25.2.3.2.3.1(c) Sprinkler System Design Curves — 20 ft (6.1 m) High Rack Storage — Class III Nonencapsulated Commodities — Conventional Pallets.

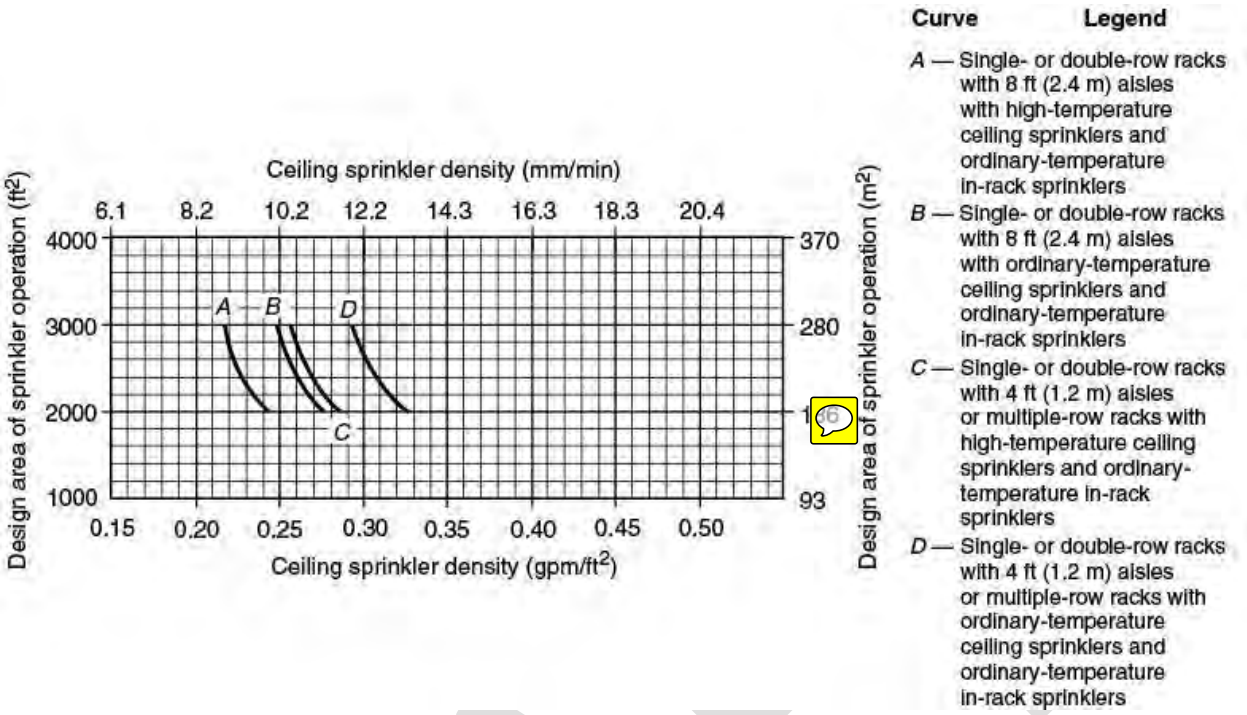


Figure 25.2.3.2.3.1(d) Sprinkler System Design Curves — 20 ft (6.1 m) High Rack Storage — Class IV Nonencapsulated Commodities — Conventional Pallets.

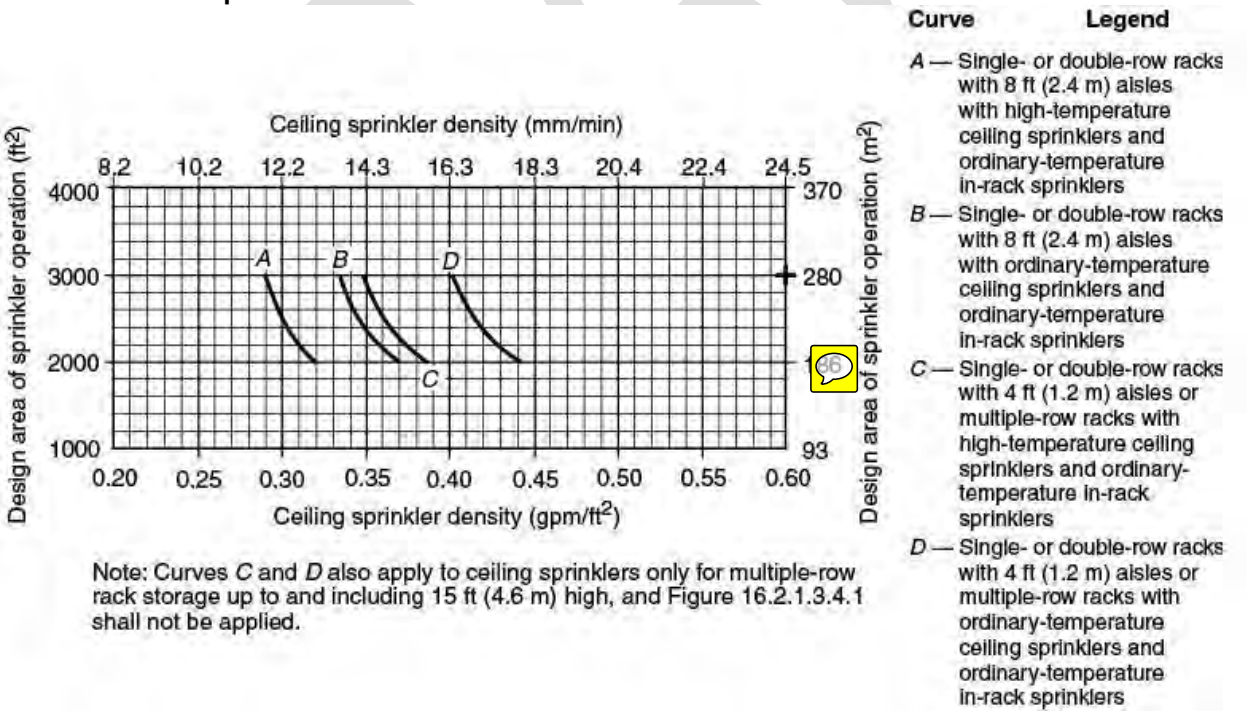


Figure 25.2.3.2.3.1(e) Single- or Double-Row Racks — 20 ft (6.1 m) High Rack Storage — Sprinkler System Design Curves — Class I and Class II Encapsulated Commodities — Conventional Pallets.

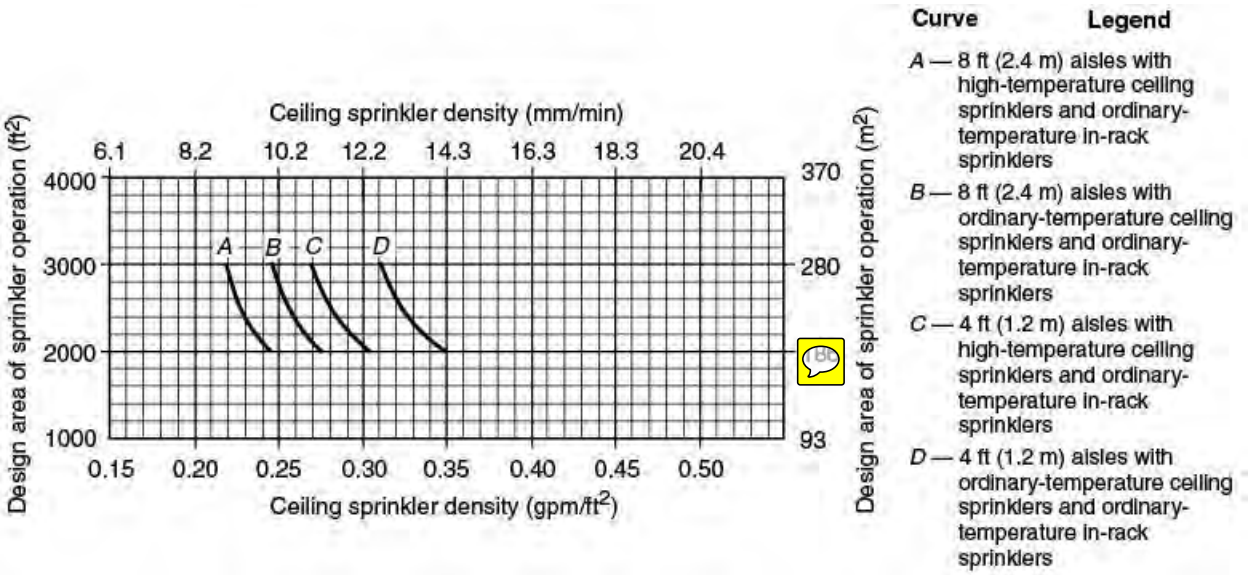


Figure 25.2.3.2.3.1(f) Single- or Double-Row Racks — 20 ft (6.1 m) High Rack Storage — Sprinkler System Design Curves — Class III Encapsulated Commodities — Conventional Pallets.

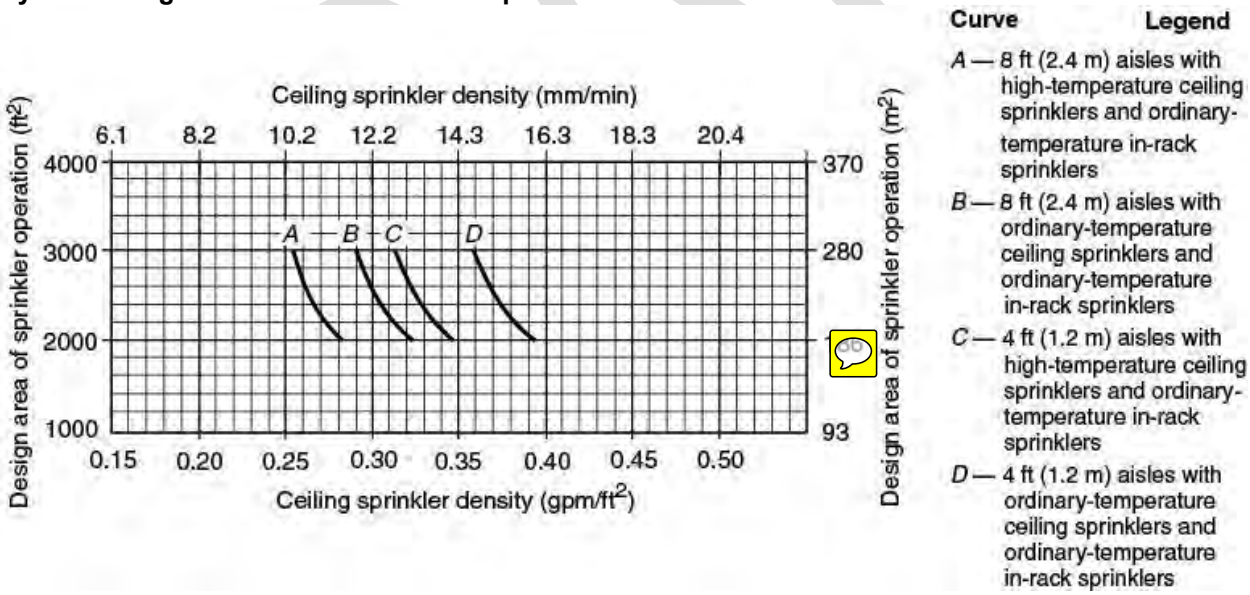
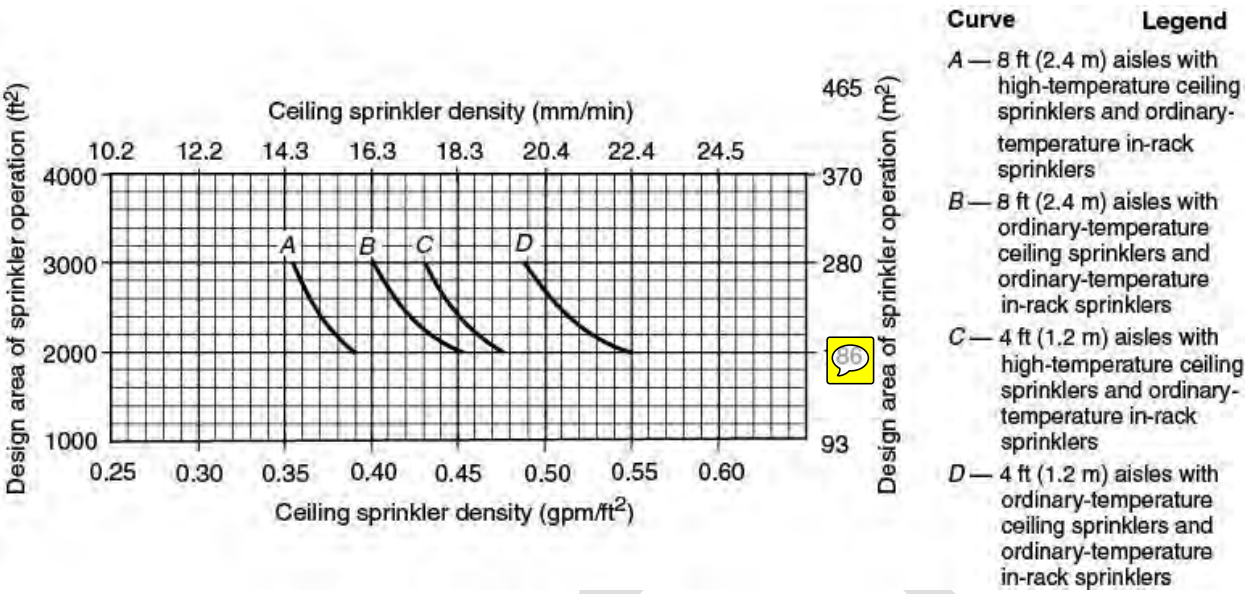


Figure 25.2.3.2.3.1(g) Single- or Double-Row Racks — 20 ft (6.1 m) High Rack Storage — Sprinkler System Design Curves — Class IV Encapsulated Commodities — Conventional Pallets.



25.2.3.2.3.2*
Design densities obtained from Figure 25.2.3.2.3.1(a)through Figure 25.2.3.2.3.1(g) for single- and double-row racks shall be selected to correspond to aisle width. (See Section C.15.)

(A)
For aisle widths between 4 ft (1.2 m) and 8 ft (2.4 m), the rules for 4 ft (1.2 m) aisle width shall be used or direct linear interpolation between the densities shall be permitted.

(B)
The density given for 8 ft (2.4 m) wide aisles shall be applied to aisles wider than 8 ft (2.4 m).

(C)
The density given for 4 ft (1.2 m) wide aisles shall be applied to aisles more narrow than 4 ft (1.2 m) down to 3-½ ft (1.1 m).

(D)
Where aisles are more narrow than 3-½ ft (1.1 m), racks shall be considered to be multiple-row racks.

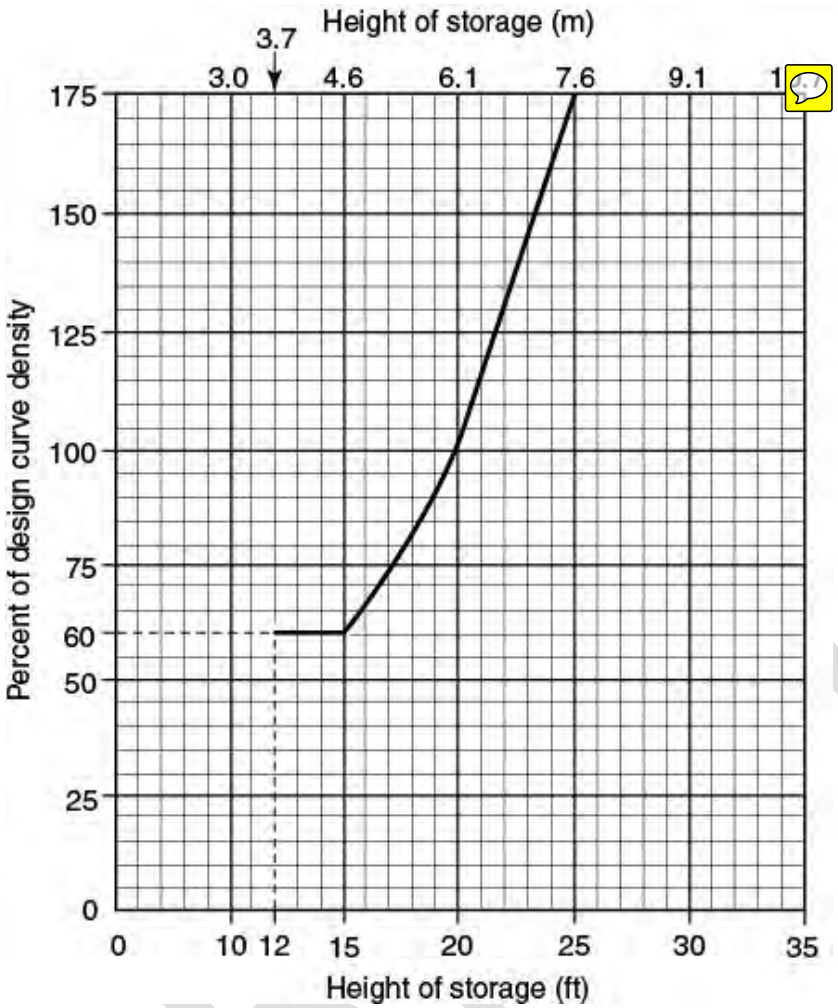
25.2.3.2.4* Ceiling Sprinkler Density Adjustments.

25.2.3.2.4.1
Where Class I, Class II, and Class III commodities are encapsulated in multiple-row racks over 12 ft (3.7 m) and up to and including 25 ft (7.6 m) in height, the ceiling sprinkler density obtained from the applicable figure in 25.2.3.2.3.1 shall be increased by 25 percent over that required for nonencapsulated commodities.

25.2.3.2.4.2
Where Class IV commodities are encapsulated in multiple-row racks over 12 ft (3.7 m) and up to and including 25 ft (7.6 m) in height, the ceiling sprinkler density obtained from the applicable figure in **25.2.3.2.3.1** shall be increased by 50 percent over that required for nonencapsulated.

25.2.3.2.4.3
Where in-rack sprinklers are being installed within racks of Class I through Class IV commodities stored over 12 ft (3.7 m) up to and including 20 ft (6.1 m) protected with CMDA sprinklers at ceiling level along with the minimum number of required in-rack sprinkler levels, densities obtained from design curves shall be adjusted in accordance with Figure 25.2.3.2.4.3.

Figure 25.2.3.2.4.3 Adjustment to Ceiling-Level Sprinkler Density Due to Storage Height.



25.2.3.2.4.4

Where in-rack sprinklers are being installed within racks of Class I through Class IV commodities stored over 12 ft (3.7 m) and up to and including 20 ft (6.1 m) in height protected with CMDA sprinklers at ceiling level along with more than one level of in-rack sprinklers, but not in every tier, densities obtained from design curves and adjusted in accordance with Figure 25.2.3.2.4.3 shall be permitted to be reduced an additional 20 percent, as indicated in Table 25.2.3.2.4.4.

Table 25.2.3.2.4.4 Adjustment to Ceiling Sprinkler Density for Storage Height and In-Rack Sprinklers

Storage Height	In-Rack Sprinklers	Apply Figure 16.2.1.3.4.1 for Storage Height Adjustment	Permitted Ceiling Sprinklers Density Adjustments Where In-Rack Sprinklers Are Installed
Over 12 ft (3.7 m) through 25 ft (7.6 m)	None	Yes	None
Over 12 ft (3.7 m) through 20 ft (6.1 m)	Minimum required	Yes	None
	More than minimum, but not in every tier	Yes	Reduce density 20% from that of minimum in-rack sprinklers

Storage Height	In-Rack Sprinklers	Apply Figure 16.2.1.3.4.1 for Storage Height Adjustment	Permitted Ceiling Sprinklers Density Adjustments Where In-Rack Sprinklers Are Installed
	In every tier except above the top tier	Yes	Reduce density 40% from that of minimum in-rack sprinklers
Over 20 ft (6.1 m) through 25 ft (7.3 m)	Minimum required	No	None
	More than minimum, but not in every tier	No	Reduce density 20% from that of minimum in-rack sprinklers
	In every tier except above the top tier	No	Reduce density 40% from that of minimum in-rack sprinklers

25.2.3.2.4.5*
Where in-rack sprinklers are being installed within racks of Class I through Class IV commodities stored over 12 ft (3.7 m) and up to and including 20 ft (6.1 m) in height protected with CMDA sprinklers at ceiling level along with in-rack sprinklers at each tier level, densities obtained from design curves and adjusted in accordance with Figure 25.2.3.2.4.3 shall be permitted to be reduced an additional 40 percent, as indicated in Table 25.2.3.2.4.4.

25.2.3.2.4.6
Where in-rack sprinklers are being installed within racks of Class I through Class IV commodities stored over 20 ft (6.1 m) and up to and including 25 ft (7.6 m) in height protected with CMDA sprinklers at ceiling level along with the minimum number of required in-rack sprinkler levels, densities obtained from design curves shall be used. Densities shall not be adjusted in accordance with Figure 25.2.3.2.4.3.

25.2.3.2.4.7
Where in-rack sprinklers are being installed within racks of Class I through Class IV commodities stored over 20 ft (6.1 m) and up to and including 25 ft (7.6 m) in height protected with CMDA sprinklers at ceiling level along with more than the minimum required level of in-rack sprinklers, but not in every tier, densities obtained from design curves shall be permitted to be reduced 20 percent, as indicated in Table 25.2.3.2.4.4. Densities shall not be adjusted in accordance with Figure 25.2.3.2.4.3 for storage height.

25.2.3.2.4.8
Where in-rack sprinklers are being installed within racks of Class I through Class IV commodities stored over 20 ft (6.1 m) and up to and including 25 ft (7.6 m) in height protected with CMDA sprinklers at ceiling level along with in-rack sprinklers at each tier level, except above the top tier, densities obtained from design curves shall be permitted to be reduced 40 percent, as indicated in Table 25.2.3.2.4.4. Densities shall not be adjusted in accordance with Figure 25.2.3.2.4.3 for storage height.

25.2.3.3 Rack Storage of Class I Through Class IV Commodities Over 25 ft (7.6 m) in Height.

25.2.3.3.1 Single- and Double-Row Racks.

25.2.3.3.1.1*
Where in-rack sprinklers are being installed within single- and double-row racks separated by aisles at least 4 ft (1.2 m) wide and with a clearance to ceiling up to and including 10 ft (3.0 m) of nonencapsulated Class I through Class IV commodities stored over 25 ft (7.6 m) in height protected by CMDA sprinklers at ceiling level, the ceiling sprinkler designs shall be in accordance with Table 25.2.3.3.1.1.

25.2.3.3.1.2
Where storage as described in 25.2.3.3.1.1 is encapsulated, the ceiling sprinkler density obtained from Table 25.2.3.3.1.1 shall be increased by 25 percent over that required for nonencapsulated commodities.

25.2.3.3.2 Multiple-Row Racks.

25.2.3.3.2.1

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Where in-rack sprinkler are being installed within multiple-row racks separated by aisles at least 4 ft (1.2 m) wide and with a clearance to ceiling up to and including 10 ft (3.0 m) of nonencapsulated Class I through Class IV commodities stored over 25 ft (7.6 m) in height protected by CMDA sprinklers at ceiling level, the ceiling sprinkler designs shall be in accordance with Table 25.2.3.3.2.1.

25.2.3.3.2.2
Where storage as described in 25.2.3.3.2.1 is encapsulated, the ceiling sprinkler density obtained from Table 25.2.3.3.2.1 shall be increased by 25 percent over that required for nonencapsulated commodities.

25.2.3.4 Rack Storage of Group A Plastic Commodities Stored Over 5 ft (1.5 m) and Up to and Including 25 ft (7.6 m) in Height.

25.2.3.4.1 Cartoned Group A Plastic Commodities.

25.2.3.4.1.1
Where rack storage of cartoned Group A plastic commodities, encapsulated or nonencapsulated, having a clearance to ceiling up to and including 10 ft (3.0 m) is protected by in-rack sprinklers, ceiling-level sprinkler designs in terms of density [gpm/ft^2 (mm/min)] and area of operation [ft^2 (m^2)] shall be selected from Figure 25.9.3.1(a) through Figure 25.9.3.1(e).

25.2.3.4.1.2
Linear interpolation of design densities and areas of application shall be permitted between storage heights with the same clearance to ceiling.

25.2.3.4.1.3
No interpolation between clearance to ceiling shall be permitted.

25.2.3.4.2 Exposed Nonexpanded Group A Plastic Commodities.
Where in-rack sprinkler protection is installed to protect rack storage of exposed nonexpanded Group A plastic commodities, encapsulated or nonencapsulated, stored over 5 ft (1.5 m) and up to and including 25 ft (7.6 m) in height protected by CMDA sprinklers at ceiling-level, the ceiling sprinkler design shall be in accordance with one of the following:

(1) Where in-rack sprinklers are installed in accordance with Figure 25.9.3.3(a), the ceiling-level sprinkler design shall be a minimum 0.45 gpm/ft^2 (18.3 mm/min) density over a 2000 ft^2 (186 m^2) demand area.

(2) Where in-rack sprinklers are installed in accordance with Figure 25.9.3.3(b), the ceiling-level sprinkler design shall be a minimum 0.30 gpm/ft^2 (12.2 mm/min) density over a 2000 ft^2 (186 m^2) demand area.

(3) Where in-rack sprinklers are installed in accordance with Figure 25.9.3.3(c), the ceiling-level sprinkler design shall be a minimum 0.45 gpm/ft^2 (18.3 mm/min) density over a 2000 ft^2 (186 m^2) demand area.

(4) Where in-rack sprinklers are installed in accordance with Figure 25.9.3.3(d), the ceiling-level sprinkler design shall be a minimum 0.30 gpm/ft^2 (12.2 mm/min) density over a 2000 ft^2 (186 m^2) demand area.

(5) Where in-rack sprinklers are installed in accordance with Figure 25.9.3.3(e), the ceiling-level sprinkler design shall be a minimum 0.6 gpm/ft^2 (24.4 mm/min) density over a 2000 ft^2 (186 m^2) demand area.

(6) Where in-rack sprinklers are installed in accordance with Figure 25.9.3.3(f), the ceiling-level sprinkler design shall be a minimum 0.45 gpm/ft^2 (18.3 mm/min) density over a 2000 ft^2 (186 m^2) demand area.

(7) Where in-rack sprinklers are installed in accordance with Figure 25.9.3.3(g), the ceiling-level sprinkler design shall be a minimum 0.8 gpm/ft^2 (32.6 mm/min) density over a 1500 ft^2 (139 m^2) demand area.

(8) Where in-rack sprinklers are installed in accordance with Figure 25.9.3.3(h), the ceiling-level sprinkler design shall be a minimum 0.6 gpm/ft^2 (24.4 mm/min) density over a 1500 ft^2 (139 m^2) demand area.

(9) Where in-rack sprinklers are installed in accordance with Figure 25.9.3.3(i), the ceiling-level sprinkler design shall be a minimum 0.30 gpm/ft^2 (12.2 mm/min) density over a 2000 ft^2 (186 m^2) demand area.

(10) Where in-rack sprinklers are installed in accordance with Figure 25.9.3.3(j), the ceiling-level sprinkler design shall be a minimum 0.8 gpm/ft^2 (32.6 mm/min) density over a 1500 ft^2 (139 m^2) demand area.

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(11) Where in-rack sprinklers are installed in accordance with Figure 25.9.3.3(k), the ceiling-level sprinkler design shall be a minimum 0.30 gpm/ft^2 (12.2 mm/min) density over a 2000 ft^2 (186 m^2) demand area.

25.2.3.5* Rack Storage of Group A Plastic Commodities Stored Over 25 ft (7.6 m) in Height.
Where rack storage of Group A plastic commodities, encapsulated or non-encapsulated, over 25 ft (7.6 m) in height are protected by in-rack sprinklers in accordance with 25.9.4[illegible].4, ceiling-level sprinkler designs, in terms of density [gpm/ft^2 (mm/min)] and area of operation [ft^2 (m^2)], shall be selected from Table 25.2.3.5Table 25.2.3.5 based on the storage height of commodity above the top level of in-rack sprinklers.

Table 25.2.3.5 Control Mode Density/Area Sprinkler Discharge Criteria for Single-, Double-, and Multiple-Row Racks of Group A Plastic Commodities with Storage Over 25 ft (7.6 m) in Height

Storage Height Above Top Level In-Rack Sprinklers		Ceiling Sprinklers Density	
ft	m	gpm/ft^2 over ft^2	mm/min over m^2
5 or less	1.5 or less	0.30/2000	12.2/186
Over 5 up to 10	Over 1.5 up to 3.0	0.45/2000	18.3/186

25.2.3.6 Rack Storage of Rubber Tires Stored Over 12 ft (3.7 m) in Height.

25.2.3.6.1 General.
The requirements of Chapter 20 shall apply unless modified in this section.

25.2.3.6.2* Ceiling Systems.
Where rack storage of rubber tires, either on-side or on-tread, over 5 ft (1.5 m) and up to and including 20 ft (6.1 m) in height protected by CMDA sprinklers at ceiling-level with a maximum clearance to ceiling of 10 ft (3.0 m) along with one level of in-rack sprinklers, the ceiling-level sprinkler system design density and area of application shall be a minimum 0.40 gpm/ft^2 (16.3 mm/min) density over a 3000 ft^2 (279 m^2) demand area.

25.2.3.6.3 Reduced-Discharge Density.
Where high-expansion foam systems are installed in accordance with NFPA 11 to protect rack storage of rubber tires, either on-side or on-tread, over 5 ft (1.5 m) and up to and including 20 ft (6.1 m) in height protected by CMDA sprinklers at ceiling-level with a maximum clearance to ceiling of 10 ft (3.0 m) and one level of in-rack sprinklers, the ceiling-level sprinkler system design density shall be permitted to be reduced from 0.40 gpm/ft^2(16.3 mm/min) 0.24 gpm/ft^2 (9.8 mm/min).

25.2.3.6.4 Water Supplies.
Total water supplies shall be capable of providing flow for automatic sprinklers, hose streams, and foam systems (if provided) for the duration required in Table 20.12.2.6.

25.2.4 CMSA Ceiling Level Sprinkler Design Criteria in Combination with In-Rack Sprinklers.

25.2.4.1 General.

25.2.4.1.1 Open Wood Joist Construction with CMSA Sprinklers at Ceiling-Level.

25.2.4.1.1.1
Where CMSA sprinklers are installed under open wood joist construction, fire-stopping in accordance with 25.2.4.1.1.3 shall be provided or the minimum operating pressure of the sprinklers shall be 50 psi (3.4 bar) for a K-11.2 (160) sprinkler or 22 psi (1.5 bar) for a K-16.8 (240) sprinkler.

25.2.4.1.1.2

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Where each joist channel of open wood joist construction is fully fire-stopped to its full depth at intervals not exceeding 20 ft (6.1 m), the lower pressures specified in Table 25.2.4.2.1 shall be permitted to be used.

25.2.4.1.2 Preaction Systems for CMSA Sprinklers.
For the purpose of using Table 25.2.4.2.1, preaction systems shall be classified as dry pipe systems.

25.2.4.2 Rack Storage of Class I Through Class IV Commodities.

25.2.4.2.1
Where rack storage of Class I through Class IV commodities is protected by CMSA sprinklers at ceiling level along with one level of in-rack sprinklers, the ceiling-level sprinkler design criteria shall be in accordance with Table 25.2.4.2.1.

25.2.4.2.2
Protection shall be provided as specified in Table 25.2.4.2.1 or appropriate NFPA standards in terms of minimum operating pressure and the number of ceiling-level sprinklers to be included in the design area.

25.2.4.3 Rack Storage of Group A Plastic Commodities.

25.2.4.3.1
Where rack storage of nonexpanded, cartoned and uncartoned, Group A plastic commodities is protected by CMSA sprinklers at ceiling level along with one level of in-rack sprinklers, the ceiling-level sprinkler system design criteria shall be in accordance with Table 25.2.4.3.1.

Table 25.2.4.3.1 CMSA Ceiling-Level Sprinkler Design Criteria for Rack Storage of Group A Plastic Commodities Stored Up and Including 25 ft (7.6 m) in Height Supplemented with In-Rack Sprinklers

Storage Arrangement	Commodity Class	Maximum Storage Height		Maximum Ceiling/Roof Height		K-Factor/ Orientation	Type of System	Number of Design Sprinklers	Minimum Operating Pressure	
		ft	m	ft	m				psi	bar
Single-, double-, and multiple-row racks (no open-top containers)	Cartoned nonexpanded plastics	20	6.1	25	7.6	11.2 (160) Upright	Wet	15	50	3.4
						16.8 (240) Upright	Wet	15	22	1.5
						19.6 (280) Pendent	Wet	15	16	1.1
				30	9.1	11.2 (160) Upright	Wet	30	50	3.4
							Wet	20	75	5.2
						16.8 (240) Upright	Wet	15*	22	1.5
						19.6 (280) Pendent	Wet	15	16	1.1
		25	7.6	30	9.1	11.2 (160) Upright	Wet	15 + 1 level of in-rack	50	3.4
						16.8 (240) Upright	Wet	15*	22	1.5
						19.6 (280) Pendent	Wet	15	16	1.1

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Storage Arrangement	Commodity Class	Maximum Storage Height		Maximum Ceiling/Roof Height		K-Factor/ Orientation	Type of System	Number of Design Sprinklers	Minimum Operating Pressure	
		ft	m	ft	m				psi	bar
	Exposed nonexpanded plastics	25	7.6	35	11	11.2 (160) Upright	Wet	30 + 1 level of in-rack	50	3.4
							Wet	20 + 1 level of in-rack	75	5.2
						16.8 (240) Upright	Wet	30 + 1 level of in-rack	22	1.5
							Wet	20 + 1 level of in-rack	35	2.4
						19.6 (280) Pendent	Wet	15	25	1.7
		20	6.1	25	7.6	11.2 (160) Upright	Wet	15	50	3.4
						16.8 (240) Upright	Wet	15	22	1.5
		20	6.1	30	9.1	11.2 (160) Upright	Wet	30	50	3.4
							Wet	20	75	5.2
						16.8 (240) Upright	Wet	15*	22	1.5
		25	7.6	30	9.1	11.2 (160) Upright	Wet	15 + 1 level of in-rack	50	3.4
						16.8 (240) Upright	Wet	15*	22	1.5
		25	7.6	35	11	11.2 (160) Upright	Wet	30 + 1 level of in-rack	50	3.4
							Wet	20 + 1 level of in-rack	75	5.2
						16.8 (240) Upright	Wet	30 + 1 level of in-rack	22	1.5
							Wet	20 + 1 level of in-rack	35	2.4

*Minimum 8 ft (2.4 m) aisle.

25.2.4.3.2

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Protection shall be provided as specified in Table 25.2.4.3.1 or appropriate NFPA standards in terms of minimum operating pressure and the number of ceiling-level sprinklers to be included in the design area.

25.2.5 ESFR Ceiling Level Sprinkler Design Criteria in Combination with In-Rack Sprinklers.

25.2.5.1 Rack Storage of Class I Through Class IV Commodities.

25.2.5.1.1
Where rack storage of Class I through Class IV commodities is protected by ESFR sprinklers at ceiling level along with one level of in-rack sprinklers, the ceiling-level sprinkler design criteria shall be in accordance with Table 25.2.5.1.1.

25.2.5.1.2
ESFR sprinkler systems, when supplemented with in-rack sprinklers, shall be designed such that the minimum operating pressure is not less than that indicated in Table 25.2.5.1.1 for type of storage, commodity, storage height, and building height involved.

25.2.5.1.3
The design area applicable to the ceiling-level design options listed in Table 25.xx shall consist of the most hydraulically demanding area of 12 sprinklers, consisting of four sprinklers on each of three branch lines.

25.2.5.2 Rack Storage of Group A Plastic Commodities.

25.2.5.2.1
Where rack storage of cartoned or exposed nonexpanded Group A plastic and cartoned expanded Group A plastic commodity is protected by ESFR sprinklers at ceiling level along with one level of in-rack sprinklers, the ceiling-level sprinkler design criteria shall be in accordance with Table 25.2.5.2.1.

Table 25.2.5.2.1 ESFR Ceiling-Level Sprinkler Design Criteria for Rack Storage of Group A Plastic Commodities Supplemented with In-Rack Sprinklers

Storage Arrangement	Commodity	Maximum Storage Height		Maximum Ceiling/Roof Height		Nominal K-Factor	Orientation	Minimum Operating Pressure		In-Rack Sprinkler Requirements
		ft	m	ft	m			psi	bar	
Single-, double-, and multiple-row racks (no open-top containers)	Cartoned nonexpanded	20	6.1	25	7.6	14.0 (200)	Upright/ pendent	50	3.4	No
						16.8 (240)	Upright/ pendent	35	2.4	No
						22.4 (320)	Pendent	25	1.7	No
						25.2 (360)	Pendent	15	1.0	No
				30	9.1	14.0 (200)	Upright/ pendent	50	3.4	No
						16.8 (240)	Upright/ pendent	35	2.4	No
						22.4 (320)	Pendent	25	1.7	No
						25.2	Pendent	15	1.0	No

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Storage Arrangement	Commodity	Maximum Storage Height		Maximum Ceiling/Roof Height		Nominal K-Factor	Orientation	Minimum Operating Pressure		In-Rack Sprinkler Requirements
		ft	m	ft	m			psi	bar	
						(360)				
				35	11	14.0 (200)	Upright/ pendent	75	5.2	No
						16.8 (240)	Upright/ pendent	52	3.6	No
						22.4 (320)	Pendent	35	2.4	No
						25.2 (360)	Pendent	20	1.4	No
				40	12	16.8 (240)	Pendent	52	3.6	No
						22.4 (320)	Pendent	40	2.7	No
						25.2 (360)	Pendent	25	1.7	No
				45	14	14.0 (200)	Pendent	90	6.2	Yes
						16.8 (240)	Pendent	63	4.3	Yes
						22.4 (320)	Pendent	40	2.7	No
						25.2 (360)	Pendent	40	2.7	No
		25	7.6	30	9.1	14.0 (200)	Upright/pendent	50	3.4	No
						16.8 (240)	Upright/ pendent	35	2.4	No
						22.4 (320)	Pendent	25	1.7	No
						25.2 (360)	Pendent	15	1.0	No
				32	10	14.0 (200)	Upright/ pendent	60	4.1	No
						16.8 (240)	Upright/ pendent	42	2.9	No
				35	11	14.0 (200)	Upright/ pendent	75	5.2	No

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Storage Arrangement	Commodity	Maximum Storage Height		Maximum Ceiling/Roof Height		Nominal K-Factor	Orientation	Minimum Operating Pressure		In-Rack Sprinkler Requirements
		ft	m	ft	m			psi	bar	
						16.8 (240)	Upright/ pendent	52	3.6	No
						22.4 (320)	Pendent	35	2.4	No
						25.2 (360)	Pendent	20	1.4	No
				40	12	16.8 (240)	Pendent	52	3.6	No
						22.4 (320)	Pendent	40	2.7	No
						25.2 (360)	Pendent	25	1.7	No
				45	14	14.0 (200)	Pendent	90	6.2	Yes
						16.8 (240)	Pendent	63	4.3	Yes
						22.4 (320)	Pendent	40	2.7	No
						25.2 (360)	Pendent	40	2.7	No
	Exposed nonexpanded	20	6.1	25	7.6	14.0 (200)	Pendent	50	3.4	No
						16.8 (240)	Pendent	35	2.4	No
				30	9.1	14.0 (200)	Pendent	50	3.4	No
						16.8 (240)	Pendent	35	2.4	No
				35	11	14.0 (200)	Pendent	75	5.2	No
						16.8 (240)	Pendent	52	3.6	No
				40	12	16.8 (240)	Pendent	52	3.6	No
				45	14	14.0 (200)	Pendent	90	6.2	Yes
						16.8	Pendent	63	4.3	Yes

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Storage Arrangement	Commodity	Maximum Storage Height		Maximum Ceiling/Roof Height		Nominal K-Factor	Orientation	Minimum Operating Pressure		In-Rack Sprinkler Requirements
		ft	m	ft	m			psi	bar	
						(240)				
		25	7.6	30	9.1	14.0 (200)	Pendent	50	3.4	No
						16.8 (240)	Pendent	35	2.4	No
				32	10	14.0 (200)	Pendent	60	4.1	No
						16.8 (240)	Pendent	42	2.9	No
				35	11	14.0 (200)	Pendent	75	5.2	No
						16.8 (240)	Pendent	52	3.6	No
				40	12	16.8 (240)	Pendent	52	3.6	No
						22.4 (320)	Pendent	50	3.4	No
						25.2 (360)	Pendent	50	3.4	No
				45	14	14.0 (200)	Pendent	90	6.2	Yes
						16.8 (240)	Pendent	63	4.3	Yes
	Cartoned expanded	20	6.1	25	7.6	14.0 (200)	Upright/ pendent	50	3.4	No
						16.8 (240)	Upright/ pendent	35	2.4	No
				30	9.1	14.0 (200)	Upright/ pendent	50	3.4	No
						16.8 (240)	Upright/ pendent	35	2.4	No
		25	7.6	30	9.1	14.0 (200)	Upright/ pendent	50	3.4	No
						16.8 (240)	Upright/ pendent	35	2.4	No
				32	10	14.0 (200)	Pendent	60	4.1	No

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Storage Arrangement	Commodity	Maximum Storage Height		Maximum Ceiling/Roof Height		Nominal K-Factor	Orientation	Minimum Operating Pressure		In-Rack Sprinkler Requirements
		ft	m	ft	m			psi	bar	
						16.8 (240)	Upright/ pendent	42	2.9	No

25.2.5.2.2
ESFR sprinkler systems, when supplemented with in-rack sprinklers, shall be designed such that the minimum operating pressure is not less than that indicated in Table 25.2.5.2.1 for type of storage, commodity, storage height, and building height involved.

25.2.5.2.3
The design area applicable to the ceiling-level design options listed in Table 25.2.5.2.1 shall consist of the most hydraulically demanding area of 12 sprinklers, consisting of four sprinklers on each of three branch lines.

25.3 In-Rack Sprinkler Characteristics.

25.3.1
In-rack sprinklers shall be pendent or upright, standard- or quick-response, ordinary-temperature rated and have a nominal K-factor of K-5.6 (80), K-8.0 (115), or K-11.2 (160).

25.3.2
In-rack sprinklers protecting open-frame rack storage where ESFR sprinklers are installed at ceiling level shall be quick-response, ordinary-temperature rated, and either K-8.0 (115) or K-11.2 (160).

25.3.3
In-rack sprinklers with intermediate- and high-temperature ratings shall be used near heat sources as required by 9.4.2.

25.3.4
In-rack sprinklers shall be permitted to have a different RTI rating than the ceiling sprinklers under which they are installed.

25.3.5 In-Rack Sprinkler Water Shields.

25.3.5.1 In-Rack Sprinkler Water Shields for Storage of Class I Through Class IV Commodities.
Water shields shall be provided directly above in-rack sprinklers, or listed intermediate level/rack storage sprinklers shall be used where there is more than one level, if not shielded by horizontal barriers. *(See Section **C.3**.)*

25.3.5.2 In-Rack Sprinkler Water Shields for Plastic Storage.
Where in-rack sprinklers are not shielded by horizontal barriers, water shields shall be provided above the sprinklers, or listed intermediate level/rack storage sprinklers shall be used.

25.4 Vertical Spacing and Location of In-Rack Sprinklers.

25.4.1
In-rack sprinklers shall not be required to meet the obstruction criteria and clearance from storage requirements of Section 9.5.

25.4.2
A minimum 6 in. (150 mm) vertical clear space shall be maintained between in-rack sprinkler deflectors and the top of storage located below them.

25.4.3*

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Where in-rack sprinklers are being installed within single- and double-row racks of Class I through Class IV commodities up to and including 20 ft (6.1 m) in height, the vertical clear space of in-rack sprinkler deflectors with respect to the top of storage located below them shall be permitted to be less than 6 in. (150 mm). (See Section C.16.)

25.4.4
In-rack sprinkler discharge shall not be obstructed by horizontal rack members.

25.4.5*
Where one level of in-rack sprinklers are required by the guidelines of this chapter, in-rack sprinklers shall be installed at the first tier level at or above one-half of the highest expected storage height.

25.4.6
Where two levels of in-rack sprinklers are required by the guidelines of this chapter for rack storage of Class I through Class IV commodities up to and including 25 ft (7.6 m) in height, in-rack sprinklers shall be installed at the first tier level at or above one-third and two-thirds of the highest expected storage height.

25.4.7 Maximum Storage Height Above Top In-Rack Sprinkler Level.

25.4.7.1
Where in-rack sprinklers are required for single- and double-row rack storage of Class I through Class IV commodities over 25 ft (7.6 m) in height and protected by CMDA sprinklers at ceiling level, storage above the top level of in-rack sprinklers shall not exceed 10 ft (3.0 m)

25.4.7.2
Where in-rack sprinklers are required for multiple-row rack storage of Class I through Class IV commodities over 25 ft (7.6 m) in height and protected by CMDA sprinklers at ceiling level, storage above the top level of in-rack sprinklers shall not exceed 10 ft (3.0 m) for Class I, Class II, or Class III commodities or 5 ft (1.5 m) for Class IV commodities.

25.4.7.3
Where in-rack sprinklers are required for rack storage of plastic commodities over 25 ft (7.6 m) in height and protected by CMDA sprinklers at ceiling level, storage above the top level of in-rack sprinklers shall not exceed 10 ft (3.0 m).

25.4.8
Where single- and double-row rack storage of Class I through Class IV commodities is over 25 ft (7.6 m) in height and protected by CMDA sprinklers at ceiling level, in-rack sprinklers shall be staggered vertically where installed in accordance with Table 25.9.2.1.1, Figure 25.9.2.2(A)(a) through Figure 25.9.2.2(A)(j), and Figure 25.9.2.1.1(A)(a) through Figure 25.9.2.1.1(A)(e).

25.4.9*
Where multiple-row rack storage of Class I through Class IV commodities is over 25 ft (7.6 m) in height and protected by CMDA sprinklers at ceiling level, in-rack sprinklers shall be staggered vertically where installed in accordance with Table 25.9.2.1.1, Figure 25.9.2.2(A)(a) through Figure 25.9.2.2(A)(j), and Figure 25.9.2.1.1(A)(a) through Figure 25.9.2.1.1(A)(e).

25.5 Horizontal Spacing and Location of In-Rack Sprinklers.

25.5.1 Horizontal Spacing of In-Rack Sprinklers.

25.5.1.1 General.

25.5.1.1.1
In-rack sprinklers shall be permitted to be installed horizontally less than 6 ft (1.8 m) apart.

25.5.1.1.2
For miscellaneous and low piled rack storage, the maximum allowable horizontal spacing of in-rack sprinklers shall be 8 ft (2.4 m).

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25.5.1.1.3
For rack storage of rubber tires, the maximum allowable horizontal spacing of in-rack sprinklers shall be 8 ft (2.4 m).

25.5.1.2 CMDA Sprinklers Installed at Ceiling Level.

25.5.1.2.1*
Where single- and double-row rack storage of Class I through Class IV commodities is up to and including 25 ft (7.6 m) in height and protected by CMDA sprinklers at ceiling level, the maximum allowable horizontal spacing of in-rack sprinklers shall be in accordance with Table 25.5.1.2.1.

Table 25.5.1.2.1 In-Rack Sprinkler Horizontal Spacing for Class I, II, III, and IV Commodities Stored in Single- or Double-Row Racks Up to 25 ft (7.6 m) in Height Protected by Control Mode Density/Area Sprinklers at Ceiling Level

			Commodity Class					
	Aisle Widths		I and II		III		IV	
Encapsulated	ft	m	ft	m	ft	m	ft	m
No	8	2.4	12	3.7	12	3.7	10	3.0
No	4	1.2	12	3.7	10	3.0	10	3.0
Yes	—	—	8	2.4	8	2.4	8	2.4

25.5.1.2.2
Where multiple-row rack storage of Class I through Class IV commodities is up to and including 25 ft (7.6 m) in height and protected by CMDA sprinklers at ceiling level, the maximum allowable horizontal spacing of in-rack sprinklers shall be in accordance with Table 25.5.1.2.2.

Table 25.5.1.2.2 In-Rack Sprinkler Horizontal Spacing for Class I, II, III, and IV Commodities Stored in Multiple-Row Racks Up to 25 ft (7.6 m) in Height Protected by Control Mode Density/Area Sprinklers at Ceiling Level

Commodity Class							
I, II, III				IV			
Spacing		Area		Spacing		Area	
ft	m	ft^2	m^2	ft	m	ft^2	m^2
12	3.7	100	9.3	8	2.4	80	7.4

(A)
The rack plan view shall be considered in determining the area covered by each sprinkler.

(B)
The aisles shall not be included in area calculations.

25.5.1.2.3*
Where rack storage of plastic commodities is up to and including 25 ft (7.6 m) in height and protected by CMDA sprinklers at ceiling level, the maximum allowable horizontal spacing of in-rack sprinklers shall be in accordance with Figure 25.9.3.1(a) through Figure 25.9.3.1(e).

25.5.1.2.4
Where single- and double-row rack storage of Class I through Class IV commodities is over 25 ft (7.6 m) in height and protected by CMDA sprinklers at ceiling level, the maximum allowable horizontal spacing of in-rack sprinklers shall be in accordance with Table 25.9.2.1.1 and Figure 25.9.2.2(a) through Figure 25.9.2.2(j).

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25.5.1.2.5
Where multiple-row rack storage of Class I through Class IV commodities is over 25 ft (7.6 m) in height and protected by CMDA sprinklers at ceiling level, the maximum allowable horizontal spacing of in-rack sprinklers shall be in accordance with Table 25.9.2.3.1 and Figure 25.9.2.3.1(a) through Figure 25.9.2.3.1(c).

25.5.1.2.6
Where single-row rack storage of cartoned Group A plastic commodities, expanded or nonexpanded, encapsulated or nonencapsulated, is over 25 ft (7.6 m) in height and protected by CMDA sprinklers at ceiling level, the maximum allowable horizontal spacing of in-rack sprinklers shall be in accordance with Figure 25.9.4.1.1(a) through Figure 25.9.4.1.1(d) or Figure 25.9.4.2.2.

25.5.1.2.7
Where double-row rack storage of cartoned Group A plastic commodities, expanded or nonexpanded, encapsulated or nonencapsulated, is over 25 ft (7.6 m) in height and protected by CMDA sprinklers at ceiling level, the maximum allowable horizontal spacing of in-rack sprinklers shall be in accordance with Figure 25.9.4.2.1(a) through Figure 25.9.4.2.1(c).

25.5.1.2.8
Where single- and double-row rack storage of exposed nonexpanded Group A plastic commodities, whether encapsulated or nonencapsulated, is over 25 ft (7.6 m) in height and protected by CMDA sprinklers at ceiling level, the maximum allowable horizontal spacing of in-rack sprinklers shall be in accordance with Figure 25.9.4.2.2.

25.5.1.2.9*
Where multiple-row rack storage of exposed nonexpanded Group A plastic commodities, whether encapsulated or nonencapsulated, or cartoned Group A plastic commodities, expanded or nonexpanded, encapsulated or nonencapsulated, is over 25 ft (7.6 m) in height and protected by CMDA sprinklers at ceiling level, the maximum allowable horizontal spacing of in-rack sprinklers shall be in accordance with Figure 25.9.4.3.1(a) through Figure 25.9.4.3.1(f).

25.5.1.3 CMSA Sprinklers Installed at Ceiling Level.

25.5.1.3.1
Where rack storage of Class I through Class IV commodities is up to and including 25 ft (7.6 m) in height and protected by CMSA sprinklers at ceiling level, the maximum allowable horizontal spacing of in-rack sprinklers shall be 8 ft (2.4 m).

25.5.1.3.2
Where rack storage of plastic commodities is up to and including 25 ft (7.6 m) in height and protected by CMSA sprinklers at ceiling level, the maximum allowable horizontal spacing of in-rack sprinklers shall be 5 ft (1.5 m).

25.5.1.3.3
Where rack storage of Class I through Class IV commodities is over 25 ft (7.6 m) in height and protected by CMSA sprinklers at ceiling level, the maximum allowable horizontal spacing of in-rack sprinklers shall be 5 ft (1.5 m).

25.5.1.4 ESFR Sprinklers Installed at Ceiling Level.
Where rack storage is protected by ESFR sprinklers at ceiling level, the maximum allowable horizontal spacing of in-rack sprinklers shall be 5 ft (1.5 m).

25.5.2 Horizontal Location of In-Rack Sprinklers.

25.5.2.1
In-rack sprinklers shall not be required to meet the obstruction criteria and clearance from storage requirements of Section 9.5.

25.5.2.2*
Where in-rack sprinklers are installed in longitudinal flues, they shall be located at an intersection of transverse and longitudinal flues while not exceeding the maximum horizontal spacing rules.

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25.5.2.3
Where horizontal distances between transverse flues exceed the maximum allowable horizontal linear spacing for in-rack sprinklers, in-rack sprinklers shall be installed at the intersection of the transverse and longitudinal flues, and additional in-rack sprinklers shall be installed between transverse flues to meet the maximum allowable horizontal linear spacing rules for in-rack sprinklers.

25.5.2.4
Where no transverse flues exist, horizontal spacing of in-rack sprinklers shall not exceed the maximum allowable spacing rules.

25.5.2.5
Where in-rack sprinklers are installed to protect a higher-hazard commodity that occupies only a portion of the length of a rack, in-rack sprinklers shall be extended a minimum of 8 ft (2.4 m) or one bay, whichever is greater, in each direction along the rack on either side of the higher hazard. The in-rack sprinklers protecting the higher hazard shall not be required to extend across the aisle.

25.5.2.6
The in-rack sprinkler arrangement protecting the higher hazard outlined in 25.5.2.5 shall not be required to be extended across the aisle.

25.5.2.7*
Where rack storage is over 25 ft (7.6 m) in height, in-rack sprinklers shall be a minimum 3 in. (75 mm) radially from the side of rack uprights.

25.5.2.8
Where rack storage of Class I through Class IV commodities is up to and including 25 ft (7.6 m), in-rack sprinklers shall be permitted to be installed horizontally without regard to rack uprights. (See Section C.17.)

25.5.2.9
Where rack storage is over 25 ft (7.6 m) in height, face sprinklers shall be located within the rack a minimum 3 in. (75 mm) from rack uprights and no more than 18 in. (450 mm) from the aisle face of storage.

25.5.2.10
Where single- and double-row rack storage of Class I through Class IV commodities is over 25 ft (7.6 m) in height and protected by CMDA sprinklers at ceiling level, in-rack sprinklers shall be staggered horizontally where installed in accordance with Table 25.9.2.1.1, Figure 25.9.2.2(a) through Figure 25.9.2.2(j), and Figure 25.9.2.1.1(a) through Figure 25.9.2.1.1(e).

25.5.2.11
Where multiple-row rack storage of Class I through Class IV commodities is over 25 ft (7.6 m) in height and protected by CMDA sprinklers at ceiling level, in-rack sprinklers shall be staggered horizontally where installed in accordance with Table 25.9.2.3.1 and Figures 25.9.2.3.1(a) through Figure 25.9.2.3.1(c).

25.5.2.12
Where rack storage of plastic commodities is over 25 ft (7.6 m) in height, in-rack sprinklers in longitudinal flues shall be installed with the deflector located at or below the bottom of horizontal load beams or above or below other adjacent horizontal rack members.

25.5.2.13
Where miscellaneous and low piled single- and double-row rack storage does not have a longitudinal flue, in-rack sprinklers shall be located within 12 in. (300 mm) of the center of the rack while not exceeding the maximum allowable horizontal in-rack sprinkler spacing.

25.6 Protection of Racks with Solid Shelves.

25.6.1 General.
The requirements of Section 25.625.6 shall apply to racks with solid shelves except as modified in this section.

25.6.2

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Ceiling-level sprinkler design criteria for CMDA, CMSA, and ESFR sprinklers shall be an applicable option for open racks combined with in-rack sprinklers installed in accordance with the criteria for solid shelving.

25.6.3 Vertical Spacing and Location of In-Rack Sprinklers in Racks with Solid Shelves.

25.6.3.1
Where CMDA sprinklers are at ceiling level protecting racks with solid shelving that exceeds 20 ft^2 (1.9 m^2) in area but not 64 ft^2 (5.9 m^2), in-rack sprinklers shall not be required below every shelf, but shall be installed below solid shelves at intermediate levels not more than 6 ft (1.8 m) apart vertically. (See Section C.11.)

25.6.3.2
Where CMDA sprinklers are at ceiling level protecting racks with solid shelving that exceeds 64 ft^2 (5.9 m^2) in area or where the levels of storage exceed 6 ft (1.8 m), in-rack sprinklers shall be installed below each level of solid shelving.

25.6.3.3
Where CMSA sprinklers are at ceiling level and protect racks with solid shelving, in-rack sprinklers shall be installed beneath all tiers under the highest solid shelf.

25.6.3.4
Where ESFR sprinklers are at ceiling level and protect racks with solid shelving, in-rack sprinklers shall be installed beneath all tiers under the highest solid shelf.

25.6.3.5
Where racks with solid shelves obstruct only a portion of an open-frame rack, in-rack sprinklers shall be installed vertically as follows:
(1) In accordance with Section 25.6.3.125.6.3.1 and 25.6.3.225.6.3.2 where CMDA sprinklers are installed at ceiling level

(2) In accordance with 25.6.3.325.6.3.3 where CMSA sprinklers are installed at ceiling level

(3) In accordance with 25.6.3.425.6.3.4 where ESFR sprinklers are installed at ceiling level

25.6.3.6
Where CMDA sprinklers are at ceiling level and protecting single- or double-row racks with solid shelves of Class I through Class IV commodities stored up to and including 25 ft (7.6 m) in height, a minimum 6 in. (150 mm) vertical clear space shall be maintained between in-rack sprinkler deflectors and the top of storage located below them.

25.6.4 Horizontal Spacing and Location of In-Rack Sprinklers in Racks with Solid Shelves.

25.6.4.1
Where racks with solid shelves contain storage of Class I through Class IV commodities, the maximum allowable horizontal spacing of in-rack sprinklers shall be 10 ft (3.0 m).

25.6.4.2
Where racks with solid shelves contain storage of plastic commodities, the maximum allowable horizontal spacing of in-rack sprinklers shall be 5 ft (1.5 m).

25.6.4.3
Where racks with solid shelves obstruct only a portion of an open-frame rack, in-rack sprinklers shall be extended beyond the end of the solid shelf a minimum of 4 ft (1.2 m) to the nearest flue space intersection.

25.7 Horizontal Barriers in Combination with In-Rack Sprinklers.

25.7.1*
Where required by sections of this chapter, horizontal barriers used in combination with in-rack sprinklers to impede vertical fire development shall be constructed of sheet metal, wood, or similar material and shall extend the full length and depth of the rack.

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25.7.2
Barriers shall be fitted within 2 in. (50 mm) horizontally around rack uprights.

25.8 In-Rack Sprinkler Arrangements and Designs, Independent of Ceiling-Level Sprinklers.

25.8.1 Alternative In-Rack Sprinkler Protection Option 1.

25.8.1.1
Where Class I, II, III, IV and Group A plastic commodities are protected in accordance with the guidelines of this section, the in-rack sprinkler system shall not be required to be hydraulically balanced with the ceiling-level sprinkler system.

25.8.1.2
Where a storage rack will not be solely dedicated to the in-rack sprinkler system outlined in this section, either of the following shall apply:
(1) Extend the protection outlined in this section horizontally one pallet load in all directions beyond the commodity storage area that is being protected by the alternative in-rack sprinkler arrangement.

(2) Install a vertical barrier to segregate the commodities that are being protected by the alternative in-rack sprinkler arrangement.

25.8.1.3
Where a storage rack is partially protected by the in-rack sprinkler system outlined in this section, commodities that can be protected by the ceiling-level sprinkler system shall be permitted to be stored vertically above and horizontally adjacent to the portions of the storage rack protected in accordance with this section.

25.8.1.4 Horizontal Barriers for Alternative In-Rack Sprinkler Protection Option 1.

25.8.1.4.1
The barrier shall be constructed of minimum 22 gauge (0.7 mm) sheet metal or of minimum 3/8 in. (10 mm) plywood.

25.8.1.4.2
The barrier shall span horizontally to both aisle faces of the rack, covering up all flue spaces of the rack bays in which they are installed.

25.8.1.4.3
A maximum 3 in. (75 mm) wide horizontal gap shall be permitted at rack uprights or other equipment that would create an opening, such as vertical in-rack sprinkler pipe drops.

25.8.1.4.4
Where the dedicated storage is in open-frame racks, horizontal barriers shall be installed at vertical increments not exceeding 12 ft (3.6 m).

25.8.1.4.5
Where the dedicated storage is in racks with solid shelves, horizontal barriers shall be installed at every tier level of the dedicated storage rack.

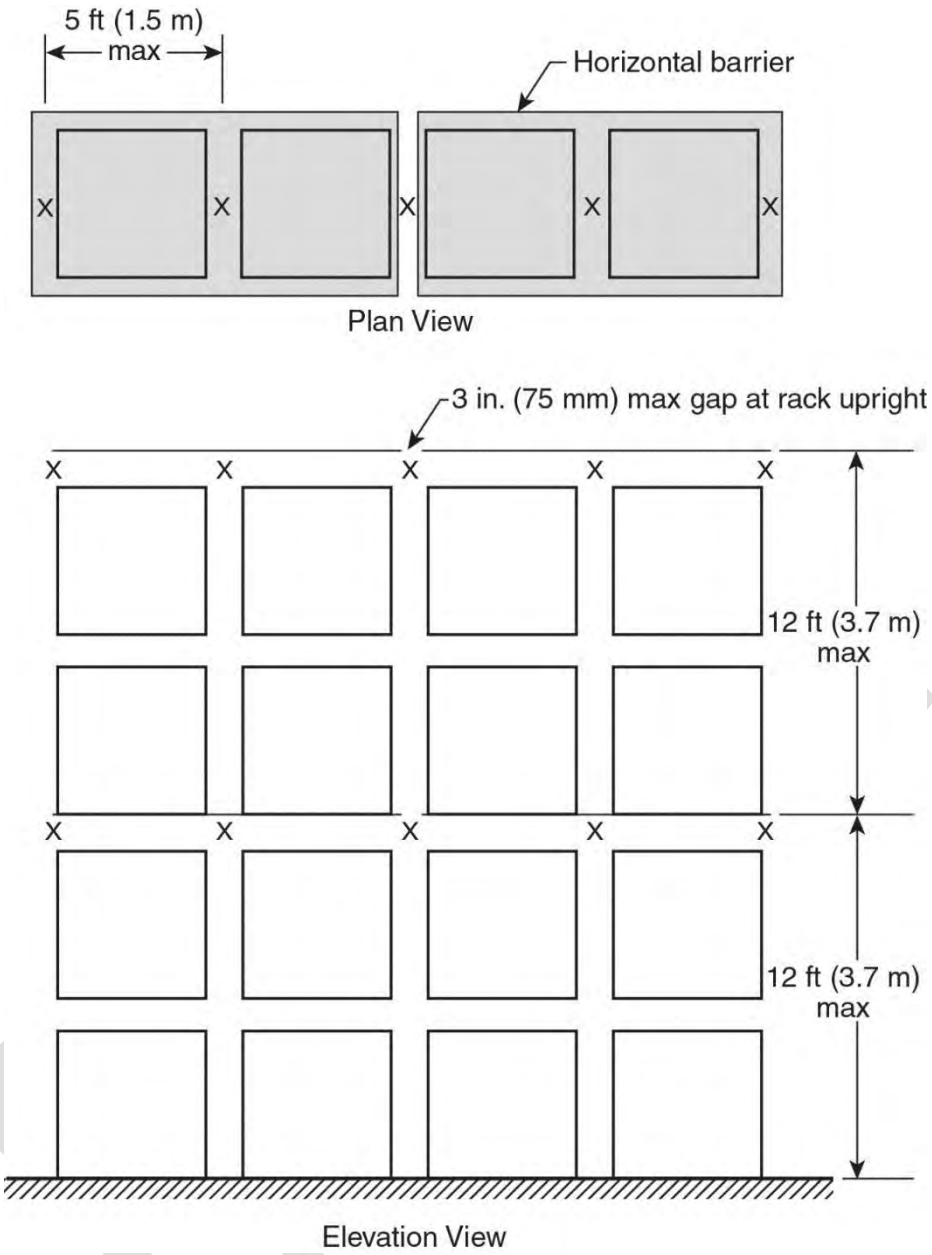
25.8.1.5
In-rack sprinklers shall be quick-response, minimum K-8.0 (K-115) installed as close to the underside of the horizontal barrier as possible.

25.8.1.6 Alternative In-Rack Sprinkler Protection Option 1 for Single-Row Racks.

25.8.1.6.1
For single-row racks, in-rack sprinklers shall be installed beneath horizontal barriers at each rack upright and within the rack bay as shown in Figure 25.8.1.6.1Figure 25.8.1.6.1.

Figure 25.8.1.6.1 Alternative In-Rack Sprinkler Protection Option 1 for Single-Row Racks.

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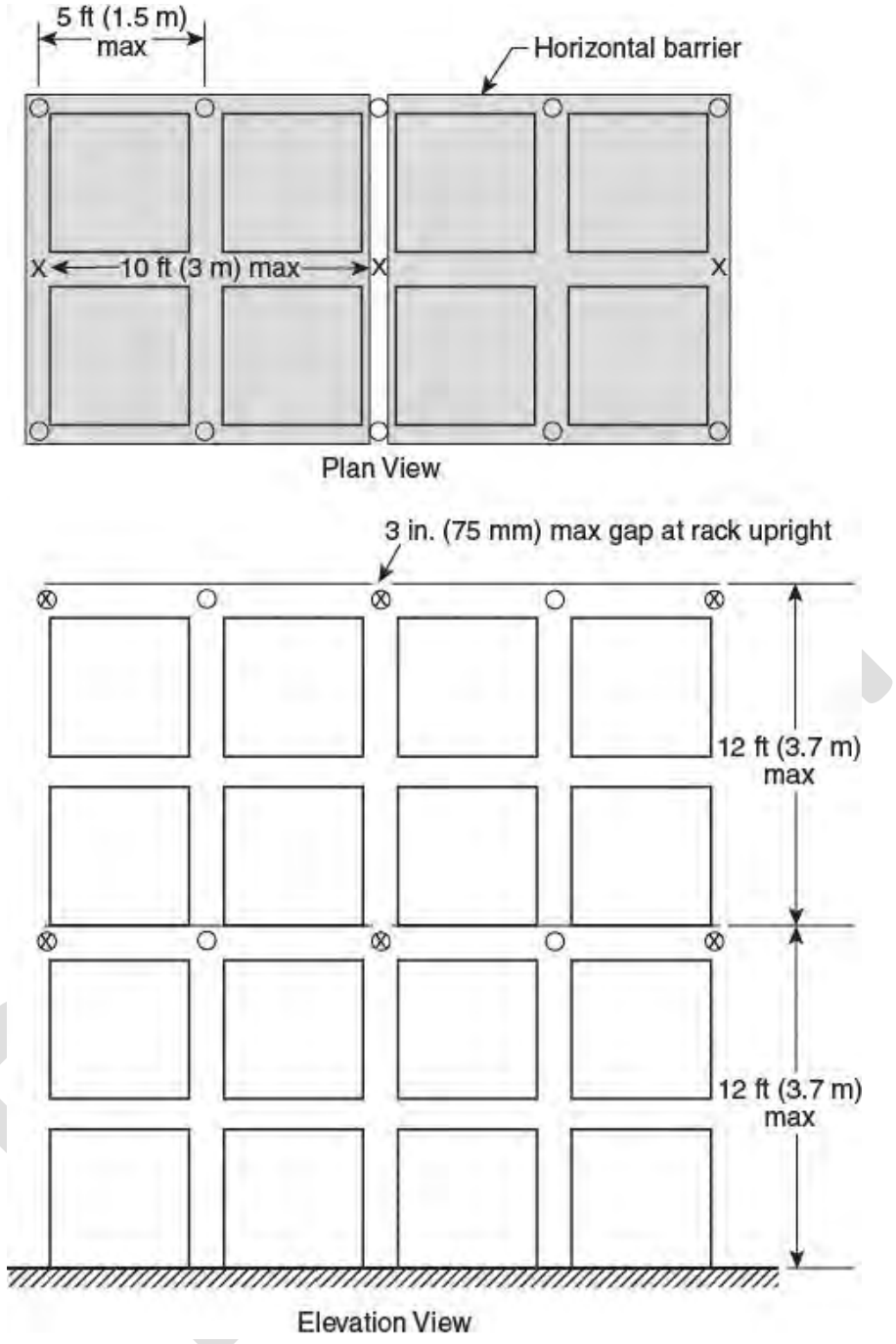


25.8.1.6.2
The maximum allowable horizontal spacing between in-rack sprinklers shall not exceed 5 ft (1.5 m).

25.8.1.7 Alternative In-Rack Sprinkler Protection Option 1 for Double-Row Racks.

25.8.1.7.1
For double-row racks, in-rack sprinklers shall be installed beneath horizontal barriers at each rack upright within the longitudinal flue space and at the face of the rack as well as at the face of each rack bay as shown in Figure 25.8.1.7.1Figure 25.8.1.7.1.

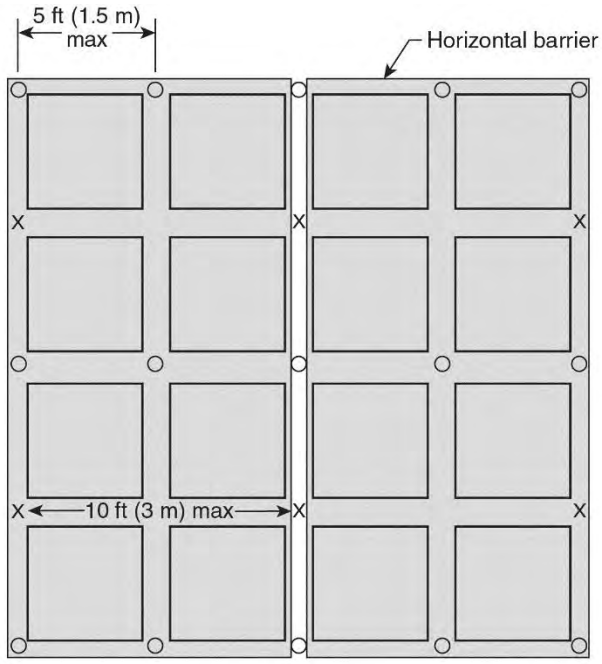
Figure 25.8.1.7.1 Alternative In-Rack Sprinkler Protection Option 1 for Double-Row Racks.



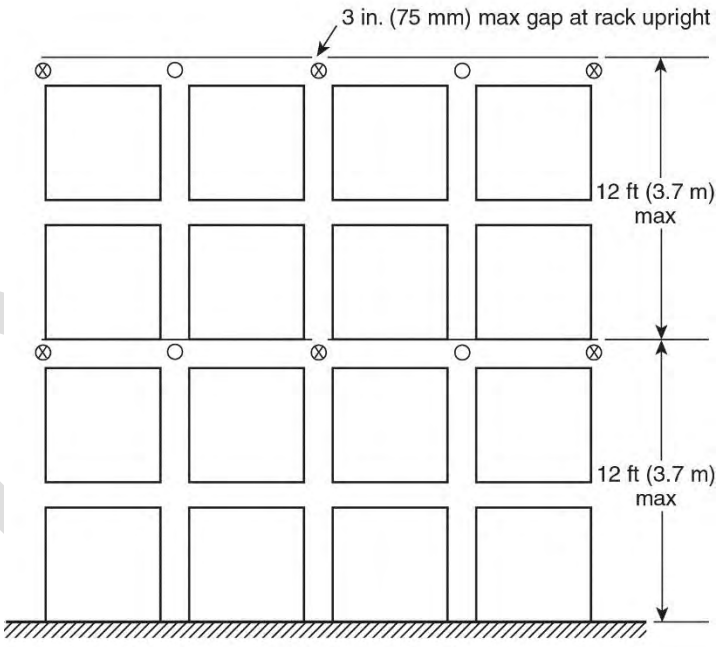
25.8.1.7.2
The maximum allowable horizontal spacing between in-rack sprinklers shall not exceed 5 ft (1.5 m) at the rack face and 10 ft (3.0 m) within the longitudinal flue space.

25.8.1.8 Alternative In-Rack Sprinkler Protection Option 1 for Multiple-Row Racks.
25.8.1.8.1
For multiple-row racks, an alternating in-rack sprinkler arrangement shall be installed within adjacent transverse flue spaces and with sprinklers at the face of each flue space as shown in Figure 25.8.1.8.**1**Figure 25.8.1.8.1.

Figure 25.8.1.8.1 Alternative In-Rack Sprinkler Protection Option 1 for Multiple-Row Racks.



Plan View



Elevation View

25.8.1.8.2
The maximum allowable horizontal spacing between in-rack sprinklers at the face and at each alternating rack bay shall not exceed 5 ft (1.5 m) and shall not exceed 10 ft (3.0 m) between in-rack sprinklers at every other rack bay.

25.8.1.9 In-Rack Sprinkler System Design.
The in-rack sprinkler system design outlined in this section shall be based on a minimum flow of 60 gpm (230 L/min) from the most remote six in-rack sprinklers for single-row racks or the most remote eight in-rack sprinklers for both double-row and multiple-row racks.

25.8.1.10 Ceiling-Level Sprinkler System Design.

The ceiling-level sprinkler system shall be designed based on the highest commodity hazard not protected by the in-rack sprinkler system outlined in this section.

25.8.2 Alternative In-Rack Sprinkler Protection Option 2.

25.8.2.1
Where Class I, II, III, IV and Group A plastic commodities are protected in accordance with this section, the in-rack sprinkler system shall not be required to be hydraulically balanced with the ceiling-level sprinkler system.

25.8.2.2
For open-frame storage racks, install horizontal barriers as outlined in 25.7 as well as in-rack sprinklers a maximum of every 6 ft (1.8 m) vertically.

25.8.2.3
For storage racks having solid shelves with shelf areas that exceed 20 ft^2 (1.9 m^2) but not 64 ft^2 (5.9 m^2) and CMDA sprinklers are installed at ceiling level, in-rack sprinklers shall be installed below shelves at intermediate levels not more than 6 ft (1.8 m) apart vertically.

25.8.2.4
For storage racks having solid shelves with shelf areas that exceed 20 ft^2 (1.9 m^2) but not 64 ft^2 (5.9 m^2) and CMSA or ESFR sprinklers are installed at ceiling level, in-rack sprinklers shall be installed below each level of shelving.

25.8.2.5
For storage racks having solid shelves with shelf areas that exceed 64 ft^2 (5.9 m^2), in-rack sprinklers shall be installed below each level of shelving.

25.8.2.6
Where CMDA sprinklers are at ceiling level and protecting single- or double-row racks with solid shelves of Class I through Class IV commodities stored up to and including 25 ft (7.6 m) in height, a minimum 6 in. (150 mm) vertical clear space shall be maintained between in-rack sprinkler deflectors and the top of storage located below them.

25.8.2.7
Where racks contain storage of Class I through Class IV commodities, the maximum allowable horizontal spacing of in-rack sprinklers shall be 10 ft (3.0 m).

25.8.2.8
Where racks with solid shelves contain storage of plastic commodities, the maximum allowable horizontal spacing of in-rack sprinklers shall be 5 ft (1.5 m).

25.8.2.9
Face sprinklers shall be installed under each solid shelf or horizontal barrier at rack uprights.

25.8.2.10 In-Rack Sprinkler System Design.
The in-rack sprinkler design for the in-rack sprinkler arrangement outlined in this section shall be based on a minimum flow of 60 gpm (230 L/min) from the most remote eight in-rack sprinklers.

25.8.2.11
Where a storage rack will not be solely dedicated to the in-rack sprinkler system outlined in this section, either of the following shall apply:

25.8.2.11.1
Extend the protection outlined in this section horizontally one pallet load in all directions beyond the commodity storage area that is being protected by the alternative in-rack sprinkler arrangement.

25.8.2.11.2
Install a vertical barrier to segregate the commodities that are being protected by the alternative in-rack sprinkler arrangement.

25.8.2.12

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Where a storage rack is partially protected by the in-rack sprinkler system outlined in this section, commodities that can be protected by the ceiling-level sprinkler system shall be permitted to be stored vertically above and horizontally adjacent to the portions of the storage rack protected in accordance with this section.

25.9 In-Rack Sprinkler Arrangements in Combination with CMDA Sprinklers at Ceiling-Level.

25.9.1 Rack Storage of Class I through Class IV Commodities Up to and Including 25 ft (7.6 m) in Height.

The in-rack arrangements for rack storage up to and including 25 ft (7.6 m) in height shall be in accordance with the guidelines outlined in Section 25.4 through 25.7 as applicable.

25.9.2 Rack Storage of Class I through Class IV Commodities Over 25 ft (7.6 m) in Height.

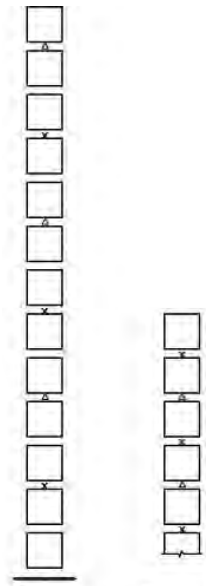
25.9.2.1 Single-Row Racks.

25.9.2.1.1*

In single-row racks with a maximum of 10 ft (3.0 m) between the top of storage and the ceiling, in-rack sprinklers shall be installed in accordance with Table 25.9.2.1.1 and Figure 25.9.2.1.1(a) through Figure 25.9.2.1.1(e).

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Figure 25.9.2.1.1(a) In-Rack Sprinkler Arrangement, Class I, II, III, or IV Commodities, Single-Row Racks, Storage Height Over 25 ft (7.6 m) — Option 1.

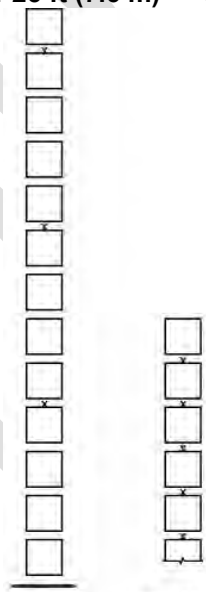


Elevation Plan View

Notes:

1. For all storage heights, sprinklers shall be installed in every other tier and staggered as indicated.
2. Symbol Δ or x indicates sprinklers on vertical or horizontal stagger.
3. Each square represents a storage cube measuring 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. (450 mm) up to 10 ft (3.0 m). Therefore, there could be as few as one load or as many as six or seven loads between in-rack sprinklers that are spaced 10 ft (3.0 m) apart vertically.

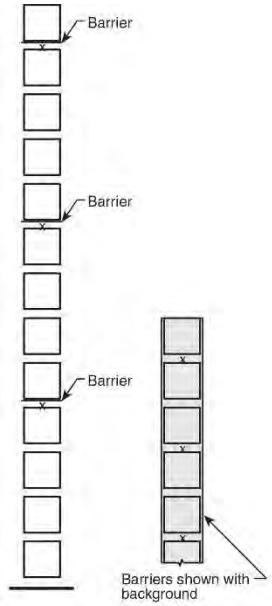
Figure 25.9.2.1.1(b) In-Rack Sprinkler Arrangement, Class I, II, or III Commodities, Single-Row Racks, Storage Height Over 25 ft (7.6 m) — Option 1.



Elevation Plan View

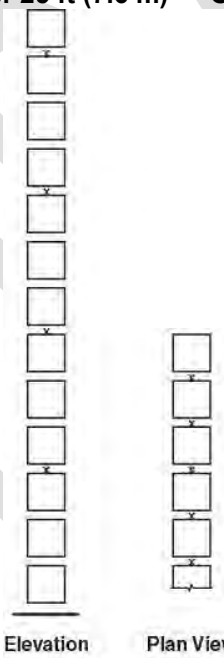
Note: Each square represents a storage cube measuring 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. (450 mm) up to 10 ft (3.0 m). Therefore, there could be as few as one load or as many as six or seven loads between in-rack sprinklers that are spaced 10 ft (3.0 m) apart vertically.

Figure 25.9.2.1.1(c) In-Rack Sprinkler Arrangement, Class I, II, or III Commodities, Single-Row Racks, Storage Height Over 25 ft (7.6 m) — Option 1.



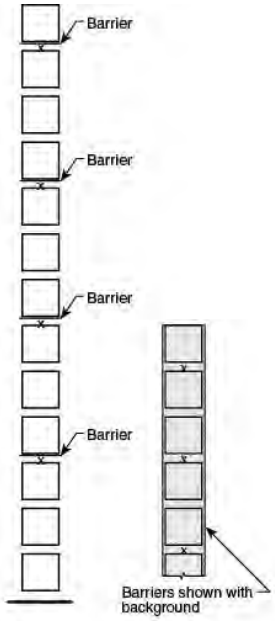
Note: Each square represents a storage cube measuring 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. (450 mm) up to 10 ft (3.0 m). Therefore, there could be as few as one load or as many as six or seven loads between in-rack sprinklers that are spaced 10 ft (3.0 m) apart vertically.

Figure 25.9.2.1.1(d) In-Rack Sprinkler Arrangement, Class I, II, III, or IV Commodities, Single-Row Racks, Storage Height Over 25 ft (7.6 m) — Option 2.



Note: Each square represents a storage cube measuring 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. (450 mm) up to 10 ft (3.0 m). Therefore, there could be as few as one load or as many as six or seven loads between in-rack sprinklers that are spaced 10 ft (3.0 m) apart vertically.

Figure 25.9.2.1.1(e) In-Rack Sprinkler Arrangement, Class I, II, III, or IV Commodities, Single-Row Racks, Storage Height Over 25 ft (7.6 m) — Option 3.



Elevation **Plan View**

Note: Each square represents a storage cube measuring 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. (450 mm) up to 10 ft (3.0 m). Therefore, there could be as few as one load or as many as six or seven loads between in-rack sprinklers that are spaced 10 ft (3.0 m) apart vertically.

25.9.2.1.2
Where a single-row rack is located against a wall, the in-rack sprinkler arrangement shall be permitted to be in accordance with Figure 25.9.2.2(a) through Figure 25.9.2.2(j).

25.9.2.1.3
Where in-rack sprinkler arrangement figures for single-row racks show in-rack sprinklers in transverse flue spaces centered between the rack faces, it shall be permitted to position these in-rack sprinklers in the transverse flue at any point between the load faces.

25.9.2.2 Double-Row Racks.

25.9.2.2.1*
In double-row racks with a maximum of 10 ft (3.0 m) between the top of storage and the ceiling, in-rack sprinklers shall be installed in accordance with Table 25.9.2.2.1 and Figure 25.9.2.2.1(a) through Figure 25.9.2.2.1(j).

Table 25.9.2.2.1 Single- or Double-Row Racks of Class I Through Class IV Commodities Stored Over 25 ft (7.6 m) in Height with Aisles 4 ft (1.2 m) or More in Width

Commodity Class	In-Rack Sprinklers Approximate Vertical Spacing at Tier Nearest the Vertical Distance and Maximum Horizontal Spacing[a,b,c]		Figure	Maximum Storage Height	Stagger	Ceiling Sprinkler Operating Area		Ceiling Sprinkler Density Clearance to Ceiling Up to 10 ft (3 m)[g]			
								Ordinary Temperature		High Temperature	
	Longitudinal Flue[d]	Face[e,f]				ft²	m²	gpm/ft²	mm/min	gpm/ft²	mm/min
I	Vertical 20 ft (6.1 m) Horizontal 10 ft (3.0 m) under horizontal barriers	None	16.3.1.3.1.1(A)(a)	30 ft (9.1 m)	No	2000	186	0.25	10.2	0.35	14.2
	Vertical 20 ft (6.1 m) Horizontal 10 ft (3.0 m)	Vertical 20 ft (6.1 m) Horizontal 10 ft (3.0 m)	16.3.1.3.1.1(A)(b)	Higher than 25 ft (7.6 m)	Yes			0.25	10.2	0.35	14.2
I, II, III	Vertical 10 ft (3.0 m) or at 15 ft (4.6 m) and 25 ft (7.6 m)	None	16.3.1.3.1.1(A)(c)	30 ft (9.1 m)	Yes	2000	186	0.3	12.2	0.4	16.3
	Vertical 10 ft (3.0 m m) Horizontal 10 ft (3.0 m m)	Vertical 30 ft (9.1 m) Horizontal 10 ft (3.0 m)	16.3.1.3.1.1(A)(d)	Higher than 25 ft (7.6 m)	Yes			0.3	12.2	0.4	16.3
	Vertical 20 ft (6.1 m) Horizontal 10 ft (3.0 m)	Vertical 20 ft (6.1 m) Horizontal 5 ft (1.5 m)	16.3.1.3.1.1(A)(e)		Yes			0.3	12.2	0.4	16.3
	Vertical 25 ft (7.6 m) Horizontal 5 ft (1.5 m)	Vertical 25 ft (7.6 m) Horizontal 5 ft (1.5 m)	16.3.1.3.1.1(A)(f)		No			0.3	12.2	0.4	16.3

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Commodity Class	In-Rack Sprinklers Approximate Vertical Spacing at Tier Nearest the Vertical Distance and Maximum Horizontal Spacing[a,b,c]		Figure	Maximum Storage Height	Stagger	Ceiling Sprinkler Operating Area		Ceiling Sprinkler Density Clearance to Ceiling Up to 10 ft (3 m)[g]			
								Ordinary Temperature		High Temperature	
	Longitudinal Flue[d]	Face[e,f]				ft²	m²	gpm/ft²	mm/min	gpm/ft²	mm/min
I, II, III, IV	Horizontal barriers at 20 ft (6.1 m) Vertical intervals — two lines of sprinklers under barriers — maximum horizontal spacing 10 ft (3.0 m), staggered		16.3.1.3.1.1(A)(g)	Higher than 25 ft (7.6 m)	Yes	2000	186	0.3	12.2	0.4	16.3
	Vertical 15 ft (4.6 m) Horizontal 10 ft (3.1 m)	Vertical 20 ft (6.1 m) Horizontal 10 ft (3.0 m)	16.3.1.3.1.1(A)(h)		Yes			0.35	14.3	0.45	18.3
	Vertical 20 ft (6.1 m) Horizontal 5 ft (1.5 m)	Vertical 20 ft (6.1 m) Horizontal 5 ft (1.5 m)	16.3.1.3.1.1(A)(i)		No			0.35	14.3	0.45	18.3
	Horizontal barriers at 15 ft (4.6 m) Vertical intervals — two lines of sprinklers under barriers — maximum horizontal		16.3.1.3.1.1(A)(j)		Yes			0.35	14.3	0.45	18.3

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Commodity Class	In-Rack Sprinklers Approximate Vertical Spacing at Tier Nearest the Vertical Distance and Maximum Horizontal Spacing[a,b,c]		Figure	Maximum Storage Height	Stagger	Ceiling Sprinkler Operating Area		Ceiling Sprinkler Density Clearance to Ceiling Up to 10 ft (3 m)[g]			
								Ordinary Temperature		High Temperature	
	Longitudinal Flue[d]	Face[e,f]				ft^2	m^2	gpm/ft^2	mm/min	gpm/ft^2	mm/min
	spacing 10 ft (3.0 m), staggered										

[a]Minimum in-rack sprinkler discharge, 30 gpm (114 L/min).

[b]Water shields required.

[c]All in-rack sprinkler spacing dimensions start from the floor.

[d]Install sprinklers at least 3 in. (75 mm)from uprights.

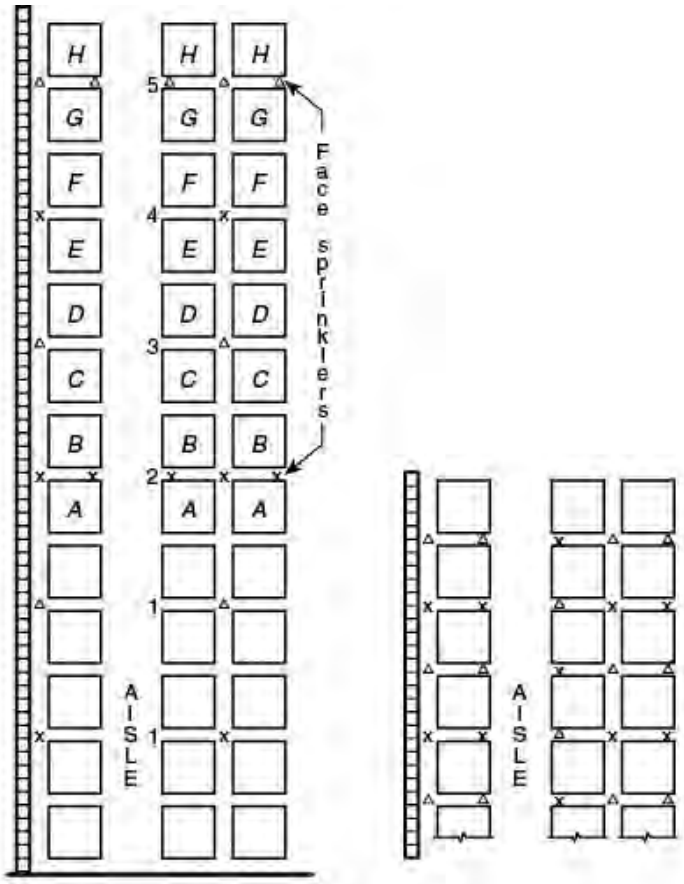
[e]Face sprinklers shall not be required for a Class I commodity consisting of noncombustible products on wood pallets (without combustible containers), except for arrays shown in Figure 16.3.1.3.1.1(A)(g) and Figure 16.3.1.3.1.1(A)(j).

[f]In Figure 16.3.1.3.1.1(A)(a) through Figure 16.3.1.3.1.1(A)(j), each square represents a storage cube that measures 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. to 10 ft (450 mm to 3.0 m). Therefore, there can be one load to six or seven loads between in-rack sprinklers that are spaced 10 ft (3.0 m) apart vertically.

[g]For encapsulated commodity, increase density 25 percent.

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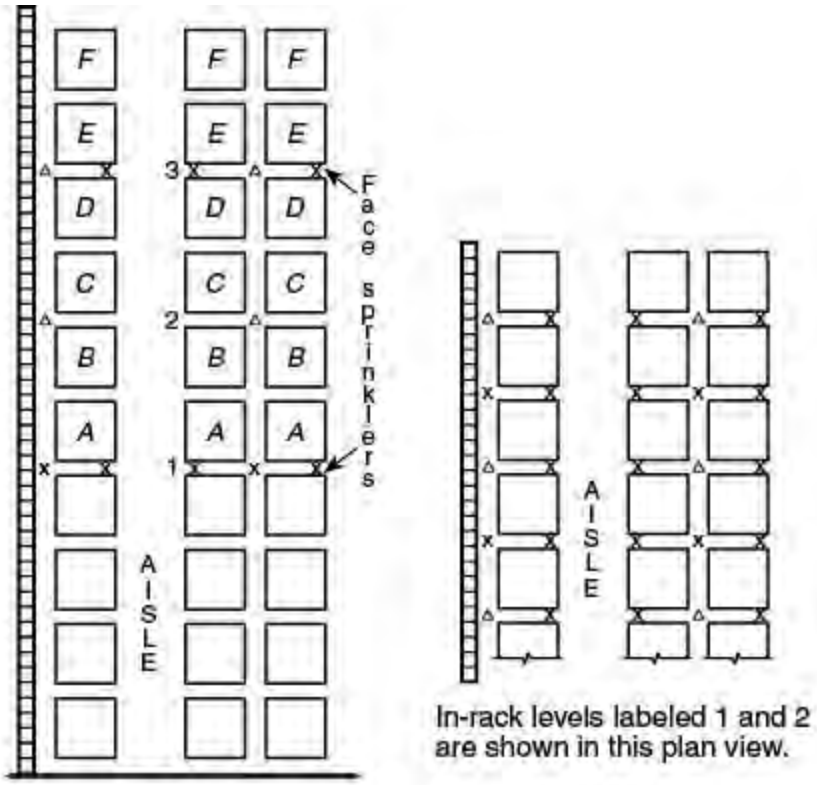
Figure 25.9.2.2.1(a) In-Rack Sprinkler Arrangement, Class I, II, or III Commodities, Storage Height Over 25 ft (7.6 m) — Option 1.



Notes:

1. Sprinklers labeled 1 shall be required where loads labeled *A* represent the top of storage.
2. Sprinklers labeled 1 and 2 shall be required where loads labeled *B* or *C* represent top of storage.
3. Sprinklers labeled 1, 2, and 3 shall be required where loads labeled *D* or *E* represent top of storage.
4. Sprinklers labeled 1, 2, 3, and 4 shall be required where loads labeled *F* or *G* represent top of storage.
5. Sprinklers labeled 1, 2, 3, 4, and 5 shall be required where loads labeled *H* represent top of storage.
6. For storage higher than represented by loads labeled *H*, the cycle defined by Notes 3, 4, and 5 is repeated with stagger as indicated.
7. The indicated face sprinklers shall be permitted to be omitted where commodity consists of unwrapped or unpackaged metal parts on wood pallets.
8. Symbol Δ or x indicates sprinklers on vertical or horizontal stagger.
9. Each square represents a storage cube measuring 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. (450 mm) up to 10 ft (3.0 m). Therefore, there could be as few as one load or as many as six or seven loads between in-rack sprinklers that are spaced 10 ft (3.0 m) apart vertically.

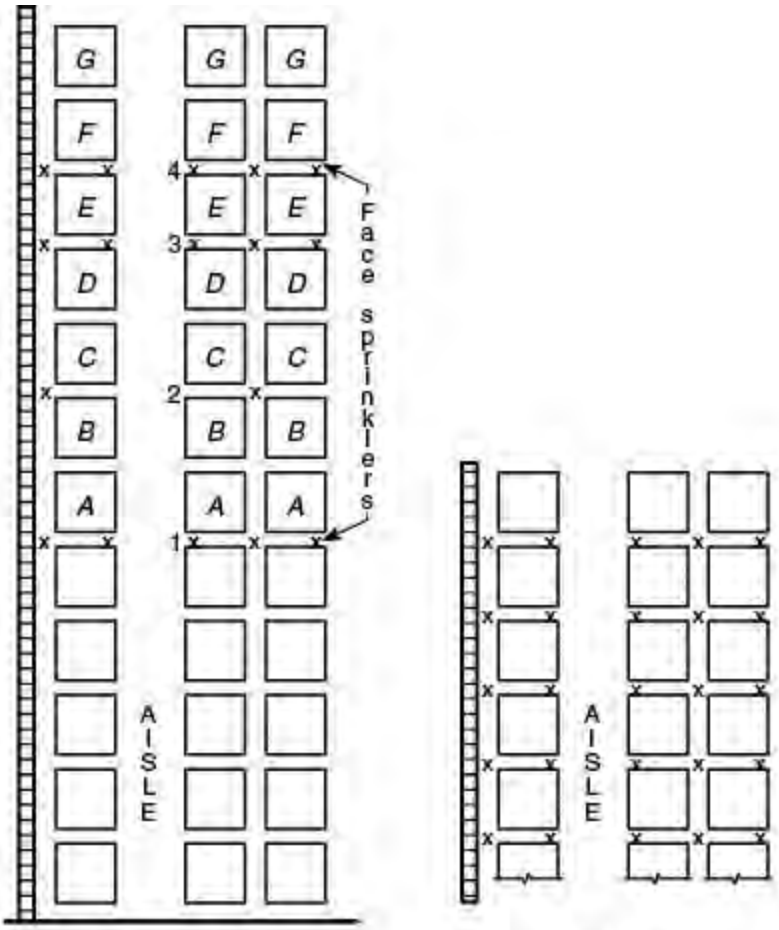
Figure 25.9.2.2.1(b) In-Rack Sprinkler Arrangement, Class I, II, or III Commodities, Storage Height Over 25 ft (7.6 m) — Option 2.



Notes:

1. Sprinklers labeled 1 (the selected array from Table 16.3.1.1) shall be required where loads labeled *A* or *B* represent top of storage.
2. Sprinklers labeled 1 and 2 shall be required where loads labeled *C* or *D* represent top of storage.
3. Sprinklers labeled 1 and 3 shall be required where loads labeled *E* or *F* represent top of storage.
4. For storage higher than represented by loads labeled *F*, the cycle defined by Notes 2 and 3 is repeated, with stagger as indicated.
5. Symbol Δ or x indicates sprinklers on vertical or horizontal stagger.
6. Each square represents a storage cube measuring 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. (450 mm) up to 10 ft (3.0 m). Therefore, there could be as few as one load or as many as six or seven loads between in-rack sprinklers that are spaced 10 ft (3.0 m) apart vertically.

Figure 25.9.2.2.1(c) In-Rack Sprinkler Arrangement, Class I, II, or III Commodities, Storage Height Over 25 ft (7.6 m) — Option 3.

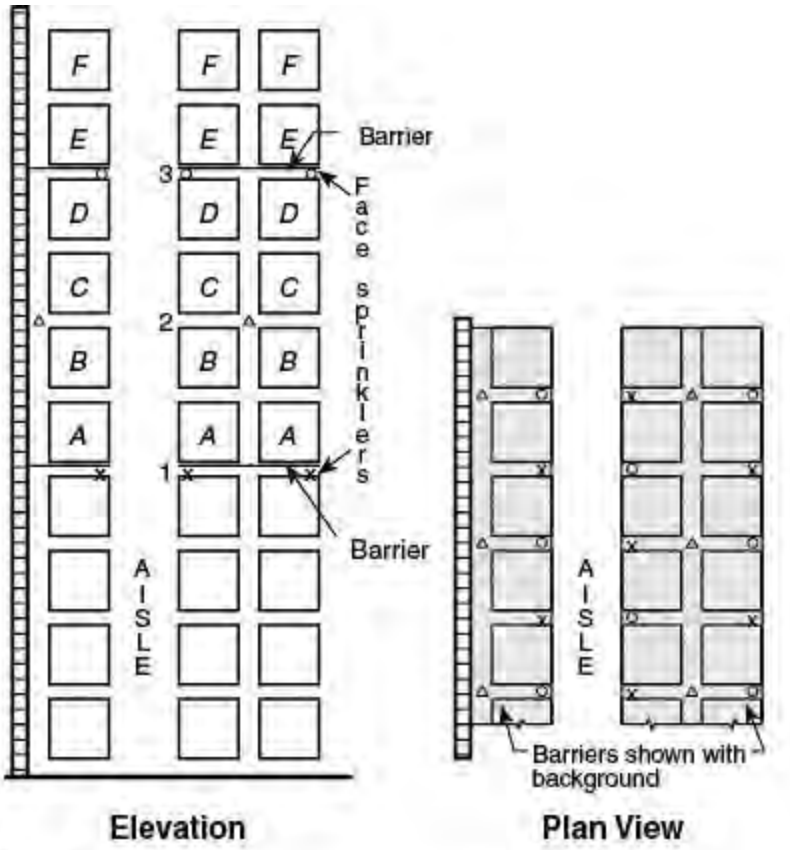


Elevation Plan View

Notes:

1. Sprinklers labeled 1 (the selected array from Table 16.3.1.1) shall be required where loads labeled *A* or *B* represent top of storage.
2. Sprinklers labeled 1 and 2 shall be required where loads labeled *C* or *D* represent top of storage.
3. Sprinklers labeled 1 and 3 shall be required where loads labeled *E* represent top of storage.
4. Sprinklers labeled 1 and 4 shall be required where loads labeled *F* or *G* represent top of storage.
5. For storage higher than represented by loads labeled *G*, the cycle defined by Notes 2, 3, and 4 is repeated.
6. Symbol x indicates face and in-rack sprinklers.
7. Each square represents a storage cube measuring 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. (450 mm) up to 10 ft (3.0 m). Therefore, there could be as few as one load or as many as six or seven loads between in-rack sprinklers that are spaced 10 ft (3.0 m) apart vertically.

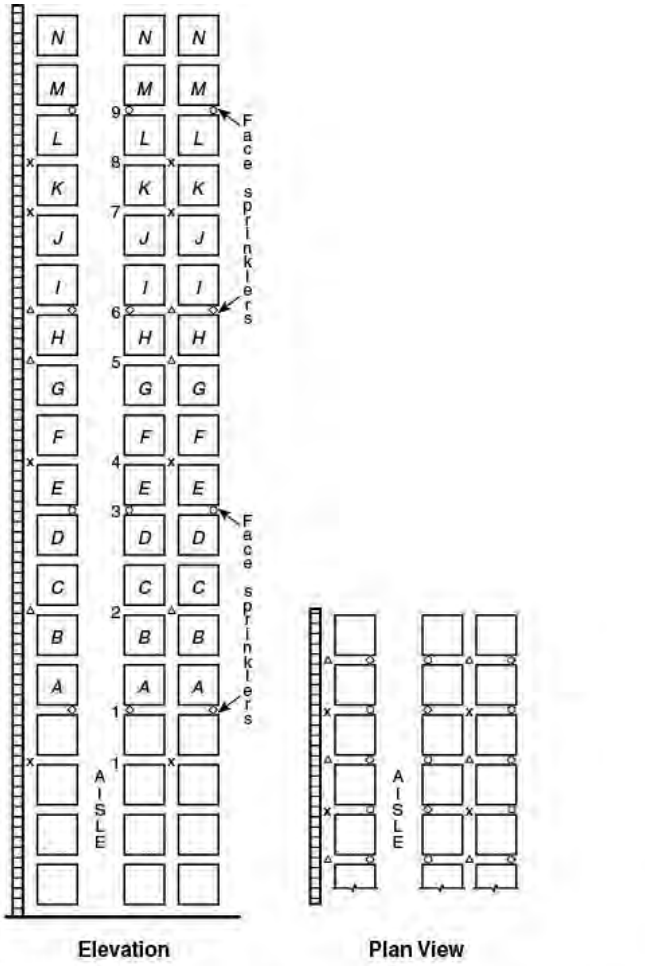
Figure 25.9.2.2.1(d) In-Rack Sprinkler Arrangement, Class I, II, or III Commodities, Storage Height Over 25 ft (7.6 m) — Option 4.



Notes:

1. Sprinklers labeled 1 (the selected array from Table 16.3.1.1) shall be required where loads labeled *A* or *B* represent top of storage.
2. Sprinklers labeled 1 and 2 shall be required where loads labeled *C* or *D* represent top of storage.
3. Sprinklers labeled 1 and 3 shall be required where loads labeled *E* or *F* represent top of storage.
4. For storage higher than represented by loads labeled *F*, the cycle defined by Notes 2 and 3 is repeated.
5. Symbols o, Δ, and x indicate sprinklers on vertical or horizontal stagger.
6. Each square represents a storage cube measuring 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. (450 mm) up to 10 ft (3.0 m). Therefore, there could be as few as one load or as many as six or seven loads between in-rack sprinklers that are spaced 10 ft (3.0 m) apart vertically.

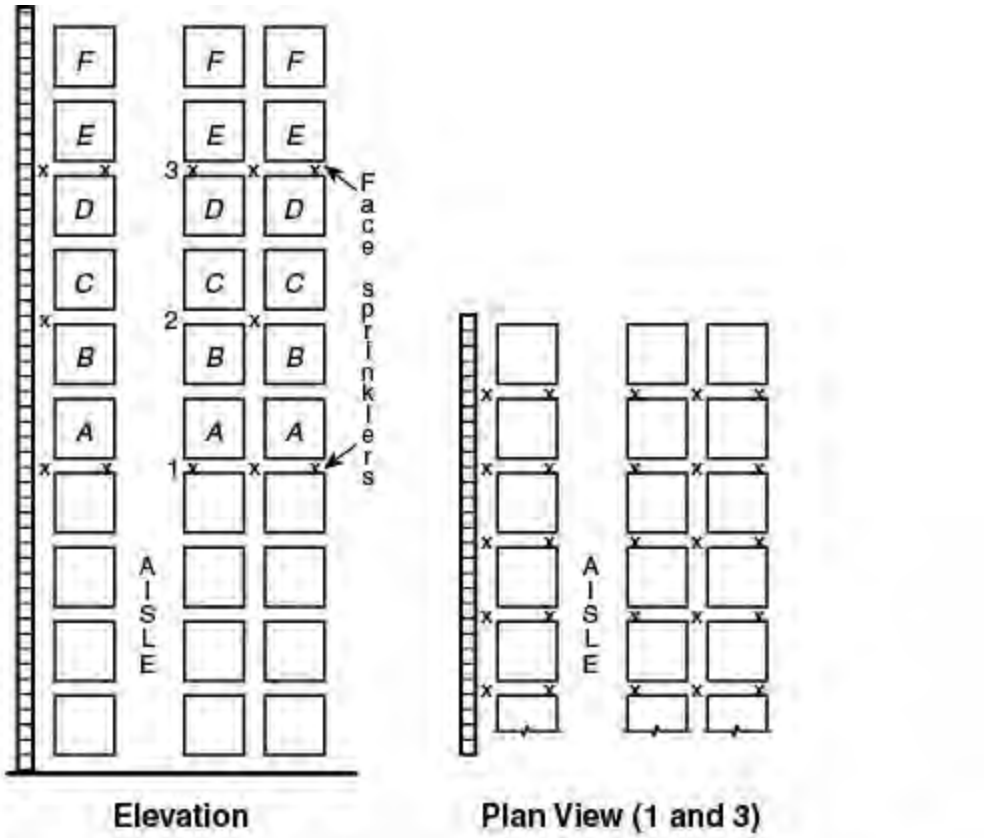
Figure 25.9.2.2.1(e) In-Rack Sprinkler Arrangement, Class I, II, III, or IV Commodities, Storage Height Over 25 ft (7.6 m) — Option 1.



Notes:

1. Sprinklers labeled 1 (the selected array from Table 16.3.1.1) shall be required where loads labeled *A* or *B* represent top of storage.
2. Sprinklers labeled 1 and 2 shall be required where loads labeled *C* or *D* represent top of storage.
3. Sprinklers labeled 1, 2, and 3 shall be required where loads labeled *E* or *F* represent top of storage.
4. Sprinklers labeled 1, 2, 3, and 4 shall be required where loads labeled *G* represent top of storage.
5. Sprinklers labeled 1, 2, 3, 4, and 5 shall be required where loads labeled *H* represent top of storage.
6. Sprinklers labeled 1, 2, 3, 4, and 6 (not 5) shall be required where loads labeled *I* or *J* represent top of storage.
7. Sprinklers labeled 1, 2, 3, 4, 6, and 7 shall be required where loads labeled *K* represent top of storage.
8. Sprinklers labeled 1, 2, 3, 4, 6, and 8 shall be required where loads labeled *L* represent top of storage.
9. Sprinklers labeled 1, 2, 3, 4, 6, 8, and 9 shall be required where loads labeled *M* or *N* represent top of storage.
10. For storage higher than represented by loads labeled *N*, the cycle defined by Notes 1 through 9 is repeated, with stagger as indicated. In the cycle, loads labeled *M* are equivalent to loads labeled *A*.
11. Symbols o, x, and Δ indicate sprinklers on vertical or horizontal stagger.
12. Each square represents a storage cube measuring 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. (450 mm) up to 10 ft (3.0 m). Therefore, there could be as few as one load or as many as six or seven loads between in-rack sprinklers that are spaced 10 ft (3.0 m) apart vertically.

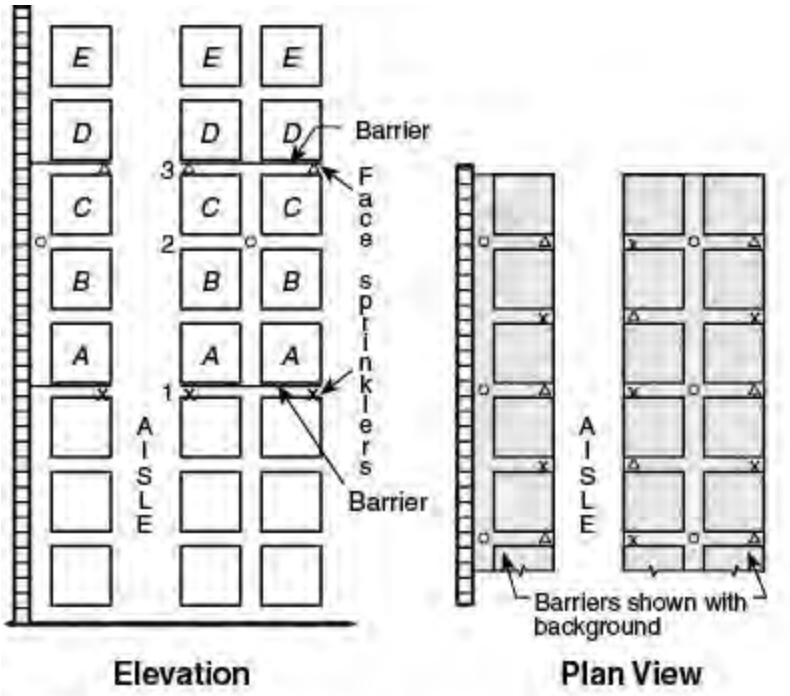
Figure 25.9.2.2.1(f) In-Rack Sprinkler Arrangement, Class I, II, III, or IV Commodities, Storage Height Over 25 ft (7.6 m) — Option 2.



Notes:

1. Sprinklers labeled 1 (the selected array from Table 16.3.1.1) shall be required where loads labeled *A* or *B* represent top of storage.
2. Sprinklers labeled 1 and 2 shall be required where loads labeled *C* or *D* represent top of storage.
3. Sprinklers labeled 1 and 3 shall be required where loads labeled *E* or *F* represent top of storage.
4. For storage higher than represented by loads labeled *F*, the cycle defined by Notes 2 and 3 is repeated.
5. Symbol x indicates face and in-rack sprinklers.
6. Each square represents a storage cube measuring 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. (450 mm) up to 10 ft (3.0 m). Therefore, there could be as few as one load or as many as six or seven loads between in-rack sprinklers that are spaced 10 ft (3.0 m) apart vertically.

Figure 25.9.2.2.1(g) In-Rack Sprinkler Arrangement, Class I, II, III, or IV Commodities, Storage Height Over 25 ft (7.6 m) — Option 3.



Notes:

1. Sprinklers labeled 1 (the selected array from Table 16.3.1.1) shall be required where loads labeled *A* or *B* represent top of storage.
2. Sprinklers labeled 1 and 2 and barrier labeled 1 shall be required where loads labeled *C* represent top of storage.
3. Sprinklers and barriers labeled 1 and 3 shall be required where loads labeled *D* or *E* represent top of storage.
4. For storage higher than represented by loads labeled *E*, the cycle defined by Notes 2 and 3 is repeated.
5. Symbol Δ or x indicates sprinklers on vertical or horizontal stagger.
6. Symbol o indicates longitudinal flue space sprinklers.
7. Each square represents a storage cube measuring 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. (450 mm) up to 10 ft (3.0 m). Therefore, there could be as few as one load or as many as six or seven loads between in-rack sprinklers that are spaced 10 ft (3.0 m) apart vertically.

25.9.2.3 Multiple-Row Racks.

25.9.2.3.1*

In multiple-row racks with a maximum of 10 ft (3.0 m) between the top of storage and the ceiling, in-rack sprinklers shall be in accordance with Table 25.9.2.3.1 and Figure 25.9.1.3.1(a) through Figure 25.9.2.3.1(c).

Table 25.9.2.3.1 Multiple-Row Racks of Class I Through Class IV Commodities Stored Over 25 ft (7.6 m) in Height

Commodity Class	Encapsulated	In-Rack Sprinklers[a,b,c]						Height Limit (ft)	Stagger	Figure	Maximum Spacing from Top of Storage to Highest In-Rack Sprinklers		Ceiling Sprinkler Operating Area		Ceiling Sprinklers Density Clearance to Ceiling Up to 10 ft			
		Maximum Vertical Spacing		Maximum Horizontal Spacing in A Flue		Maximum Horizontal Spacing across Flue									165°F (74°C) Rating		286°F (141°C) Rating	
		ft	m	ft	m	ft	m				ft	m	ft^2	m^2	gpm/ft^2	mm/min	gpm/ft^2	mm/min
I	No	20	6.1	12	3.7	10	3.0	None	Between adjacent flues	16.3.1.3.1.3(A)(a)	10	3.0	2000	186	0.25	10.2	0.35	14.3
	Yes														0.31	12.6	0.44	17.9
I, II, and III	No	15	4.6	10	3.0	10	3.0			16.3.1.3.1.3(A)(b)	10	3.0			0.30	12.2	0.40	16.3
	Yes														0.37	15.1	0.50	20.4
I, II, III, and IV	No	10	3.1	10	3.0	10	3.0			16.3.1.3.1.3(A)(c)	5	1.5			0.35	14.2	0.45	18.3
	Yes														0.44	17.9	0.56	22.8

For SI units, °C = ⅝ (°F-32); 1 gpm/ft^2 = 40.746 mm/min.

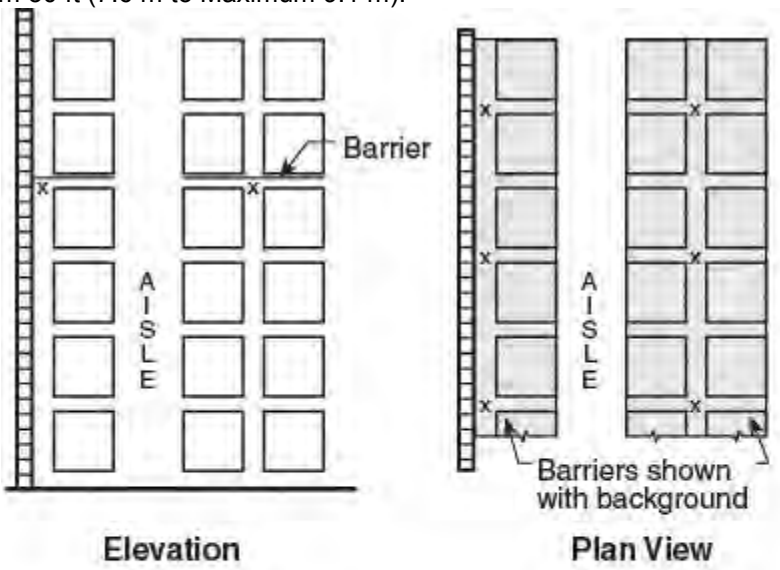
[a]All four rack faces shall be protected by sprinklers located within the racks and no more than 18 in. (450 mm) from the faces, as indicated in Figure 16.3.1.3.1.3(A)(a) through Figure 16.3.1.3.1.3(A)(c). It shall not be required for each sprinkler level to protect all faces.

[b]All in-rack sprinkler spacing dimensions start from the floor.

[c]In Figure 16.3.1.3.1.3(A)(a) through Figure 16.3.1.3.1.3(A)(c), each square represents a storage cube measuring 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. to 10 ft (450 mm to 3.0 m). Therefore, there could be as few as one load or as many as six or seven loads between in-rack sprinklers that are spaced 10 ft (3.1 m) apart vertically.

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Figure 25.9.2.3.1(a) In-Rack Sprinkler Arrangement, Class I Commodities, Storage Height 25 ft to Maximum 30 ft (7.6 m to Maximum 9.1 m).

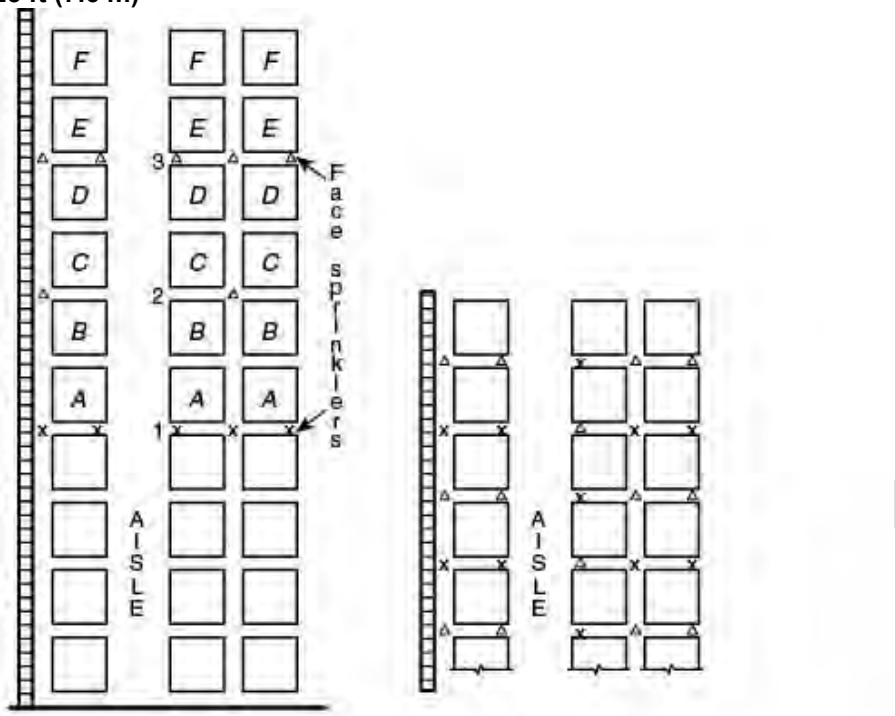


Notes:

1. Symbol x indicates in-rack sprinklers.
2. Each square represents a storage cube measuring 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. (450 mm) up to 10 ft (3.0 m). Therefore, there could be as few as one load or as many as six or seven loads between in-rack sprinklers that are spaced 10 ft (3.0 m) apart vertically.

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Figure 25.9.2.3.1(b) In-Rack Sprinkler Arrangement, Class I Commodities, Storage Height Over 25 ft (7.6 m)

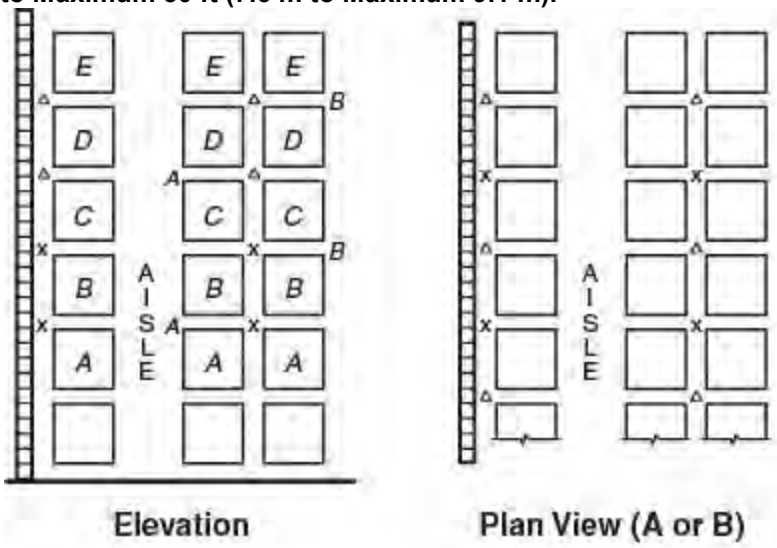


Elevation Plan View

Notes:

1. Sprinklers labeled 1 (the selected array from Table 16.3.1.1) shall be required where loads labeled *A* or *B* represent top of storage.
2. Sprinklers labeled 1 and 2 shall be required where loads labeled *C* or *D* represent top of storage.
3. Sprinklers labeled 1 and 3 shall be required where loads labeled *E* or *F* represent top of storage.
4. For storage higher than represented by loads labeled *F*, the cycle defined by Notes 2 and 3 is repeated, with stagger as indicated.
5. Symbol Δ or x indicates sprinklers on vertical or horizontal stagger.
6. Each square represents a storage cube measuring 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. (450 mm) up to 10 ft (3.0 m). Therefore, there could be as few as one load or as many as six or seven loads between in-rack sprinklers that are spaced 10 ft (3.0 m) apart vertically.

Figure 25.9.2.3.1(c) In-Rack Sprinkler Arrangement, Class I, II, or III Commodities, Storage Height 25 ft to Maximum 30 ft (7.6 m to Maximum 9.1 m).



Notes:

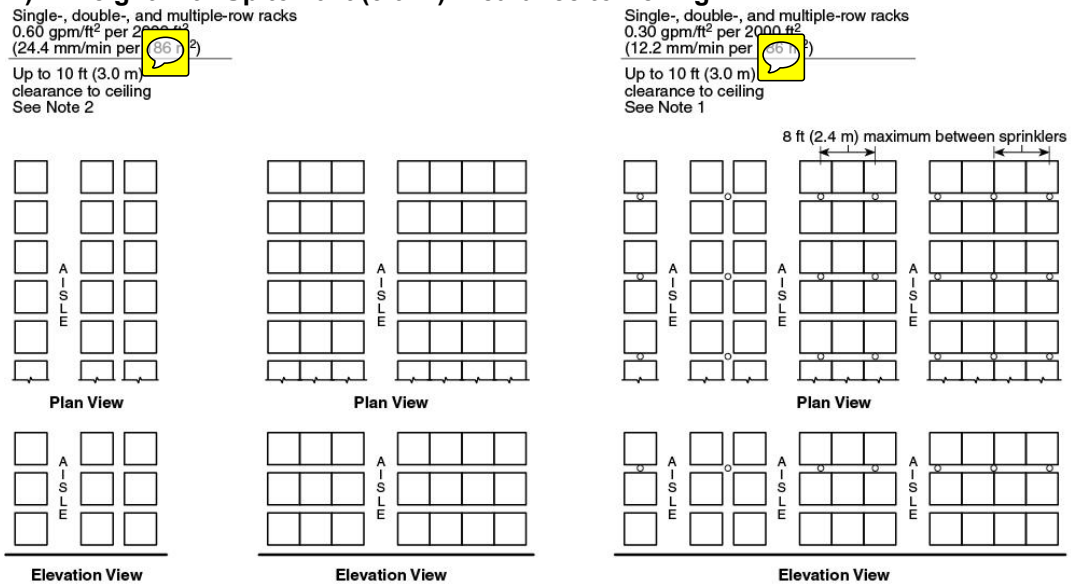
1. Alternate location of in-rack sprinklers. Sprinklers shall be permitted to be installed above loads *A* and *C* or above loads *B* and *D*.
2. Symbol Δ or x indicates sprinklers on vertical or horizontal stagger.
3. Each square represents a storage cube measuring 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. (450 mm) up to 10 ft (3.0 m). Therefore, there could be as few as one load or as many as six or seven loads between in-rack sprinklers that are spaced 10 ft (3.0 m) apart vertically.

25.9.3 Rack Storage of Group A Plastic Commodities Up to and Including 25 ft (7.6 m) in Height.

25.9.3.1

Where rack storage of cartoned Group A plastic commodities, encapsulated or nonencapsulated, having a clearance to ceiling up to and including 10 ft (3.1 m) require in-rack sprinklers, in-rack sprinkler arrangements shall be selected from Figure 25.9.3.1(a)Figure 25.9.3.1(a) through Figure 25.9.3.1(e)Figure 25.9.3.1(e).

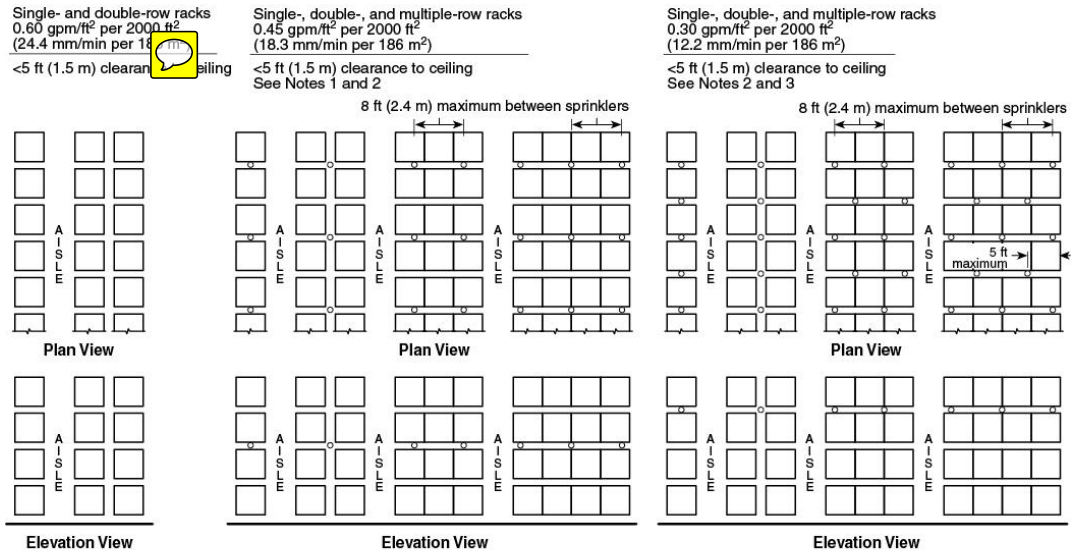
Figure 25.9.3.1(a) In-Rack Sprinkler Arrangement, Cartoned Group A Plastic Storage Up to 15 ft (4.6 m) in Height with Up to 10 ft (3.0 m) Clearance to Ceiling.



Notes:

1. Single level of in-rack sprinklers [K-5.6 (80) or K-8.0 (115) operating at 15 psi (1.0 bar) minimum] installed as indicated in the transverse flue spaces.
2. Where sprinklers listed for storage use are installed at the ceiling only and the ceiling height in the protected area does not exceed 22 ft (6.7 m) and a minimum clearance of 5 ft (1.5 m) and the storage height does not exceed 15 ft (4.6 m), the ceiling sprinkler discharge criteria shall be permitted to be reduced to 0.45 gpm/ft² per 2000 ft² (18.3 mm/min per
3. Each square represents a storage cube measuring 4 ft to 5 ft (1.2 m to
on a side. Actual load heights can vary from approximately 18 in. (450 mm) up to 10 ft (3.0 m). Therefore, there could be as few as one load or as many as six or seven loads between in-rack sprinklers that are spaced 10 ft (3.0 m) apart vertically.

Figure 25.9.3.1(b) In-Rack Sprinkler Arrangement, Cartoned Group A Plastic Storage Up to Storage 20 ft (6.1 m) in Height with <5 ft (1.5 m) Clearance to Ceiling.

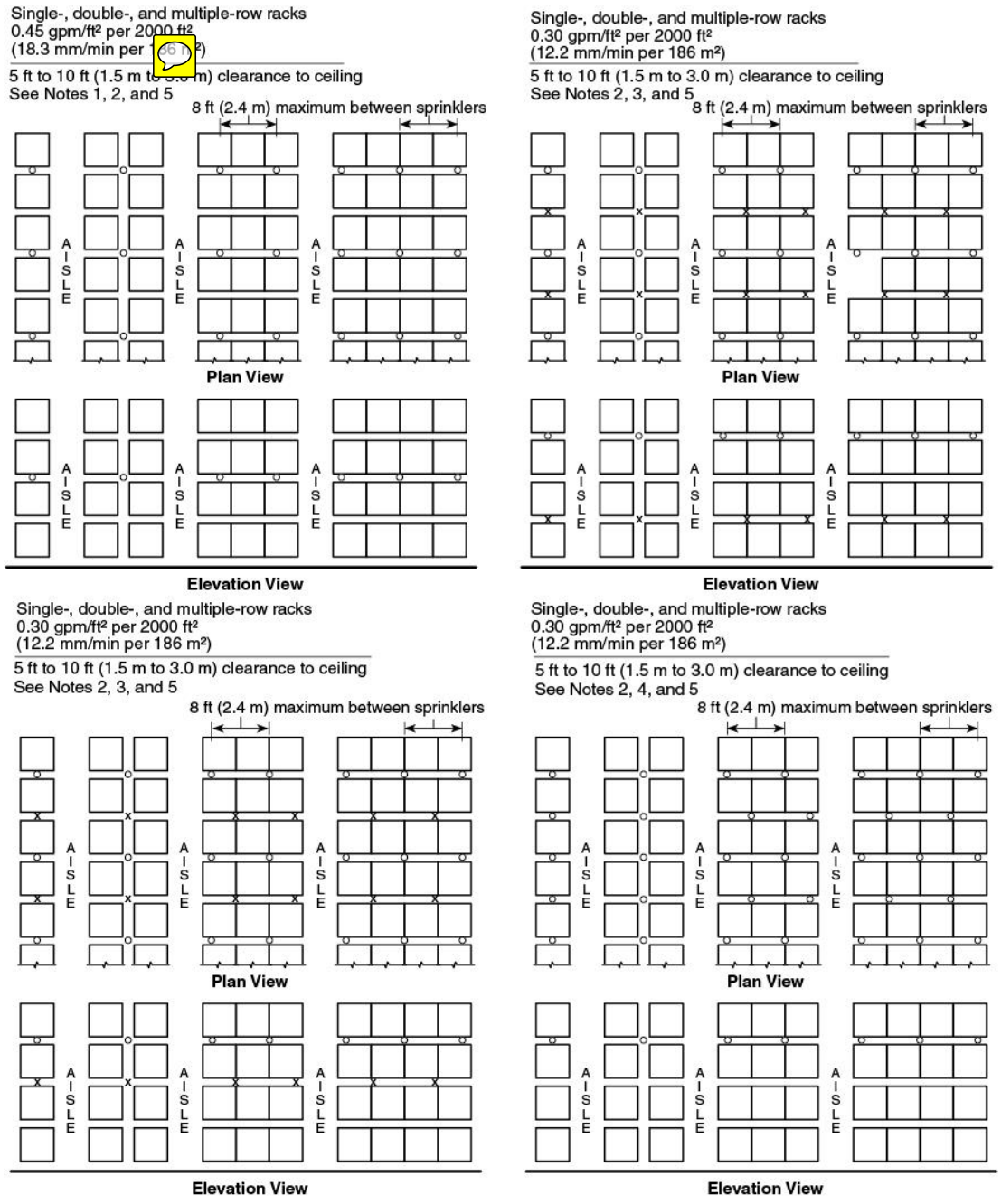


Notes:

1. Single level of in-rack sprinklers [K-5.6 (80) or K-8.0 (115) operating at 15 psi (1.0 bar) minimum] installed as indicated in the transverse flue spaces.
2. Ceiling-only protection is not permitted for this storage configuration except where K-11.2 or larger spray sprinklers listed for storage use are installed. In-rack sprinklers are not required, provided the ceiling sprinkler discharge criterion is increased to 0.6 gpm/ft² (24 mm/min) over 2000 ft² (186 m²).
3. Single level of in-rack sprinklers [K-8.0 (115) operating at 15 psi (1.0 bar) minimum or K-5.6 (80) operating at 30 psi (2.1 bar) minimum] installed on 4 ft to 5 ft (1.2 m to 1.5 m) spacings located, as indicated, in the longitudinal flue space at the intersection of every transverse flue space.
4. Each square represents a storage cube measuring 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. (450 mm) up to 10 ft (3.0 m). Therefore, there could be as few as one load or as many as six or seven loads between in-rack sprinklers that are spaced 10 ft (3.0 m) apart vertically.

Figure 25.9.3.1(c) In-Rack Sprinkler Arrangement, Cartoned Group A Plastic Storage Up to Storage 20 ft (6.1 m) in Height with 5 ft to 10 ft (1.5 m to 3.0 m) Clearance to Ceiling.

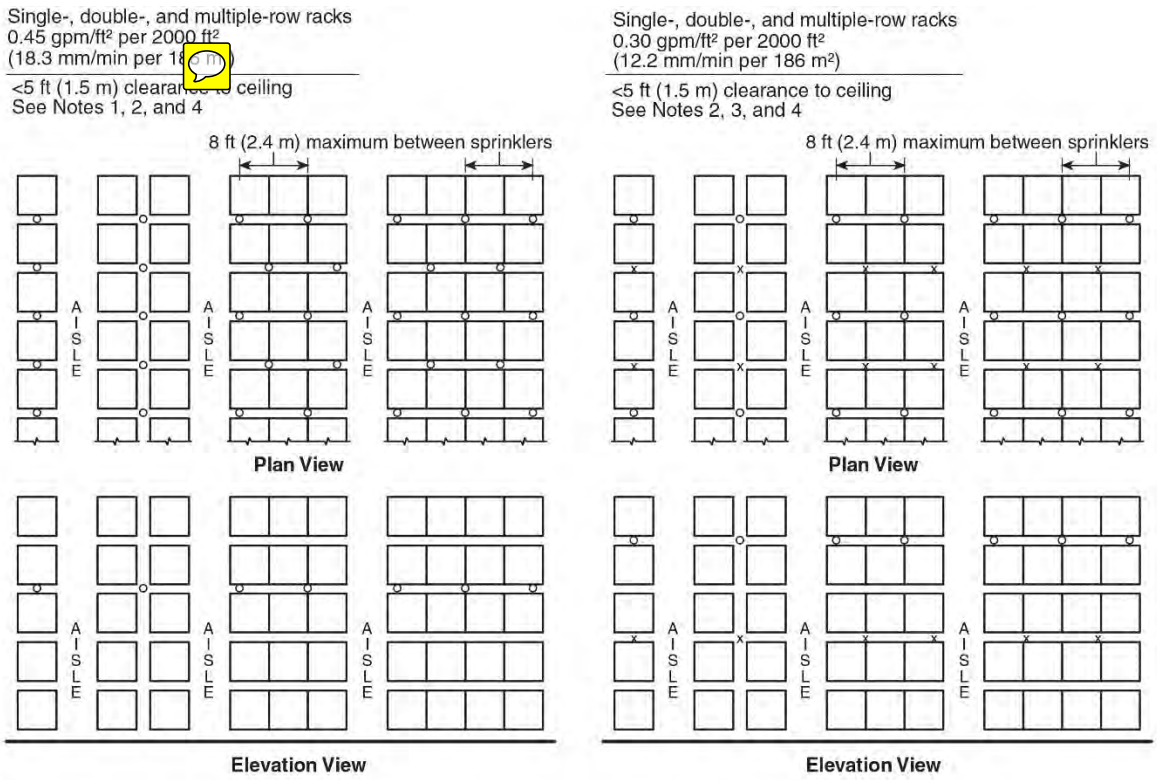
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Notes:

1. Single level of in-rack sprinklers [K-5.6 (80) or K-8.0 (115) operating at 15 psi (1.0 bar) minimum] installed as indicated in the transverse flue spaces.
2. Ceiling-only protection shall not be permitted for this storage configuration except where K-11.2 or larger orifice spray sprinklers listed for storage use are installed. In-rack sprinklers shall not be required, provided the ceiling sprinkler discharge criterion is increased to 0.6 gpm/ft² (24.4 mm/min) over 2000 ft² (186 m²) and the ceiling height in the protected area does not exceed 27 ft (8.2 m).
3. Two levels of in-rack sprinklers [K-5.6 (80) or K-8.0 (115) operating at 15 psi (1.0 bar) minimum] installed as indicated and staggered in the transverse flue space.
4. Single level of in-rack sprinklers [K-8 (115) operating at 15 psi (1.0 bar) or K-5.6 (80) operating at 30 psi (2.1 bar) minimum] installed on 4 ft to 5 ft (1.2 m to 1.5 m) spacings located, as indicated, in the longitudinal flue space at the intersection of every transverse flue space.
5. Each square represents a storage cube measuring 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. (450 mm) up to 10 ft (3.0 m). Therefore, there could be as few as one load or as many as six or seven loads between in-rack sprinklers that are spaced 10 ft (3.0 m) apart vertically.

Figure 25.9.3.1(d) In-Rack Sprinkler Arrangement, Cartoned Group A Plastic Storage Up to Storage 25 ft (7.6 m) in Height with <5 ft (1.5 m) Clearance to Ceiling. ***(See Note 2.)***



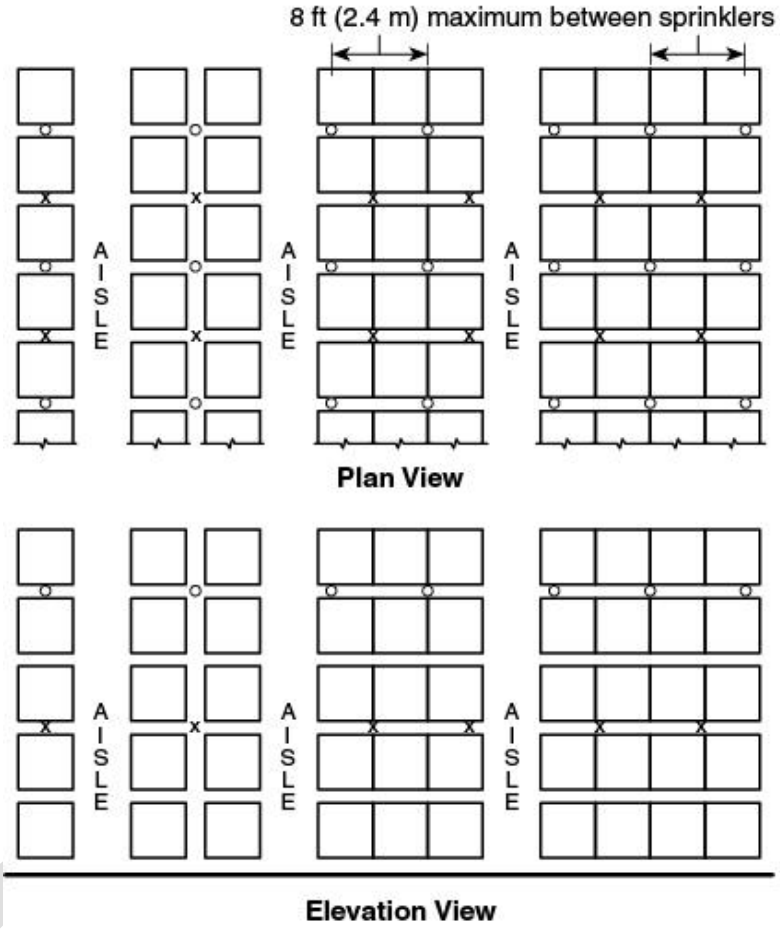
Notes:

1. Single level of in-rack sprinklers [K-8.0 (115) operating at 15 psi (1.0 bar) minimum or K-5.6 (80) operating at 30 psi (2.1 bar) minimum] installed on 4 ft to 5 ft (1.2 m to 1.5 m) spacings located, as indicated, in the longitudinal flue space at the intersection of every transverse flue space.
2. Ceiling-only protection shall not be permitted for this storage configuration except where K-16.8 spray sprinklers listed for storage use are installed. In-rack sprinklers shall not be required, provided the ceiling sprinkler discharge criterion is increased to 0.8 gpm/ft² (32.6 mm/min) over 2000 ft² (186 m²) for wet systems and 4500 ft² (418 m²) for dry systems and the ceiling height in the protected area does not exceed 30 ft (9.1 m).
3. Two levels of in-rack sprinklers [K-5.6 (80) or K-8.0 (115) operating at 15 psi (1.0 bar) minimum] installed as indicated and staggered in the transverse flue space.
4. Each square represents a storage cube measuring 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. (450 mm) up to 10 ft (3.0 m). Therefore, there could be as few as one load or as many as six or seven loads between in-rack sprinklers that are spaced 10 ft (3.0 m) apart vertically.

Figure 25.9.3.1(e) In-Rack Sprinkler Arrangement, Cartoned Group A Plastic Storage Up to Storage 25 ft (7.6 m) in Height with 5 ft to 10 ft (1.5 m to 3.0 m) Clearance to Ceiling. ***(See Note 2.)***

Single-, double-, and multiple-row racks
0.30 gpm/ft² per 2000 ft²
(12.2 mm/min per 186 m²)

5 ft to 10 ft (1.5 m to 3.0 m) clearance to ceiling
See Notes 1, 2, and 3



Notes:

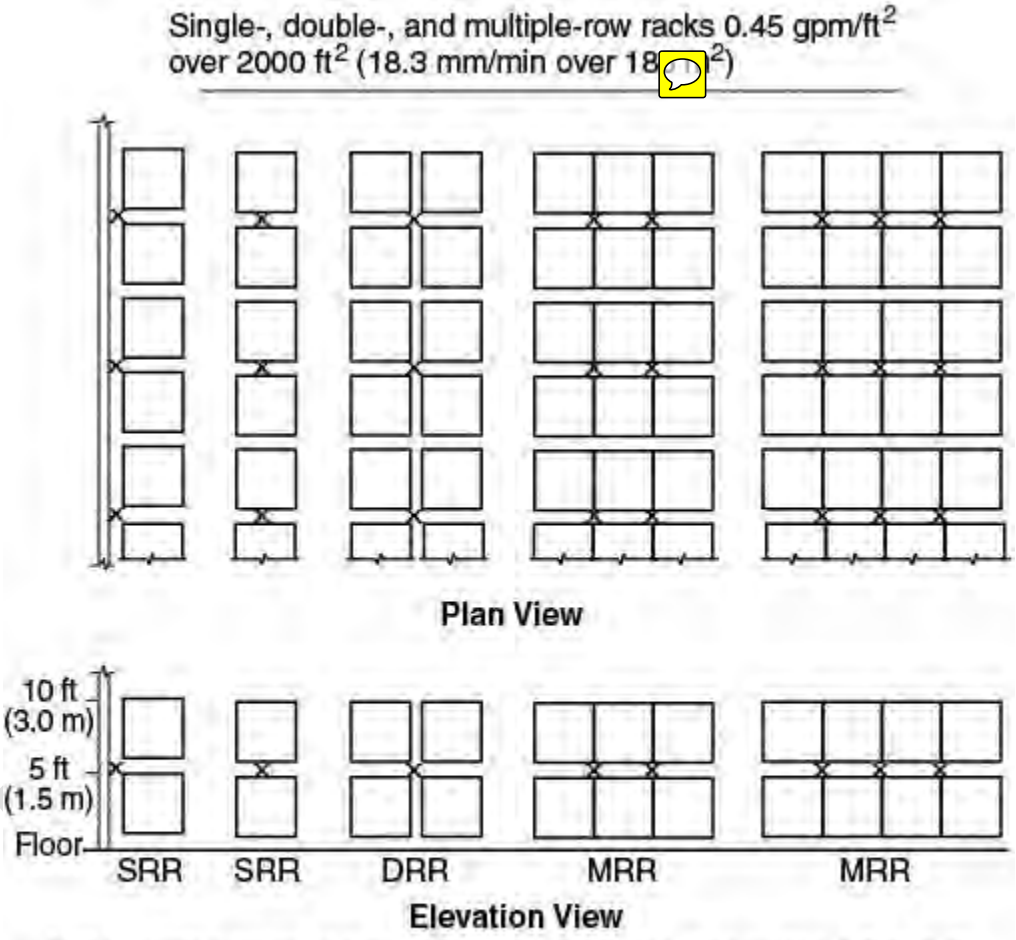
1. Two levels of in-rack sprinklers [K-5.6 (80) or K-8.0 (115) operating at 15 psi (1.0 bar) minimum] installed on 8 ft to 10 ft (2.4 m to 3.0 m) spacings located as indicated and staggered in the transverse flue space.
2. Ceiling-only protection shall not be permitted for this storage configuration except where K-16.8 spray sprinklers listed for storage use are installed. In-rack sprinklers shall not be required, provided the ceiling sprinkler discharge criterion is increased to 0.8 gpm/ft² (32.6 mm/min) over 2000 ft² (186 m²) for wet systems and 4500 ft² (418 m²) for dry systems and the ceiling height in the protected area does not exceed 30 ft (9.1 m).
3. Each square represents a storage cube measuring 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. (450 mm) up to 10 ft (3.0 m). Therefore, there could be as few as one load or as many as six or seven loads between in-rack sprinklers that are spaced 10 ft (3.0 m) apart vertically.

25.9.3.2*

Notes in each figure shall be permitted to clarify options or to present additional options not shown in the figures.

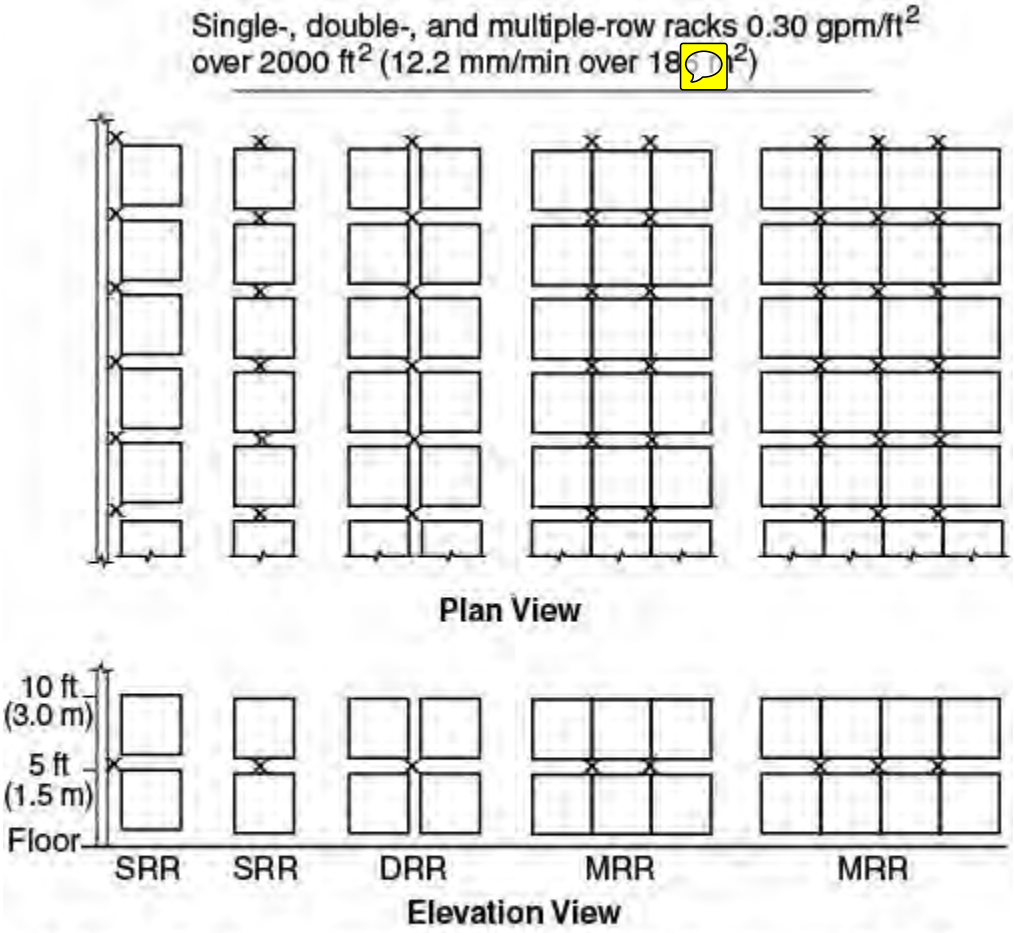
25.9.3.3*
Where rack storage of exposed nonexpanded Group A plastic commodities, encapsulated or nonencapsulated, require in-rack sprinklers, in-rack sprinkler arrangements shall be selected from Figure 25.9.3.3(a) through Figure 25.9.3.3(k).

Figure 25.9.3.3(a) In-Rack Sprinkler Arrangement, Exposed Nonexpanded Group A Plastic Commodities Up to 10 ft (3.0 m) in Height in Up to a 20 ft (6.1 m) High Building — Option 1.



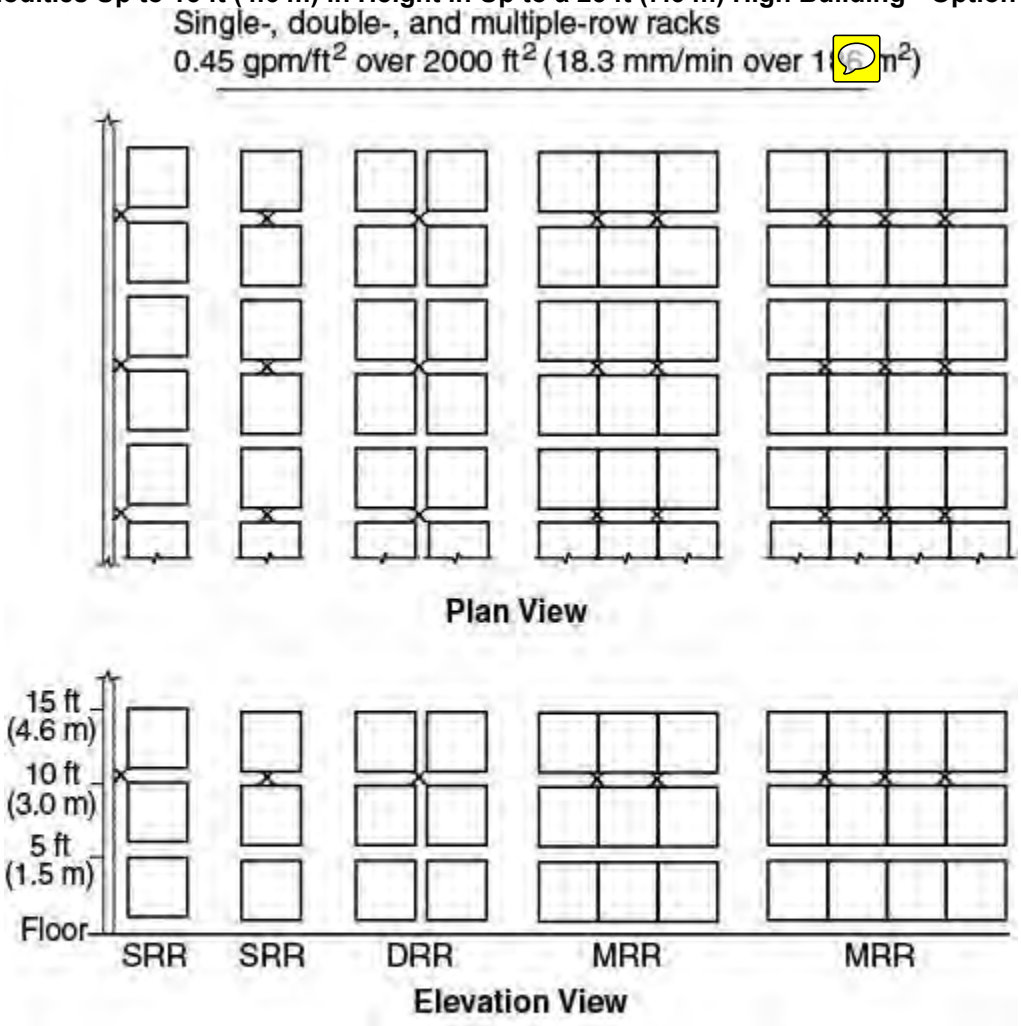
Note: Each square represents a storage cube measuring 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. to 10 ft (450 mm to 3.0 m). Therefore, there could be as few as one load or as many as six or seven loads between in-rack sprinklers that are spaced 10 ft (3.0 m) apart vertically.

Figure 25.9.3.3(b) In-Rack Sprinkler Arrangement, Exposed Nonexpanded Group A Plastic Commodities Up to 10 ft (3.0 m) in Height in Up to a 20 ft (6.1 m) High Building — Option 2.



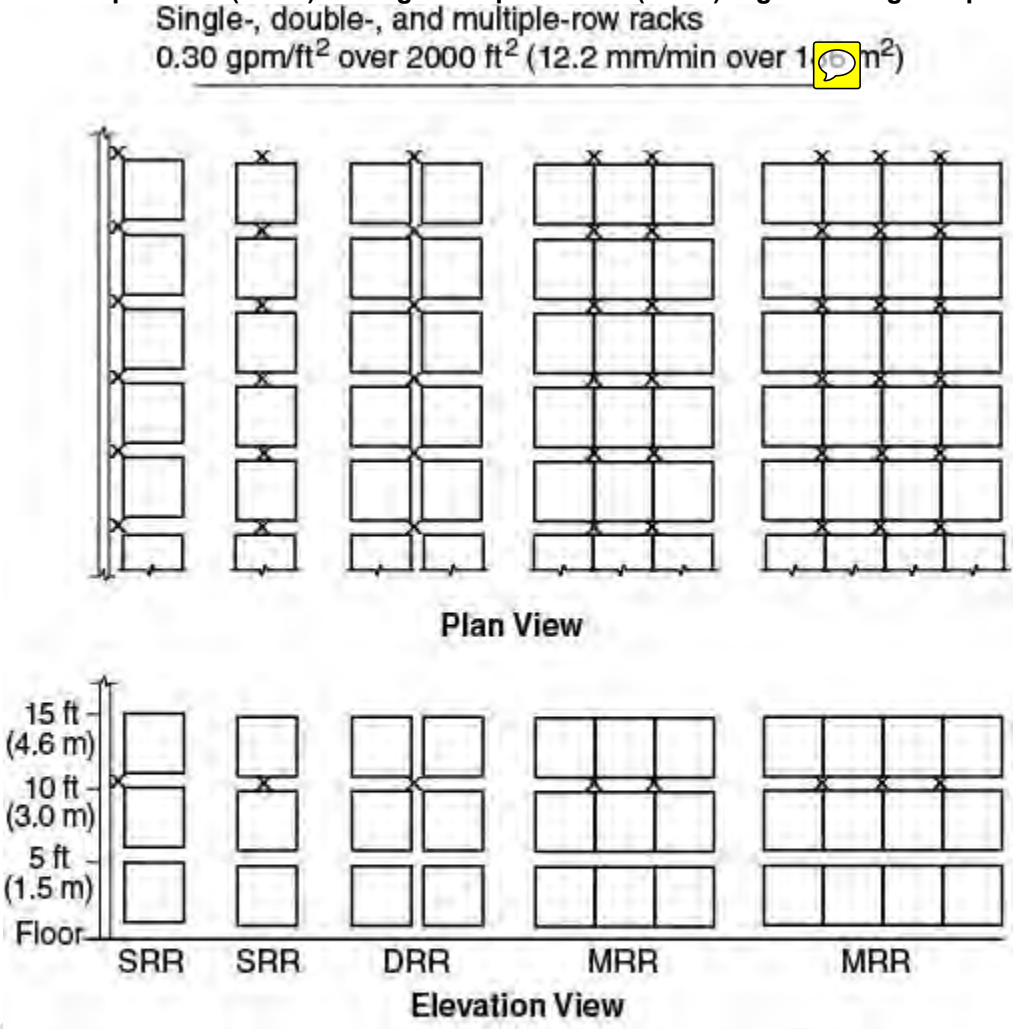
Note: Each square represents a storage cube measuring 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. to 10 ft (450 mm to 3.0 m). Therefore, there could be as few as one load or as many as six or seven loads between in-rack sprinklers that are spaced 10 ft (3.0 m) apart vertically.

Figure 25.9.3.3(c) In-Rack Sprinkler Arrangement, Exposed Nonexpanded Group A Plastic Commodities Up to 15 ft (4.6 m) in Height in Up to a 25 ft (7.6 m) High Building - Option 1.



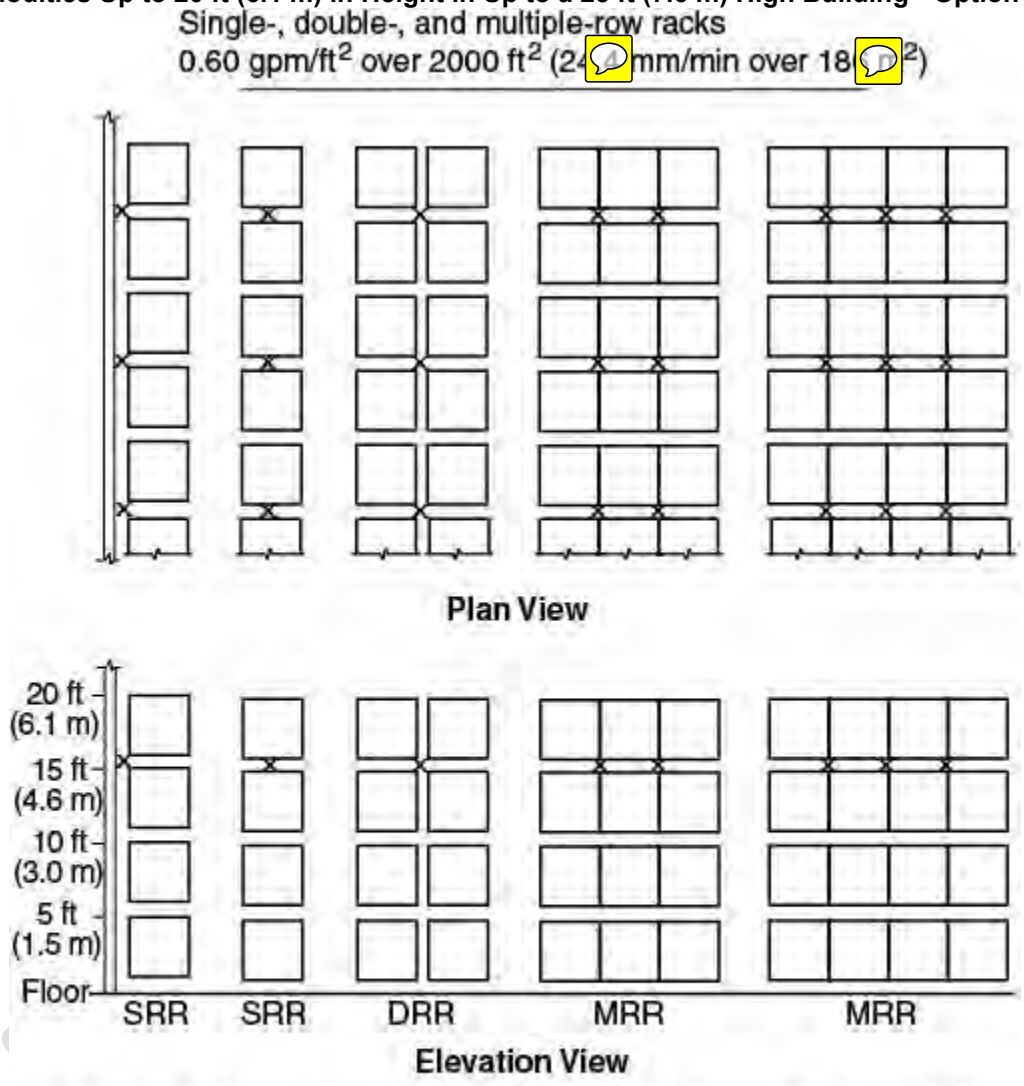
Note: Each square represents a storage cube measuring 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. to 10 ft (450 mm to 3.0 m). Therefore, there could be as few as one load or as many as six or seven loads between in-rack sprinklers that are spaced 10 ft (3.0 m) apart vertically.

Figure 25.9.3.3(d) In-Rack Sprinkler Arrangement, Exposed Nonexpanded Group A Plastic Commodities Up to 15 ft (4.6 m) in Height in Up to a 25 ft (7.6 m) High Building — Option 2.



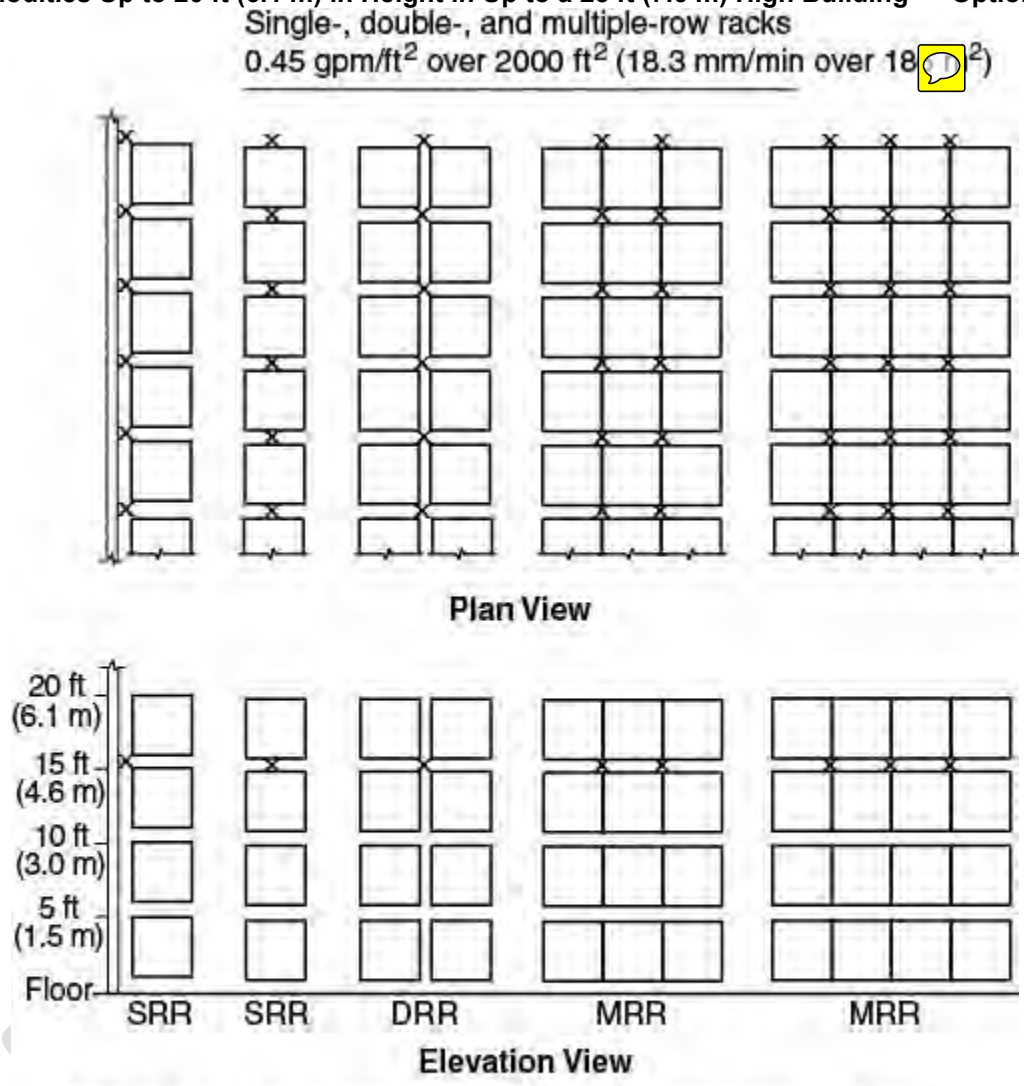
Note: Each square represents a storage cube measuring 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. to 10 ft (450 mm to 3.0 m). Therefore, there could be as few as one load or as many as six or seven loads between in-rack sprinklers that are spaced 10 ft (3.0 m) apart vertically.

Figure 25.9.3.3(e) In-Rack Sprinkler Arrangement, Exposed Nonexpanded Group A Plastic Commodities Up to 20 ft (6.1 m) in Height in Up to a 25 ft (7.6 m) High Building - Option 1.



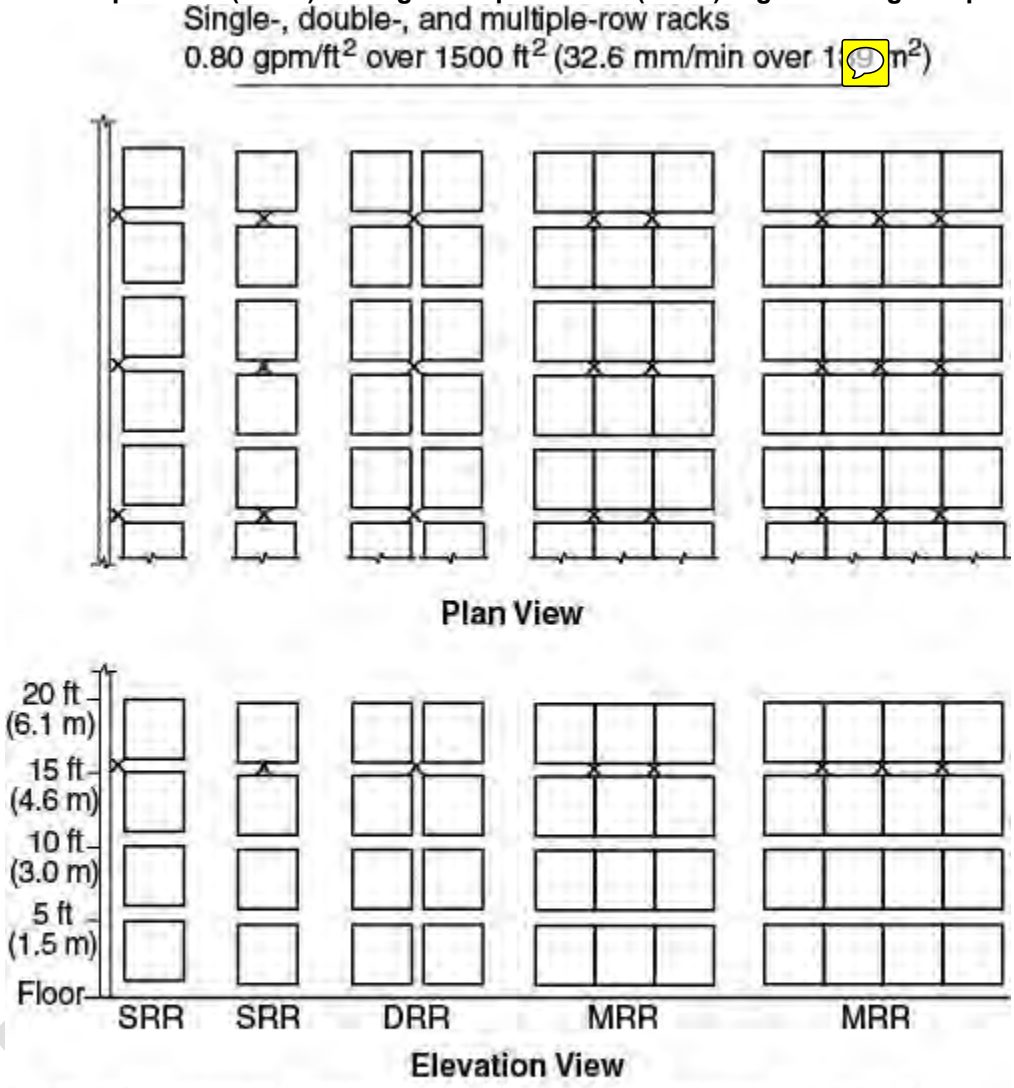
Note: Each square represents a storage cube measuring 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. to 10 ft (450 mm to 3.0 m). Therefore, there could be as few as one load or as many as six or seven loads between in-rack sprinklers that are spaced 10 ft (3.0 m) apart vertically.

Figure 25.9.3.3(f) In-Rack Sprinkler Arrangement, Exposed Nonexpanded Group A Plastic Commodities Up to 20 ft (6.1 m) in Height in Up to a 25 ft (7.6 m) High Building — Option 2.



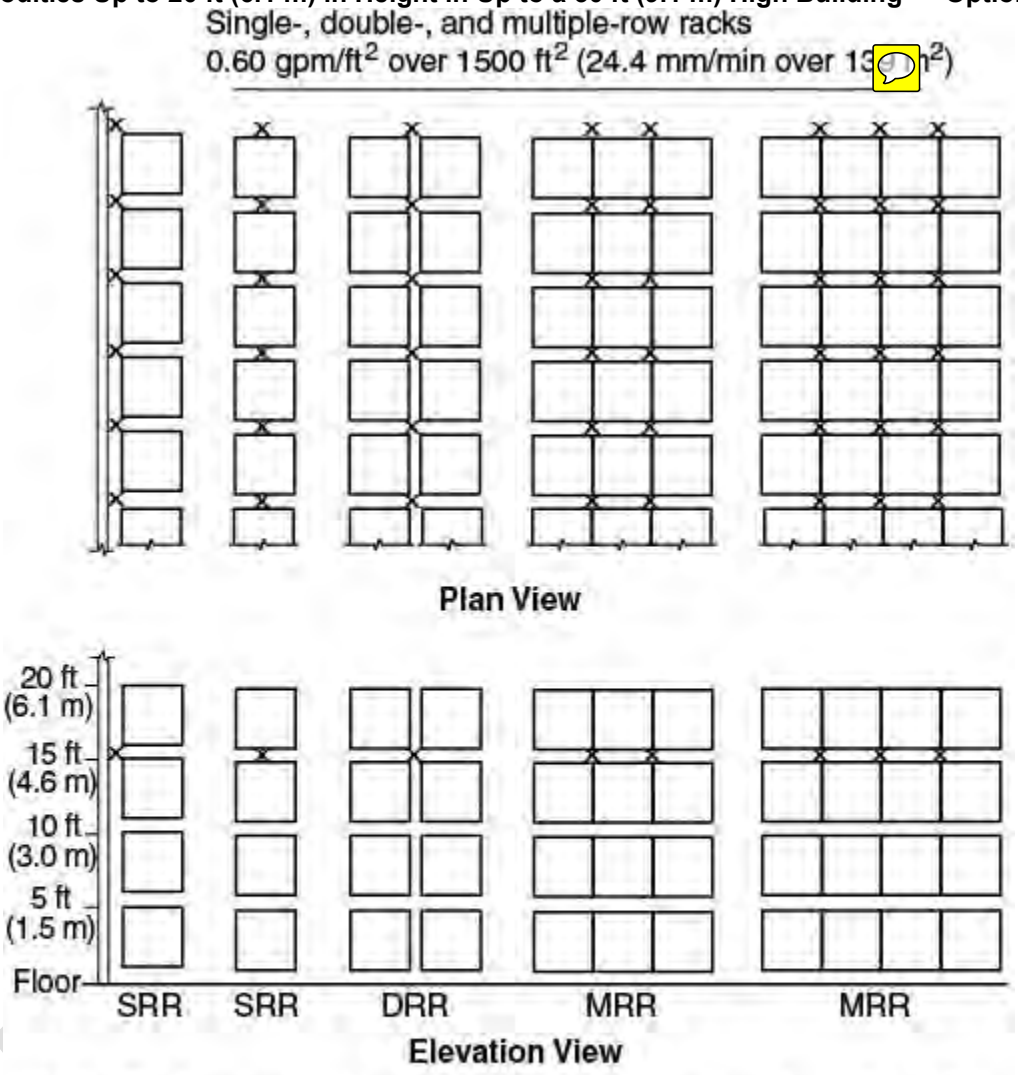
Note: Each square represents a storage cube measuring 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. to 10 ft (450 mm to 3.0 m). Therefore, there could be as few as one load or as many as six or seven loads between in-rack sprinklers that are spaced 10 ft (3.0 m) apart vertically.

Figure 25.9.3.3(g) In-Rack Sprinkler Arrangement, Exposed Nonexpanded Group A Plastic Commodities Up to 20 ft (6.1 m) in Height in Up to a 30 ft (9.1 m) High Building — Option 1.



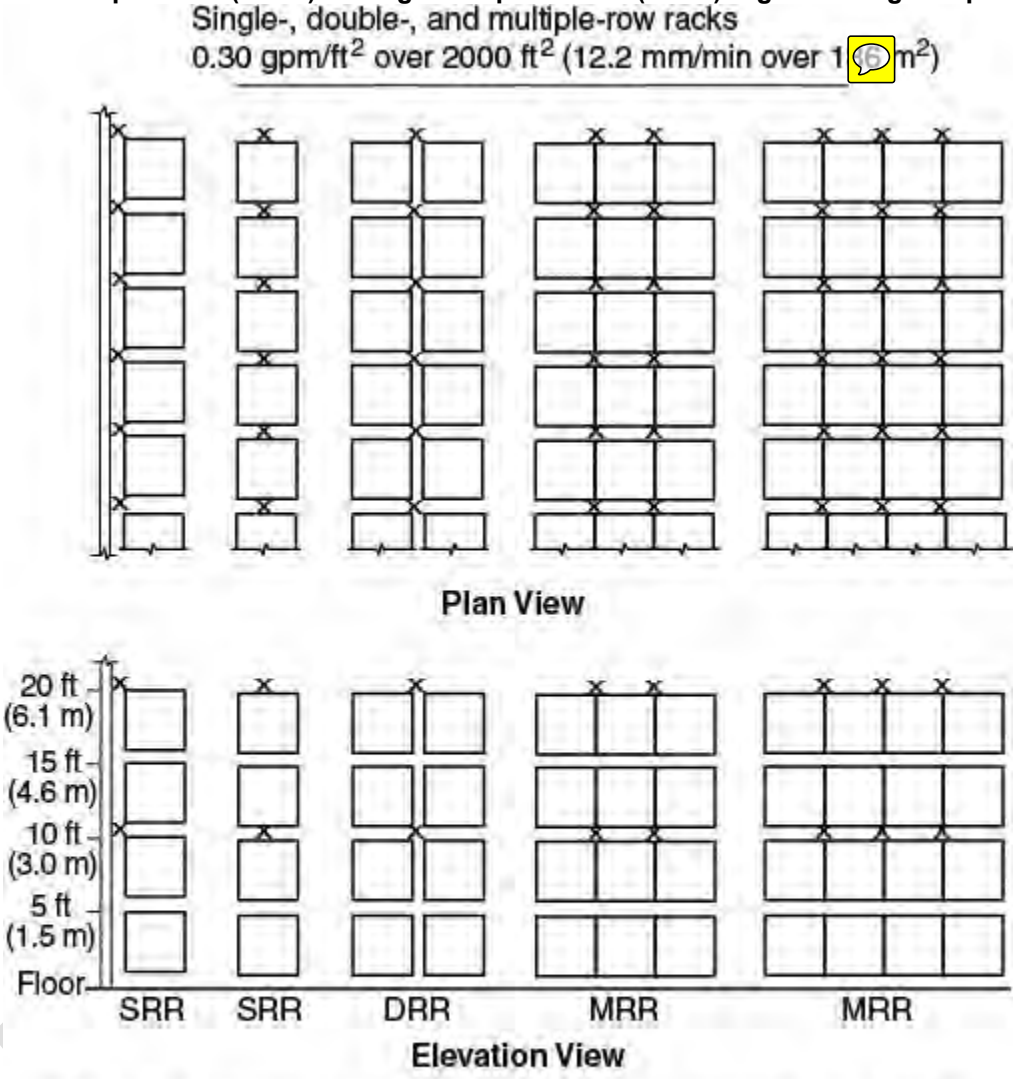
Note: Each square represents a storage cube measuring 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. to 10 ft (450 mm to 3.0 m). Therefore, there could be as few as one load or as many as six or seven loads between in-rack sprinklers that are spaced 10 ft (3.0 m) apart vertically.

Figure 25.9.3.3(h) In-Rack Sprinkler Arrangement, Exposed Nonexpanded Group A Plastic Commodities Up to 20 ft (6.1 m) in Height in Up to a 30 ft (9.1 m) High Building — Option 2.



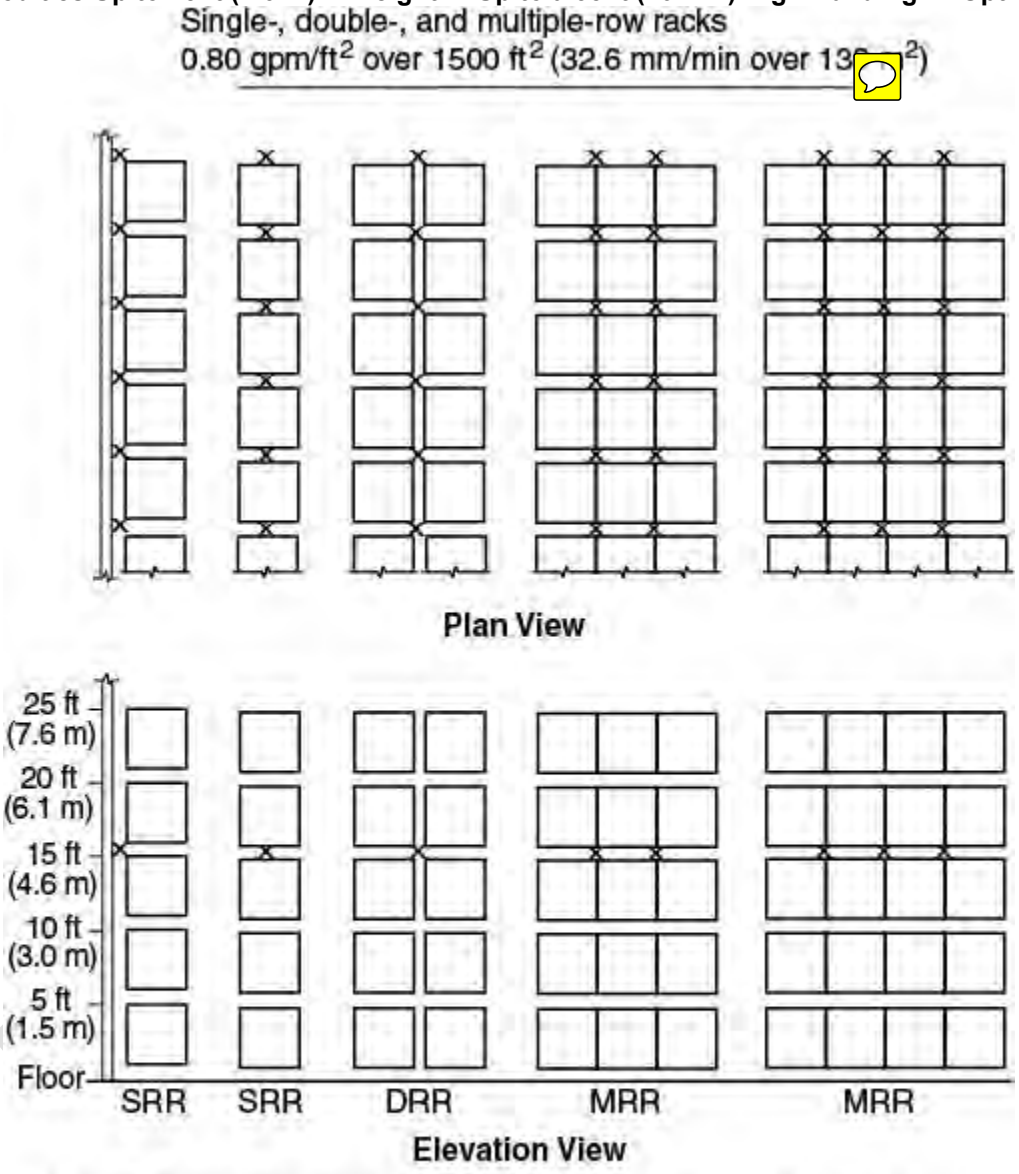
Note: Each square represents a storage cube measuring 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. to 10 ft (450 mm to 3.0 m). Therefore, there could be as few as one load or as many as six or seven loads between in-rack sprinklers that are spaced 10 ft (3.0 m) apart vertically.

Figure 25.9.3.3(i) In-Rack Sprinkler Arrangement, Exposed Nonexpanded Group A Plastic Commodities Up to 20 ft (6.1 m) in Height in Up to a 30 ft (9.1 m) High Building — Option 3.



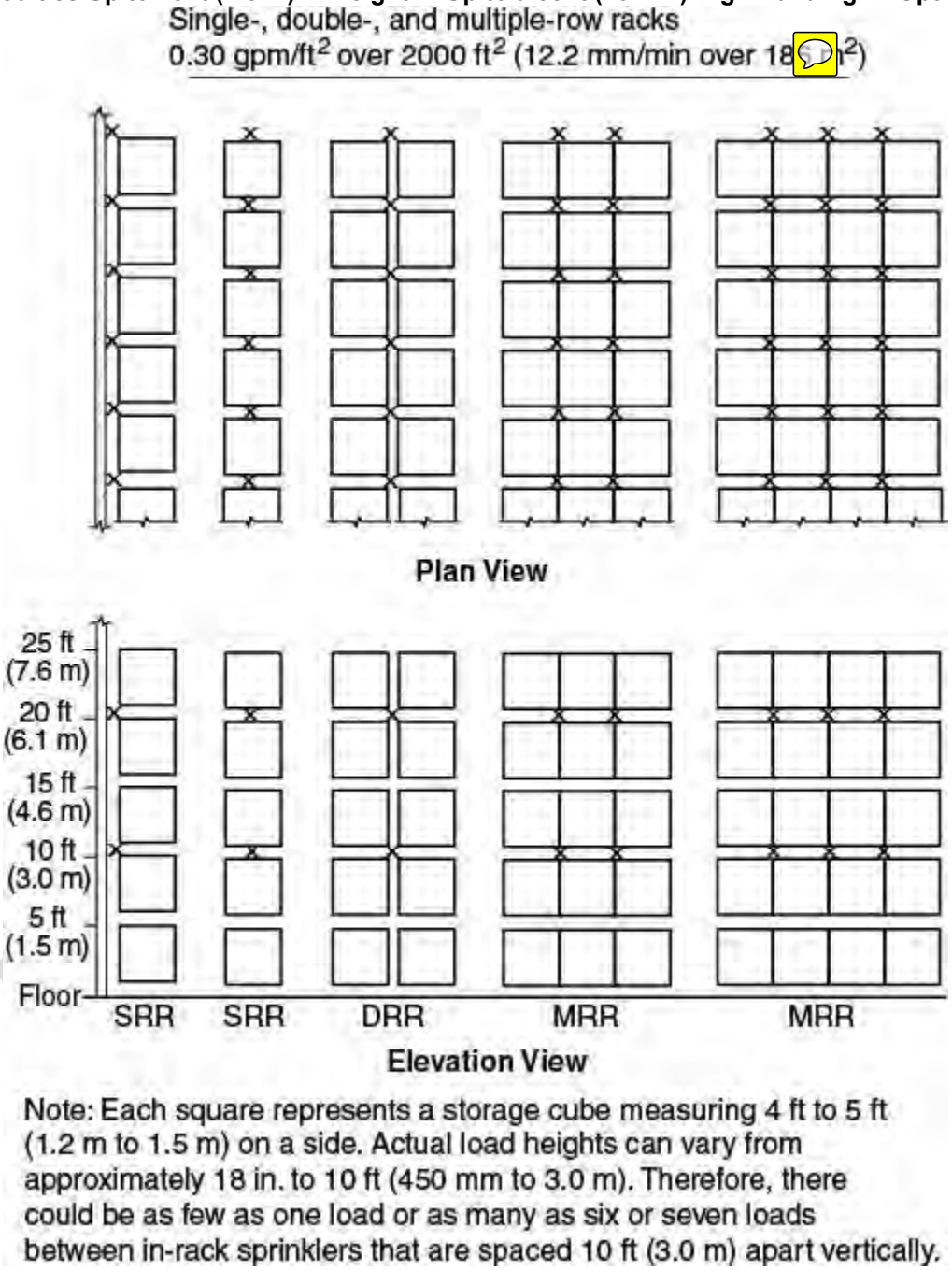
Note: Each square represents a storage cube measuring 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. to 10 ft (450 mm to 3.0 m). Therefore, there could be as few as one load or as many as six or seven loads between in-rack sprinklers that are spaced 10 ft (3.0 m) apart vertically.

Figure 25.9.3.3(j) In-Rack Sprinkler Arrangement, Exposed Nonexpanded Group A Plastic Commodities Up to 25 ft (7.6 m) in Height in Up to a 35 ft (10.7 m) High Building — Option 1.



Note: Each square represents a storage cube measuring 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. to 10 ft (450 mm to 3.0 m). Therefore, there could be as few as one load or as many as six or seven loads between in-rack sprinklers that are spaced 10 ft (3.0 m) apart vertically.

Figure 25.9.3.3(k) In-Rack Sprinkler Arrangement, Exposed Nonexpanded Group A Plastic Commodities Up to 25 ft (7.6 m) in Height in Up to a 35 ft (10.7 m) High Building — Option 2.

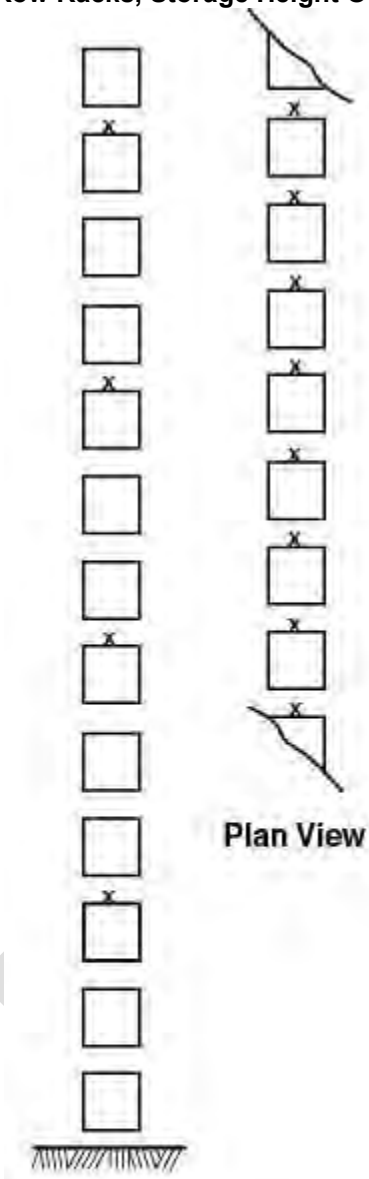


25.9.4 Rack Storage of Group A Commodities Over 25 ft (7.6 m) in Height.

25.9.4.1 Single-Row Racks.

25.9.4.1.1
Where single-row rack storage of cartoned Group A plastic commodities, expanded or nonexpanded, encapsulated or nonencapsulated, is over 25 ft (7.6 m) in height, in-rack sprinklers shall be arranged in accordance with one of the options in Figure 25.9.4.1.1(a) through Figure 25.9.4.1.1(d).

Figure 25.9.4.1.1(a) In-Rack Sprinkler Arrangement, Cartoned Group A Plastic Commodities, Single-Row Racks, Storage Height Over 25 ft (7.6 m) — Option 1.

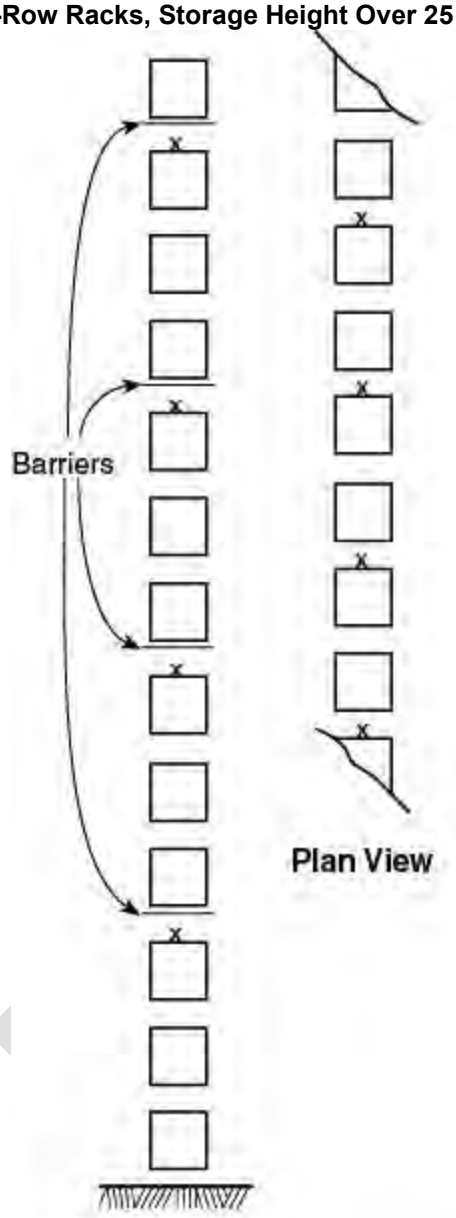


Plan View

Elevation View

Note: Each square represents a storage cube measuring 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. (450 mm) up to 10 ft (3.0 m). Therefore, there could be as few as one load or as many as six or seven loads between in-rack sprinklers that are spaced 10 ft (3.0 m) apart vertically.

Figure 25.9.4.1.1(b) In-Rack Sprinkler Arrangement, Cartoned Group A Plastic Commodities, Single-Row Racks, Storage Height Over 25 ft (7.6 m) — Option 2.



Note: Each square represents a storage cube measuring 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. (450 mm) up to 10 ft (3.0 m). Therefore, there could be as few as one load or as many as six or seven loads between in-rack sprinklers that are spaced 10 ft (3.0 m) apart vertically.

Figure 25.9.4.1.1(c) In-Rack Sprinkler Arrangement, Cartoned Group A Plastic Commodities, Single-Row Racks, Storage Height Over 25 ft (7.6 m) — Option 3.

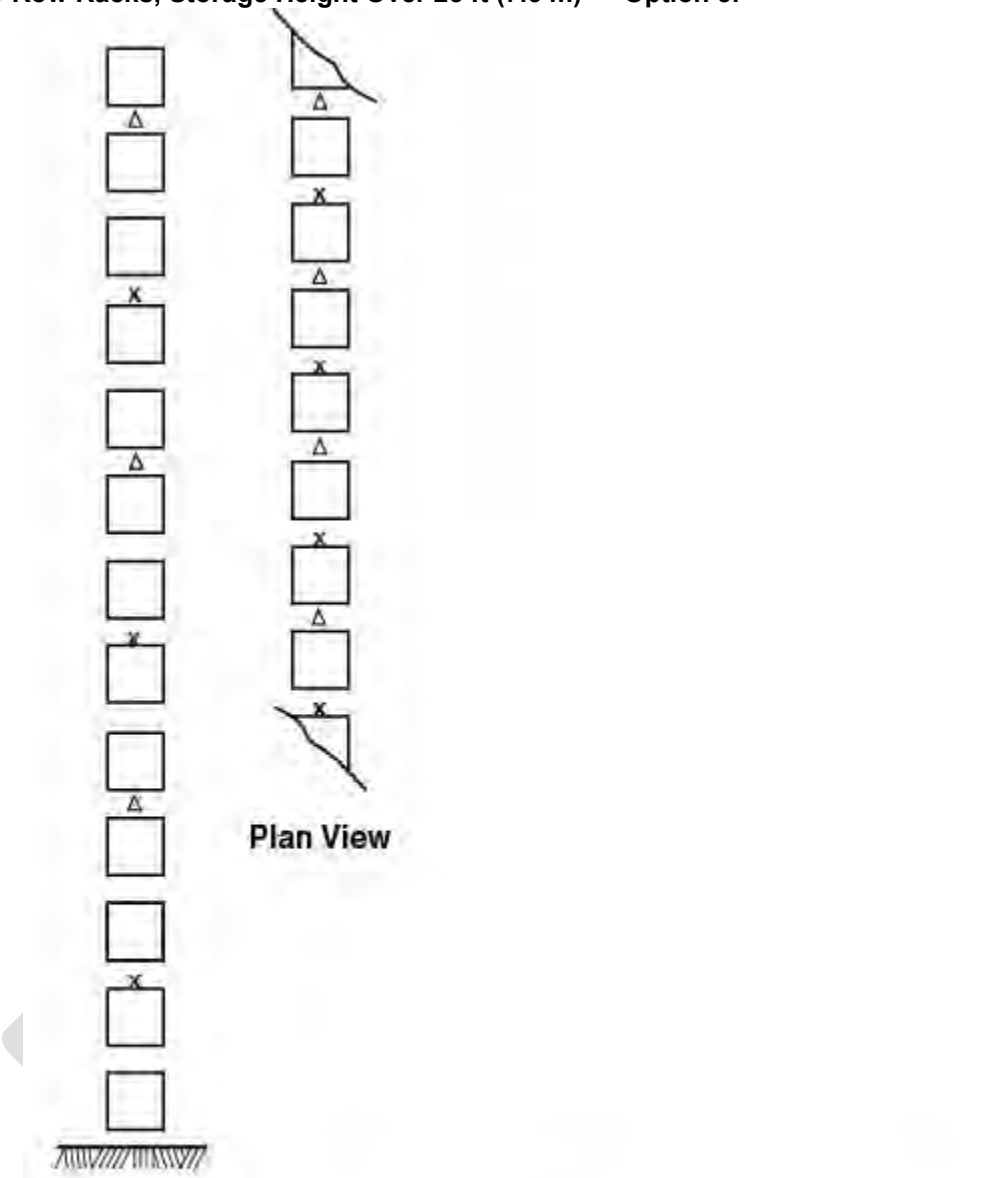


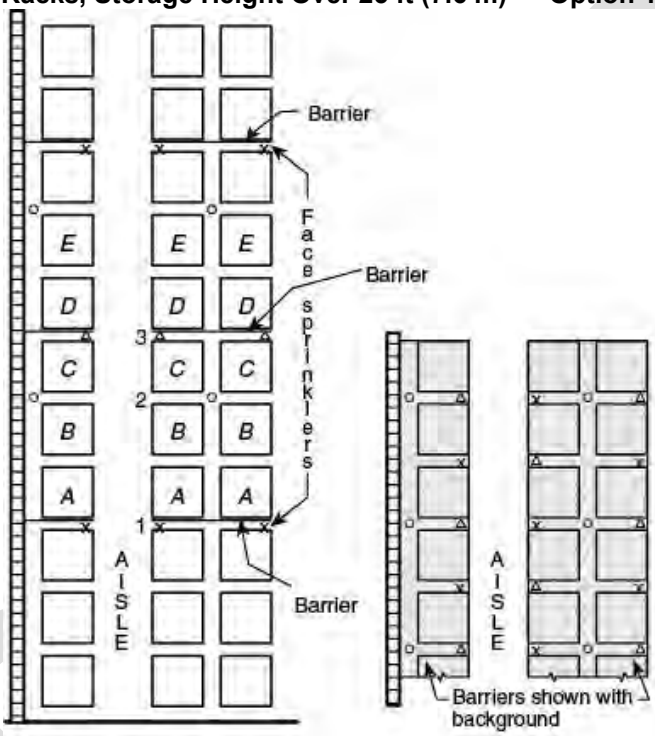
Figure 25.9.4.1.1(d) In-Rack Sprinkler Arrangement, Cartoned Group A Plastic Commodities, Single-Row Racks, Storage Height Over 25 ft (7.6 m) — Option 4. [missing figure?]

25.9.4.1.2
Where a single-row rack of cartoned Group A plastic commodities is located against a wall, the in-rack sprinkler arrangement shall be permitted to be in accordance with Figure 25.9.4.2(a) or Figure 25.9.4.2(b).

25.9.4.2 Double-Row Racks.

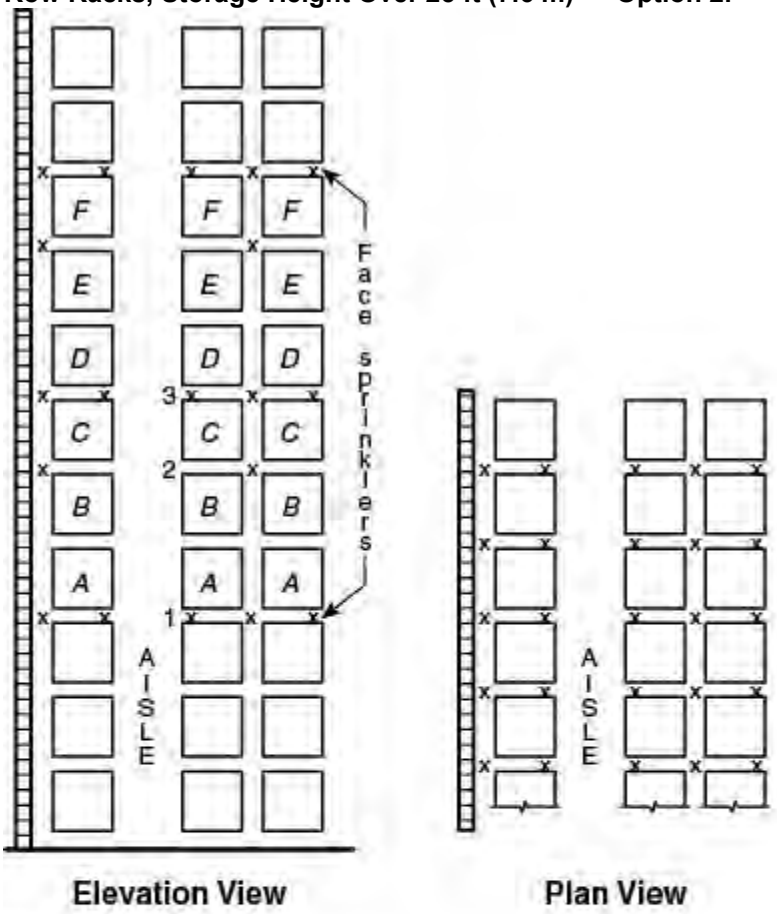
25.9.4.2.1
Where double-row rack storage of cartoned Group A plastic commodities, expanded or nonexpanded, encapsulated or nonencapsulated, is over 25 ft (7.6 m) in height, in-rack sprinklers shall be arranged in accordance with one of the options in Figure 25.3.5.2.1(a) through Figure 25.3.5.2.1(c).

Figure 25.9.4.2.1(a) In-Rack Sprinkler Arrangement, Cartoned Group A Plastic Commodities, Double-Row Racks, Storage Height Over 25 ft (7.6 m) — Option 1.



Notes:
1. Sprinklers and barriers labeled 1 shall be required where loads labeled *A* or *B* represent top of storage.
2. Sprinklers labeled 1 and 2 and barriers labeled 1 shall be required where loads labeled *C* represent top of storage.
3. Sprinklers and barriers labeled 1 and 3 shall be required where loads labeled *D* or *E* represent top of storage.
4. For storage higher than represented by loads labeled *E*, the cycle defined by Notes 2 and 3 is repeated.
5. Symbol Δ or x indicates face sprinklers on vertical or horizontal stagger.
6. Symbol o indicates longitudinal flue space sprinklers.
7. Each square represents a storage cube measuring 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. (450 mm) up to 10 ft (3.0 m). Therefore, there could be as few as one load or as many as six or seven loads between in-rack sprinklers that are spaced 10 ft (3.0 m) apart vertically.

Figure 25.9.4.2.1(b) In-Rack Sprinkler Arrangement, Cartoned Group A Plastic Commodities, Double-Row Racks, Storage Height Over 25 ft (7.6 m) — Option 2.



Elevation View Plan View

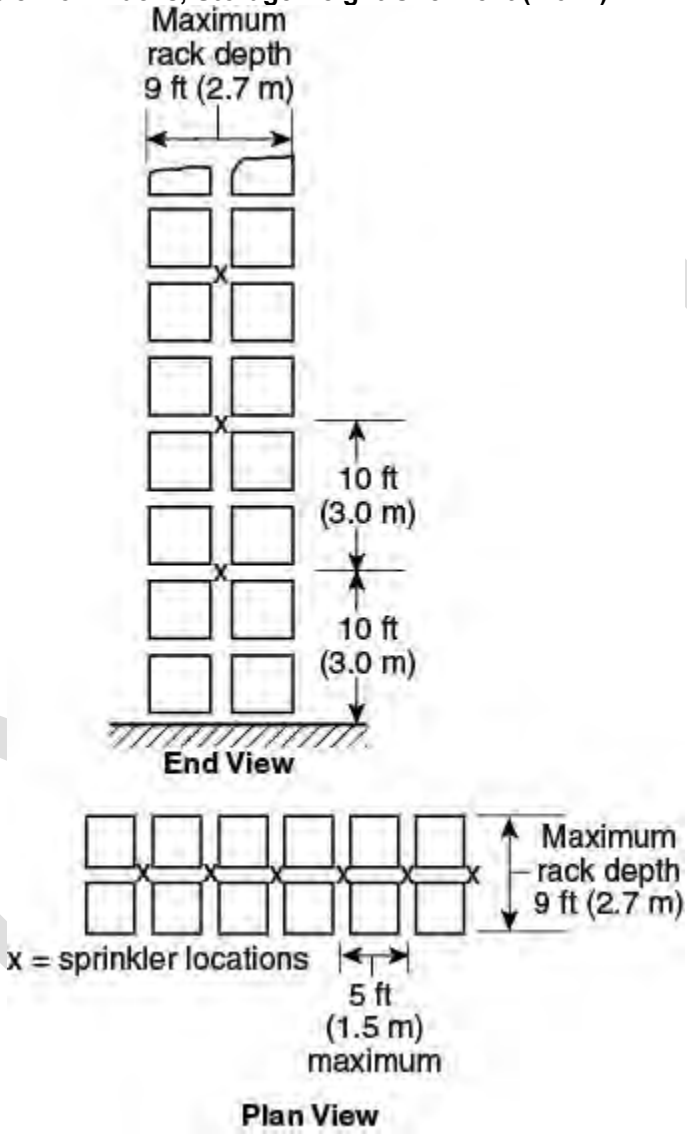
Notes:

1. Sprinklers labeled 1 shall be required where loads labeled *A* or *B* represent top of storage.
2. Sprinklers labeled 1 and 2 shall be required where loads labeled *C* represent top of storage.
3. Sprinklers labeled 1 and 3 shall be required where loads labeled *D* or *E* represent top of storage.
4. For storage higher than loads labeled *F*, the cycle defined by Notes 2 and 3 is repeated.
5. Symbol x indicates face and in-rack sprinklers.
6. Each square represents a storage cube measuring 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. (450 mm) up to 10 ft (3.0 m). Therefore, there could be as few as one load or as many as six or seven loads between in-rack sprinklers that are spaced 10 ft (3.0 m) apart vertically.

Figure 25.9.4.2.1(c) In-Rack Sprinkler Arrangement, Cartoned Group A Plastic Commodities, Double-Row Racks, Storage Height Over 25 ft (7.6 m) — Option 3. [missing figure?]

25.9.4.2.2*
Where double-row rack storage of exposed nonexpanded Group A plastic commodities, whether encapsulated or nonencapsulated, is over 25 ft (7.6 m) in height and has minimum 4 ft (1.2 m) wide aisles, in-rack sprinklers shall be arranged in accordance with Figure 25.9.4.2.2.

Figure 25.9.4.2.2 In-Rack Sprinkler Arrangement, Exposed Nonexpanded Group A Plastic Commodities, Double-Row Racks, Storage Height Over 25 ft (7.6 m).



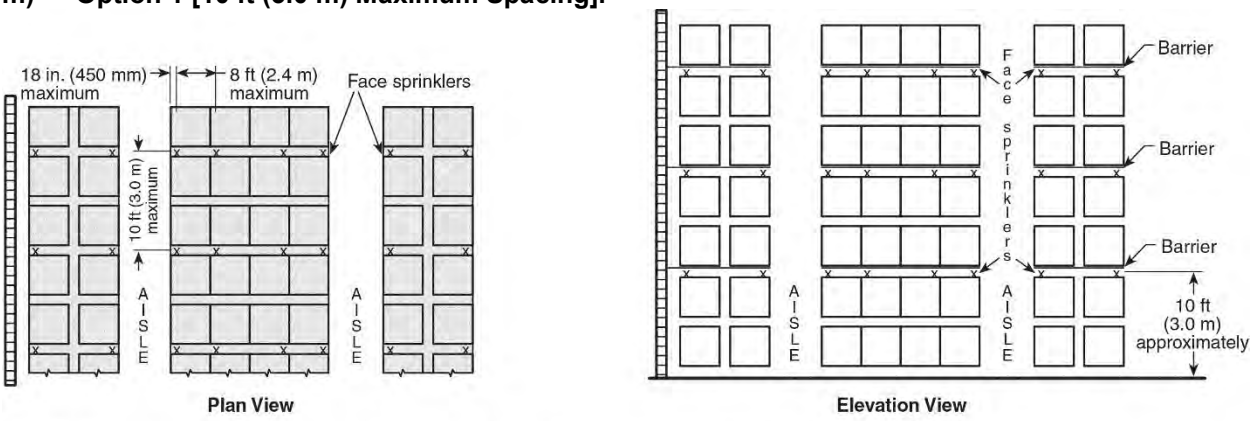
25.9.4.2.3
Protection of Group A plastic commodities that are exposed and nonexpanded, whether encapsulated or nonencapsulated racks and with a clearance to ceiling up to and including 10 ft (3.1 m), shall be permitted only using in-rack sprinkler arrangements that are specifically permitted to be used with exposed nonexpanded plastic commodities.

25.9.4.3 Multiple-Row Racks.

25.9.4.3.1

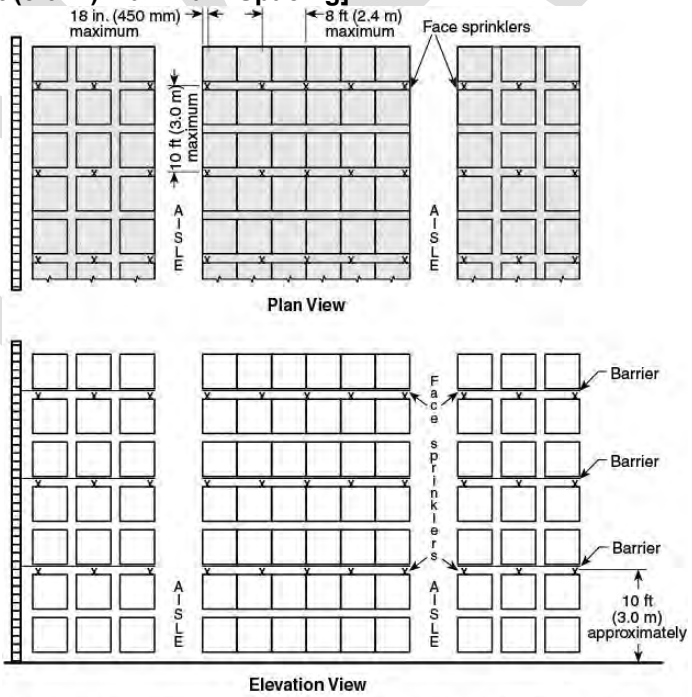
Where multiple-row rack storage of exposed nonexpanded Group A plastic commodities, encapsulated or nonencapsulated, or cartoned Group A plastic commodities, expanded or nonexpanded, encapsulated or nonencapsulated, is over 25 ft (7.6 m) in height, in-rack sprinklers shall be arranged in accordance with one of the options in Figure 25.9.4.3.1(a) through Figure 25.9.4.3.1(f).

Figure 25.9.4.3.1(a) In-Rack Sprinkler Arrangement, Cartoned Group A Plastic and Exposed Nonexpanded Group A Plastic Commodities, Multiple-Row Racks, Storage Height Over 25 ft (7.6 m) — Option 1 [10 ft (3.0 m) Maximum Spacing].



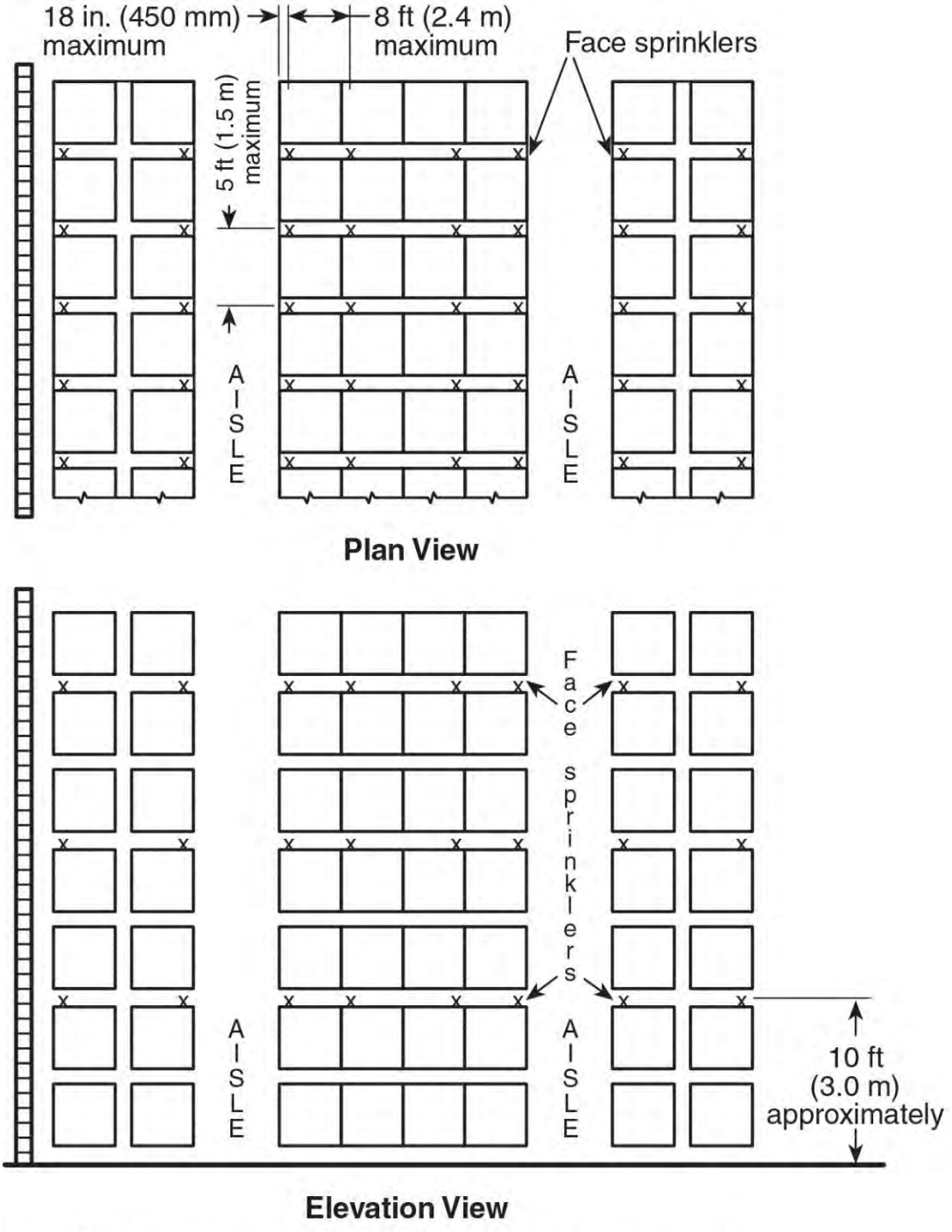
Note: Each square represents a storage cube measuring 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. (450 mm) up to 10 ft (3.0 m). Therefore, there could be as few as one load or as many as six or seven loads between in-rack sprinklers that are spaced 10 ft (3.0 m) apart vertically.

Figure 25.9.4.3.1(b) In-Rack Sprinkler Arrangement, Cartoned Group A Plastic and Exposed Nonexpanded Group A Plastic Commodities, Multiple-Row Racks, Storage Height Over 25 ft (7.6 m) — Option 2 [10 ft (3.0 m) Maximum Spacing].



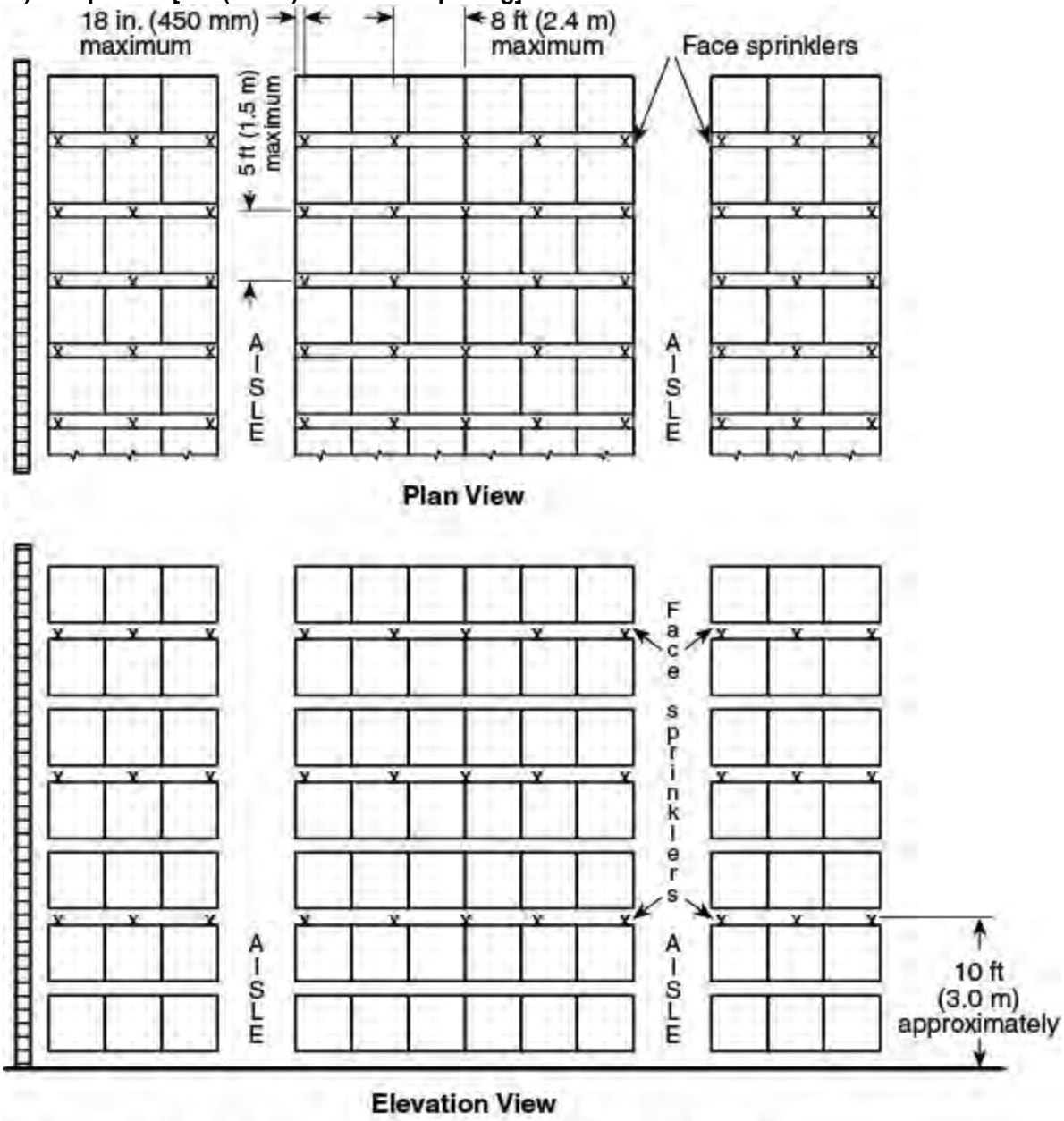
Note: Each square represents a storage cube measuring 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. (450 mm) up to 10 ft (3.0 m). Therefore, there could be as few as one load or as many as six or seven loads between in-rack sprinklers that are spaced 10 ft (3.0 m) apart vertically.

Figure 25.9.4.3.1(c) In-Rack Sprinkler Arrangement, Cartoned Group A Plastic and Exposed Nonexpanded Group A Plastic Commodities, Multiple-Row Racks, Storage Height Over 25 ft (7.6 m) — Option 1 [5 ft (1.5 m) Maximum Spacing].



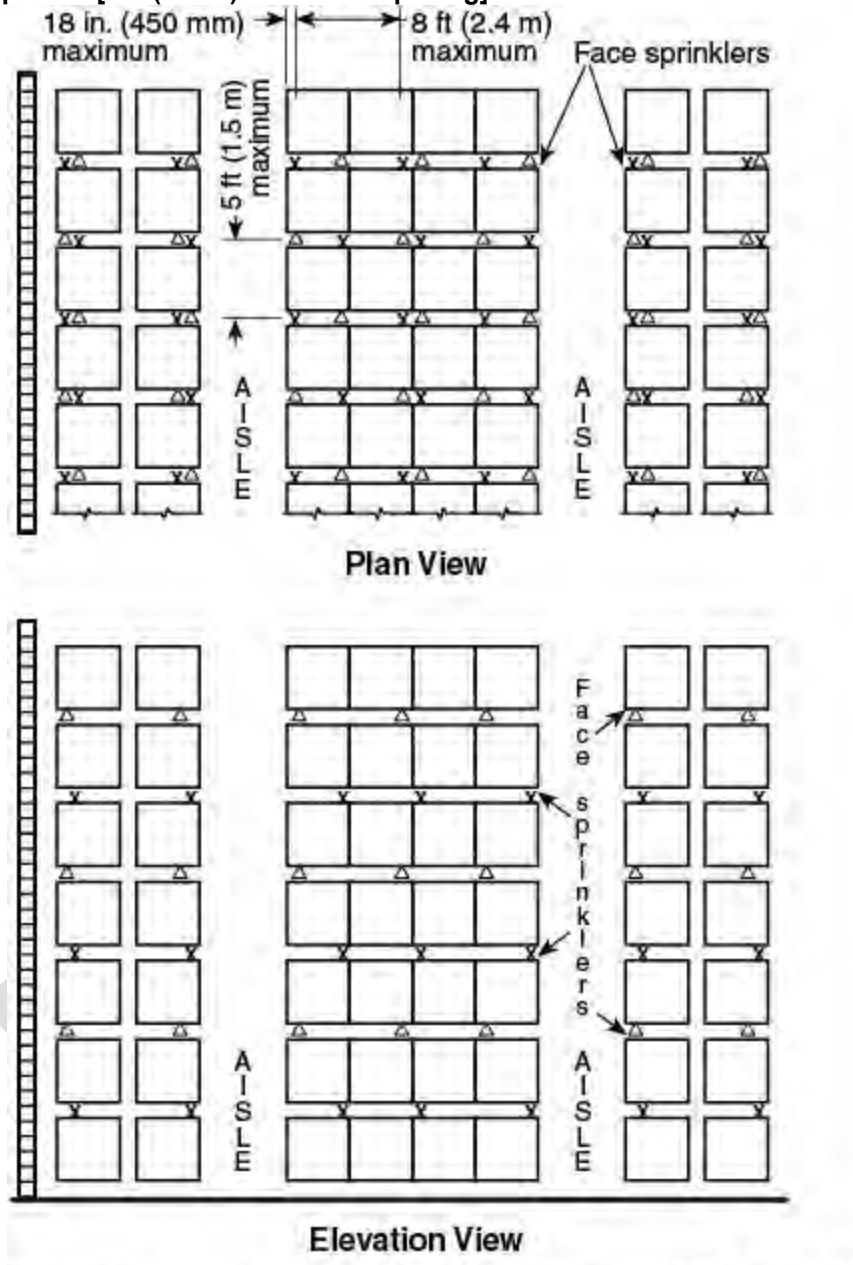
Note: Each square represents a storage cube measuring 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. (450 mm) up to 10 ft (3.0 m). Therefore, there could be as few as one load or as many as six or seven loads between in-rack sprinklers that are spaced 10 ft (3.0 m) apart vertically.

Figure 25.9.4.3.1(d) In-Rack Sprinkler Arrangement, Cartoned Group A Plastic and Exposed Nonexpanded Group A Plastic Commodities, Multiple-Row Racks, Storage Height Over 25 ft (7.6 m) — Option 2 [5 ft (1.5 m) Maximum Spacing].



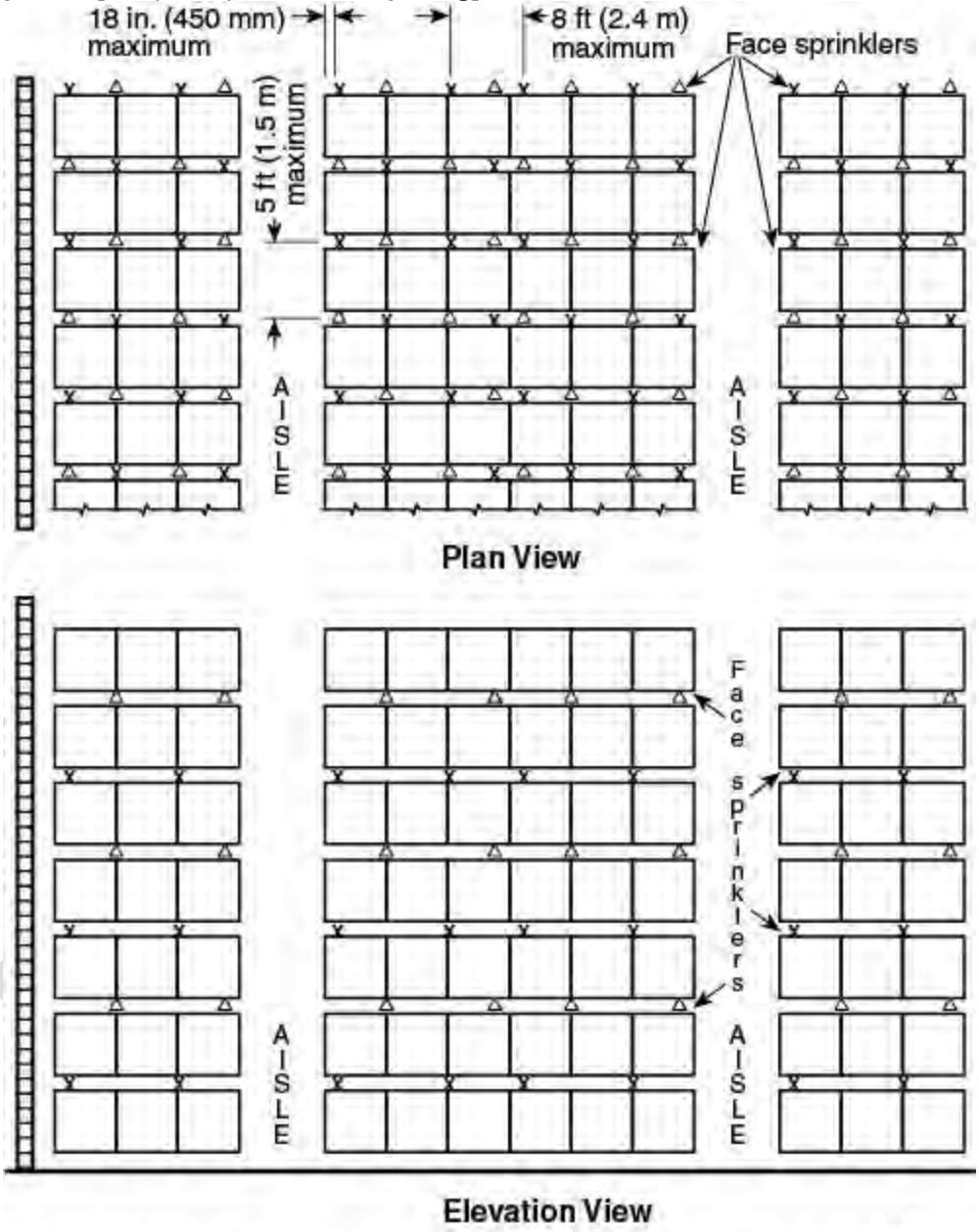
Note: Each square represents a storage cube measuring 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. (450 mm) up to 10 ft (3.0 m). Therefore, there could be as few as one load or as many as six or seven loads between in-rack sprinklers that are spaced 10 ft (3.0 m) apart vertically.

Figure 25.9.4.3.1(e) In-Rack Sprinkler Arrangement, Cartoned Group A Plastic and Exposed Nonexpanded Group A Plastic Commodities, Multiple-Row Racks, Storage Height Over 25 ft (7.6 m) — Option 3 [5 ft (1.5 m) Maximum Spacing].



Note: Each square represents a storage cube measuring 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. (450 mm) up to 10 ft (3.0 m). Therefore, there could be as few as one load or as many as six or seven loads between in-rack sprinklers that are spaced 10 ft (3.0 m) apart vertically.

Figure 25.9.4.3.1(f) In-Rack Sprinkler Arrangement, Cartoned Group A Plastic and Exposed Nonexpanded Group A Plastic Commodities, Multiple-Row Racks, Storage Height Over 25 ft (7.6 m) — Option 4 [5 ft (1.5 m) Maximum Spacing].



Note: Each square represents a storage cube measuring 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. (450 mm) up to 10 ft (3.0 m). Therefore, there could be as few as one load or as many as six or seven loads between in-rack sprinklers that are spaced 10 ft (3.0 m) apart vertically.

25.9.5 In-Rack Sprinkler Arrangements Due to Excessive Clearance.

25.9.5.1
Where the clearance to ceiling for rack storage of Class 1 through Class IV commodities up to and including 25 ft (7.6 m) in height protected by CMDA ceiling-level sprinklers exceeds 20 ft (6.1 m) and the ceiling-level protection is not capable of providing the protection needed for the storage height that would result in a clearance to ceiling of 20 ft (6.1 m), one level of supplemental, quick-response in-rack sprinklers located directly below the top tier of storage and at every flue space intersection shall be installed.

25.9.5.2
Where the clearance to ceiling for rack storage of plastic commodities up to and including 25 ft (7.6 m) in height protected by CMDA ceiling-level sprinklers exceeds 10 ft (3.0 m), and the ceiling-level protection is not capable of providing the protection needed for the storage height that would result in a clearance to ceiling of 10 ft (3.0 m) one level of supplemental, quick-response in-rack sprinklers located directly below the top tier of storage and at every flue space intersection shall be installed.

25.9.5.3
Where the clearance to ceiling exceeds 10 ft (3.0 m) for rack storage over 25 ft (7.6 m) in height, and the ceiling-level protection is not capable of providing the protection needed for the storage height that would result in a clearance to ceiling of 10 ft (3.0 m) one level of supplemental, quick-response in-rack sprinklers located directly below the top tier of storage and at every flue space intersection shall be installed.

25.9.5.4
Where the supplemental in-rack sprinkler protection has been installed in accordance with this section, the ceiling-level sprinkler system design shall be based upon the storage height that results in an acceptable clearance to ceiling.

25.9.5.5
Where in-rack sprinklers are required for the actual storage height based on a theoretical acceptable clearance to ceiling, in-rack sprinklers shall be installed as indicated by that criteria and supplemented as outlined in this section.

25.9.6 Rack Storage of Rubber Tires Up to and Including 20 ft (6.1 m) in Height.
The in-rack arrangements for rack storage of rubber tires, either on-side or on-tread, up to and including 20 ft (6.1 m) in height shall be in accordance with the guidelines outlined in 25.4 through 25.7 as applicable.

25.10 In-Rack Sprinkler Arrangements in Combination with CMSA Sprinklers at Ceiling-Level.

25.10.1* Rack Storage of Class I Through Class IV and Group A Plastic Commodities.
The in-rack arrangements for rack storage of Class I through Class IV and Group A plastic commodities protected by CMSA sprinklers at ceiling level shall be in accordance with the guidelines outlined in Section 25.4 through 25.7 as applicable.

25.11 In-Rack Sprinkler Arrangements in Combination with ESFR Sprinklers at Ceiling-Level.

25.11.1 Rack Storage of Class I Through Class IV and Group A Plastic Commodities.
The in-rack arrangements for rack storage of Class I through Class IV and Group A plastic commodities protected by ESFR sprinklers at ceiling level shall be in accordance with the guidelines outlined in Section 25.4 through 25.7 as applicable.

25.12 Design Criteria for In-Rack Sprinklers in Combination with Ceiling-Level Sprinklers.

25.12.1 General.

25.12.1.1
In-rack sprinkler design criteria for Group A plastic commodities shall be permitted for the protection of the same storage height and configuration of Class I, II, III, and IV commodities.

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25.12.1.2
Pipe sizing of an in-rack sprinkler system shall be permitted to be based on hydraulic calculations and not restricted by any pipe schedule.

25.12.1.3
Where in-rack sprinklers are being installed to protect a storage rack and, due to the length of the rack, fewer in-rack sprinklers will be installed than the number of in-rack sprinklers specified in the in-rack design, the in-rack sprinkler design shall be based on only those in-rack sprinklers installed within the protected rack.

25.12.1.4
Where in-rack sprinkler arrangements have been installed in accordance with Section 25.10, Section 25.11 or Section 25.12, the flow and pressure requirements of both the ceiling and in-rack sprinkler systems over the same protected area shall be hydraulically balanced together to the higher sprinkler system pressure requirement at their point of connection.

25.12.1.5
The minimum water supply requirements for a hydraulically designed occupancy hazard automatic in-rack sprinkler system shall be determined by adding the hose stream allowance from Table 20.12.2.6 to the water supply for ceiling-level sprinklers determined in Section 25.2, unless indicated otherwise.

25.12.2 Number of Operating In-Rack Sprinklers.

25.12.2.1 In-Rack Design Based on 4 In-Rack Sprinklers.
Where in-rack sprinklers have been installed to protect miscellaneous storage, the number of in-rack sprinklers to account for in the design shall be based on the simultaneous operation of the most hydraulically remote four in-rack sprinklers.

25.12.2.2 In-Rack Design Based on 6 In-Rack Sprinklers.

25.12.2.2.1
Where in-rack sprinklers have been installed on one level to protect the following commodities and storage arrangements, the number of in-rack sprinklers to account for in the design shall be based on the simultaneous operation of the most hydraulically remote six in-rack sprinklers:
(1) Class I through Class III commodities stored in racks with solid shelves.

(2) Class I through Class III commodities stored in racks protected by CMDA sprinklers at ceiling level.

25.12.2.3 In-Rack Design Based on 8 In-Rack Sprinklers.

25.12.2.3.1
Where in-rack sprinklers have been installed on one level to protect the following commodities and storage arrangements, the number of in-rack sprinklers to account for in the design shall be based on the simultaneous operation of the most hydraulically remote eight in-rack sprinklers:
(1) Class IV and Group A plastic commodities stored in racks with solid shelves.

(2) Class IV and Group A plastic commodities stored in racks protected by CMDA sprinklers at ceiling level.

(3) Class I through Class IV commodities stored in racks protected by CMSA sprinklers at ceiling level.

(4) Group A plastic commodities stored in racks up to and including 25 ft (7.6 m) in height protected by CMSA sprinklers at ceiling level.

(5) Class I through Class IV commodities stored in racks protected by ESFR sprinklers at ceiling level.

25.12.2.4 In-Rack Design Based on 10 In-Rack Sprinklers.

25.12.2.4.1
Where in-rack sprinklers have been installed on more than one level to protect the following commodities and storage arrangements, the number of in-rack sprinklers to account for in the design shall be based on

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the simultaneous operation of the most hydraulically remote ten in-rack sprinklers (five on each of the top two levels):
(1) Class I through Class III commodities stored in racks with solid shelves.

(2) Class I through Class III commodities stored in racks over 25 ft (7.6 m) in height protected by CMDA sprinklers at ceiling level.

(3) Class IV commodities stored in racks up to and including 25 ft (7.6 m) in height protected by CMDA sprinklers at ceiling level.

25.12.2.5 In-Rack Design Based on 12 In-Rack Sprinklers.
Where in-rack sprinklers have been installed on one level to protect rack storage of rubber tires, the number of in-rack sprinklers to account for in the design shall be based on the simultaneous operation of the most hydraulically remote twelve in-rack sprinklers.

25.12.2.6 In-Rack Design Based on 14 In-Rack Sprinklers.

25.12.2.6.1
Where in-rack sprinklers have been installed on more than one level to protect the following commodities and storage arrangements, the number of in-rack sprinklers to account for in the design shall be based on the simultaneous operation of the most hydraulically remote fourteen in-rack sprinklers (seven on each of the top two levels):
(1) Class IV and Group A plastic commodities stored in racks with solid shelves.

(2) Class IV and Group A plastic commodities stored in racks protected by CMDA sprinklers at ceiling level.

25.12.3 In-Rack Sprinkler Flow/Pressure.

25.12.3.1 In-Rack Design Based on 15 psi (1.0 bar).

25.12.3.1.1
Where in-rack sprinklers have been installed to protect the following commodities and storage arrangements, the minimum allowable design pressure at the hydraulically most remote in-rack sprinkler shall be 15 psi (1.0 bar). (See Section C.19.)
(1) Miscellaneous storage.

(2) Class I through Class IV commodities stored in racks up to and including 25 ft (7.6 m) in height protected by CMDA sprinklers at ceiling level.

(3) Class I through Class IV commodities stored in racks protected by CMSA sprinklers at ceiling level.

(4) Group A plastic commodities stored in racks up to and including 25 ft (7.6 m) in height protected by CMDA sprinklers at ceiling level.

(5) Group A plastic commodities stored in racks up to and including 25 ft (7.6 m) in height protected by CMSA sprinklers at ceiling level.

25.12.3.2 In-Rack Design Based on 30 psi (2.1 bar).
Where in-rack sprinklers have been installed to protect rack storage of rubber tires, the minimum allowable design pressure at the hydraulically most remote in-rack sprinkler shall 30 psi (2.1 bar).

25.12.3.3 In-Rack Design Based on 30 gpm (115 L/min).

25.12.3.3.1
Where in-rack sprinklers have been installed to protect rack storage of the following commodities and storage arrangements, the minimum allowable design pressure at the hydraulically most remote in-rack sprinkler shall be 30 gpm (115 L/min).
(1) Class I through Class IV and Group A plastic commodities stored in racks with solid shelves.

(2) Class I through Class IV and Group A plastic commodities stored in racks over 25 ft (7.6 m) in height protected by CMDA sprinklers at ceiling level.

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25.12.3.4 In-Rack Design Based on 60 gpm (230 L/min).
Where in-rack sprinklers have been installed to protect rack storage protected by ESFR sprinklers at ceiling level, the minimum allowable design pressure at the hydraulically most remote in-rack sprinkler shall be 60 gpm (230 L/min).

Chapter 26 Special Occupancy Requirements

26.1 General.

26.1.1 Application.

26.1.1.1
In addition to the requirements of Chapter 8, Chapters 11 through 22, and Chapter 23, the following special occupancy requirements shall apply.

26.1.1.1.1
All provisions of design criteria in this standard, including design area increases and reductions, shall also apply to these special occupancy requirements.

26.1.1.2
Where the requirements of the reference standard differ from the requirements of this standard, the reference standard shall take precedence.

26.1.2 Definitions.
For terms not defined in Chapter **3**, the definitions of the reference standard shall apply.

26.2 Flammable and Combustible Liquids.

26.2.1 Design Requirements.
Sprinkler system discharge criteria for the protection of flammable and combustible liquids shall comply with NFPA 30.

26.2.2 Installation Requirements. (Reserved)

26.3 Aerosol Products.

26.3.1 Design Requirements.
Sprinkler system discharge criteria for the protection of aerosol products shall comply with NFPA 30B.

26.3.2 Installation Requirements. (Reserved)

26.4 Spray Application Using Flammable or Combustible Materials.

26.4.1 Design Requirements.

26.4.1.1*
The automatic sprinkler system shall be a wet pipe system, a dry pipe system, a preaction system, or an open-head deluge system, whichever is most appropriate for the portion of the spray operation being protected. [**33:**9.4.1]

26.4.1.2
The automatic sprinkler system shall be designed for Extra Hazard (Group 2) occupancies as defined in NFPA 13.

Exception No. 1: For spray application of styrene cross-link thermoset resins, Section 17.3 of NFPA 33 shall apply.
*Exception No. 2: Automatic sprinkler systems for powder coating operations shall be designed for Ordinary Hazard (Group 2), as defined in NFPA 13. [**33:**9.4.2]*

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26.4.1.3
The water supply shall be sufficient to supply all sprinklers likely to open in any one fire incident without depleting the available water for use in hose streams. [**33:**9.4.3]

26.4.1.4
Where sprinklers are installed to protect spray areas and mixing rooms only, water shall be permitted to be supplied from domestic water systems, provided the domestic supply can meet the design criteria of **26.4.1.2**. [**33:**9.4.4]

26.4.1.5
The sprinkler system shall be controlled by a separate, listed indicating valve(s), operable from floor level. [**33:**9.4.5]

26.4.1.6
Automated liquid electrostatic spray application equipment that is unlisted shall be protected further by the following:
(1) In addition to meeting the requirements in 9.8.1 of NFPA 33, the optical flame detection system shall also activate one of the following over each zone in which fire has been detected:
(a) An open head deluge system designed to discharge a minimum density of 24.4 mm/min (0.6 gpm/ft^2)

(b) A carbon dioxide extinguishing system

(c) A dry chemical extinguishing system

(d) A gaseous agent extinguishing system

[**33:**9.8.2(1)]

(2) A wet pipe sprinkler system shall also be provided throughout the spray booth. This system shall meet all the applicable requirements of this standard for Extra Hazard (Group 2**) occupancies.**

[**33:**9.8.2(3)]

26.4.2 Installation Requirements.

26.4.2.1*
Sprinkler systems protecting stacks or ducts shall meet all of the following requirements:
(1) Sprinklers shall be spaced no more than 3.7 m (12 ft) apart.

(2) If exhaust ducts are manifolded, a sprinkler shall be located in the manifold at the junction of each exhaust duct with the manifold.

(3) Sprinklers shall provide a minimum flow of 114 L/min (30 gpm) per head at a minimum of 1 bar (15 psi) pressure.

(4) Sprinklers shall be ordinary temperature rated, unless required to be higher due to operating temperatures measured in the ducts, in which case the operating temperature shall be at least 28°C (50°F) above the inside temperature of the duct.

[**33:**9.4.6]

26.4.2.1.1
Stacks and exhaust ducts shall be provided with access openings for inspection and cleaning of sprinklers. [**33:**9.4.6.1]

26.4.2.1.2
Sprinkler systems protecting stacks and ducts that are subject to freezing shall be of a nonfreezing type or be a manually controlled open-head system. [**33:**9.4.6.2]

26.4.2.2
Sprinklers shall be protected against overspray residue, either by location or covering, so that they will operate quickly in event of fire. [**33:**9.4.7]

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26.4.2.2.1
Sprinklers shall be permitted to be covered only by cellophane bags having a thickness of 0.08 mm (0.003 in.) or less or by thin paper bags. These coverings shall be replaced frequently so that heavy deposits of residue do not accumulate. [**33:**9.4.7.1]

26.4.2.2.2
Sprinklers that have been painted or coated by overspray or residues shall be replaced with new sprinklers. [**33:**9.4.7.2]

26.5 Solvent Extraction Plants. [NFPA 36]

26.5.1* Design Requirements.

26.5.2 Installation Requirements. (Reserved)

26.6 Installation and Use of Stationary Combustion Engines and Gas Turbines.

26.6.1* Design Requirements.
Automatic sprinkler systems shall be designed to provide for a density of 0.3 gpm/ft^2 (12.2 mm/min) over the most remote 2500 ft^2 (230 m^2). [**37:**11.4.5.1]

26.6.2 Installation Requirements.

26.6.2.1
Sprinklers and spray nozzles shall be spaced at a 100 ft^2 (9 m^2) maximum area of coverage per sprinkler or spray nozzle. [**37:**11.4.5.1.1]

26.6.2.2
Sprinkler and water spray system coverage shall be provided to all areas within the enclosure located within 20 ft (6 m) of the following:
(1) The engine

(2) The lubricating oil system

(3) The fuel system

[**37:**11.4.5.1.2]

26.6.2.3
Sprinklers and water spray nozzles shall not be directed at engine components that are susceptible to thermal shock or deformation. [**37:**11.4.5.2]

26.7 Nitrate Film.

26.7.1 Design Requirements.

26.7.1.1
Every room, except projection booths and rewinding rooms, where nitrate film is stored or handled in quantities greater than 51 lb (23 kg), or 10 standard rolls, shall be protected by an automatic sprinkler system that is installed in accordance with the requirements for Group II extra hazard occupancies. [**40:**5.1.2]

26.7.1.2
Water supplies for automatic sprinklers shall be based on 20 gpm (1.26 L/sec) per sprinkler for 20 minutes for the total number of sprinklers in one vault plus 25 percent of the sprinklers in the communicating fire area. [**40:**5.2.2]

26.7.1.3* Vaults Other Than Extended Term Storage Vaults.
[**40:**6.3] *(See Figure A.26.7.1.3.)* Fire protection in vaults shall be provided by a deluge system with directional nozzles meeting the criteria in **26.7.1.4**. [**40:**6.3.7]

26.7.1.4

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For extended term storage vaults in accordance with Section 6.5.5 of NFPA 40, fire protection shall be provided by a deluge system with directional nozzles installed in accordance with NFPA 15 and meeting the criteria in 26.7.1.4.1 through 26.7.1.4.9. [**40:**6.5.6]

26.7.1.4.1
Sprinkler systems in existing extended term storage vaults that were in compliance with the provisions of this standard at the time of installation shall be permitted to be continued in use. [**40:**6.5.6.1]

26.7.1.4.2
High-velocity open head nozzles each capable of providing a discharge rate of 1.26 L/sec (20 gpm) at a gauge pressure of 345 kPa (50 psi) shall be installed. [**40:**6.5.6.2]

26.7.1.4.3
The design shall be based on a discharge density of 28 mm/min (0.68 gpm/ft^2) over each face of storage racks. [**40:**6.5.6.3]

26.7.1.4.4*
The nozzles shall have a combined spray pattern capable of covering the face of the film storage racks. [**40:**6.5.6.4]

26.7.1.4.5
The nozzles shall be installed at the top of the storage shelf array, aimed at the opposite shelf array. [**40:**6.5.6.5]

26.7.1.4.6*
Nozzles shall be installed on opposite faces of the storage shelf array in a staggered pattern such that no nozzles are directly opposite one another. [**40:**6.5.6.6]

26.7.1.4.7
The water supply duration shall be a minimum of 20 minutes. [**40:**6.5.6.7]

26.7.1.4.8
The deluge system shall be activated by a signal from one of the following: [**40:**6.5.6.8]
(1) An air sampling–type smoke detection system

(2) A fixed temperature heat sensitive cable

26.7.1.4.9
Full water flow shall be discharged from the water spray nozzles within 10 seconds of reaching the set point actuation of the detection system [**40:**6.5.6.9.6]

26.7.2 Installation Requirements.
26.7.2.1
In areas or rooms where nitrate film is handled, the area that is protected per sprinkler head shall not exceed 64 ft^2 (6 m^2) with sprinklers not being more than 8 ft (2.4 m) apart. [**40:**5.1.4]

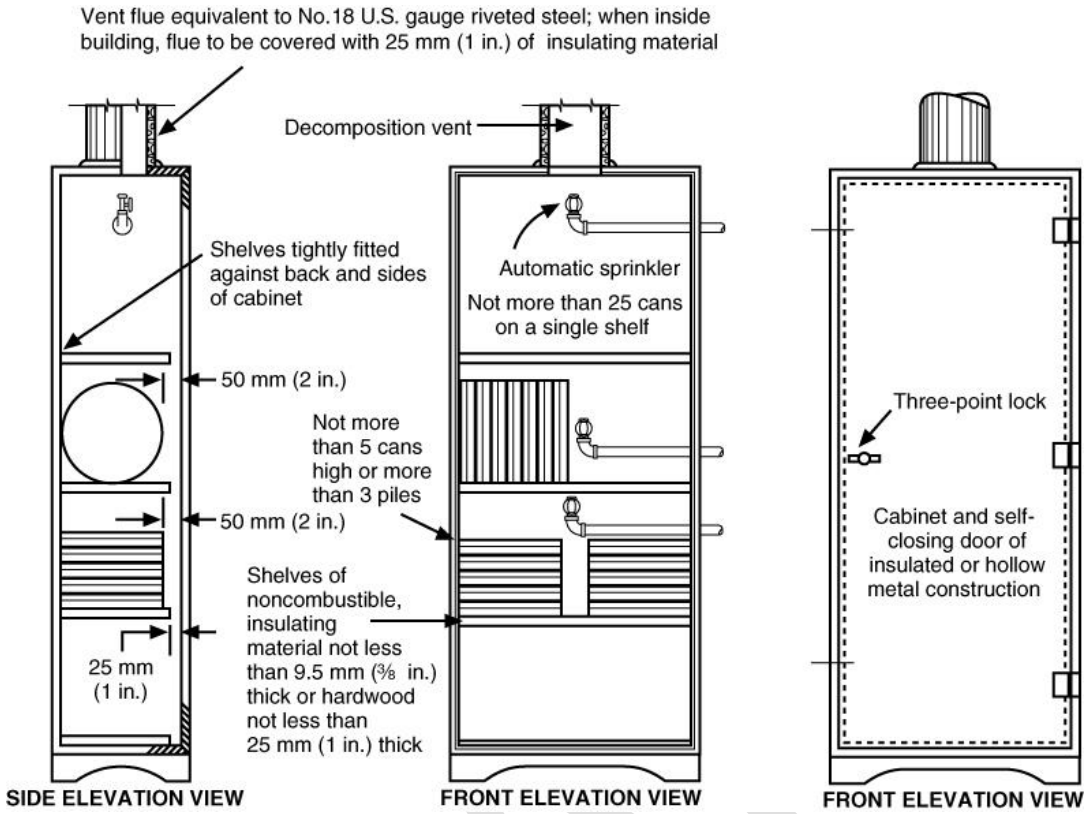
26.7.2.2 Cabinet Protection.
[**40:**6.2.5]

26.7.2.2.1
Cabinets having a capacity of more than 34 kg (75 lb), or 15 standard rolls, of film shall be provided with at least one automatic sprinkler head. [**40:**6.2.5.1]

26.7.2.2.2
Where cans are stored on more than one shelf, as shown in Figure 26.7.2.2.2 and as described in 6.2.6.2 or 6.2.6.3 of NFPA 40, one sprinkler shall be provided for each shelf. [**40:**6.2.5.2]

Figure 26.7.2.2.2 Standard Film Cabinet for Other Than Extended Term Storage Film. [40:Figure 6.2.1]

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26.7.2.3 Motion Picture Film Laboratories.
In all cases, sprinklers shall be arranged so that not more than two machines are protected by any one sprinkler head. [**40:**9.2.5.2]

26.8 Laboratories Using Chemicals.

26.8.1 Design Requirements.
Automatic sprinkler system protection shall be required for all new laboratories in accordance with the following:
(1) Automatic sprinkler system protection for Class A and Class B laboratories shall be in accordance with NFPA 13 for ordinary hazard (Group 2) occupancies.

(2) Automatic sprinkler system protection for Class C and Class D laboratories shall be in accordance with NFPA 3 for ordinary hazard (Group 1) occupancies.

[**45:**6.1.1.1]

26.8.2 Installation Requirements.
Fire sprinklers in laboratory units shall be the quick response (QR) sprinkler type installed in accordance with NFPA 13. [**45:**6.1.1.2]

26.9 Oxygen-Fuel Gas Systems for Welding, Cutting, and Allied Processes.

26.9.1 Design Requirements.

26.9.1.1
Oxygen cylinders connected to one manifold shall be limited to a total gas capacity of 6500 ft^3 (184 m^3). [**51:**5.2.5]

26.9.1.1.1

Two such manifolds with connected cylinders shall be permitted to be located in the same room, provided the building is protected throughout with an approved automatic sprinkler system designed in accordance with this standard, furnishing a sprinkler discharge density of at least 0.25 gpm/ft^2 (10.2 mm/min) over a minimum operating area of at least 3000 ft^2 (279 m^2) with sprinklers located not more than 20 ft (6.1 m) above the floor where the manifolds are located. [**51:**5.2.5.1]

26.9.1.2
For mobile acetylene trailer systems, a deluge sprinkler system shall be provided for MATS fire areas used as indoor and outdoor discharging stations. [**51:**10.5.8.1.1]

26.9.1.3
Deluge sprinkler systems shall provide a minimum density of 0.3 gpm/ft^2 (12.2 mm/min) over the MATS fire area being protected. [**51:**10.5.8.1.2]

26.9.1.4
The deluge system shall be identified and marked with a sign and shall be activated automatically by a fast-acting fire detection system and also by a manual actuator. [**51:**10.5.8.1.3]

26.9.1.5
The requirements of 26.9.1.2 shall not apply to existing indoor or outdoor facilities, equipment, structures, or installations where MATS are discharged that existed or were approved for construction or installation prior to the effective date of this standard, provided the MATS are protected with an automatic sprinkler system with a minimum design density of not less than 0.25 gm/ft^2 (10.2 mm/min). [**51:**10.5.8.1.4.1]

26.9.2 Installation Requirements.

26.9.2.1
In buildings protected by an automatic sprinkler system and water supply designed in accordance with this standard for an Ordinary Hazard Group 2 or more hazardous occupancy, where the occupancy other than the cylinder storage is not more hazardous than ordinary hazard as defined in this standard, the distance between designated storage areas shall be permitted to be reduced to 15.2 m (50 ft) (15.2 m). [**51:**4.3.4.1].

26.9.2.2
If the occupancy in such protected buildings between the designated storage areas is free of combustible material, the distance shall be permitted to be reduced to 25 ft (7.6 m). [**51:**4.3.4.2].

26.10 Acetylene Cylinder Charging Plants.

26.10.1 Design Requirements.

26.10.1.1
When sprinkler protection is provided, the area in which flammable compressed gases are stored or used shall be protected with a sprinkler system designed to be not less than that required by NFPA 13 for Extra Hazard Group 1 with a minimum design area of 2500 ft^2 (232.26 m^2). [**51A:**11.2.1.2]

26.10.1.2
At mobile acetylene trailer systems (MATS) at mobile acetylene charging plants, a fire sprinkler system in accordance with this standard, Extra Hazard Group I shall be installed in the areas occupied by trailers in charging or discharging stations. [**51A:**11.2.1.3]

26.10.2 Installation Requirements. (Reserved)

26.11 Compressed Gases and Cryogenic Fluids Code.

26.11.1 Design Criteria.

26.11.1.1

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When sprinkler protection is required, the area in which compressed gases or cryogenic fluids are stored or used shall be protected with a sprinkler system designed to be not less than that required by NFPA 13 for Ordinary Hazard Group 2. [**55:**6.10.2.1]

26.11.1.2
When sprinkler protection is required, the area in which the flammable or pyrophoric compressed gases or cryogenic fluids are stored or used shall be protected with a sprinkler system designed to be not less than that required by NFPA 13 for Extra Hazard Group 1. [**55:**6.10.2.2]

26.11.2 Installation Requirements. (Reserved)

26.12 Utility LP-Gas Plants.

26.12.1 Design Requirements.

26.12.1.1
The design of fire water supply and distribution systems, where used, shall provide for the simultaneous supply of those fixed fire protection systems involved in the maximum single incident expected in the plant, including monitor nozzles, at their design flow and pressure. [**59:**13.4.2]

26.12.1.2
An additional supply of 1000 gal/min (63 L/s[illegible]) shall be available for hand hose streams for a period of not less than 2 hours. [**59:**13.4.2.1]

26.12.1.3
Manually actuated monitors shall be permitted to be used to augment hand hose streams. [**59:**13.4.2.2]

26.12.2 Installation Requirements. (Reserved)

26.13 Production, Storage, and Handling of Liquefied Natural Gas (LNG).

26.13.1 Design Requirements.
The fire water supply and distribution systems, if provided, shall simultaneously supply water to fixed fire protection systems, including monitor nozzles, at their design flow and pressure, involved in the maximum single incident expected in the plant plus an allowance of 1000 gpm (63 L/s[illegible]) for hand hose streams for not less than 2 hours. [**59A:**12.5.2]

26.13.2 Installation Requirements. (Reserved)

26.14 Protection of Information Technology Equipment.

26.14.1 Design Requirements. (Reserved)

26.14.2 Installation Requirements.

26.14.2.1*
Information technology equipment rooms and information technology equipment areas located in a sprinklered building shall be provided with an automatic sprinkler system. [**75:**9.1.1]

26.14.2.2
Sprinkler systems protecting information technology equipment areas shall be valved separately from other sprinkler systems. [**75:**9.1.3]

26.14.2.3*
An automatic sprinkler system or a gaseous fire extinguishing system shall be provided for the protection of the area below a raised floor in an information technology equipment room or information technology equipment area when one or more of the following exist:
(1) There is a critical need to protect data in the process, reduce equipment damage, and facilitate return to service.

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(2) The area below the raised floor contains combustible material.

[**75:**9.1.1.2]

26.15 Standard on Incinerators, and Waste and Linen Handling Systems and Equipment.

26.15.1 Design Requirements. (Reserved)

26.15.2 Installation Requirements.

26.15.2.1
Automatic sprinklers shall be provided in incinerator rooms in accordance with this standard. [**82:**5.2.7.3]

26.15.2.2* Waste and Linen Chutes and Transport Systems.
[**82:**6]

26.15.2.2.1 Gravity Waste or Linen Chutes.
[**82:**6.2]

26.15.2.2.1.1
Lined metal chutes shall be protected internally by automatic sprinklers unless they are lined in accordance with 6.2.2.6.1 in NFPA 82. [**82:**6.2.2.6.2]

26.15.2.2.1.2
This protection requires that a sprinkler be installed at or above the top service opening of the chute. [**82:**6.2.6.1.2]

26.15.2.2.1.3 Chute Sprinkler Protection.
Automatic sprinklers installed in gravity chute service openings shall be recessed out of the chute area through which the material travels. [**82:**6.2.6.1.3]

26.15.2.2.1.4
In addition, a sprinkler shall be installed within the chute at alternate floor levels in buildings over two stories in height, with a mandatory sprinkler located at the lowest service level. [**82:**6.2.6.1.4]

26.15.2.2.1.5
Gravity chutes shall be protected internally by automatic sprinklers unless they are lined in accordance with 6.2.2.6.1 in NFPA 82. [**82:**6.2.6.1.1]

26.15.2.2.1.6 Chute Room Automatic Sprinklers.
Automatic sprinklers shall be installed in chute terminal rooms. [**82:**6.2.6.2.1]

26.15.2.2.2 Full Pneumatic Waste and Linen Conveying Systems.
[**82:**6.3]

26.15.2.2.2.1
Full pneumatic-type risers shall be protected internally by automatic sprinklers. [**82:**6.3.4.1]

26.15.2.2.2.2
A sprinkler shall be required at or above the top loading station and at alternate floor levels in buildings over two stories in height, with a mandatory sprinkler located at the lowest loading station. [**82:**6.3.4.2]

26.15.2.2.2.3
Sprinklers shall be recessed out of the station area through which the material travels. [**82:**6.3.4.3]

26.15.2.2.3 Gravity Pneumatic Trash or Linen Conveying Systems.
[**82:**6.4]

26.15.2.2.3.1 Chute Automatic Sprinklers.
Where material is to be stored at the bottom of the chute and above the riser discharge damper (above the transport tee), automatic sprinklers shall be installed below the last service door on the chute. [**82:**6.4.2.3]

26.15.2.2.3.2

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Automatic sprinklers shall be installed in chute discharge rooms. [**82:**6.4.2.4.3]

26.15.2.3 Other Waste Handling Systems. [82:7.4]

26.15.2.3.1
Automatic sprinklers shall be installed in rooms where waste handling systems and equipment are used to transport waste from interim storage areas to waste processing equipment, such as incinerators. [**82:**7.4.1]

26.15.2.3.2
In locations or rooms where waste handling systems and equipment are used for interim storage of waste only, the rooms shall be sprinklered in accordance with requirements specified in **26.15.2.4**. [**82:**7.4.2]

26.15.2.4 Waste Compactors. [82:8]

26.15.2.4.1
All chute-fed compactors shall have an automatic sprinkler with a minimum 13 mm (½ in.) orifice installed in the hopper of the compactor. [**82:**8.2.1]

26.15.2.4.2
Sprinklers shall be ordinary temperature-rated sprinklers. [**82:**8.2.1.1]

26.15.2.4.3
Sprinklers shall be supplied by a minimum of 1 in. (25.4 mm) ferrous piping or ¾ in. (19 mm) copper tubing line from the domestic cold water supply or by the building fire sprinkler system. [**82:**8.2.1.2]

26.15.2.4.4
Sprinkler water pipe shall be protected from freezing in outdoor installations. [**82:**8.2.1.3]

26.15.2.4.5
Hand-fed compactors located within a building and not operated in conjunction with a chute shall not require installation of an automatic sprinkler in the hopper. [**82:**8.2.2]

26.15.2.5
Waste and recyclables storage rooms shall be provided with automatic sprinklers in accordance with this standard. [**82:**9.3]

26.15.2.6
Rooms in which waste processing equipment is located shall be installed with automatic sprinklers. [**82:**10.4.1]

26.16 Standard for Ovens and Furnaces.

26.16.1 Design Requirements. (Reserved)

26.16.2 Installation Requirements.

26.16.2.1*
Where automatic sprinklers are provided, they shall be installed in accordance with NFPA 13, unless otherwise permitted by 26.16.2.2. [**86:**9.2.1]

26.16.2.2
Where sprinklers that protect only ovens are installed and connection to a reliable fire protection water supply is not feasible, a domestic water supply connection shall be permitted to supply these sprinklers subject to the approval of the authority having jurisdiction. [**86:**9.2.2]

26.16.2.3
Where sprinklers are selected for the protection of ovens, furnaces, or related equipment, the use of closed-head sprinkler systems shall be prohibited and only deluge sprinkler systems shall be used where the following conditions exist:
(1) In equipment where temperatures can exceed 625°F (329°C)

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(2) Where flash fire conditions can occur

[**86:**9.3.3]

26.16.2.4
Furnaces shall be located so as to minimize exposure to power equipment, process equipment, and sprinkler risers. [**86:**5.1.3.1]

26.16.2.5
Where water from a fixed protection system could come in contact with molten materials, such as molten salt or molten metal, shielding shall be provided to prevent water from contacting the molten material. [**86:**9.3.1]

26.16.2.6*
Galvanized pipe shall not be used in sprinkler or water spray systems in ovens, furnaces, or related equipment. [**86:**9.3.2]

26.17 Health Care Facilities Code, Class A Hyperbaric Chambers.

26.17.1 Design Requirements.

26.17.1.1
A fixed water deluge extinguishing system shall be installed in all chamber compartments that are designed for manned operations. [**99:**14.2.5.2]

26.17.1.2
In chambers that consist of more than one chamber compartment (lock), the design of the deluge system shall meet the requirements of 26.17.1.1 when the chamber compartments are at different depths (pressures). [**99:**14.2.5.2.1]

26.17.1.3
The deluge system in different compartments (locks) shall operate independently or simultaneously. [**99:**14.2.5.2.2]

26.17.1.4
Fixed deluge systems shall not be required in chamber compartments that are used strictly as personnel transfer compartments (locks) and for no other purposes. [**99:**14.2.5.2.3]

26.17.1.5*
Manual activation and deactivation deluge controls shall be located at the operator's console and in each chamber compartment (lock) containing a deluge system. [**99:**14.2.5.2.4]

26.17.1.6
Controls shall be designed to prevent unintended activation. [**99:**14.2.5.2.4.1]

26.17.1.7
Water shall be delivered from the fixed discharge nozzles as specified in **26.17.1.9** within 3 seconds of activation of any affiliated deluge control. [**99:**14.2.5.2.5]

26.17.1.8*
Average spray density at floor level shall be not less than 2 gpm/ft^2 (81.5 L/min/m^2), with no floor area larger than 10.76 ft^2 (1 m^2) receiving less than 1 gpm/ft^2 (40.75 L/min/m^2). [**99:**14.2.5.2.6]

26.17.1.9
Water shall be available in the deluge system to maintain the flow specified in **26.17.1.8** simultaneously in each chamber compartment (lock) containing the deluge system for 1 minute. [**99:**14.2.5.2.7]

26.17.1.10
The limit on maximum extinguishment duration shall be governed by the chamber capacity (bilge capacity also, if so equipped) or its drainage system, or both. [**99:**14.2.5.2.7.1]

26.17.1.11

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The deluge system shall have stored pressure to operate for at least 15 seconds without electrical branch power. [**99:**14.2.5.2.8]

26.17.2 Installation Requirements. (Reserved)

26.18 Fixed Guideway Transit and Passenger Rail Systems.

26.18.1 Design Requirements.

26.18.1.1
Other fire suppression systems, if approved, shall be permitted to be substituted for automatic sprinkler systems in the areas listed in 26.18.2.1. [**130:**5.7.3.4]

26.18.2 Installation Requirements.

26.18.2.1
An automatic sprinkler protection system shall be provided in areas of stations used for concessions, in storage areas, in trash rooms, and in the steel truss area of all escalators and other similar areas with combustible loadings, except trainways. [**130:**5.7.3.1]

26.18.2.2
Sprinkler protection shall be permitted to be omitted in areas of open stations remotely located from public spaces. [**130:**5.7.3.1.1]

26.18.2.3
Installation of sprinkler systems shall comply with NFPA 13 or applicable local codes as required. [**130:**5.7.3.2]

26.18.2.4
A sprinkler system waterflow alarm and supervisory signal service shall be installed. [**130:**5.7.3.3]

26.19 Motion Picture and Television Production Studio Soundstages, Approved Production Facilities, and Production Locations.

26.19.1 Design Requirements. (Reserved)

26.19.2 Installation Requirements.

26.19.2.1
The requirements of NFPA 13 prohibiting obstructions to sprinkler discharge shall not be applicable if approved mitigation is employed. [**140:**4.11.1.3.1]

26.19.2.2
The requirements of NFPA 13 prohibiting obstructions to sprinkler discharge shall not be applicable if the building sprinkler system meets the design criteria for Extra Hazard, Group 2. [**140:**4.11.1.3.2]

26.19.2.3
In any production location building protected by an existing automatic sprinkler system, where solid- or hard-ceiling sets or platforms are introduced and create an obstruction to sprinkler discharge, the provisions of 26.19.2.4 or 26.19.2.5 shall be met. [**140:**5.11.3]

26.19.2.4*
The requirements of NFPA 13 prohibiting obstructions to sprinkler discharge shall not be applicable if approved mitigation is employed. [**140:**5.11.4]

26.19.2.5*
The requirements of NFPA 13 prohibiting obstructions to sprinkler discharge shall not be applicable if the building sprinkler system meets the design criteria for Extra Hazard, Group 2. [**140:**5.11.5]

26.20 Animal Housing Facilities.

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26.20.1 Design Requirements. (Reserved)

26.20.1.1 (Reserved)

26.20.2 Installation Requirements. (Reserved)

26.20.2.1
Quick-response sprinklers shall be utilized in animal housing facilities. [**150:**9.2.3]

26.21 Water Cooling Towers.

26.21.1 Design Requirements.

26.21.1.1 Types of Systems.

26.21.1.1.1*
Because the counterflow tower design lends itself to either closed- or open-head systems, the following systems shall be permitted to be used:
(1) Wet-pipe

(2) Dry-pipe

(3) Preaction

(4) Deluge

[**214:**5.2.2.1]

26.21.1.1.2*
The open-head deluge system shall be used in crossflow towers to maximize the water distribution and heat detection activation. [**214:**5.2.2.2]

26.21.1.2 Minimum Rate of Application.
[**214:**5.2.3]

26.21.1.2.1
Under the fan decks of counterflow towers, the rate of application of water shall be 0.5 gpm/ft^2 (20.4 mm/min), including fan opening. [**214:**5.2.3.1]

26.21.1.2.2
Under the fan decks of crossflow towers, the rate of application of water shall be 0.33 gpm/ft^2 (13.45 mm/min), including fan opening. [**214:**5.2.3.2]

26.21.1.2.3
Over the fill areas of crossflow towers, the rate of application of water shall be 0.5 gpm/ft^2 (20.4 mm/min). [**214:**5.2.3.3]

26.21.1.3 Extended Fan Decks.
On towers having extended fan decks that completely enclose the distribution basin, the discharge outlets protecting the fill area shall be located over the basin, under the extension of the fan deck. [**214:**5.2.4.3]

26.21.1.3.1
These discharge outlets shall be open directional spray nozzles or other approved spray devices arranged to discharge 0.35 gpm/ft^2 (14.26 mm/min) directly on the distribution basin and 0.15 gpm/ft^2 (6.11 mm/min) on the underside of the fan deck extension. [**214:**5.2.4.3.1]

26.21.1.3.2
On towers having extended fan decks that do not completely enclose the hot-water basin, outlets protecting the fill shall be located under the distribution basin in accordance with 5.2.4.2.2 of NFPA 214. [**214:**5.2.4.3.2]

26.21.1.4 Combustible Fan Decks.

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For deluge systems using directional spray nozzles in the pendant position, provisions shall be made to protect the underside of a combustible fan deck at a minimum of 0.15 gpm/ft^2 (6.11 mm/min), which shall be included as part of the application rate specified in 5.2.3 of NFPA 214. [**214:**5.2.4.4]

26.21.1.5* Water Basin Covers.
On film-filled towers that have solid, hot-water basin covers over the complete basin, the discharge outlets protecting the fill area shall be permitted to be located under the basin covers. [**214:**5.2.4.5]

26.21.1.5.1
These discharge outlets shall be open directional spray nozzles or other approved devices arranged to discharge 0.50 gpm/ft^2 (20.4 mm/min) into the distribution basin horizontally, with some of the spray splashing up and on the underside of the water basin covers. [**214:**5.2.4.5.1]

26.21.1.6 Exterior Protection.
[**214:**5.2.10]

26.21.1.6.1
Where any combustible exterior surfaces of a tower, including the fan deck and distribution basins, are less than 100 ft (30.5 m) from significant concentrations of combustibles such as structures or piled material, the combustible exposed surfaces of the tower shall be protected by an automatic water spray system. [**214:**5.2.10.1]

26.21.1.6.2
Systems for exterior protection shall be designed with the same attention and care as interior systems. [**214:**5.2.10.2]

26.21.1.6.2.1
Pipe sizing shall be based on hydraulic calculations. [**214:**5.2.10.2.1]

26.21.1.6.2.2
Water supply and discharge rate shall be based on a minimum 0.15 gpm/ft^2 (6.11 mm/min) for all protected surfaces. [**214:**5.2.10.2.2]

26.21.1.7 Sprinkler System Water Supply.

26.21.1.7.1 Deluge Systems.

26.21.1.7.1.1*
Where all cells of a cooling tower are protected by a single deluge system, the water supply shall be adequate to supply all discharge outlets on that system. [**214:**5.6.1.1]

26.21.1.7.1.2
Where two or more deluge systems are used to protect a cooling tower and fire-resistant partitions are not provided between the deluge systems, the water supply shall be adequate to supply all discharge outlets in the two most hydraulically demanding adjacent systems. [**214:**5.6.1.2]

26.21.1.7.1.3*
Where two or more deluge systems are separated by fire-resistant partitions, the water supply shall be adequate to supply all discharge outlets in the single most hydraulically demanding system. [**214:**5.6.1.3]

26.21.1.7.2 Wet, Dry, and Preaction Systems.

26.21.1.7.2.1*
Where each cell of the cooling tower is separated by a fire-resistant partition, the water supply shall be adequate to supply all discharge outlets in the hydraulically most demanding single cell. [**214:**5.6.2.1]

26.21.1.7.2.2*
Where fire-resistant partitions are not provided between each cell of a cooling tower, the water supply shall be adequate to supply all discharge outlets in the two most hydraulically demanding adjoining cells. [**214:**5.6.2.2]

26.21.1.7.3 Hose Streams.

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Water supplies shall be sufficient to include a minimum of 500 gpm (1892.5 L/min) for hose streams in addition to the sprinkler requirements. [**214:**5.6.3]

26.21.1.7.4 Duration.
A water supply adequate for at least a 2-hour duration shall be provided for the combination of the water supply specified in 5.6.1 or 5.6.2 of NFPA 214, plus the hose stream demand specified in 26.21.1.7.3. [**214:**5.6.4]

26.21.2 Installation Requirements.

26.21.2.1* Counterflow Towers.
[**214:**5.2.4.1]

26.21.2.1.1
The discharge outlets shall be located under the fan deck and fan opening. [**214:**5.2.4.1.1]

26.21.2.1.2
Except under the fan opening, all discharge outlets shall have deflector distances installed in accordance with Section 9.5 of NFPA 13. [**214:**5.2.4.1.2]

26.21.2.1.3
Closed-head discharge outlets for dry-pipe and preaction systems shall be installed in the upright position only. [**214:**5.2.4.1.3]

26.21.2.2* Crossflow Towers.
[**214:**5.2.4.2]

26.21.2.2.1
The discharge outlets protecting the plenum area shall be located under the fan deck and in the fan opening. [**214:**5.2.4.2.1]

26.21.2.2.2
Discharge outlets protecting the fill shall be located under the distribution basin on either the louver or drift eliminator side, discharging horizontally through the joist channels. [**214:**5.2.4.2.2]

26.21.2.2.3
Towers with an air travel dimension longer than the maximum allowable for the discharge device being used shall have discharge devices placed on both sides of the fill area in each joist channel. [**214:**5.2.4.2.3.1]

26.21.2.2.4
The pressure at each discharge device shall be adequate to provide protection for half of the length of the fill measured along the air travel. [**214:**5.2.4.2.3.2]

26.21.2.2.5
Where joist channels are wider than 2 ft (0.6 m), more than one discharge device shall be required per joist channel. [**214:**5.2.4.2.4.1]

26.21.2.2.6
If the discharge device being used is listed for the width of the joist channel being protected, one discharge device per joist channel shall be permitted to be used. [**214:**5.2.4.2.4.2]

26.21.2.3* Extended Fan Decks.
On towers having extended fan decks that completely enclose the distribution basin, the discharge outlets protecting the fill area shall be located over the basin, under the extension of the fan deck. [**214:**5.2.4.3]

26.21.2.4* Water Basin Covers.
On film-filled towers that have solid, hot-water basin covers over the complete basin, the discharge outlets protecting the fill area shall be permitted to be located under the basin covers. [**214:**5.2.4.5]

26.21.2.5 Valves.
[**214:**5.2.6]

26.21.2.5.1

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Shutoff valves and automatically operated water control valves, if provided, shall be located as follows:
(1) Outside the fire-exposed area

(2) As close to the cooling tower as possible to minimize the amount of pipe to the discharge device

(3) Where they will be accessible during a fire emergency

[**214:**5.2.6.1.2]

26.21.2.5.2 Manual Release Valve.
[**214:**5.2.6.2]

26.21.2.5.2.1
Remote manual release valves, where required, shall be conspicuously located and accessible during a fire emergency. [**214:**5.2.6.2.1]

26.21.2.5.2.2
Where remote manual release valves are not required, an inspector's test valve shall be provided for each pilot-head-operated system. [**214:**5.2.6.2.2]

26.21.2.6 Strainers.
Strainers shall be required for systems utilizing discharge devices with waterways of less than ⅜ in. (9.5 mm) diameter. [**214:**5.2.7]

26.21.2.7 Heat Detectors.
Where deluge or preaction systems are used, heat detectors shall be installed and shall be selected from either of the types in 5.2.8.1 or 5.2.8.2 of NFPA 214. [**214:**5.2.8]

26.21.2.7.1
In mechanical-draft towers, pilot line detectors shall be located under the fan deck at the circumference of the fan opening and under the fan opening where necessary to comply with the spacing requirements in **26.21.2.7.1.1**. *(For extended fan decks, see 5.2.8.2.3 in NFPA 214.)* [**214:**5.2.8.1.2.1(A)]

26.21.2.7.1.1
Pilot line detectors shall be spaced not more than 8 ft (2.4 m) apart in any direction including the fan opening. Temperature ratings shall be selected in accordance with operating conditions, but shall be no less than intermediate. [**214:**5.2.8.1.2.1(B)]

26.21.2.7.2
On towers having extended fan decks that completely enclose the distribution basin, electrical heat detectors shall be located under the fan deck extension in accordance with standard, indoor-spacing rules for the type detectors used in accordance with *NFPA 72*. [**214:**5.2.8.2.3]

26.21.2.7.2.1
Where the fan deck extension is 16 ft (4.9 m) or less and this dimension is the length of the joist channel, then only one row of detectors centered on and at right angles to the joist channels shall be required. Spacing between detectors shall be in accordance with *NFPA 72*. [**214:**5.2.8.2.3.1]

26.21.2.7.2.2
On towers having extended fan decks that do not completely enclose the hot-water basin, electrical heat detectors shall not be required under the fan deck extension. [**214:**5.2.8.2.3.2]

26.21.2.7.3
Where electrical heat detectors are inaccessible during tower operation, an accessible test detector shall be provided for each detection zone. [**214:**5.2.8.3]

26.21.2.7.4
Electrical heat detector components exposed to corrosive vapors or liquids shall be protected by materials of construction or by protective coatings applied by the equipment manufacturer. [**214:**5.2.8.4]

26.21.2.8 Protection for Fan Drive Motor.
[**214:**5.2.9]

26.21.2.8.1

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A sprinkler or spray nozzle shall be provided over each fan drive motor where the motor is located so that it is not within the protected area of the tower. [**214:**5.2.9.1]

26.21.2.8.2
Where a preaction or deluge system is used, the detection system shall be extended to cover the motor. [**214:**5.2.9.2]

26.21.2.8.3
Provision shall be made to interlock the fan motors with the fire protection system so that the cooling tower fan motors are stopped in the cell(s) for which the system is actuated. [**214:**5.2.9.3]

26.21.2.8.4
Where the continued operation of the fans is vital to the process, a manual override switch shall be permitted to be provided to reactivate the fan when it is determined that there is no fire. [**214:**5.2.9.4]

26.21.2.9 Corrosion Protection.
[**214:**5.3]

26.21.2.9.1
Piping, fittings, hangers, braces, and attachment hardware including fasteners shall be hot-dipped galvanized steel in accordance with ASTM A153A/153M*, Standard Specification for Zinc Coating (Hot Dip) on Iron and Steel Hardware,* or other materials having a superior corrosion resistance. [**214:**5.3.1]

26.21.2.9.1.1
Exposed pipe threads and bolts on fittings shall be protected against corrosion. [**214:**5.3.1.1]

26.21.2.9.1.2
All other components shall be corrosion resistant or protected against corrosion by a coating. [**214:**5.3.1.2]

26.21.2.9.2*
Wax-type coatings shall not be used on devices without fusible elements. [**214:**5.3.2]

26.21.2.9.3*
Special care shall be taken in the handling and installation of wax-coated or similar sprinklers to avoid damaging the coating. [**214:**5.3.3]

26.21.2.9.3.1
Corrosion-resistant coatings shall not be applied to the sprinklers by anyone other than the manufacturer of the sprinklers. [**214:**5.3.3.1]

26.21.2.9.3.2
In all cases, any damage to the protective coating occurring at the time of installation shall be repaired at once using only the coating of the manufacturer of the sprinkler in an approved manner, so that no part of the sprinkler will be exposed after the installation has been completed. [**214:**5.3.3.2]

26.22 Standard for the Construction and Fire Protection of Marine Terminals, Piers, and Wharves.

26.22.1 Design Requirements.

26.22.1.1*
Unless the requirements of 26.22.1.2 apply, automatic sprinkler systems shall be designed based upon the design criteria for the protection of Group A plastics. [**307:**5.4.2.1]

26.22.1.2
With the approval of the authority having jurisdiction, the requirements of 26.22.1.1 shall not apply to buildings used exclusively for the handling or storage of specific cargoes and commodities that are defined as commodity classes less than Group A plastics by this standard. [**307:**5.4.2.2]

26.22.1.3
Buildings consistent with 26.22.1.2 shall be protected in accordance with the design criteria for the applicable commodity as required by this standard. [**307:**5.4.2.3]

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26.22.1.4
Buildings used for the storage of hazardous materials shall be protected in accordance with this standard and the applicable codes and standards for the type of hazardous material being stored. [**307:**5.4.2.4]

26.22.2 Installation Requirements.

26.22.2.1 Piers and Wharves with Combustible Substructure.

26.22.2.1.1
Where there is danger of damage to sprinkler equipment by floating objects, physical barriers shall be provided to exclude such objects. [**307:**4.3.3.1.2.2]

26.22.2.1.2
The installation requirements in 26.22.2.1.2.1, 26.22.2.1.2.1(A), and 26.22.2.1.2.1(B) are also required.

26.22.2.1.2.1* Upward Projecting Sprinklers.
Where narrow horizontal channels or spaces are caused by caps, stringers, ties, and other structural members and where the standard upright sprinkler does not project sufficient water upward to extinguish or control fires on the underside of the pier or wharf deck, a sprinkler that projects water upward to wet the overhead shall be used. [**307:**4.3.3.1.3.1]

(A)
Location, spacing, and deflector position shall be governed by the discharge pattern of the sprinkler and the structure being protected. [**307:**4.3.3.1.3.1(A)]

(B)
The following design and installation guides shall apply where pendent sprinklers in the upright position or old-style sprinklers are to be utilized:
(1) The maximum coverage per sprinkler head shall be limited to 80 ft^2 (7.5 m^2).

(2) Where spacing or arrangement of stringers constitutes typical open-joist construction directly supporting the deck, sprinkler branch lines shall be installed between the bents at right angles to the stringers and shall meet the following requirements:
(a) Spacing between branch lines shall not exceed 10 ft (3 m).

(b) Sprinklers on branch lines shall be staggered and spaced not to exceed 8 ft (2.5 m) on center.

(3) *Where crisscross construction is involved, closer spacing of sprinklers shall be permitted as necessary to provide wetting of the entire structure.

(4) The deflectors of sprinklers on lines under stringers shall be located not less than 4 in. (100 mm) nor more than 10 in. (250 mm) below the bottom plane of the stringer, and not more than 18 in. (450 mm) below the underside of the pier or wharf deck.

(5) *The sprinkler system shall be hydraulically designed in accordance with the requirements of this standard and shall meet the following requirements:
(a) Sprinkler orifice shall be ½ in. (12.7 mm) and shall discharge at a minimum pressure of 12.5 psi (85 kPa).

(b) Design area shall be based upon the largest area between firestops plus an additional area embracing at least two branch lines on opposite sides of the firestop.

(c) Minimum design area shall be not less than 5000 ft^2 (465 m^2).

(6) The temperature rating of the sprinkler shall not exceed 165°F (74°C).

(7) The maximum area to be protected by any one system shall be limited to 25,000 ft^2 (2325 m^2).

[**307:**4.3.3.1.3.1(B)]

26.23 Semiconductor Fabrication Facilities.

26.23.1 Design Requirements.

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26.23.1.1*
Automatic sprinklers for cleanrooms or clean zones shall be installed in accordance with this standard and shall be hydraulically designed for a density of 0.20 gpm/ft² (8.15 L/min·m²) over a design area of 3000 ft² (278.8 m²). [**318:**4.1.2.1]

26.23.1.2
Automatic sprinkler protection shall be designed and installed in the plenum and interstitial space above cleanrooms in accordance with this standard, for a density of 0.20 gpm/ft² (8.15 L/min·m²) over a design area of 3000 ft² (278.8 m²). [**318:**4.1.2.5]

26.23.1.2.1*
Automatic sprinklers shall be permitted to be omitted if the construction and occupancy of these spaces are noncombustible. [**318:**4.1.2.5.1]

26.23.1.3*
Sprinklers installed in duct systems shall be hydraulically designed to provide 0.5 gpm (1.9 L/min) over an area derived by multiplying the distance between the sprinklers in a horizontal duct by the width of the duct. [**318:**4.1.2.6.2]

26.23.1.3.1*
Minimum discharge shall be 20 gpm (76 L/min) per sprinkler from the five hydraulically most remote sprinklers. [**318:**4.1.2.6.2.1]

26.23.2 Installation Requirements.

26.23.2.1*
Wet pipe automatic sprinkler protection shall be provided throughout facilities containing cleanrooms and clean zones. [**318:**4.1.1]

26.23.2.2*
Approved quick-response sprinklers shall be utilized for sprinkler installations within down-flow airstreams in cleanrooms and clean zones. [**318:**4.1.2.2]

26.23.2.3*
Sprinklers shall be spaced a maximum of 20 ft (6.1 m) apart horizontally and 12 ft (3.7 m) apart vertically. [**318:**4.1.2.6.2.2]

26.23.2.4
A separate indicating control valve shall be provided for sprinklers installed in ductwork. [**318:**4.1.2.6.3]

26.23.2.5
The sprinklers shall be accessible for periodic inspection and maintenance. [**318:**4.1.2.6.6]

26.24 Aircraft Hangars.

26.24.1 Design Requirements.
Sprinkler systems installed in aircraft hangars shall comply with NFPA 409.

26.24.2 Installation Requirements.
Sprinkler systems installed in aircraft hangars shall comply with NFPA 409.

26.25 Airport Terminal Buildings, Fueling Ramp Drainage, and Loading Walkways.

26.25.1 Design Requirements.

26.25.1.1
Passenger-handling areas shall be classified as Ordinary Hazard Group 1 Occupancy for the purpose of sprinkler system design. [**415:**4.5.1.3]

26.25.1.2*
Baggage, package, and mail-handling areas shall be classified as Ordinary Hazard Group 2 Occupancy for the purpose of sprinkler system design. [**415:**4.5.1.4]

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26.25.1.3
Other areas of the airport terminal building shall be classified in accordance with Chapter 5 of this standard. [**415:**4.5.1.5]

26.25.1.4 Water Supply.
Water supply from public and private sources shall be adequate to supply maximum calculated sprinkler demand plus a minimum of 500 gpm (1893 L/min) for hose streams. The supply shall be available at the rate specified for a period of at least 1 hour. [**415:**4.5.5]

26.25.1.4.1
Main sizes shall be hydraulically calculated based on the total domestic and fire protection requirements. Mains shall not be less than 8 in. (203 mm) in diameter except that laterals shall be permitted to be 6 in. (152 mm) in diameter if not over 200 ft (61 m) long. [**415:**4.5.5.1]

26.25.2 Installation Requirements. (Reserved)

26.26 Aircraft Engine Test Facilities.

26.26.1 Design Requirements.

26.26.1.1*
In engine test cells, the minimum design discharge density shall be 0.50 gpm/ft^2 (0.34 L/sec/m^2) of protected area. [**423:**7.6.3]

26.26.1.2
In engine test cells, water supplies shall be capable of meeting the largest demand at the design rate plus hose stream demand for a period of 30 minutes. [**423:**7.6.4]

26.26.1.2.1
Hose stream demand shall be a minimum of 250 gpm (16 L/sec). [**423:**7.6.4.1]

26.26.1.2.2
The hydraulic calculation and the water supply shall be based on the assumption that all sprinklers in the test cell are operating simultaneously. [**423:**7.6.4.2]

26.26.2 Installation Requirements. (Reserved)

26.27 Advanced Light Water Reactor Electric Generating Plants.

26.27.1 Design Requirements.

26.27.1.1* Sprinkler System Water Supply.
The fire water supply shall be calculated on the basis of the largest expected flow rate for a period of 2 hours but shall not be less than 300,000 gal (1,135,500 L), and the following criteria also shall apply:
(1) The flow rate shall be based on 500 gpm (1892.5 L/min) for manual hose streams plus the largest design demand of any sprinkler or fixed water spray system as determined in accordance with this standard, with NFPA 15, or with NFPA 804.

(2) The fire water supply shall be capable of delivering the design demand specified in 26.27.1.1(1) with the hydraulically least demanding portion of fire main loop out of service.

[**804:**9.2.1]

26.27.1.2 Yard Mains.
The underground yard fire main loop shall be installed to furnish anticipated water requirements, and the following criteria also shall be met:
(1) The type of pipe and water treatment shall be design considerations, with tuberculation as one of the parameters.

(2) Means for inspecting and flushing the systems shall be provided.

[**804:**9.4.1]

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26.27.1.3 Cable Spreading Room.
The cable spreading room shall have an automatic fixed water-based suppression system, and the following criteria also shall be met:
(1) The location of sprinklers or spray nozzles shall protect cable tray arrangements to ensure water coverage for areas that could present exposure fire hazards to the cable raceways.

(2) Automatic sprinkler systems shall be designed for a density of 0.30 gpm/ft² (12.2 L/min·m²) over the most remote 2500 ft² (232.2 m²).

[**804:**10.4.1.1]

26.27.1.4 Cable Tunnels.
[**804:**10.4.2]

26.27.1.4.1
Automatic sprinkler systems shall be designed for a density of 0.30 gpm/ft² (12.2 L/min·m²) for the most remote 100 linear ft (30.5 m) of cable tunnel up to the most remote 2500 ft² (232.2 m²). [**804:**10.4.2.2.2]

26.27.1.4.2
Deluge sprinkler systems or deluge spray systems shall meet the following criteria:
(1) They shall be zoned to limit the area of protection to that which the drainage system can handle with any two adjacent systems actuated.

(2) They shall be hydraulically designed with each zone calculated with the largest adjacent zone flowing.

[**804:**10.4.2.2.4]

26.27.1.5* Beneath Turbine Generator Operating Floor.
All areas beneath the turbine generator operating floor shall be protected by an automatic sprinkler or foam-water sprinkler system meeting the following criteria:
(1) The sprinkler system beneath the turbine generator shall be designed around obstructions from structural members and piping.

(2) The sprinkler system shall be designed to a minimum density of 0.30 gpm/ft² (12.2 L/min·m²) over a minimum application of 5000 ft² (464.5 m²).

[**804:**10.8.2.1]

26.27.1.6* Turbine Generator Bearings.
[**804:**10.8.3]

26.27.1.6.1
Lubricating oil lines above the turbine operating floor shall be protected with an automatic sprinkler system to a minimum density of 0.30 gpm/ft² (12.2 L/min·m²) that covers those areas subject to oil accumulation, including the area within the turbine lagging (skirt). [**804:**10.8.4]

26.27.1.6.2
Where shaft-driven ventilation systems are used, an automatic preaction sprinkler system providing a density of 0.30 gpm/ft² (12.2 L/min·m²) over the entire area shall be provided. [**804:**10.8.7(2)]

26.27.1.7 Standby Emergency Diesel Generators and Combustion Turbines.
The sprinkler and water spray protection systems shall be designed for a 0.25 gpm/ft² (10.19 L/min·m²) density over the entire area. [**804:**10.9.3(2)]

26.27.1.8 Fire Pump Room/House.
If sprinkler and water spray systems are provided for fire pump houses, they shall be designed for a minimum density of 0.25 gpm/ft² (10.19 L/min·m²) over the entire fire area. [**804:**10.22.2]

26.27.1.9 Auxiliary Boilers.
Sprinkler and water spray systems shall be designed for a minimum density of 0.25 gpm/ft² (10.19 L/min·m²) over the entire area. [**804:**10.24.3]

26.27.2 Installation Requirements.

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26.27.2.1 Yard Mains, Hydrants, and Building Standpipes.
[**804:**9.4]

26.27.2.1.1
Approved visually indicating sectional control valves such as postindicator valves shall be provided to isolate portions of the main for maintenance or repair without simultaneously shutting off the supply to both primary and backup fire suppression systems. [**804:**9.4.2]

26.27.2.1.2*
Sectional control valves shall allow maintaining independence of the individual loop around each unit, and the following also shall apply:
(1) For such installations, common water supplies shall also be permitted to be utilized.

(2) For multiple-reactor sites with widely separated plants [approaching 1 mi (1.6 km) or more], separate yard fire main loops shall be used.

[**804:**9.4.4]

26.27.2.1.3
Sprinkler systems and manual hose station standpipes shall have connections to the plant underground water main so that a single active failure or a crack in a moderate-energy line can be isolated so as not to impair both the primary and the backup fire suppression systems unless otherwise permitted by the following:
(1) Alternatively, headers fed from each end shall be permitted inside buildings to supply both sprinkler and standpipe systems, provided steel piping and fittings meeting the requirements of ASME B31.1, *Code for Power Piping*, are used for the headers (up to and including the first valve) supplying the sprinkler systems where such headers are part of the seismically analyzed hose standpipe system.

(2) Where provided, such headers shall be considered an extension of the yard main system.

(3) Each sprinkler and standpipe system shall be equipped with an outside screw and yoke (OS&Y) gate valve or other approved shutoff valve.

[**804:**9.4.7]

26.27.2.2 Cable Tunnels.
The location of sprinklers or spray nozzles shall protect cable tray arrangements and possible transient combustibles to ensure water coverage for areas that could present exposure fire hazards to the cable raceways. [**804:**10.4.2.2.3]

26.27.2.3 Deluge.
Deluge sprinkler systems or deluge spray systems shall meet the following criteria:
(1) They shall be zoned to limit the area of protection to that which the drainage system can handle with any two adjacent systems actuated.

(2) They shall be hydraulically designed with each zone calculated with the largest adjacent zone flowing.

[**804:**10.4.2.2.4]

26.27.2.4
Cable tunnels over 50 ft (15.2 m) long shall be provided with hose stations and portable fire extinguishers installed outside the tunnel. [**804:**10.4.2.4(3)]

26.28 Light Water Nuclear Power Plants.

26.28.1 Design Requirements.
A fire protection water supply of reliability, quantity, and duration shall be provided by one of the two following methods:
(1) A fire protection water supply of not less than two separate 300,000 gal (1,135,500 L) supplies shall be provided.

(2) The 2-hour fire flow rate for 2 hours shall be calculated, and the following criteria shall be met:

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(a) The flow rate shall be based on 500 gpm (1892.5 L/min) for manual hose streams plus the largest design demand of any sprinkler or fixed water spray system(s) in the power block as determined in accordance with NFPA 13 or NFPA 15.

(b) The fire water supply shall be capable of delivering this design demand with the hydraulically least demanding portion of fire main loop out of service.

[**805:**5.5.1]

26.28.2 Installation Requirements.

26.28.2.1
Sprinkler systems and manual hose station standpipes shall be connected to the plant fire protection water main so that a single active failure or a crack to the water supply piping to these systems can be isolated so as not to impair both the primary and backup fire suppression systems. [**805:**5.5.12]

26.28.2.2
Each sprinkler and standpipe system shall be equipped with an outside screw and yoke (OS&Y) gate valve or other approved shutoff valve. [**805:**5.5.17]

26.29 Hydroelectric Generating Plants. [NFPA 851]

26.29.1 Design Requirements.

26.29.1.1 Hydraulic Control Systems.
Fixed fire protection for this equipment, where provided, should be as follows:
(1) Automatic wet pipe sprinkler systems utilizing a design density of 0.25 gpm/ft^2 (10.2 mm/min) for the entire hazard area.

(2) Automatic foam-water sprinkler systems providing a density of 0.16 gpm/ft^2 (6.5 mm/min).

[**851:**7.2.4]

26.29.1.2 Cable Concentrations.
Sprinkler or water spray systems should be designed for a density of 0.30 gpm/ft^2 (12.2 mm/min) over 2500 ft^2 (232 m^2). This coverage is for area protection. Individual cable tray tier coverage could be required based on the fire risk evaluation. [**851:**7.5.3]

26.29.1.3 Cable Tunnels.
Where protection is required by the fire risk evaluation, cable tunnels should be protected by automatic water spray, automatic wet pipe sprinkler, or foam-water spray systems. Automatic sprinkler systems should be designed for a density of 0.30 gpm/ft^2 (12.2 mm/min) over 2500 ft^2 (232 m^2) or the most remote 100 linear ft (30.5 m) of cable tunnel up to 2500 ft^2 (232 m^2). [**851:**7.6.1]

26.29.1.4 Emergency Generators.
Emergency generators located within main plant structures should be protected by automatic sprinkler, water spray, foam-water sprinkler, compressed air foam, or gaseous-type extinguishing systems. Sprinkler and water spray protection systems should be designed for a 0.25 gpm/ft^2 (10.2 mm/ min) density over the fire area. [**851:**7.11.2]

26.29.1.5 Air Compressors.
Automatic sprinkler protection designed for a density of 0.25 gpm/ft^2 (10.2 mm/min) over the postulated oil spill or compressed air foam should be considered for air compressors containing a large quantity of oil. [**851:**7.12]

26.29.1.6 Hydraulic Systems for Gate and Valve Operators.
Hydraulic control systems should use a listed fire-resistant fluid. Automatic sprinkler protection designed for a density of 0.25 gpm/ft^2 (10.2 mm/min) over the fire area or compressed air foam systems should be considered for hydraulic systems not using a listed fire-resistant fluid. [**851:**7.13]

26.29.1.7 Fire Pumps.

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Rooms housing diesel-driven fire pumps should be protected by automatic sprinkler, water spray, foam-water sprinkler, or compressed air foam systems. If sprinkler and water spray protection systems are provided, they should be designed for a density of 0.25 gpm/ft^2 (10.2 mm/min) over the fire area. For automatic foam-water sprinkler systems, a density of 0.16 gpm/ft^2 (6.5 mm/min) should be provided. [**851:**7.14]

26.29.2 Installation Requirements.

26.29.2.1 Hydraulic Control Systems.
Fire extinguishing systems, where installed for lube oil systems employing combustible-type oil, should include protection for the reservoirs, pumps, and all oil lines, especially where unions exist on piping and beneath any shielded area where flowing oil can collect. Facilities not provided with curbs or drains should extend coverage for a distance of 20 ft (6 m) from the oil lines, when measured from the outermost oil line. [**851:**7.2.7]

26.30 Code for the Protection of Cultural Resource Properties — Museums, Libraries, and Places of Worship. [NFPA 909]

26.30.1 Design Requirements.

26.30.1.1*
Standard-response sprinklers shall be permitted for use in light-hazard areas. [**909:**9.12.13.1]

26.30.1.2*
Preaction and dry pipe systems shall be designed to minimize the risk of corrosion in accordance with the requirements of **26.30.2.1** through 22.30.2.5. [**909:**9.12.13.5]

26.30.1.3 System Design for Museums, Libraries, and Their Collections in Compact Storage.

26.30.1.3.1*
The design shall recognize the nature of the potential threat of a fire that originates in a compact mobile storage unit, where fuel loads are invariably large and fire growth is significantly different from that in other kinds of storage. [**909:**9.12.23.4.1.3]

26.30.1.3.2*
The automatic fire suppression system, the compact storage system, and the storage compartmentalization features shall be designed to limit fire damage in accordance with the facility's fire safety objectives. [**909:**9.12.23.4.1.4(A)]

26.30.1.3.3
Design calculations shall include the number and size of the storage modules, the separation provided between the modules end-to-end and back-to-back, and the type of material being stored. [**909:**9.12.23.4.1.4(B)]

26.30.1.3.4
Where the automatic fire suppression is provided by automatic fire sprinkler systems, the systems shall be wet pipe, single interlock pre-action, or single non-interlock pre-action systems. [**909:**9.12.23.4.1.4(C)]

26.30.1.3.5
Dry pipe or double-interlock pre-action systems shall not be installed in compact storage areas. [**909:**9.12.23.4.1.4(D)]

26.30.1.3.6
Where compact storage is installed in an existing storage area, the existing automatic fire detection and fire suppression systems shall be modified as required to accommodate the increased fire loading. [**909:**9.12.23.4.1.4(E)]

26.30.2 Installation Requirements.

26.30.2.1*

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Branch lines shall be pitched at least ½ in. per 10 ft (4 mm/m), and mains shall be pitched at least ¼ in. per 10 ft (2 mm/m). [**909:**9.12.13.3.1]

26.30.2.2*
Auxiliary drains shall be provided at all low points in accordance with NFPA 13 requirements for dry pipe systems and preaction systems subject to freezing. [**909:**9.12.13.3.2.1]

26.30.2.3*
Where steel pipe is used in dry pipe and preaction systems, the provisions of this standard shall be applied assuming water supplies and environmental conditions that contribute to unusual corrosive properties, and a plan shall be developed to address piping corrosion. [**909:**9.12.13.3.3]

26.31 National Electrical Code.

26.31.1 Design Requirements. (Reserved)

26.31.2 Installation Requirements.

26.31.2.1 Dedicated Electrical Space.
The space equal to the width and depth of the equipment and extending from the floor to a height of 6 ft (1.8 m) above the equipment or to the structural ceiling, whichever is lower, shall be dedicated to the electrical installation. No piping, ducts, leak protection apparatus, or other equipment foreign to the electrical installation shall be located in this zone.

Exception: Suspended ceilings with removable panels shall be permitted within the 1.8-m (6-ft) zone.
[
70:
110.26(E)(1)(a)]

26.31.2.2
The area above the dedicated space required by 26.31.2.1 shall be permitted to contain foreign systems, provided protection is installed to avoid damage to the electrical equipment from condensation, leaks, or breaks in such foreign systems. [**70:**110.26(E)(1)(b)]

26.31.2.3
Sprinkler protection shall be permitted for the dedicated space where the piping complies with this section. [**70:**110.26(E)(1)(c)]

26.32 Fire Protection of Telecommunication Facilities.

26.32.1 Design Requirements. (Reserved)

26.32.2 Installation Requirements.

26.32.2.1
All piping for dry pipe and pre-action sprinkler systems shall be installed with a pitch in accordance with NFPA 13 whether or not the piping is subjected to freezing conditions. [**76:**8.6.2.2.2]

26.33 Exhaust Systems for Air Conveying of Vapors, Gases, Mists, and Noncombustible Particulate Solids.

26.33.1 Design Requirements.

26.33.1.1
Any portion of an exhaust system utilizing combustible components or having the potential for combustible residue buildup on the inside, where the duct cross-sectional area is greater than or equal to 75 in.^{2} (480 cm^2), shall be provided with an automatic extinguishing system within the duct and at the duct intake, hood, enclosure, or canopy, or shall be constructed of material listed for use without sprinkler protection. [**91:**9.1]

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26.33.1.2
When a sprinkler system is installed, means shall be provided to prevent water accumulation in the duct or flow of water back to a process subject that could be damaged by water. [**91:**9.2]

26.33.2 Installation Requirements. (Reserved)

26.34 Hypobaric Facilities.

26.34.1 Design Requirements.

26.34.1.1
A fire suppression system consisting of independently supplied and operating handline and fixed deluge-type water spray systems shall be installed. [**99B:**4.5.1.5]

26.34.1.2
Design of the fire suppression system shall be such that failure of components in either the handline or deluge system will not render the other system inoperative. [**99B:**4.5.1.6]

26.34.1.3
System design shall be such that activation of either the handline or the deluge system shall automatically cause the following:
(1) Visual and audio alarm indicators shall be activated at the chamber operator's console.

(2) All ungrounded electrical leads for power and lighting circuits contained inside the chamber shall be disconnected.

(3) Emergency lighting and communication, where used, shall be activated.

[**99B:**4.5.1.7]

26.34.1.4
Intrinsically safe circuits, including sound-powered communications, shall be permitted to remain connected when either the handline or deluge system is activated. [**99B:**4.5.1.8]

26.34.1.5
Control circuitry and other electrical equipment involved in the fire detection and suppression system shall be powered from the critical branch of the emergency electrical system and connected to the uninterruptible power supply (UPS). [**99B:**4.5.1.11]

26.34.1.6
In chambers that consist of more than one compartment, the deluge system shall operate independently or simultaneously even if the compartments are at different pressures (altitudes). [**99B:**4.5.2.2]

26.34.1.7
Fixed deluge systems shall not be required in chamber compartments that are used strictly as personnel transfer compartments and for no other purpose. [**99B:**4.5.2.3]

26.34.1.8
Manual activation and deactivation deluge controls shall be located at the operator's console and in each chamber compartment containing a deluge system. [**99B:**4.5.2.4]

26.34.1.9
Controls shall be designed to prevent unintended activation. [**99B:**4.5.2.4.1]

26.34.1.10
Water shall be delivered from the fixed discharge nozzles of the deluge system within 3 seconds of activation of any affiliated deluge control. [**99B:**4.5.2.5]

26.34.1.11*
Total water density shall be determined by multiplying the total chamber floor area by 7.5 gpm/ft^2 (305.6 L/min/m^2). [**99B:**4.5.2.5.1]

26.34.1.12

The minimum operating pressure at the nozzle shall be 30 psi (206 kPa). [**99B:**4.5.2.5.2]

26.34.1.13
The water supply shall be constantly and fully charged. [**99B:**4.5.2.6]

26.34.1.14
The water supply pressure shall be constantly monitored and an interlock shall prevent chamber operation if water supply pressure has fallen 10 percent below normal operating charge pressure. [**99B:**4.5.2.7]

26.34.1.15
There shall be water in the deluge system to maintain the flow specified in 26.34.1.11 simultaneously in each chamber containing the deluge system for 1 minute. [**99B:**4.5.2.8]

26.34.1.16
The limit on maximum extinguishment duration shall be governed by the chamber capacity (bilge capacity also, if so equipped) and/or its drainage system. [**99B:**4.5.2.9]

26.34.1.17
The deluge system shall have stored pressure to operate for at least 15 seconds without electrical branch power. [**99B:**4.5.2.10]

26.34.2 Installation Requirements. (Reserved)

26.35 Coal Mines.

26.35.1 Design Requirements.

26.35.1.1 Underground Mining Operations.

26.35.1.1.1*
Fire sprinkler systems for underground mining operations shall be designed and installed in accordance with NFPA 120.

26.35.1.2 Coal Preparation Plants and Crusher Buildings.

26.35.1.2.1
When automatic sprinkler systems are to be supplied through the standpipe system, hydraulic calculations shall be used to ensure that the piping and the water supply meet the hose and automatic sprinkler demands simultaneously. [**120:**6.3.2.3.2]

26.35.1.3 Underground Conveyors.

26.35.1.3.1
The application rate shall not be less than 10.2 L/min/m^2 (0.25 gpm/ft^2) of the top surface of the top belt. [**120:**9.4.6.4]

26.35.1.3.2
The water supply shall be free of excessive sediment and corrosives and provide the required flow for not less than 10 minutes. A strainer with a flush-out connection and manual shutoff valve shall be provided. [**120:**9.4.6.6]

26.35.1.3.3
The system shall be interlocked to shut down the conveyor and provide an audible and a visual alarm. [**120:**9.4.6.8]

26.35.1.3.4
Fire suppression systems shall also comply with 26.35.1.1.1. [**120:**9.4.6.10]

26.35.1.3.5
Sprinkler systems shall meet the following requirements:

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(1) The sprinklers shall be installed in accordance with NFPA 13 as far as practical, and shall have components that have been listed.

(2) The water supply shall be capable of supplying a constant flow of water with all heads functioning for a period of 10 minutes.

(3) The sprinkler head activation temperature shall not be less than 65.6°C (150°F) or greater than 148.9°C (300°F).

[**120:**9.4.6.13]

26.35.2 Installation Requirements.

26.35.2.1 Underground Conveyors.

26.35.2.1.1
Deluge water spray systems, foam systems, closed-head sprinkler systems, or dry-chemical systems automatically actuated by rise in temperature shall be installed at main and secondary belt conveyor drives. [**120:**9.4.6.1]

26.35.2.1.2
Fire suppression systems shall extend to the drive areas of belt conveyors, including drive motor(s), reducer, head pulley, and belt storage unit (takeup), including any hydraulic power unit; its electrical controls; and the top and bottom of the first 15.2 m (50 ft) of belt from the drive on the downwind side. [**120:**9.4.6.2]

26.35.2.1.3
Piping for the deluge, foam, or closed-head sprinkler system shall be metal and listed for sprinkler applications. [**120:**9.4.6.3]

26.35.2.1.4
The discharge shall be directed at both the upper and the bottom surface of the top belt and the upper surface of the bottom belt. [**120:**9.4.6.5]

26.35.2.1.5
Maximum distance between nozzles on a branch line shall not exceed 2.4 m (8 ft). [**120:**9.4.6.7]

26.35.2.1.6
The components of the system shall be located so as to minimize the possibility of damage by roof fall or by the moving belt and its load. [**120:**9.4.6.9]

26.35.2.1.7
Deluge water spray systems shall meet the requirements of 26.35.2.1.7.1 through 26.35.2.1.7.5. [**120:**9.4.6.11]

26.35.2.1.7.1
The system shall be activated by heat detectors. [**120:**9.4.6.11.1]

26.35.2.1.7.2
Heat detectors shall be located at the belt drive, hydraulic takeup unit (unless fire-resistive fluid is used), discharge roller, and the roof above the conveyor. [**120:**9.4.6.11.1.1]

26.35.2.1.7.3
Heat detectors at the roof line should be spaced 2.4 m to 3.0 m (8 ft to 10 ft) apart along the entire length of the protected area of the belt. [**120:**9.4.6.11.1.2]

26.35.2.1.7.4
The nozzles shall be full cone, corrosion resistant, and provided with blow-off dust covers. [**120:**9.4.6.11.2]

26.35.2.1.7.5
A closed sprinkler head shall be used over the electrical controls. [**120:**9.4.6.11.3]

26.35.2.2 Mine Surface Buildings.

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26.35.2.2.1
If sprinklers are installed, waterflow, valve tamper, and low building temperature alarms shall be provided. [**120:**8.6.1.2]

26.36 Metal/Nonmetal Mining and Metal Mineral Processing Facilities.

26.36.1 Design Requirements.

26.36.1.1 Water Supplies.

26.36.1.1.1
When automatic sprinkler systems are supplied through the hand hose line standpipe system, hydraulic calculations shall be used to ensure that the piping and water supply will supply the hose and automatic sprinkler demands simultaneously. [**122:**6.2.3]

26.36.1.1.2
Where a fire water supply [for a surface mineral processing plant] is required by the risk assessment, capacity and availability shall provide the water demand for fire-fighting purposes, including hose and sprinkler systems, for a minimum duration of 2 hours. [**122:**13.7.2]

26.36.1.2*
Where provided, automatic sprinkler systems installed for the protection of flammable liquid or diesel fuel storage areas shall be of the foam-water type. [**122:**11.3.1]

26.36.1.3 New Solvent Extraction (SX) Facilities.

26.36.1.3.1
Fixed fire suppression shall be provided for the following SX facility areas and equipment:
(1) Buildings housing SX processes
(2) Interior of all mixer-settler vessels/cells
(3) Crud tanks that include treatment filters and centrifuges
(4) Coalescers
(5) Along launders and weirs outside of mixer-settler vessels
(6) Inside pipe trenches carrying solvents
(7) Inside organic solvent and diluent tanks
(8) Inside dikes enclosing organic solvent storage tanks
(9) Over organic solvent pumps
(10) Over elevated pipe racks carrying organic solvents in plastic pipes
(11) Other areas handling, processing, or exposed to flammable or combustible liquids

[**122:**13.19.1]

26.36.1.3.2*
Fire suppression for applications in 26.36.1.3.1 shall be water, foam, dry chemical, or water mist. [**122:**13.19.1.1]

26.36.1.3.3*
Design of fire suppression systems in 26.36.1.3.1 shall be based on criteria set forth in NFPA 11,NFPA 15,NFPA 16, and NFPA 17. [**122:**13.19.1.2]

26.36.1.3.4*
Actuation of fire suppression systems in 26.36.1.3.1 shall be automatic. [**122:**13.19.1.3]

26.36.1.3.5

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As exposure protection, automatic water-only deluge (open-head) sprinkler systems shall be provided between mixer-settler trains if spaced closer than 15.24 m (50 ft) from each other. [**122:**13.19.2]

26.36.1.3.6
As exposure protection, automatic water-only deluge sprinkler systems shall be provided around the exterior perimeter of organic solvent tanks if spaced closer than 15.24 m (50 ft) from each other. [**122:**13.19.3]

26.36.1.3.7
As exposure protection, automatic fire suppression shall be provided over other critical equipment (i.e., transformers) or outside along important building walls [i.e., motor control center (MCC) rooms] that are within 15.24 m (50 ft) of a solvent fire area. [**122:**13.19.4]

26.36.1.3.8
Hydraulic design of automatic fire suppression systems in 26.36.1.3.1 shall include the simultaneous operation of all fire protection systems associated with a single (multi-cell) train. [**122:**13.19.5]

26.36.1.3.9
The total flow rate of foam application and water associated with the discharge of automatic fire extinguishing systems, fixed monitors, and hydrants shall determine the total volume of fire water required. [**122:**13.19.6]

26.36.2 Installation Requirements. (Reserved)

26.37 Hazardous Materials Code.

26.37.1 Design Requirements.
Sprinkler system discharge criteria for the protection of hazardous materials shall comply with NFPA 400.

26.37.1.1 Requirements for Occupancies Storing Quantities of Hazardous Materials Exceeding the Maximum Allowable Quantities per Control Area for High Hazard Contents.
The design of the sprinkler system shall be not less than ordinary hazard Group 2 in accordance with NFPA 13, except as follows:
(1) Where different requirements are specified in Chapters 11 through 21 of NFPA 400

(2) Where the materials or storage arrangement requires a higher level of sprinkler system protection in accordance with nationally recognized standards

(3) Where approved alternative automatic fire extinguishing systems are permitted

[**400:**6.2.1.1.1]

26.37.1.2 General Requirements for Storage of Ammonium Nitrate Solids and Liquids.
Sprinkler systems shall be of the approved type and designed and installed in accordance with NFPA 13, and the following:
(1) Ammonium nitrate in noncombustible or combustible containers (paper bags or noncombustible containers with removable combustible liners) shall be designated as a Class I commodity.

(2) Where contained in plastic containers, ammonium nitrate shall be designated as a Class II commodity.

(3) Where contained in fiber packs or noncombustible containers in combustible packaging, ammonium nitrate shall be designated as a Class III commodity.

[**400:**11.2.6.1.3]

26.37.1.3 General Requirements for Storage of Organic Peroxide Formulations.

6.37.1.3.1
Where required by other provisions of this code, automatic sprinklers and water spray systems shall be designed and installed according to the requirements of NFPA 13 and NFPA 15 and shall provide the following discharge densities:
(1) Class I — 0.50 gpm/ft^2 (20.4 L/min/m^2)

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(2) Class II — 0.40 gpm/ft² (16.3 L/min/m²)

(3) Class III — 0.30 gpm/ft² (12.2 L/min/m²)

(4) Class IV — 0.25 gpm/ft² (10.2 L/min/m²)

[**400:**14.2.6.1]

26.37.1.3.2
The system shall be designed as follows:
(1) It shall provide the required density over a 3000 ft² (280 m²) area for areas protected by a wet pipe sprinkler system or 3900 ft² (360 m²) for areas protected by a dry pipe sprinkler system.

(2) The entire area of any building of less than 3000 ft² (280 m²) shall be used as the area of application.

[**400:**14.2.6.2]

26.37.1.3.3
Where required for detached storage buildings containing Class I organic peroxide formulations in quantities exceeding 2000 lb (907 kg), automatic sprinkler protection shall be open-head deluge-type, designed and installed in accordance with NFPA 13. [**400:**14.2.6.3]

26.37.1.4 Indoor Storage of Oxidizer Solids and Liquids.

26.37.1.4.1
Sprinkler protection for Class 2 oxidizers shall be designed in accordance with Table 26.37.1.4.1. [**400:**15.3.2.3.4.1]

Table 26.37.1.4.1 Ceiling Sprinkler Protection for Class 2 Oxidizers in Palletized or Bulk and Rack Storage Areas

	Ceiling Sprinklers						
	Storage Height		Density		Area of Application		
Type of Storage	ft	m	gpm/ft²	L/min/m²	ft²	m²	In-Rack Sprinklers
Palletized or bulk	8	2.4	0.20	8	3750	348	
Palletized or bulk	12	3.7	0.35	14	3750	348	—
Rack	12	3.7	0.20	8	3750	348	One line above each level of storage, except the top level
Rack	16	4.9	0.30	12	2000	186	One line above each level of storage, except the top level

[**400:** Table 15.3.2.3.2.10(B)]

26.37.1.4.2
Ceiling sprinklers shall be high-temperature sprinklers. [**400:**15.3.2.3.4.2]

26.37.1.4.3 Storage Protection for Class 2 Oxidizers with In-Rack Sprinklers.

(A)
In-rack sprinklers shall be quick-response sprinklers with an ordinary-temperature rating and have a K-factor of not less than K = 8.0. [**400:**15.3.2.3.4.3(A)]

(B)
In-rack sprinklers shall be designed to provide 25 psi (172 kPa) for the six most hydraulically remote sprinklers on each level. [**400:**15.3.2.3.4.3(B)]

(C)

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The in-rack sprinklers shall be 8 ft to 10 ft (2.4 m to 3.0 m) spacings in the longitudinal flue space at the intersection of the transverse flue spaces. [**400:**15.3.2.3.4.3(C)]

26.37.1.4.4 Sprinkler Criteria for Class 3 Oxidizers.

26.37.1.4.4.1 Class 3 Oxidizers Less than 2300 lb (1043 kg).

(A)
Sprinkler design criteria for buildings that require sprinkler protection and contain total quantities of Class 3 oxidizers less than 2300 lb (1043 kg) shall be in accordance with the requirements of 26.37.1.4.4.1(B). [**400:**15.3.2.4.13.1(A)]

(B)
Facilities that require sprinkler protection and contain total quantities of Class 3 oxidizers greater than 200 lb (91 kg), but less than 2300 lb (1043 kg), shall follow the sprinkler design criteria in Table 26.37.1.4.4.1(B**)**. [**400:**15.3.2.4.13.1(B)]

Table 26.37.1.4.4.1(B) Sprinkler Protection of Class 3 Oxidizers Stored in Total Quantities Greater than 200 lb (91 kg) but Less than 2300 lb (1043 kg)

Storage Parameters	Shelf	Bulk or Pile	Bulk or Pile	Rack
Maximum storage height	6 ft (1.8 m)	5 ft (1.5 m)	10 ft (3 m)	10 ft (3 m)
Maximum ceiling height	25 ft (7.6 m)	25 ft (7.6 m)	25 ft (7.6 m)	NA
Aisles — pile separation	4 ft (1.2 m) min. clear aisles	4 ft (1.2 m) min. clear aisles	8 ft (2.4 m) min. clear aisles	8 ft (2.4 m) min. clear aisles
Ceiling design criteria	0.45 gpm/ft²/2000 ft²	0.35 gpm/ft²/or 5000 ft² or 0.6 gpm/2000 ft²	0.65 gpm/ft²/5000 ft²	0.35 gpm/ft²/or 5000 ft² or 0.6 gpm/ft²/2000 ft²
In-rack sprinklers	NP	NP	NA	See 15.3.2.4.12.2.
Hose stream demand	500 gpm	500 gpm	500 gpm	500 gpm
Duration	120 minutes	120 minutes	120 minutes	120 minutes

For SI units, 1 gal = 3.79 L. NA: Not applicable. NP: Not permitted.

[**400:** Table 15.3.2.4.12.1(B)]

26.37.1.4.4.2 Storage Protection for Class 3 Oxidizers In-Rack Sprinkler Criteria.

(A)
Where required by Table 26.37.1.4.4.1(B**)**, in-rack sprinkler protection shall be as follows:
(1) In-rack sprinklers shall be installed above every level of oxidizer storage.

(2) In-rack sprinklers shall be spaced at maximum 4 ft (1.2 m) intervals to provide one sprinkler in each flue space.

(3) In-rack sprinklers shall be quick-response sprinklers with an ordinary-temperature rating and have a K-factor of not less than K = 8.0.

(4) In-rack sprinklers shall be designed to provide 25 psi (172 kPa) for the six most hydraulically remote sprinklers on each level.

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[**400:**15.3.2.4.13.3(A)]

26.37.1.4.4.3 Class 3 Oxidizers Greater than or Equal to 2300 lb (1043 kg).
The sprinkler protection shall be in accordance with Table 26.37.1.4.4.3. [**400:**15.3.2.4.13.4(B)]

Table 26.37.1.4.4.3 Sprinkler Protection of Class 3 Oxidizers Stored in Total Quantities of Greater than or Equal to 2300 lb (1043 kg)

Storage Parameters	Bulk or Pile	Rack
Maximum storage height	5 ft (1.5 m)	10 ft (3 m)
Maximum ceiling height	25 ft (7.6 m)	NP
Aisles — pile separation	8 ft (2.4 m) min. clear aisles	8 ft (2.4 m) min. clear aisles
Ceiling design criteria	0.35 gpm/ft^2/5000 ft^2 (1.32 L/min/m^2/464.5 m^2)	Predominant for other commodities but not less than ordinary hazard Group II
In-rack sprinklers	NP	See 15.3.2.4.12.4
Hose stream demand	500 gpm (1893 L/min)	500 gpm (1893 L/min)
Duration	120 minutes	120 minutes

NP: Not permitted.

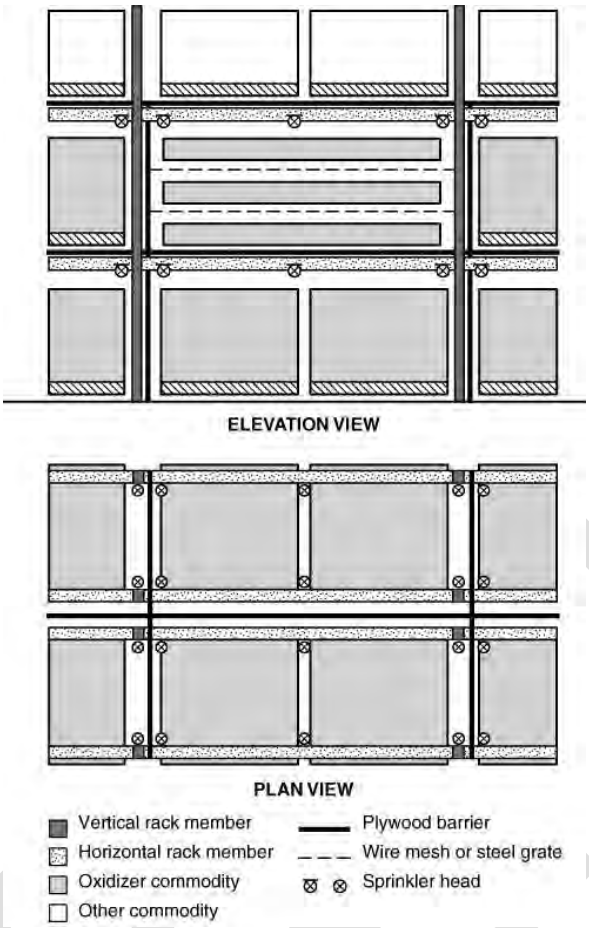
[**400:** Table 15.3.2.4.12.3(B)]

26.37.1.4.4.4 Special In-Rack Sprinkler Protection for Class 3 Oxidizers.

(A)
Where required by Table 26.37.1.4.4.3, special in-rack sprinkler protection shall be as shown in Figure 26.37.1.4.4.4(A). [**400:**15.3.2.4.13.5(A)]

Figure 26.37.1.4.4.4(A) Arrangement of Barriers and In-Rack Sprinklers for Special Fire Protection Provisions. [400: Figure 15.3.2.4.13.5(A)]

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(B)
In-rack automatic sprinklers shall be provided under each horizontal barrier and arranged in accordance with 26.37.1.4.4.4(C) through 26.37.1.4.4.4(I). [**400:**15.3.2.4.13.5(K)]

(C)
For double-row racks, two lines of in-rack sprinklers shall be provided between the face of the rack and the longitudinal vertical barrier located in the center of the rack. [**400:**15.3.2.4.13.5(L)]

(D)
For single-row racks, two lines of in-rack sprinklers shall be provided between each rack face. [**400:**15.3.2.4.13.5(M)]

(E)
Three in-rack sprinklers shall be provided on each in-rack sprinkler line as follows:
(1) Two sprinklers on each line shall be spaced approximately 1½ in. (38.1 mm) from each transverse vertical barrier.

(2) One in-rack sprinkler on each in-rack sprinkler line shall be located approximately equidistant between the transverse vertical barriers.

[**400:**15.3.2.4.13.5(N)]

(F)
In-rack sprinklers shall be of the upright or pendent type, with the fusible element located no more than 6 in. (152.4 mm) from the horizontal barrier. [**400:**15.3.2.4.13.5(O)]

(G)
In-rack sprinklers shall be K = 8.0, quick-response, ordinary-temperature-rated sprinklers. [**400:**15.3.2.4.13.5(Q)]

(H)
The in-rack sprinkler system shall be designed to supply 6 sprinklers on each line, with a total of 12 sprinklers operating at gauge pressure of 25 psi (172 kPa). [**400:**15.3.2.4.13.5(R)]

(I)
The design of the in-rack sprinkler system shall be independent of, and shall not be required to be balanced with, ceiling sprinkler systems. [**400:**15.3.2.4.13.5(S)]

26.37.1.4.4.5 Sprinkler Criteria for Class 4 Oxidizers.

(A)
Sprinkler protection for Class 4 oxidizers shall be installed on a deluge sprinkler system to provide water density of 0.35 gpm/ft^2 (14.4 L/min/m^2) over the entire storage area. [**400:**15.3.2.5.4.6(A)]

(B)
Sprinkler protection shall be installed in accordance with NFPA 13. [**400:**15.3.2.5.4.6(B)]

26.37.2 Installation Requirements. (Reserved)

Chapter 27 Systems Acceptance

27.1 Approval of Sprinkler Systems and Private Fire Service Mains.
The installing contractor shall do the following:
(1) Notify the authority having jurisdiction and the property owner or the property owner's authorized representative of the time and date testing will be performed

(2) Perform all required acceptance tests *(see Section 27.2)*

(3) Complete and sign the appropriate contractor's material and test certificate(s) *(see Figure 27.1)*

(4) Remove all caps and straps prior to placing the sprinkler system in service

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Figure 27.1 Contractor's Material and Test Certificate for Aboveground Piping.

B.2.1.5 Future Upgrading of System Performance.
It is desirable in some cases to build into the system the capability to achieve a higher level of sprinkler performance than needed at present. If this is to be a consideration in conservatism, consideration needs to be given to maintaining sprinkler operating pressures on the lower side of the optimum operating range and/or designing for low pipeline velocities, particularly on feed and cross mains, to facilitate future reinforcement.

B.3 Effect of Clearance to Ceiling on Sprinkler Performance.
The problems with large clearances to ceiling were well recognized by the 1970s in terms of the effect both on delayed sprinkler activation and on the effect on droplet penetration through the fire plume. The work of Alpert (1972, 1975), Heskestad and Delichatsios (1979), and Beyler (1984) clearly identified the effect of clearance to ceiling on detection and activation of sprinklers. This was supplemented by the work of Heskestad and Smith (1976) in which the thermal responsiveness of sprinklers was studied and modeled. Similarly, the effect of the strong plumes resulting from large clearances to ceiling and highly challenging fires was recognized in the 1970s through the work of Yao and Kalelkar (1970), Yao (1976), and Yao (1980). This understanding was reflected in the development of large drop sprinklers in the 1970s [Yao (1997)]. The inability of ½ in. and 17/32 in. (12.7 mm and 13 mm) standard sprinklers to penetrate high-challenging fires was well understood and demonstrated in the 1970s [Yao (1976)]. The effect of excessive clearance to ceiling was also demonstrated in the testing summarized in Annex **C**.

This understanding of the role of clearance to ceiling on fire performance had a strong effect on the development of advanced sprinkler technologies.

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Annex C Explanation of Test Data and Procedures for Rack Storage
This annex is not a part of the requirements of this NFPA document but is included for informational purposes only.

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C.1
Annex **C** provides an explanation of the test data and procedures that led to the development of sprinkler system discharge criteria for rack storage applications. Numbers in brackets refer to paragraphs in the text.

C.2 [5.6]
A review of full-scale fire tests run on the standard commodity (double tri-wall carton with metal liner), of Hallmark products and 3M products (e.g., abrasives, pressure-sensitive tapes of plastic fiber, and paper), and of the considerable number of commodity tests conducted provides a guide for commodity classifications. Such guidance is not related to any other method of classification of materials; therefore, sound engineering judgment and analysis of the commodity and the packaging should be used when selecting a commodity classification.

C.3 [8.13.3.1]
Tests 71, 73, 81, 83, 91, 92, 95, and 100 in the 20 ft (6.1 m) high array involving a single level of in-rack sprinklers were conducted without heat or water shields. Results were satisfactory.

Test 115 was conducted with two levels of sprinklers in racks with shields. Test 116, identical to Test 115 but without water shields, produced a lack of control. Visual observation of lower level in-rack sprinklers that did not operate although they were in the fire area indicated a need for water shields.

Tests 115 and 116 were conducted to investigate the necessity for water shields where multiple levels of in-rack sprinklers are installed. Where water shields were not installed in Test 116, the fire jumped the aisle, and approximately 76 boxes were damaged. In Test 115 with water shields, the fire did not jump the aisle, and only 32 boxes were damaged. Water shields are, therefore, suggested wherever multiple levels of in-rack sprinklers are installed, except for installations with horizontal barriers or shelves that serve as water shields.

C.4 [8.17.1.7]
The time of operation of the first sprinkler varied from 52 seconds to 3 minutes and 55 seconds, with most tests under 3 minutes, except in Test 64 (Class III), where the first sprinkler operated in 7 minutes and 44 seconds. Fire detection more sensitive than waterflow is, therefore, considered necessary only in exceptional cases.

C.5 [8.17.5.1]
In most tests conducted, it was necessary to use small hose for mop-up operations. Small hose was not used in the high-expansion foam test.

Test 97 was conducted to evaluate the effect of dry pipe sprinkler operation. Test results were approximately the same as the base test with a wet pipe system. A study of NFPA records, however, indicates an increase in area of operation of 30 percent to be in order for dry pipe systems as compared with wet pipe systems.

C.6 [12.1.1]
Tests were conducted as a part of this program with eave line windows or louvers open to simulate smoke and heat venting. These tests opened 87.5 percent and 91 percent more sprinklers than did comparative tests without windows or louvers open. Venting tests that have been conducted in other programs were without the benefit of sprinkler protection and, as such, are not considered in this report, which covers only buildings protected by sprinklers. The design curves are based upon the absence of roof vents or draft curtains in the building. During mop-up operations, ventilating systems, where installed, should be capable of manual exhaust operations.

C.7 [12.12.1.3]
No tests were conducted with idle pallets in racks using standard spray sprinklers. However, tests were conducted using ESFR and large drop sprinklers. Such storage conceivably would introduce fire severity in excess of that contemplated by protection criteria for an individual commodity classification.

C.8 [12.8.6]
In all valid tests with double-row racks, sprinkler water supplies were shut off at approximately 60 minutes. In only one test did the last sprinkler operate in excess of 30 minutes after ignition; the last

sprinkler operated in excess of 25 minutes in three tests, with the majority of tests involving the last sprinkler operating within 20 minutes.

C.9 [16.1.1 and 17.1.1]
The discharge criteria of Section 12.3 uses as a basis the large-scale fire test series conducted at the Factory Mutual Research Center, West Glocester, Rhode Island.

The test building is approximately 200 ft × 250 ft (61 m × 76 m) [50,000 ft^2 (4650 m^2) in area], of fire-resistive construction, and contains a volume of approximately 2.25 million ft^3 (63,713 m^3), the equivalent of a 100,000 ft^2 (9300 m^2) building that is 22.5 ft (6.9 m) high. The test building has two primary heights beneath a single large ceiling. The east section is 30 ft (9.1 m) high, and the west section is 60 ft (18 m) high.

The test series for storage height of 20 ft (6.1 m) was conducted in the 30 ft (9.1 m) section with clearances from the top of storage to the ceiling nominally 10 ft (3.0 m).

Doors at the lower and intermediate levels and ventilation louvers at the tops of walls were kept closed during the majority of the fire tests, which minimized the effect of exterior conditions.

The entire test series was fully instrumented with thermocouples attached to rack members, simulated building columns, bar joists, and the ceiling.

Racks were constructed of steel vertical and horizontal members designed for 4000 lb (1815 kg) loads. Vertical members were 8 ft (2.4 m) on center for conventional racks and 4 ft (1.2 m) on center for simulated automated racks. Racks were 3½ ft (1 m) wide with 6 in. (150 mm) longitudinal flue space for an overall width of 7½ ft (2.3 m). Simulated automated racks and slave pallets were used in the main central rack in the 4 ft (1.2 m) aisle tests. Conventional racks and conventional pallets were used in the main central rack in the 8 ft (2.4 m) aisle tests. The majority of the tests were conducted with 100 ft^2 (9.3 m^2) sprinkler spacing.

The test configuration for storage heights of 15 ft (4.6 m), 20 ft (6.1 m), and 25 ft (7.6 m) covered an 1800 ft^2 (167.2 m^2) floor area, including aisles between racks. Tests that were used in producing this standard limited fire damage to this area. The maximum water damage area anticipated in the standard is 6000 ft^2 (555 m^2), the upper limit of the design curves.

The test data show that, as density is increased, both the extent of fire damage and sprinkler operation are reduced. The data also indicate that, with sprinklers installed in the racks, a reduction is gained in the area of fire damage and sprinkler operations (e.g., water damage).

Table C.9 illustrates these points. The information shown in the table is taken from the test series for storage height of 20 ft (6.1 m) using the standard commodity.

The fact that there is a reduction in both fire damage and area of water application as sprinkler densities are increased or where sprinklers are installed in racks should be considered carefully by those responsible for applying this standard to the rack storage situation.

In the test for storage height of 25 ft (7.6 m), a density of 0.55 gpm/ft^2 (22.4 mm/min) produced 42 percent, or 756 ft^2 (70 m^2), fire damage in the test array and a sprinkler-wetted area of 1400 ft^2 (130 m^2). Lesser densities would not be expected to achieve the same limited degree of control. Therefore, if the goal of smaller areas of fire damage is to be achieved, sprinklers in racks should be considered.

The test series for storage height over 25 ft (7.6 m) was conducted in the 60 ft (18 m) section of the test building with nominal clearances from the top of storage to the ceiling of either 30 ft (9.1 m) or 10 ft (3.0 m).

Doors at the lower and intermediate levels and ventilation louvers at the top of walls were kept closed during the fire tests, which minimized the effect of exterior wind conditions.

The purpose of the tests for storage height over 25 ft (7.6 m) was to accomplish the following:
(1) Determine the arrangement of in-rack sprinklers that can be repeated as pile height increases and that provide control of the fire

(2) Determine other protective arrangements, such as high-expansion foam, that provide control of the fire

Control was considered to have been accomplished if the fire was unlikely to spread from the rack of origin to adjacent racks or spread beyond the length of the 25 ft (7.6 m) test rack. To aid in this judgment, control was considered to have been achieved if the fire failed to exhibit the following characteristics:
(1) Jump the 4 ft (1.2 m) aisles to adjoining racks

(2) Reach the end face of the end stacks (north or south ends) of the main rack

Control is defined as holding the fire in check through the extinguishing system until the commodities initially involved are consumed or until the fire is extinguished by the extinguishing system or manual aid.

The standard commodity as selected in the 20 ft (6.1 m) test series was used in the majority of tests for storage over 25 ft (7.6 m). Hallmark products and 3M products described in the 20 ft (6.1 m) test series report also were used as representative of Class III or Class IV commodities, or both, in several tests. The results of privately sponsored tests on Hallmark products and plastic encapsulated standard commodities also were made available to the committee.

A 25 ft (7.6 m) long test array was used for the majority of the tests for storage over 25 ft (7.6 m). The decision to use such an array was made because it was believed that a fire in racks over 25 ft (7.6 m) high that extended the full length of a 50 ft (15 m) long rack could not be considered controlled, particularly as storage heights increased.

One of the purposes of the tests was to determine arrangements of in-rack sprinklers that can be repeated as pile height increases and that provide control of the fire. The tests for storage height of 30 ft (9.1 m) explored the effect of such arrays. Many of these tests, however, produced appreciable fire spread in storage in tiers above the top level of protection within the racks. (In some cases, a total burnout of the top tiers of both the main rack and the target rack occurred.) In the case of the 30 ft (9.1 m) Hallmark Test 134 on the 60 ft (18 m) site, the material in the top tiers of storage burned vigorously, and the fire jumped the aisle above the fourth tier. The fire then burned downward into the south end of the fourth tier. In the test on the floor, a nominal 30 ft (9.1 m) clearance occurred between the top of storage and the ceiling sprinklers, whereas on the platform this clearance was reduced to nominal 10 ft (3.0 m). In most cases, the in-rack sprinklers were effective in controlling fire below the top level of protection within the racks. It has been assumed by the Test Planning Committee that, in an actual case with a clearance of 10 ft (3.0 m) or less above storage, ceiling sprinklers would be expected to control damage above the top level of protection within the racks. Tests have been planned to investigate lesser clearances.

Tests 114 and 128 explore the effect of changing the ignition point from the in-rack standard ignition point to a face ignition location. It should be noted, however, that both of these tests were conducted with 30 ft (9.1 m) clearance from the ceiling sprinklers to the top of storage and, as such, ceiling sprinklers had little effect on the fire in the top two tiers of storage. Firespread in the three lower tiers is essentially the same. A similar change in the firespread where the ignition point is changed was noted in Tests 126 and 127. Once again, 30 ft (9.1 m) clearance occurred between the top of storage and the ceiling sprinklers, and, as such, the ceiling sprinklers had little effect on the face fire. Comparisons of Tests 129, 130, and 131 in the test series for storage height of 50 ft (15 m) indicate little effect of point of ignition in the particular configuration tested.

Test 125, when compared with Test 133, indicates no significant difference in result between approved low-profile sprinklers and standard sprinklers in the racks.

Table C.9 Summary of Relationship Between Sprinkler Discharge Density and the Extent of Fire Damage and Sprinkler Operation

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Density [gpm/ft^2 (Lpm/m^2)]	Fire Damage in Test Array		Sprinkler Operation [165°F (74°C)] Area [ft^2 (m^2)]
	%	ft^2(m^2)	
0.30 (12.2) (ceiling only)	22	395 (37)	4500–4800 (418–446)
0.375 (15.2) (ceiling only)	17	306 (24)	1800 (167)
0.45 (18.3) (ceiling only)	9	162 (15)	700 (65)
0.20 (8.1) (ceiling only)	28–36	504–648 (46–60)	13,100–14,000 (1217–1300)
0.20 (8.1) (sprinklers at ceiling and in racks)	8	144 (13)	4100 (380)
0.30 (12.2) (sprinklers at ceiling and in racks)	7	126 (12)	700 (65)

For SI units, 1 ft = 0.3048 m; °C = ⅝(°F- 32); 1 gpm/ft^2 = 40.746 mm/min.

C.10 [16.1.4 and 17.1.4]
Temperatures in the test column were maintained below 1000°F (538°C) with densities, of roof ceiling sprinklers only, of 0.375 gpm/ft^2 (15.3 mm/min) with 8 ft (2.4 m) aisles and 0.45 gpm/ft^2 (18.3 mm/min) with 4 ft (1.2 m) aisles using the standard commodity.

C.11 [16.1.6.1 and 17.1.5.1]
Test 98 with solid shelves 24 ft (7.3 m) long and 7½ ft (2.3 m) deep at each level produced total destruction of the commodity in the main rack and jumped the aisle. Density was 0.3 gpm/ft^2 (12.2 mm/min) from the ceiling sprinklers only. Test 108 with shelves 24 ft (7.3 m) long and 3½ ft (1.0 m) deep and with a 6 in. (150 mm) longitudinal flue space and one level of sprinklers in the rack resulted in damage to most of the commodity in the main rack but did not jump the aisle. Density from ceiling sprinklers was 0.375 gpm/ft^2 (15.3 mm/min), and rack sprinklers discharged at 15 psi (1.0 bar).

These tests did not yield sufficient information to develop a comprehensive protection standard for solid shelf racks. Items such as increased ceiling density, use of bulkheads, other configurations of sprinklers in racks, and limitation of shelf length and depth should be considered.

Where such rack installations exist or are contemplated, the damage potential should be considered, and sound engineering judgment should be used in designing the protection system.

Test 98, with solid shelving obstructing both the longitudinal and transverse flue space, produced unsatisfactory results and indicates a need for sprinklers at each level in such a rack structure.

Test 147 was conducted with ceiling sprinklers only. Density was 0.45 gpm/ft^2 (18.3 mm/min) with a sprinkler spacing of 100 ft^2 (9.3 m^2). A total of 47 sprinklers opened, and 83 percent of the commodity was consumed. The fire jumped both aisles and spread to both ends of the main and target racks. The test was considered unsuccessful.

Test 148 was conducted with ceiling sprinklers and in-rack sprinklers. In-rack sprinklers were provided at each level (top of first, second, and third tiers) and were located in the longitudinal flue. They were directly above each other and 24 ft (7.3 m) on center or 22 ft (6.7 m) on each side of the ignition flue. Ceiling sprinkler discharge density was 0.375 gpm/ft^2 (15.3 mm/min). In-rack sprinkler discharge pressure was 30 psi (2.1 bar). A total of 46 ceiling sprinklers and three in-rack sprinklers opened, and 34 percent of the commodity was consumed. The fire consumed most of the material between the in-rack sprinklers and jumped both aisles.

C.12 [16.1.7 and 17.1.6]
Fire tests with open-top containers in the upper tier of storage and a portion of the third tier of storage produced an increase in sprinkler operation from 36 to 41 sprinklers and a more pronounced aisle jump and increase in firespread in the main array. The smooth underside of the containers closely approximates fire behavior of slave pallets.

C.13 [16.1.10 and 17.1.9]

Test 80 was conducted to determine the effect of closing back-to-back longitudinal 6 in. (150 mm) flue spaces in conventional pallet racks. Test results indicated fewer sprinklers operating than with the flue space open, and, as such, no minimum back-to-back clearance is necessary if the transverse flue space is kept open.

Tests 145 and 146 were conducted to investigate the influence of longitudinal and transverse flue dimensions in double-row racks without solid shelves. Results were compared with Tests 65 and 66. Flue dimensions in Tests 65, 66, 145, and 146 were 6 in. (150 mm), 6 in. (150 mm), 3 in. (75 mm), and 12 in. (300 mm), respectively. All other conditions were the same.

In Tests 65 and 66, 45, and 48, sprinklers operated compared with 59 and 58 for Tests 145 and 146, respectively. Fire damage in Tests 145 and 146 was somewhat less than in Tests 65 and 66; 2100 ft^3 (59 m^3) and 1800 ft^3 (51 m^3) in Tests 145 and 146, respectively, versus 2300 ft^3 (65 m^3) and 2300 ft^3 (65 m^3) in Tests 65 and 66, respectively, of combustible material were consumed.

Test results indicate narrow flue spaces of about 3 in. (75 mm) allow reasonable passage of sprinkler water down through the racks.

Tests 96 and 107, on multiple-row racks, used 6 in. (150 mm) transverse flue spaces. The water demand recommended in the standard is limited to those cases with nominal 6 in. (150 mm) transverse flues in vertical alignment.

C.14 [16.2.1.3.1]
Tests 65 and 66, compared with Test 69, and Test 93, compared with Test 94, indicated a reduction in areas of application of 44.5 percent and 45.5 percent, respectively, with high temperature–rated sprinklers as compared with ordinary temperature–rated sprinklers. Other extensive Factory Mutual tests produced an average reduction of 40 percent. Design curves are based on this area reduction. In constructing the design curves, the high-temperature curves above 3600 ft^2 (335 m^2) of application, therefore, represent 40 percent reductions in area of application of the ordinary temperature curves in the 6000 ft^2 to 10,000 ft^2 (555 m^2 to 930 m^2) range.

Test 84 indicated the number of intermediate temperature–rated sprinklers operating is essentially the same as ordinary temperature–rated sprinklers.

C.15 [16.2.1.3.2.1]
Tests were not conducted with aisles wider than 8 ft (2.4 m) or narrower than 4 ft (1.2 m). It is, therefore, not possible to determine whether lower ceiling densities should be used for aisle widths greater than 8 ft (2.4 m) or if higher densities should be used for aisle widths less than 4 ft (1.2 m).

C.16 [16.2.1.4.2.3]
In one 20 ft (6.1 m) high test, sprinklers were buried in the flue space 1 ft (300 mm) above the bottom of the pallet load, and results were satisfactory. Coverage of aisles by in-rack sprinklers is, therefore, not necessary, and distribution across the tops of pallet loads at any level is not necessary for the occupancy classes tested.

C.17 [16.2.1.4.2.6]
In all tests with in-rack sprinklers, obstructions measuring 3 in. × 3 ft (75 mm × 900 mm) were introduced on each side of the sprinkler approximately 3 in. (75 mm) from the sprinkler to simulate rack structure member obstruction. This obstruction had no effect on sprinkler performance in the 20 ft (6.1 m) high tests.

Tests 103, 104, 105, and 109 in the 30 ft (9.1 m) high test with in-rack sprinklers obstructed by rack uprights produced unsatisfactory results. Tests 113, 114, 115, 117, 118, and 120 in the 30 ft (9.1 m) high test series with in-rack sprinklers located a minimum of 2 ft (600 mm) from rack uprights produced improved results.

C.18 [16.2.1.4.3]
In all except one case, using the standard commodity with one line of sprinklers installed in racks, only two sprinklers opened. In the one exception, two sprinklers opened in the main rack, and two sprinklers opened in the target rack.

C.19 [16.2.1.4.4, 16.3.2.7.10, 17.2.2.6.8]

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Operating pressures were 15 psi (1.0 bar) on all tests of sprinklers in racks with storage 20 ft (6.1 m) high and 30 psi (2.1 bar) for storage 30 ft (9.1 m) and 50 ft (15 m) high.

Tests 112 and 124 were conducted to compare the effect of increasing sprinkler discharge pressure at in-rack sprinklers from 30 psi to 75 psi (2.1 bar to 5.2 bar). With the higher discharge pressure, the fire did not jump the aisle, and damage below the top level of protection within the racks was somewhat better controlled by the higher discharge pressure of the in-rack sprinklers. A pressure of 15 psi (1 bar) was maintained on in-rack sprinklers in the first 30 ft (9.1 m) high tests (Tests 103 and 104). Pressure on in-rack sprinklers in subsequent tests was 30 psi (2.1 bar), except in Test 124, where it was 75 psi (5.2 bar).

C.20 [16.2.4.1.1, 17.2.4.1.1]
A full-scale test program was conducted with various double-row rack storage arrangements of a cartoned Group A nonexpanded plastic commodity at the Factory Mutual Research Corporation (FMRC) test facility. The series of nine tests included several variations, one of which involved the use of the following four distinct shelving arrangements: slatted wood, solid wood, wire mesh, and no shelving. The results of the testing program, specifically Tests 1, 2, 3, and 5, clearly demonstrate the acceptable performance of sprinkler systems protecting storage configurations that involve the use of slated shelving as described in 16.2.4.1.1 and 17.2.4.1.1. As a result of the test program, Factory Mutual has amended FM Loss Prevention Data Sheet 8-9 to allow slatted shelving to be protected in the same manner as an open rack arrangement.

Complete details of the test program are documented in the FMRC technical report FMRC J. I. 0X1R0.RR, “Large-Scale Fire Tests of Rack Storage Group A Plastics in Retail Operation Scenarios Protected by Extra Large Orifice (ELO) Sprinklers.”

C.21 [17.1.2.1]
In the RSP rack storage test series as well as the stored plastics program palletized test series, compartmented 16 oz (1.1 bar) polystyrene jars were found to produce significantly higher protection requirements than the same commodity in a nested configuration. Polystyrene glasses and expanded polystyrene plates were comparable to the nested jars.

Different storage configurations within cartons or different products of the same basic plastic might, therefore, require reduced protection requirements.

In Test RSP-[illegible]ith nominal 15 ft (4.6 m) high storage with compartmented jars, a 0.6 gpm/ft^2 (24.4 mm/mi[illegible]ensity, 8 ft (2.4 m) aisles, and a 10 ft (3.0 m) clearance to ceiling, 29 sprinklers opened. In Tests RSP-4 with polystyrene glasses, RSP-5 with expanded polystyrene plates, and RSP-16 with nested polystyrene jars all stored at nom[illegible] 15 ft (4.6 m) height, 10 ft (3.1 m) clearance to ceiling, 8 ft (2.4 m) aisles, and 0.6 gpm/ft^2 (24.4 mm[illegible]) density, only four sprinklers opened.

However, Test RSP-11, with expanded polystyrene plates and 6 ft (1.8 m) aisles, demonstrated an increase in the number of operating sprinklers to 29. Test RSP-10 with expanded polystyrene plates, nominally 15 ft (4.6 m) high with a 10 ft (3.1 m) clearance and 8 ft (2.4 m) aisles, but protected only by 0.45 gpm/ft^2 (18.3 mm/min) density, opened 46 sprinklers and burned 100 percent of the plastic commodity.

At a nominal 20 ft (6.1 m) storage height with 8 ft (2.4 m) aisles, a 3 ft (900 mm) clearance to ceiling, and a 0.6 gpm/ft^2 (24.4 m[illegible]in) density opened four sprinklers with polystyrene glasses in Test RSP-2 and 11 sprinklers with expanded polystyrene plates in Test RSP-6. In Test RSP-8, however, with the clearance to ceiling increased to 10 ft (3.1 m) and other variables held constant, 51 sprinklers opened, and 100 percent of the plastic commodity burned.

Test RSP-3, with polystyrene glasses at a nominal h[illegible]t of 25 ft (7.6 m) with a 3 ft (900 mm) clearance to ceiling, 8 ft (2.4 m) aisles, and 0.6 gpm/ft^2 (24.4 m[illegible]in) ceiling sprinkler density in combination with one level of in-rack sprinklers, resulted in four ceiling sprinklers and two in-rack sprinklers operating. Test RSP-9, with the same configuration but with polystyrene plates, opened 12 ceiling sprinklers and three in-rack sprinklers.

No tests were conducted with compartmented polystyrene jars at storage heights in excess of a nominal 15 ft (4.6 m) as a part of this program.

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C.22 [17.2.1.2]

The protection of Group A plastics by extra large orifice (ELO) sprinklers designed to provide 0.6 gpm/ft^2/2000 ft^2 (24.4 mm/min/186 m^2) or 0.45 gpm/ft^2/2000 ft^2 (18.3 mm/min/186 m^2) without the installation of in-rack sprinklers was developed from full-scale testing conducted with various double-row rack storage arrangements of a cartoned Group A nonexpanded plastic commodity at the Factory Mutual Research Corporation (FMRC) test facility. The results of this test program are documented in the FMRC technical report, FMRC J.I. 0X1R0.RR, "Large-Scale Fire Tests of Rack Stored Group A Plastics in Retail Operation Scenarios Protected by Extra Large Orifice (ELO) Sprinklers." The test program was initiated to address the fire protection issues presented by warehouse-type retail stores with regard to the display and storage of Group A plastic commodities including, but not limited to, acrylonitrile-butadiene-styrene copolymer (ABS) piping, polyvinyl chloride (PVC) hose and hose racks, tool boxes, polypropylene trash and storage containers, and patio furniture. Tests 1 and 2 of this series included protection of the Group A plastic commodity stored to 20 ft (6.1 m) under a 27 ft (8.2 m) ceiling by a design density of 0.6 gpm/ft^2 (24.4 mm/min) utilizing ELO sprinklers. The results of the testing program clearly demonstrate the acceptable performance of sprinkler systems that protect storage configurations involving Group A plastics up to 20 ft (6.1 m) in height under a 27 ft (8.2 m) ceiling where using ELO sprinklers to deliver a design density of 0.6 gpm/ft^2 (24.4 mm/min) and Group A plastics up to 14 ft (4.2 m) in height under a 22 ft (6.7 m) ceiling where using ELO sprinklers to deliver a design density of 0.45 gpm/ft^2 (18.3 mm/min). The tabulation of the pertinent tests shown in Table C.22 demonstrates acceptable performance.

Table C.22 Summary of Test Results for Plastic Commodities Using in. (15.9 mm) Orifice Sprinklers

Test Parameters	Date of Test						
	8/20/93	8/25/93	9/2/93	10/7/93	2/17/94	2/25/94	4/27/94
Type of shelving	Slatted wood	Slatted wood	Slatted wood	Slatted wood	Slatted wood	Slatted wood	Wire mesh
Other conditions/ inclusions	—	—	—	—	Draft curtains	Draft curtains	—
Storage height (ft-in.)	19-11	19-11	15-4	15-4	19-11	19-11	13-11
Number of tiers	6[a]	6[a]	5[b]	5[b]	6[a]	6[b]	3
Clearance to ceiling/sprinklers (ft-in.)	6-10/6-3	6-10/6-3	11-5/10-10	11-5/10-10	6-10/6-3	6-10/6-3	8-4/7-9
Longitudinal/ transverse flues (in.)	6/6 to 7½	6/6 to 7½	6/6 to 7	6/6 to 7½	6/6 to 7½	6/6 to 7½	6/3[c]
Aisle width (ft)	7½	7½	7½	7½	7½	7½	7½
Ignition centered below (number of sprinklers)	2	2	1	1	2	2	1
Sprinkler orifice size (in.)	0.64	0.64	0.64	0.64	0.64	0.64	0.64
Sprinkler temperature rating (°F)	165	286	286	165	165	286	286
Sprinkler RTI (ft-sec)$^{1/2}$	300	300	300	300	300	300	300
Sprinkler spacing (ft× ft)	8 × 10	8 × 10	8 × 10	8 × 10	8 × 10	8 × 10	10 × 10
Sprinkler identification	ELO-231	ELO-231	ELO-231	ELO-231	ELO-231	ELO-231	ELO-231
Constant water pressure (psi)	19	19	19	19	19	19	15.5

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Test Parameters	Date of Test						
	8/20/93	8/25/93	9/2/93	10/7/93	2/17/94	2/25/94	4/27/94
Minimum density (gpm/ft^2)	0.6	0.6	0.6	0.6	0.6	0.6	0.45
Test Results							
First sprinkler operation (min:sec)	2:03	2:25	1:12	0:44	1:25	0:52	0:49
Last sprinkler operation (min:sec)	2:12	15:19	6:34	7:34	15:54	14:08	10:58
Total sprinklers opened	4	9	7	13	35	18	12
Total sprinkler discharge (gpm)	205	450	363	613	1651	945	600
Average discharge per sprinkler (gpm)	51	50	52	47	47	52	50
Peak/maximum 1-min average gas temperature (°F)	1107/566	1412/868	965/308	662/184	1575/883	1162/767	1464/895
Peak/maximum 1-min average steel temperature (°F)	185/172	197/196	233/232	146/145	226/225	255/254	502/500
Peak/maximum 1-min average plume velocity (ft/sec)	27/15	25/18	18/15[d]	14/10[d]	26/23	20/18[d]	33/20
Peak/maximum 1-min heat flux (Btu/ft^2/sec)	0.6/0.5	2.0/1.9	2.8/2.5	1.1/0.8	1.0/0.9	4.8/3.0	1.6/1.4
Aisle jump, east/west target ignition (min:sec)	None	8:24/None	5:35/10:10	None	None	[e]/8:18	[e]/None
Equivalent number of pallet loads consumed	3	9	6	5	12	13	12
Test duration (min)	30	30	30	30	30	30	30
Results acceptable	Yes	Yes	Yes	Yes	No[f]	No[g]	Yes

For SI units, 1 ft = 0.305 m; 1 in. = 25.4 mm; °F = (1.8 ×°C) + 32; °C = (°F - 32)/1.8; 1 psi = 0.069 bar; 1 gpm = 3.8 L/min; 1 ft/sec = 0.31 m/sec; 1 gpm/ft^2 = 40.746 mm/min.

[a] Main (ignition) racks divided into five or six tiers; bottom tiers each approximately 2 ft (600 mm) high and upper tiers each about 5 ft (1.5 m) high; wood shelving below commodity at second through fifth tiers.

[b] Main (ignition) racks divided into five or six tiers; bottom tiers each approximately 2 ft (600 mm) high and upper tiers each about 5 ft (1.5 m) high; wood shelving below commodity at second through fifth tiers; wire mesh shelving below commodity at sixth tier or below fifth (top) tier commodity.

[c] Transverse flues spaced 8 ft (2.4 m) apart [versus 3½ ft (1.1 m) apart in all other tests].

[d] Instrumentation located 5 ft (1.5 m) north of ignition.

[e] Minor surface damage to cartons.

[f] High water demand.

[g] Excessive firespread; marginally high water demand.

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C.23 [16.3.1.1]
The recommended use of ordinary temperature–rated sprinklers at ceiling for storage higher than 25 ft (7.6 m) was determined by the results of fire test data. A test with high temperature–rated sprinklers and 0.45 gpm/ft^2 (18.3 mm/min) density resulted in fire damage in the two top tiers just within acceptable limits, with three ceiling sprinklers operating. A test with 0.45 gpm/ft^2 (18.3 mm/min) density and ordinary temperature–rated sprinklers produced a dramatic reduction in fire damage with four ceiling sprinklers operating.

The four ordinary temperature-rated ceiling sprinklers operated before the first of the three high temperature–rated ceiling sprinklers. In both tests, two in-rack sprinklers at two levels operated at approximately the same time. The high temperature–rated sprinklers were at all times fighting a larger fire with less water than the ordinary temperature–rated ceiling sprinklers.

Tests 115 and 119 compare ceiling sprinkler density of 0.3 gpm/ft^2 (12.2 mm/min) with 0.45 gpm/ft^2 (18.3 mm/min). Damage patterns coupled with the number of boxes damaged in the main rack suggest that the increase in density produces improved control, particularly in the area above the top tier of in-rack sprinklers.

Tests 119 and 122 compare ceiling sprinkler temperature ratings of 286°F (141°C) and 165°F (74°C). A review of the number of boxes damaged and the firespread patterns indicates that the use of ordinary temperature–rated ceiling sprinklers on a rack configuration that incorporates in-rack sprinklers dramatically reduces the amount of firespread. Considering that in-rack sprinklers in the tests for storage over 25 ft (7.6 m) operated prior to ceiling sprinklers, it would seem that the installation of in-rack sprinklers converts an otherwise rapidly developing fire, from the standpoint of ceiling sprinklers, to a slower developing fire with a lower rate of heat release.

In the 20 ft (6.1 m) high test series, ceiling sprinklers operated before in-rack sprinklers. In the 30 ft (9.1 m) high series, ceiling sprinklers operated after in-rack sprinklers. The 50 ft (15 m) high test did not operate ceiling sprinklers. Ceiling sprinklers would, however, be needed if fire occurred in upper levels.

The results of these tests indicate the effect of in-rack sprinklers on storage higher than 25 ft (7.6 m). From the ceiling sprinkler operation standpoint, a fire with an expected high heat release rate was converted to a fire with a much lower heat release rate.

Since the fires developed slowly and opened sprinklers at two levels in the racks, only a few ceiling sprinklers were needed to establish control. Thus, the sprinkler operating area does not vary with height for storage over 25 ft (7.6 m) or for changes in sprinkler temperature rating and density.

All tests with sprinklers in racks were conducted using nominal ½ in. (15 mm) orifice size sprinklers of ordinary temperature.

C.24
[20.6] A series of fire tests were conducted by Spacesaver Corporation that indicated control was achieved with light hazard sprinkler spacing and design. The tests used quick-response, ordinary-temperature sprinklers on 15 ft × 15 ft (4.6 m × 4.6 m) spacing with an 8 ft (2.4 m) high compact storage unit located in the middle of the sprinkler array. Results indicated a classic definition of control, the fire was held in check within the compact storage module and the fire did not jump the aisle or ignite any of the target arrays.

C.25
[20.5] In July and August of 2007, a series of three large-scale fire tests were conducted at Southwest Research Institute to investigate the effectiveness of a specific ceiling and in-rack sprinkler protection scheme dedicated for the protection of paper files in 12 in. (300 mm) wide, and 16 in. (400 mm) and 10 in. (250 mm) high corrugated cardboard boxes (containers) maintained in multiple-row racks to a nominal height of 37 ft (11 m).

The storage rack for the main array in all three tests consisted of two 50 in. (1.3 m) deep racks placed back-to-back and separated by a 2 in. (50 mm) gap. The storage rack for the target array in all three tests consisted of a single 50 in. (1.3 m) deep rack separated on both sides of the main array by a 30 in. (750 mm) wide aisle. Rack uprights were a nominal 3 in. (75 mm) wide. Rack bays were 120 in. (3.0 m) wide, 38 in. (950 mm) high, and equipped with perforated metal decking having a minimum of 50 percent

openings. Each storage bay was provided with 9 containers between uprights that was 3 containers deep and 3 containers high for a total of 81 containers per rack bay. Nominal 6 in. (150 mm) wide transverse flue spaces were provided at each rack upright. Both the main array and the target array were 4 bays long for an overall length of 41 ft 3 in. (12.6 m).

Open-grated (expanded) catwalks were provided in both storage aisles at the top of the third [9 ft 8 in. (2.9 m)], sixth [19 ft 2 in. (5.8 m)], and ninth [28 ft 8 in. (8.7 m)] tier levels.

The ceiling sprinkler system consisted of K-8.0 (115), 165°F (74°C) nominally rated, standard-response pendent automatic sprinklers installed on 10 ft × 10 ft (3.0 m × 3.0 m) spacing arranged to provide a constant 0.30 gpm/ft^2 (12.2 mm/min) density. A nominal 3 ft (900 mm) clearance was provided between the top of storage and the ceiling sprinklers.

The in-rack sprinkler system consisted of K-8.0 (115), 165°F (74°C) nominally rated, quick-response upright automatic sprinklers that were equipped with water shields and arranged to provide a constant 30 gpm (115 L/min) flow from each operating in-rack sprinkler. In-rack sprinklers were provided within the transverse flue spaces of the main array, 2 ft (600 mm) horizontally from the face of the rack, at the top of the third and ninth tier levels on one side of the main array and at the top of the sixth tier level on the other side of the main array. A minimum 6 in. (150 mm) vertical clearance was provided between the in-rack sprinkler and the top of storage within the storage rack.

The same type of sprinklers installed within the storage racks were also installed under each catwalk and designed to provide a constant 30 gpm (115 L/min) flow from each operating sprinkler. These sprinklers were centered within the aisles and installed 10 ft 3 in. (3.1 m) on line. They were arranged to be aligned with the adjacent transverse flue space when the flue space was not equipped with an in-rack sprinkler; they were positioned halfway between transverse flue spaces when the adjacent flue spaces were equipped with in-rack sprinklers.

In Test No. 1, ignition was at grade level, at the face of the rack and centered between rack uprights. The in-rack sprinklers within the transverse flue spaces nearest to the ignition location were at the top of the sixth tier level; the sprinkler under the catwalk at the top of the sixth tier level was located a horizontal distance of 15 in. (375 mm) away from the ignition location. The sprinkler under the catwalk at the top of the sixth tier level was the first sprinkler to operate at a time 2 minutes and 49 seconds after ignition. A total of 3 in-rack sprinklers and 1 catwalk sprinkler operated during this test; no ceiling-level sprinklers operated. The results of the test were considered acceptable.

In Test No. 2, ignition was at grade level at a rack upright, 2 ft (600 mm) horizontally from the rack face. The in-rack sprinkler within the transverse flue space of fire origin was at the top of the sixth tier level. The in-rack sprinkler directly over the ignition location was the first sprinkler to operate at a time 2 minutes and 9 seconds after ignition. A total of 2 in-rack sprinklers operated during this test; no ceiling-level sprinklers operated. The results of the test were considered acceptable.

In Test No. 3, ignition was at grade level, centered between rack uprights within the 2 in. (50 mm) gap. To allow vertical fire growth directly above the point of ignition, the gap was maintained open throughout the height of the storage rack. A total of 4 in-rack sprinklers and 1 sprinkler under a catwalk operated during the test; no ceiling-level sprinklers operated. The first in-rack sprinkler to operate was located at the top of the sixth tier level at a time 3 minutes and 1 second after ignition. The second in-rack sprinkler to operate was also at the top of the sixth tier level. The last 2 in-rack sprinklers to operate were both located at the top of the third tier level. The fifth and final sprinkler to operate was a sprinkler located under a catwalk at the top of the third tier level. The results of the test were considered acceptable.

All three tests were considered successful and confirmed that the ceiling and in-rack sprinkler protection scheme outlined in this standard for the protection of cartoned records storage maintained in multiple-row racks with catwalk access is acceptable.

C.26 [16.1.10.3, 16.1.11.1.2, 17.1.9.3, 17.1.10.1.2]

During full-scale fire tests, flue space width and alignment are typically set with care for test consistency and repeatability. Some full-scale fire tests and fire experience have shown sprinkler protection designed and installed in accordance with this standard are able to tolerate random variations in flue width and vertical flue alignment. For example, see Test 7 in the National Quick Response Sprinkler Research

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Project: Large-Scale Fire Evaluation of Early Suppression Quick-Response (ESFR) Automatic Sprinklers (report available from the NFPA Research Foundation web site). For Test 7, transverse flue variations were substantial such that some flues at various tiers were completely closed (i.e., pallet loads placed immediately adjacent to each other), and the vertical alignment of one transverse flue was completely disrupted. The result was the operation of eight K14 (K200) ESFR sprinklers as well as minor aisle jump to both target racks. Reported damage was 2½ pallet loads in the main rack array and ¼ pallet load in the large racks. Findings such as Test 7 support the toleration of flue variations in the real world. However, ideally pallet loads should be positioned in racks with care to reduce the challenge faced by sprinklers should a fire occur.

Annex D Sprinkler System Information from the 2012 Edition of the *Life Safety Code*

This annex is not a part of the requirements of this NFPA document but is included for informational purposes only.

D.1 Introduction.

This annex is provided as an aid to the user of NFPA 13 by identifying those portions of the 2012 edition of NFPA *101* that pertain to sprinkler system design and installation. It is not intended that this annex provide complete information regarding all aspects of fire protection addressed by NFPA *101*. It is important to note that this information was copied from NFPA *101* ut did not use NFPA's extract policy and is not intended to be a part of the requirements of NFPA 13.

D.1.1

The following sections cover situations where NFPA *101* provides different guidance on the design or installation of a fire sprinkler system from NFPA 13. In some cases, this different guidance is based on descriptions of unique situations handled by NFPA *101*. In other cases, this different guidance stems from the different objective for NFPA *101*, life safety of the occupant, rather than the property protection afforded by NFPA 13.

D.1.1.1 Features of Fire Protection.

D.1.1.1.1 Atriums.

Glass walls and inoperable windows shall be permitted in lieu of the fire barriers where all the following are met:

(1) Automatic sprinklers are spaced along both sides of the glass wall and the inoperable windows at intervals not to exceed 6 ft (1830 mm).

(2) The automatic sprinklers specified in 8.6.7(1)(c)(i) of NFPA *101* are located at a distance from the glass wall not to exceed 12 in. (305 mm) and arranged so that the entire surface of the glass is wet upon operation of the sprinklers.

(3) The glass wall is of tempered, wired, or laminated glass held in place by a gasket system that allows the glass framing system to deflect without breaking (loading) the glass before the sprinklers operate.

(4) The automatic sprinklers required by 8.6.7(1)(c)(i) of NFPA *101* are not required on the atrium side of the glass wall and the inoperable window where there is no walkway or other floor area on the atrium side above the main floor level. [***101*:**8.6.7(1)(c)]

D.1.1.2 Special Structures and High-Rise Buildings.

D.1.1.2.1

High-rise buildings shall be protected throughout by an approved, supervised automatic sprinkler system in accordance with NFPA *101*, Section 9.7. A sprinkler control valve and a waterflow device shall be provided for each floor. [***101*:**11.8.3.1]

D.1.1.3 Lodging or Rooming Houses.

D.1.1.3.1

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In buildings sprinklered in accordance with NFPA 13, closets that contain equipment such as washers, dryers, furnaces, or water heaters shall be sprinklered regardless of size. [***101*:**26.3.6.3.5]

D.1.1.3.2
In existing lodging or rooming houses, sprinkler installations shall not be required in closets not exceeding 24 ft^2 (2.2 m^2) and in bathrooms not exceeding 55 ft^2 (5.1 m^2). [***101*:**26.3.6.3.6]

D.1.1.4 New Hotels and Dormitories.

D.1.1.4.1
The provisions for draft stops and closely spaced sprinklers in NFPA 13 shall not be required for openings complying with NFPA *101*, 8.6.9.1, where the opening is within the guest room or guest suite. [***101*:**28.3.5.4]

D.1.1.4.2
Listed quick-response or listed residential sprinklers shall be used throughout guest rooms and guest room suites. [***101*:**28.3.5.6]

D.1.1.5 Existing Hotels and Dormitories.

D.1.1.5.1
In guest rooms and in guest room suites, sprinkler installations shall not be required in closets not exceeding 24 ft^2 (2.2 m^2) and in bathrooms not exceeding 55 ft^2 (5.1 m^2). [***101*:**29.3.5.5]

D.1.1.6 New Apartment Buildings.

D.1.1.6.1
In buildings sprinklered in accordance with NFPA 13, closets less than 12 ft^2 (1.1 m^2) in area in individual dwelling units shall not be required to be sprinklered. Closets that contain equipment such as washers, dryers, furnaces, or water heaters shall be sprinklered regardless of size. [***101*:**30.3.5.3]

D.1.1.6.2
Listed quick-response or listed residential sprinklers shall be used throughout all dwelling units. [***101*:**30.3.5.5]

D.1.1.6.3
The draft stop and closely spaced sprinkler requirements of NFPA 13 shall not be required for convenience openings complying with NFPA *101*, 8.6.9.1, where the convenience opening is within the dwelling unit. [***101*:**30.3.5.4]

D.1.1.7 Existing Apartment Buildings.

D.1.1.7.1
In individual dwelling units, sprinkler installation shall not be required in closets not exceeding 24 ft^2 (2.2 m^2) and in bathrooms not exceeding 55 ft^2 (5.1 m^2). Closets that contain equipment such as washers, dryers, furnaces, or water heaters shall be sprinklered regardless of size. [***101*:**31.3.5.3]

D.1.1.7.2
The draft stop and closely spaced sprinkler requirements of NFPA 13 shall not be required for convenience openings complying with NFPA *101*, 8.6.9.1, where the convenience opening is within the dwelling unit. [***101*:**31.3.5.4]

D.1.1.8 Existing Residential Board and Care Occupancies.

D.1.1.8.1
Standard response sprinklers shall be permitted for use in hazardous areas in accordance with NFPA *101*, 33.2.3.2. [***101*:**33.2.2.2.4]

D.1.1.8.2
Where an automatic sprinkler system is installed, for either total or partial building coverage, all of the following requirements shall be met:

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(1) The system shall be in accordance with NFPA *101*, Section 9.7, and shall initiate the fire alarm system in accordance with 33.2.3.4.1, as modified by 33.2.3.5.3.1 through 33.2.3.5.3.6 of NFPA *101*

(2) The adequacy of the water supply shall be documented to the authority having jurisdiction.

[***101*:**33.2.3.5.3]

D.1.1.8.2.1
In prompt evacuation capability facilities, all of the following shall apply:
(1) An automatic sprinkler system in accordance with NFPA 13D shall be permitted.

(2) Automatic sprinklers shall not be required in closets not exceeding 24 ft^2 (2.2 m^2) and in bathrooms not exceeding 55 ft^2 (5.1 m^2), provided that such spaces are finished with lath and plaster or materials providing a 15-minute thermal barrier.

[***101*:**33.2.3.5.3.1]

D.1.1.8.2.2
In slow and impractical evacuation capability facilities, all of the following shall apply:
(1) An automatic sprinkler system in accordance with NFPA 13D with a 30-minute water supply, shall be permitted.

(2) All habitable areas and closets shall be sprinklered.

(3) Automatic sprinklers shall not be required in bathrooms not exceeding 55 ft^2 (5.1 m^2), provided that such spaces ster or materials providing a 15-minute thermal barrier.

[***101*:**33.2.3.5.3.2]

D.1.1.8.2.3
In prompt and slow evacuation capability facilities, where an automatic sprinkler system is in accordance with NFPA 13, sprinklers shall not be required in closets not exceeding 24 ft^2 (2.2 m^2) and in bathrooms not exceeding 55 ft^2 (5.1 m^2), provided that such spaces are finished with lath and plaster or materials providing a 15-minute thermal barrier. [***101*:**33.2.3.5.3.3]

D.1.1.8.2.4
In prompt and slow evacuation capability facilities in buildings four or fewer stories above grade plane, systems in accordance with NFPA 13R shall be permitted. [***101*:**33.2.3.5.3.4]

D.1.1.8.2.5
In impractical evacuation capability facilities in buildings four or fewer stories above grade plane, systems in accordance with NFPA 13R shall be permitted. All habitable areas and closets shall be sprinklered. Automatic sprinklers shall not be required in bathrooms not exceeding 55 ft^2 (5.1 m^2), provided that such spaces are finished with lath and plaster or materials providing a 15-minute thermal barrier. [***101*:**33.2.3.5.3.5]

D.1.1.8.2.6
Initiation of the fire alarm system shall not be required for existing installations in accordance with NFPA *101*, 33.2.3.5.6. [***101*:**33.2.3.5.3.6]

D.1.1.8.2.7
All impractical evacuation capability facilities shall be protected throughout by an approved, supervised automatic sprinkler system in accordance with NFPA *101*, 33.2.3.5.3. [***101*:**33.2.3.5.3.7]

D.1.1.9 New Mercantile Occupancies.

D.1.1.9.1 Protection of Vertical Openings.
Any vertical opening shall be protected in accordance with NFPA *101*, Section 8.6, except under the following conditions:
(1) In Class A or Class B mercantile occupancies protected throughout by an approved, supervised automatic sprinkler system in accordance with NFPA *101*, 9.7.1.1(1), unprotected vertical openings shall be permitted at one of the following locations:
(a) Between any two floors

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(b) Among the street floor, the first adjacent floor below, and adjacent floor (or mezzanine) above

(2) In Class C mercantile occupancies, unprotected openings shall be permitted between the street floor and the mezzanine.

(3) The draft stop and closely spaced sprinkler requirements of NFPA 13 shall not be required for unenclosed vertical openings permitted in NFPA *101*, 36.3.1(1) and (2).

[***101*:**36.3.1]

D.1.1.9.2
Rooms housing building service equipment, janitor closets, and service elevators shall be permitted to open directly onto exit passageways, provided that the following criteria are met:
(1) The required fire resistance rating between such rooms or areas and the exit passageway shall be maintained in accordance with NFPA *101*, 7.1.3.2.

(2) Such rooms or areas shall be protected by an approved, supervised automatic sprinkler system in accordance with NFPA *101*, 9.7.1.1(1) but the exceptions in NFPA 13 allowing the omission of sprinklers from such rooms shall not be permitted.

[***101*:**36.4.4.6.2]

D.1.1.10 Existing Mercantile Occupancies.

D.1.1.10.1 Protection of Vertical Openings.
Any vertical opening shall be protected in accordance with NFPA *101*, Section 8.6, except under the following conditions:
(1) In Class A or Class B mercantile occupancies protected throughout by an approved, supervised automatic sprinkler system in accordance with NFPA *101*, 9.7.1.1(1), unprotected vertical openings shall be permitted at one of the following locations:
(a) Between any two floors

(b) Among the street floor, the first adjacent floor below, and adjacent floor (or mezzanine) above

(2) In Class C mercantile occupancies, unprotected openings shall be permitted between the street floor and the mezzanine.

(3) The draft stop and closely spaced sprinkler requirements of NFPA 13 shall not be required for unenclosed vertical openings permitted in NFPA *101*, 37.3.1(1) and (2).

[***101*:**37.3.1]

D.1.1.10.2
Rooms housing building service equipment, janitor closets, and service elevators shall be permitted to open directly onto exit passageways, provided that the following criteria are met:
(1) The required fire resistance rating between such rooms or areas and the exit passageway shall be maintained in accordance with NFPA *101*, 7.1.3.2.

(2) Such rooms or areas shall be protected by an approved automatic sprinkler system in accordance with NFPA *101*, 9.7.1.1(1) but the exceptions in NFPA 13 allowing the omission of sprinklers from such rooms shall not be permitted.

[***101*:**37.4.4.6.2]

D.1.1.11 Industrial Occupancies.

D.1.1.11.1 Special Provisions — High-Rise Buildings.
The provisions of NFPA *101*, 11.8.5.2.4(2) for jockey pumps and NFPA *101*, 11.8.5.2.4(3) for air compressors serving dry-pipe and pre-action systems shall not apply to special-purpose industrial occupancies. [***101*:**40.4.1]

D.2 Life Safety Code.

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D.2.1 Features of Fire Protection.

D.2.1.1 Design Requirements. (Reserved)

D.2.1.2 Installation Requirements.

D.2.1.2.1 Atriums.
Glass walls and inoperable windows shall be permitted in lieu of the fire barriers where all the following are met:
(1) Automatic sprinklers are spaced along both sides of the glass wall and the inoperable window at intervals not to exceed 6 ft (1830 mm).

(2) The automatic sprinklers specified by NFPA *101*, 8.6.7(1)(c)(i) are located at a distance from the glass wall not to exceed 12 in. (305 mm) and arranged so that the entire surface of the glass is wet upon operation of the sprinklers.

(3) The glass wall is of tempered, wired, or laminated glass held in place by a gasket system that allows the glass framing system to deflect without breaking (loading) the glass before the sprinklers operate.

(4) The automatic sprinklers required by NFPA *101*, 8.6.7(1)(c)(i) are not required on the atrium side of the glass wall and the inoperable window where there is no walkway or other floor area on the atrium side above the main floor level. [***101*:**8.6.7(1)(c)]

D.2.2 Special Structures and High-Rise Buildings.

D.2.2.1 Design Criteria.

D.2.2.1.1
High-rise buildings shall be protected throughout by an approved, supervised automatic sprinkler system in accordance with NFPA *101*, Section 9.7. A sprinkler control valve and a waterflow device shall be provided for each floor. [***101*:**11.8.3.1]

D.2.3 New Assembly Occupancies.

D.2.3.1 Design Criteria.

D.2.3.1.1 Protection of Vertical Openings.
Any vertical opening shall be enclosed or protected in accordance with Section 8.6 of NFPA *101*, unless otherwise permitted by one of the following:
(1) Stairs or ramps shall be permitted to be unenclosed between balconies or mezzanines and main assembly areas located below, provided that the balcony or mezzanine is open to the main assembly area.

(2) Exit access stairs from lighting and access catwalks, galleries, and gridirons shall not be required to be enclosed.

(3) Assembly occupancies protected by an approved, supervised automatic sprinkler system in accordance with Section 9.7 of NFPA *101* shall be permitted to have unprotected vertical openings between any two adjacent floors, provided that such openings are separated from unprotected vertical openings serving other floors by a barrier complying with 8.6.5 of NFPA 101.

(4) Assembly occupancies protected by an approved, supervised automatic sprinkler system in accordance with Section 9.7 of NFPA *101* shall be permitted to have convenience stair openings in accordance with 8.6.9.2 of NFPA *101*.

[***101:***12.3.1]

D.2.3.2 Installation Requirements. (Reserved)

D.2.4 Existing Assembly Occupancies.

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D.2.4.1 Design Criteria.

D.2.4.1.1 Protection of Vertical Openings.
Any vertical opening shall be enclosed or protected in accordance with NFPA *101*, Section 8.6, unless otherwise permitted by one of the following:
(1) Stairs or ramps shall be permitted to be unenclosed between balconies or mezzanines and main assembly areas located below, provided that the balcony or mezzanine is open to the main assembly area.

(2) Exit access stairs from lighting and access catwalks, galleries, and gridirons shall not be required to be enclosed.

(3) Assembly occupancies protected by an approved, supervised automatic sprinkler system in accordance with NFPA *101*, Section 9.7, shall be permitted to have unprotected vertical openings between any two adjacent floors, provided that such openings are separated from unprotected vertical openings serving other floors by a barrier complying with NFPA *101*, 8.6.5.

(4) Assembly occupancies protected by an approved, supervised automatic sprinkler system in accordance with NFPA *101*, Section 9.7, shall be permitted to have convenience stair openings in accordance with NFPA *101*, 8.6.9.2.

[***101:***13.3.1]

D.2.4.2 Installation Requirements. (Reserved)

D.2.5 New Educational Occupancies. (Reserved)

D.2.6 Existing Educational Occupancies. (Reserved)

D.2.7 New Day-Care Occupancies. (Reserved)

D.2.8 Existing Day-Care Occupancies. (Reserved)

D.2.9 New Health Care Occupancies. (Reserved)

D.2.10 Existing Health Care Occupancies. (Reserved)

D.2.11 New Ambulatory Health Care Occupancies. (Reserved)

D.2.12 Existing Ambulatory Health Care Occupancies. (Reserved)

D.2.13 New Detention and Correctional Occupancies. (Reserved)

D.2.14 Existing Detention and Correctional Occupancies. (Reserved)

D.2.15 One- and Two-Family Dwellings. (Reserved)

D.2.16 Lodging or Rooming Houses.

D.2.16.1 Design Requirements. (Reserved)

D.2.16.2 Installation Requirements.

D.2.16.2.1
In buildings sprinklered in accordance with NFPA 13, closets that contain equipment such as washers, dryers, furnaces, or water heaters shall be sprinklered, regardless of size. [***101*:**26.3.6.3.5]

D.2.16.2.2

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In existing lodging or rooming houses, sprinkler installations shall not be required in closets not exceeding 24 ft^2 (2.2 m^2) and in bathrooms not exceeding 55 ft^2 (5.1 m^2). [***101*:**26.3.6.3.6]

D.2.17 New Hotels and Dormitories.

D.2.17.1 Design Requirements. (Reserved)

D.2.17.2 Installation Requirements.

D.2.17.2.1
The provisions for draft stops and closely spaced sprinklers in NFPA 13 shall not be required for openings complying with NFPA *101*, 8.6.9.1, where the opening is within the guest room or guest suite. [***101*:**28.3.5.4]

D.2.17.2.2
Listed quick-response or listed residential sprinklers shall be used throughout guest rooms and guest room suites. [***101*:**28.3.5.6]

D.2.18 Existing Hotels and Dormitories.

D.2.18.1 Design Requirements. (Reserved)

D.2.18.2 Installation Requirements.

D.2.18.2.1
In guest rooms and in guest room suites, sprinkler installations shall not be required in closets not exceeding 24 ft^2 (2.2 m^2) and in bathrooms not exceeding 55 ft^2 (5.1 m^2). [***101*:**29.3.5.5]

D.2.19 New Apartment Buildings.

D.2.19.1 Design Requirements. (Reserved)

D.2.19.2 Installation Requirements.

D.2.19.2.1
In buildings sprinklered in accordance with NFPA 13, closets less than 12 ft^2 (1.1 m^2) in area in individual dwelling units shall not be required to be sprinklered. Closets that contain equipment such as washers, dryers, furnaces, or water heaters shall be sprinklered regardless of size. [***101*:**30.3.5.3]

D.2.19.2.2
Listed quick-response or listed residential sprinklers shall be used throughout all dwelling units. [***101*:**30.3.5.5]

D.2.19.2.3
The draft stop and closely spaced sprinkler requirements of NFPA 13 shall not be required for convenience openings complying with NFPA *101*, 8.6.9.1, where the convenience opening is within the dwelling unit. [***101*:**30.3.5.4]

D.2.20 Existing Apartment Buildings.

D.2.20.1 Design Requirements. (Reserved)

D.2.20.2 Installation Requirements.

D.2.20.2.1
In individual dwelling units, sprinkler installation shall not be required in closets not exceeding 24 ft^2 (2.2 m^2) and in bathrooms not exceeding 55 ft^2 (5.1 m^2). Closets that contain equipment such as washers, dryers, furnaces, or water heaters shall be sprinklered, regardless of size. [***101*:**31.3.5.3]

D.2.20.2.2

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The draft stop and closely spaced sprinkler requirements of NFPA 13 shall not be required for convenience openings complying with NFPA *101*, 8.6.9.1, where the convenience opening is within the dwelling unit. [***101*:**31.3.5.4]

D.2.21 New Residential Board and Care Occupancies. (Reserved)

D.2.22 Existing Residential Board and Care Occupancies.

D.2.22.1 Design Requirements. (Reserved)

D.2.22.2 Installation Requirements.

D.2.22.2.1
Standard-response sprinklers shall be permitted for use in hazardous areas in accordance with NFPA *101*, 33.2.3.2. [***101*:**33.2.2.2.4]

D.2.22.2.2
In prompt and slow evacuation facilities, where an automatic sprinkler system is in accordance with NFPA 13 sprinklers shall not be required in closets not exceeding 24 ft^2 (2.2 m^2) and in bathrooms not exceeding 55 ft^2 (5.1 m^2), provided that such spaces are finished with lath and plaster or materials providing a 15-minute thermal barrier. [***101*:**33.2.3.5.3.3]

D.2.23 New Mercantile Occupancies.

D.2.23.1 Design Requirements. (Reserved)

D.2.23.2 Installation Requirements.

D.2.23.2.1 Protection of Vertical Openings.
Any vertical opening shall be protected in accordance with NFPA *101*, Section 8.6, except under the following conditions:
(1) In Class A or Class B mercantile occupancies protected throughout by an approved, supervised automatic sprinkler system in accordance with NFPA *101*, 9.7.1.1(1), unprotected vertical openings shall be permitted at one of the following locations:
(a) Between any two floors

(b) Among the street floor, the first adjacent floor below, and adjacent floor (or mezzanine) above

(2) In Class C mercantile occupancies, unprotected openings shall be permitted between the street floor and the mezzanine.

(3) The draft stop and closely spaced sprinkler requirements of NFPA 13 shall not be required for unenclosed vertical openings permitted in NFPA *101*, 36.3.1(1) and (2).

[***101:***36.3.1]

D.2.23.2.2
Rooms housing building service equipment, janitor closets, and service elevators shall be permitted to open directly onto exit passageways, provided that the following criteria are met:
(1) The required fire resistance rating between such rooms or areas and the exit passageway shall be maintained in accordance with NFPA *101*, 7.1.3.2.

(2) Such rooms or areas shall be protected by an approved, supervised automatic sprinkler system in accordance with NFPA *101*, 9.7.1.1(1) but the exceptions in NFPA 13 allowing the omission of sprinklers from such rooms shall not be permitted.

[***101*:**36.4.4.6.2]

D.2.24 Existing Mercantile Occupancies.

D.2.24.1 Design Requirements. (Reserved)

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D.2.24.2 Installation Requirements.

D.2.24.2.1 Protection of Vertical Openings.
Any vertical opening shall be protected in accordance with NFPA *101*, Section 8.6, except under the following conditions:
(1) In Class A or Class B mercantile occupancies protected throughout by an approved, supervised automatic sprinkler system in accordance with NFPA *101*, 9.7.1.1(1), unprotected vertical openings shall be permitted at one of the following locations:
(a) Between any two floors

(b) Among the street floor, the first adjacent floor below, and adjacent floor (or mezzanine) above

(2) In Class C mercantile occupancies, unprotected openings shall be permitted between the street floor and the mezzanine.

(3) The draft stop and closely spaced sprinkler requirements of NFPA 13 shall not be required for unenclosed vertical openings permitted in NFPA *101*, 37.3.1(1) and (2). [*101*:37.3.1]

D.2.24.2.2
Rooms housing building service equipment, janitor closets, and service elevators shall be permitted to open directly onto exit passageways, provided that the following criteria are met:
(1) The required fire resistance rating between such rooms or areas and the exit passageway shall be maintained in accordance with NFPA *101*, 7.1.3.2.

(2) Such rooms or areas shall be protected by an approved, supervised automatic sprinkler system in accordance with NFPA *101*, 9.7.1.1(1), but the exceptions in NFPA 13 allowing the omission of sprinklers from such rooms shall not be permitted. [*101*:37.4.4.6.2]

D.2.25 New Business Occupancies.

D.2.25.1 Design Requirements. (Reserved)

D.2.25.2 Installation Requirements. (Reserved)

D.2.26 Existing Business Occupancies.

D.2.26.1 Design Requirements. (Reserved)

D.2.26.2 Installation Requirements. (Reserved)

D.2.27 Industrial Occupancies. (Reserved)

D.2.27.1 Design Criteria.

D.2.27.1.1 Special Provisions — High-Rise Buildings.
The provisions of NFPA *101*, 11.8.5.2.4(2), for jockey pumps and NFPA *101*, 11.8.5.2.4(3), for air compressors serving dry-pipe and pre-action systems shall not apply to special-purpose industrial occupancies. [***101*:**40.4.1]

D.2.28 Storage Occupancies. (Reserved)

Annex E Development of the Design Approach to Conform with SEI/ASCE 7

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Length					
.003”	.08 mm	7.5”	190 mm	26”	650 mm
.0315”	.8 mm	8”	200 mm	27.6”	690 mm
1/32”	0.8 mm	8.5”	215 mm	28”	700 mm
1/16”	1.6 mm	9”	225 mm	29”	725 mm
3/32”	2 mm	9.25”	230 mm	30”	750 mm
1/8”	3 mm	9.5”	240 mm	30.5”	765 mm
3/16”	5 mm	10”	250 mm	31”	775 mm
¼”	6 mm	11”	275 mm	32”	800 mm
5/16”	8 mm	11.5”	290 mm	33”	825 mm
3/8”	10 mm	12”	300 mm	35”	875 mm
½”	13 mm	12.25”	305 mm	35.4”	885 mm
17/32”	13 mm	12.5”	315 mm	36”	900 mm
9/16”	14 mm	12.75”	320 mm	37”	925 mm
5/8”	16 mm	14”	350 mm	38”	950 mm
¾”	19 mm	15”	375 mm	40”	1000 mm
7/8”	22 mm	15.5”	390 mm	42”	1050 mm
1”	25 mm	16”	400 mm	44”	1100 mm
1.5”	40 mm	16.25”	410 mm	47”	1175 mm
1.75”	45 mm	16.5”	415 mm	48”	1200 mm
2”	50 mm	17”	425 mm	54”	1350 mm
2.5”	65 mm	17.5”	440 mm	55”	1375 mm
2.75”	70 mm	18”	450 mm	57”	1425 mm
3”	75 mm	19”	475 mm	58”	1450 mm
3.5”	90 mm	20”	500 mm	66”	1650 mm
4”	100 mm	21”	525 mm	68”	1700 mm
4.5”	115 mm	22”	550 mm	72”	1800 mm
5”	125 mm	22.5”	565 mm	76”	1900 mm
5.5”	140 mm	23”	575 mm	78”	1950 mm
5.75”	145 mm	24”	600 mm	96”	2400 mm
6”	150 mm	25”	625 mm	102”	2550 mm
7”	175 mm	25.5”	640 mm	120”	3000 mm
				148”	3700 mm

Length					
3.5ft	1.1 m	10’-10”	3.3 m	22’-6”	6.9 m
3’-8”	1.1 m	11’-0”	3.4 m	24ft	7.3 m
4ft	1.2 m	11’-3”	3.4 m	25ft	7.6 m
4’-2”	1.3 m	11’-5”	3.5 m	25’-3”	7.7 m
4.5ft	1.4 m	11’-6”	3.5 m	26ft	7.9 m
4’-7”	1.4 m	11’-611/16”	3.5 m	27ft	8.2 m
4’-9”	1.4 m	11’-8”	3.6 m	28ft	8.5 m
5ft	1.5 m	12ft	3.7 m	28’-8”	8.7 m
5’-2”	1.6 m	12’-4”	3.8 m	29’-8”	9 m
5.5ft	1.7 m	13ft	4.0 m	30ft	9.1 m
5’-8”	1.7 m	13’-6”	4.1 m	32ft	10 m
5’-9 5/16”	1.8 m	13’-71/2”	4.2 m	33ft	10 m
6ft	1.8 m	13’-11”	4.2 m	35ft	11 m
6’-3”	1.9 m	14ft	4.3 m	36ft	11 m
6’-4”	1.9 m	14’-6”	4.4 m	40ft	12 m
6.5ft	2 m	15ft	4.6 m	41’-3”	13 m
6’-10”	2.1 m	15’-4”	4.7 m	45ft	14 m
7ft	2.1 m	16ft	4.9 m	50ft	15 m
7.5ft	2.3 m	16’-6”	5.0 m	51’-6”	16 m
7’-7”	2.3 m	16’-8”	5.1 m	55ft	17 m
7’-9”	2.4 m	17ft	5.2 m	60ft	18 m
8ft	2.4 m	18ft	5.5 m	65ft	20 m
8’-2”	2.5 m	18’-6”	5.6 m	70ft	21 m
8’-4”	2.5 m	19’-2”	5.8 m	75ft	23 m
8’-77/8”	2.6 m	19’-10”	6 m	76ft	23 m
9ft	2.7 m	19’-11”	6.1 m	80ft	24 m
9’-5”	2.9 m	20ft	6.1 m	100ft	30 m
9’-6”	2.9 m	20’-8”	6.3 m	200ft	61 m
10ft	3 m	21’-6”	6.6 m	250ft	76 m
10.5ft	3.2 m	21’-10”	6.7 m	300ft	91 m
10’-9”	3.3 m	22 ft	6.7 m	400ft	120 m

Area					
3.5 ft2	0.3 m2	256 ft2	24 m2	2,700 ft2	250 m2
6 ft2	0.6 m2	300 ft2	28 m2	2,734 ft2	255 m2
10 ft2	0.9 m2	306 ft2	28 m2	2,800 ft2	260 m2
12 ft2	1.1 m2	324 ft2	30 m2	3,000 ft2	280 m2
16 ft2	1.5 m2	395 ft2	37 m2	3,250 ft2	300 m2
18 ft2	1.7m2	400 ft2	37 m2	3,300 ft2	305 m2
20 ft2	1.9m2	450 ft2	42 m2	3,450 ft2	320 m2
24 ft2	2.2m2	504 ft2	47 m2	3,500 ft2	325 m2
25 ft2	2.3 m2	585 ft2	54 m2	3,600 ft2	335 m2
32 ft2	3.0 m2	600 ft2	56 m2	3,750 ft2	350 m2
50 ft2	4.6 m2	648 ft2	60 m2	3,900 ft2	360 m2
55 ft2	5.1 m2	700 ft2	65 m2	4,000 ft2	370 m2
64 ft2	5.9 m2	756 ft2	70 m2	4,100 ft2	380 m2
70 ft2	6.5 m2	768 ft2	71 m2	4,500 ft2	420 m2
80 ft2	7.4 m2	800 ft2	74 m2	4,800 ft2	445 m2
90 ft2	8.4 m2	1,000 ft2	93 m2	5,000 ft2	465 m2
100 ft2	9 m2	1,200ft2	112 m2	6,000 ft2	555 m2
110 ft2	10 m2	1,300 ft2	120 m2	6,400 ft2	595 m2
120 ft2	11 m2	1,365 ft2	125 m2	8,000 ft2	740 m2
124 ft2	12 m2	1,400 ft2	130 m2	8,800 ft2	820 m2
130 ft2	12 m2	1,500 ft2	140 m2	10,000 ft2	930 m2
144 ft2	13 m2	1,700 ft2	160 m2	13,100 ft2	1 215 m2
150 ft2	14 m2	1,800 ft2	165 m2	25,000 ft2	2 320 m2
168 ft2	16 m2	1,950 ft2	180 m2	40,000 ft2	3 720 m2
175 ft2	16 m2	2,000 ft2	185 m2	50,000 ft2	4 650 m2
196 ft2	18 m2	2,300 ft2	215 m2	52,000 ft2	4 830 m2
200 ft2	18 m2	2,500 ft2	230m2	100,000 ft2	9 230 m2
225 ft2	20 m2	2,535 ft2	235 m2		
250 ft2	23 m2	2,600 ft2	240 m2		

Volume			
1.76 cuin	28 ml	160 ft3	4.5 m3
15.5 ft3	0.5 m3	400 ft3	11 m3
17.4 ft3	0.5 m3	1,000 ft3	28 m3
17.6 ft3	0.5 m3	1,800 ft3	51 m3
20.7 ft3	0.6 m3	2,100 ft3	59 m3
21.1 ft3	0.6 m3	2,300 ft3	65 m3
22 ft3	0.6 m3	6,500 ft3	184 m3
100 ft3	2.8 m3	2.25M ft3	63,720 m3

Capacity	
16 oz.	0.5 l
32 oz.	1 l
1 gal	4 l
5 gal	20 l
40 gal	150 l
100 gal	380 l
150 gal	570 l
250 gal	950 l
500 gal	1900 l
750 gal	2850 l
300,000 gal	1,135,500 l

Drill Size	
3/32”	2,3 mm
1/8”	3,2 mm
3/8”	10 mm

Density of Cotton Bales	
22.0 lb/ft^3	350 kg/m^3
22.7 lb/ft^3	365 kg/m^3
24.2 lb/ft^3	390 kg/m^3
28.4 lb/ft^3	455 kg/m^3
28.7 lb/ft^3	460 kg/m^3
32.2 lb/ft^3	515 kg/m^3

Flow					
30 gpm	115 lpm	300 gpm	1150 lpm	1000 gpm	3800 lpm
15 gpm	57 lpm	400 gpm	1500 lpm	1500 gpm	5700 lpm
20 gpm	75 lpm	500 gpm	1900 lpm	1992 gpm	7540 lpm
50 gpm	190 lpm	600 gpm	2250 lpm	1993 gpm	7543 lpm
60 gpm	230 lpm	700 gpm	2650 lpm	2156 gpm	8160 lpm
100 gpm	380 lpm	750 gpm	2850 lpm	2575 gpm	9750 lpm
102.8 gpm	390 lpm	800 gpm	3050 lpm	4907 gpm	18,572 lpm
200 gpm	760 lpm	850 gpm	3200 lpm		
215.8 gpm	815 lpm	900 gpm	3400 lpm		
250 gpm	950 lpm				

Pressure			
5 psi	0.3 bar	75	5.2 bar
7	0.5 bar	90	6.2 bar
10	0.7 bar	100	6.9 bar
11	.8 bar	150	10 bar
15	1.0 bar	165	11 bar
20	1.4 bar	175	12 bar
22	15 bar	189	13 bar
25	1.7 bar	200	14 bar
30	2.1 bar	259	17 bar
35	2.4 bar	300	21 bar
50	3.4 bar	400	28 bar
63	4.3 bar		

Gauge	
12	2.8 mm
14	1.98 mm
16	1.57 mm
22	.78 mm
24	.63mm

Weight			
6 lb	2.7 kg	350 lb	160 kg
10 lb	4.5 kg	440 lb	200 kg
20 lb	9.1 kg	520 lb	235 kg
40 lb	18 kg	750 lb	340 kg
61 lb	27 kg	787 lb	355 kg
91 lb	41 kg	1200 lb	544 kg
131 lb	59 kg	1634 lb	740 kg
200 lb	91 kg	2000 lb	907 kg
250 lb	115 kg	2300 lb	1043 kg
		4000 lb	1815 kg

Velocity	
30 mph	49 km/h

Discharge Density			
gpm/ft2	mm/min	gpm/ft2	mm/min
.005	.2	.425	17.3
.05	2.04	.426	17.4
.1	4.1	.44	17.9
.15	6.1	.45	18.3
.16	6.5	.46	18.7
.17	7.0	.49	20
.18	7.3	.5	20.4
.19	7.7	.55	22.4
.2	8.2	.56	22.8
.21	8.6	.57	23.2
.225	9.2	.6	24.5
.24	9.8	.61	24.9
.25	10.2	.65	26.5
.26	10.6	.68	27.7
.28	11.4	.7	28.5
.29	11.8	.74	30.2
.3	12.2	.75	30.6
.31	12.6	.77	31.4
.32	13.0	.8	32.6
.33	13.4	.85	34.6
.34	13.9	.9	36.7
.35	14.3	.92	37.5
.37	15.1	.96	39.1
.375	15.3	1.1	44.8
.39	15.9	1.2	48.9
.4	16.3	6.0	245
.42	17.1	7.5	306

Second Revision No. 369-NFPA 13-2017 [Section No. 3.3.8.2]

3.3.8.2 Closed Array (Rolled Paper).

A vertical storage arrangement in which the distances between columns in both directions are short [not more than 2 in. (50 mm) in one direction and 1 in. (25 mm) in the other].

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Committee Statement

Committee Statement: Editorial.
Response Message:

Second Revision No. 370-NFPA 13-2017 [Sections 3.3.8.4, 3.3.8.5]

3.3.8.4 Open Array (Rolled Paper).

A vertical storage arrangement in which the distance between columns in both directions is lengthy (all vertical arrays other than closed or standard).

3.3.8.5* Standard Array (Rolled Paper).

A vertical storage arrangement in which the distance between columns in one direction is short [1 in. (25 mm) or less] and is in excess of 2 in. (50 mm) in the other direction.

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Committee Statement

Committee Statement: Editorial.
Response Message:

Second Revision No. 371-NFPA 13-2017 [Section No. 3.3.33]

3.3.32 Closed Array (Rolled Paper).

See 3.3.8.2.

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Submitter Full Name: AUT-SSD
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Committee Statement

Committee Statement: Editorial.
Response Message:

Second Revision No. 372-NFPA 13-2017 [Section No. 3.3.39]

3.3.34 Column (Rolled Paper) .

A single vertical stack of rolls.

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Committee Statement

Committee Statement: Editorial.
Response Message:

Second Revision No. 373-NFPA 13-2017 [Section No. 3.3.50]

3.3.49 Core (Rolled Paper) .

The central tube around which paper is wound to form a roll.

Submitter Information Verification

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Committee Statement

Committee Statement: Editorial.
Response Message:

Second Revision No. 333-NFPA 13-2017 [Sections 3.3.70, 3.3.71]

3.3.70 Extra Hazard (Group 1) (EH1) .

See 3.3.135.1.

3.3.71 Extra Hazard (Group 2) (EH2) .

See 3.3.135.2.

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Committee Statement

Committee Statement: Editorial.
Response Message:

Second Revision No. 368-NFPA 13-2017 [Section No. 3.3.128]

3.3.128 Multiple-Row Racks.

Racks greater than 12 ft (~~300 mm~~ 3.7 m) in depth or single- or double-row racks separated by aisles less than 3.5 ft (1.1 m) wide having an overall width greater than 12 ft (~~300 mm~~ 3.7 m).

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Committee Statement

Committee Statement: Editorial.
Response Message:

Second Revision No. 334-NFPA 13-2017 [Sections 3.3.135.1, 3.3.135.2]

3.3.135.1 Extra Hazard (Group 1) (EH1) .

~~Extra hazard (Group 1) occupancies shall be defined as occupancies~~ Occupancies or portions of other occupancies where the quantity and combustibility of contents are very high and dust, lint, or other materials are present, introducing the probability of rapidly developing fires with high rates of heat release but with little or no combustible or flammable liquids.

3.3.135.2 Extra Hazard (Group 2) (EH2) .

~~Extra hazard (Group 2) occupancies shall be defined as occupancies~~ Occupancies or portions of other occupancies with moderate to substantial amounts of flammable or combustible liquids or occupancies where shielding of combustibles is extensive.

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Committee Statement

Committee Statement: Editorial.
Response Message:

Second Revision No. 335-NFPA 13-2017 [Sections 3.3.135.4, 3.3.135.5]

3.3.135.4 Ordinary Hazard (Group 1) (OH1) .

~~Ordinary hazard (Group 1) occupancies shall be defined as occupancies~~ Occupancies or portions of other occupancies where the quantity and combustibility of the contents does not exceed the amount of miscellaneous storage of Class 2, 3, 4, plastics, tires, and roll paper provided in ~~Table 13.2.1~~ Table 4.3.1.7.1 .

3.3.135.5 Ordinary Hazard (Group 2) (OH2) .

~~Ordinary hazard (Group 2) occupancies shall be defined as occupancies~~ Occupancies or portions of other occupancies where the quantity and combustibility of contents are moderate to high, stockpiles of contents with moderate rates of heat release do not exceed 12 ft (3.66 m), and stockpiles of contents with high rates of heat release do not exceed 8 ft (2.4 m).

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Committee Statement

Committee Statement: Editorial.
Response Message:

Second Revision No. 374-NFPA 13-2017 [Section No. 3.3.140]

3.3.140 Open Array (Rolled Paper).

See 3.3.8.4.

Submitter Information Verification

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Committee Statement

Committee Statement: Editorial.
Response Message:

Second Revision No. 336-NFPA 13-2017 [Sections 3.3.144, 3.3.145]

3.3.144 Ordinary Hazard (Group 1) (OH1) .

See 3.3.135.4.

3.3.145 Ordinary Hazard (Group 2) (OH2) .

See 3.3.135.5.

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Committee Statement

Committee Statement: Editorial.
Response Message:

Second Revision No. 375-NFPA 13-2017 [Section No. 3.3.208]

3.3.209 Standard Array (Rolled Paper).

See 3.3.8.5.

Submitter Information Verification

Submitter Full Name: AUT-SSD
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Committee Statement

Committee Statement: Editorial.
Response Message:

Second Revision No. 376-NFPA 13-2017 [Section No. 3.3.220]

3.3.220* Tiered Storage (Baled Cotton) .

An arrangement in which bales are stored directly on the floor, two or more bales high.

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Committee Statement

Committee Statement: Editorial.
Response Message:

Second Revision No. 367-NFPA 13-2017 [Section No. 4.2]

4.2* Owner's Certificate.

The owner(s) of a building or structure where the fire sprinkler system is going to be installed or their authorized agent shall provide the sprinkler system installer with the following information prior to the layout and detailing of the fire sprinkler system *[see ~~Figure A.4.6(b)~~ Figure A.27.1(b)]*:

(1) Intended use of the building including the materials within the building and the maximum height of any storage

(2) A preliminary plan of the building or structure along with the design concepts necessary to perform the layout and detail for the fire sprinkler system

(3) Water supply information as identified in 5.2.2.2.1

(4)* Any special knowledge of the water supply, including known environmental conditions that might be responsible for corrosion, including microbiologically influenced corrosion (MIC)

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Committee Statement

Committee Statement: This information is required prior to the design of the system.
Response Message:

Second Revision No. 302-NFPA 13-2017 [Sections 4.3.1.5.1, 4.3.1.5.2]

4.3.1.5.1

For storage of Class I through Class IV commodities 12 ft (3.7 m) or less in height that ~~does~~ do not meet the definition of *Miscellaneous Storage* that is on solid shelf racks, in-rack sprinklers shall be provided in accordance with ~~16.1.6~~ 25.6.1 , and ceiling sprinkler protection shall be provided in accordance with ~~Chapter 13~~ this chapter for the applicable occupancy hazard criteria .

4.3.1.5.2

For storage of Group A ~~Plastics~~ plastic commodities 5 ft (1.5 m) or less in height that ~~does~~ do not meet the definition of *Miscellaneous Storage* that is on solid shelf racks, in-rack sprinklers shall be provided in accordance with ~~17.1.5~~ 25.6.1 , and ceiling sprinkler protection shall be provided in accordance with ~~Chapter 13~~ this chapter for the applicable occupancy hazard criteria .

Supplemental Information

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Committee Statement

Committee Statement: In the First Draft Report the references are from the 2016 edition of the NFPA 13. These matters need to be revised to match the new chapter structure for the standard.
Response Message:

Public Comment No. 310-NFPA 13-2017 [Sections 4.3.1.5.1, 4.3.1.5.2]

Second Revision No. 387-NFPA 13-2017 [New Section after 4.3.1.6.2]

4.3.1.7 Protection Criteria for Miscellaneous and Low-Piled Storage.

4.3.1.7.1

The protection criteria for miscellaneous and low-piled storage protected by ceiling sprinklers only shall be selected from Table 4.3.1.7.1 and Figure 19.3.3.1.1 in accordance with the density/area method of 19.3.3.2 .

Table 4.3.1.7.1 Discharge Criteria for Miscellaneous Storage Up to 12 ft (3.7 m) in Height

Commodity		Type of Storage	Storage Height		Maximum Ceiling Height		Design Curve Figure 19.3.3.1.1	Note	Inside Hose		Total Combined Inside and Outside Hose	
			ft	m	ft	m			gpm	L/min	gpm	L/mi
Class I to Class IV												
Class I		Solid-piled, palletized, bin box, shelf, single-, double-, multiple-row rack, and back-to-back shelf storage	≤12	≤3.7	—	—	OH1	-	0, 50, 100	0, 190, 380	250	950
Class II			≤10	≤3.0	—	—	OH1	-	0, 50, 100	0, 190, 380	250	950
Class II			>10 to ≤12	>3.0 to ≤3.7	—	—	OH2	-	0, 50, 100	0, 190, 380	250	950
Class III			≤12	≤3.7	—	—	OH2	-	0, 50, 100	0, 190, 380	250	950
Class IV			≤10	≤3.0	—	—	OH2	-	0, 50, 100	0, 190, 380	250	950
Class IV		Palletized, bin box, shelf, and solid-piled	>10 to ≤12	>3.0 to ≤3.7	32	10	OH2	-	0, 50, 100	0, 190, 380	250	950
		Single-, double-, multiple-row rack and back-to-back shelf storage	>10 to ≤12	>3.0 to ≤3.7	32	10	EH1	-	0, 50, 100	0, 190, 380	500	1900
		Singles,double-, multiple-row rack	>10 to ≤12	>3.0 to ≤3.7	32	10	See Chapter 25	+1 level of in-rack	0, 50, 100	0, 190, 380	250	950
Group A Plastic Storage												
Cartoned	Nonexpanded and expanded	Solid-piled, palletized, bin box, shelf, single-, double-, multiple-row rack, and back-to-back shelf storage	≤5	≤1.5	—	—	OH2	-	0, 50, 100	0, 190, 380	250	950
			>5 to ≤10	>1.5 to ≤3.0	15	4.6	EH1	-	0, 50, 100	0, 190, 380	500	1900
			>5 to ≤10	>1.5 to ≤3.0	20	6.1	EH2	-	0, 50, 100	0, 190, 380	500	1900
			>10 to ≤12	>3.0 to ≤3.7	17	5.2	EH2	-	0, 50, 100	0, 190, 380	500	1900

Commodity		Type of Storage	Storage Height		Maximum Ceiling Height		Design Curve Figure 19.3.3.1.1	Note	Inside Hose		Total Combined Inside and Outside Hose	
			ft	m	ft	m			gpm	L/min	gpm	L/min
Exposed		Solid-piled, palletized, bin box, shelf, and back-to-back shelf storage	>10 to ≤12	>3.0 to ≤3.7	32	10	EH2	-	0, 50, 100	0, 190, 380	500	1900
		Single-, double-, multiple-row rack	>10 to ≤12	>3.0 to ≤3.7	32	10	See Chapter 25.	+ 1 level of in-rack	0, 50, 100	0, 190, 380	250	950
		Solid-piled, palletized, bin box, shelf, single-, double-, multiple-row rack, and back-to-back shelf storage	≤5	≤1.5	—	—	OH2	-	0, 50, 100	0, 190, 380	250	950
	Nonexpanded and expanded	Solid-piled, palletized, bin box, shelf, and back-to-back shelf storage	>5 to ≤8	>1.5 to ≤2.4	28	8.5	EH2	-	0, 50, 100	0, 190, 380	500	1900
		Solid-piled, palletized, bin box, shelf, single-, double-, multiple-row rack, and back-to-back shelf storage	>5 to ≤10	>1.5 to ≤3.0	15	4.6	EH2	-	0, 50, 100	0, 190, 380	500	1900
	Nonexpanded	Solid-piled, palletized, bin box, shelf, single-, double-, multiple-row rack, and back-to-back shelf storage	>5 to ≤10	>1.5 to ≤3.0	20	6.1	EH2	-	0, 50, 100	0, 190, 380	500	1900
	Expanded	Single-, double-, multiple-row rack	>5 to ≤10	>1.5 to ≤3.0	20	6.1	See Chapter 25.	+1 level of in-rack	0, 50, 100	0, 190, 380	250	950
	Nonexpanded and expanded	Solid-piled, palletized, bin box, shelf, and back-to-back shelf storage	>10 to ≤12	>3.0 to ≤3.7	17	5.2	EH2	-	0, 50, 100	0, 190, 380	500	1900

Commodity		Type of Storage	Storage Height		Maximum Ceiling Height		Design Curve Figure 19.3.3.1.1	Note	Inside Hose		Total Combined Inside and Outside Hose	
			ft	m	ft	m			gpm	L/min	gpm	L/min
Tires		Single-, double-, multiple-row rack	>10 to ≤12	>3.0 to ≤3.7	17	5.2	EH2	-	0, 50, 100	0, 190, 380	500	1900
			>10 to ≤12	>3.0 to ≤3.7	32	10	See Chapter 25.	+1 level of in-rack	0, 50, 100	0, 190, 380	250	950
		Tire Storage										
		On floor, on side	>5 to ≤12	>1.5 to ≤3.7	32	10	EH1	-	0, 50, 100	0, 190, 380	500	1900
		On floor, on tread, or on side	≤5	≤1.5	—	—	OH2	-	0, 50, 100	0, 190, 380	250	950
		Single-, double-, or multiple-row racks on tread or on side	≤5	≤1.5	—	—	OH2	-	0, 50, 100	0, 190, 380	250	950
		Single-row rack, portable, on tread or on side	>5 to ≤12	>1.5 to ≤3.7	32	10	EH1	-	0, 50, 100	0, 190, 380	500	1900
		Single-row rack, fixed, on tread or on side	>5 to ≤12	>1.5 to ≤3.7	32	10	EH1	-	0, 50, 100	0, 190, 380	500	950
			>5 to ≤12	>1.5 to ≤3.7	32	10	See Chapter 25.	+1 level of in-rack	0, 50, 100	0, 190, 380	250	950
		Rolled Paper Storage										
-	Heavyweight and mediumweight	On end	≤10	≤3.0	30	9.1	OH2	-	0, 50, 100	0, 190, 380	250	950
-	Tissue and lightweight	On end	≤10	≤3.0	30	9.1	EH1	-	0, 50, 100	0, 190, 380	250	950

4.3.1.7.1.1

The protection criteria for rack storage of miscellaneous and low-piled storage with in-rack sprinklers shall be in accordance with 25.2.2 .

4.3.1.7.2

Except as provided in 4.3.1.6.1 , the maximum design area for miscellaneous and low-piled storage shall not exceed 3000 ft^2 (279 m^2).

Supplemental Information

File Name	Description	Approved

New_Table_4.3.1.7.1.docx Table 4.3.1.7.1. For staff use.

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Committee Statement

Committee Statement: Former Table 13.2.1 has been added back into the 2019 edition as Table 4.3.1.7.1 in order to make it easier for the end user to find ceiling only criteria for miscellaneous and low-piled storage applications. For in-rack information the user must go to Chapter 25.

Response Message:

Public Comment No. 174-NFPA 13-2017 [New Section after A.19.3.2.6]

Public Comment No. 313-NFPA 13-2017 [Section No. 20.1.1]

Second Revision No. 388-NFPA 13-2017 [Section No. 4.3.3]

4.3.3* Ordinary Hazard (Group 1).

The following shall be protected with ~~ordinary hazard group 1~~ OH1 occupancy criteria in this standard:

(1) Spaces with moderate quantity and low combustibility of contents

(2) Stockpiles of contents with low combustibility that do not exceed 8 ft (2.4 m)

~~Miscellaneous storage or storage facilities of solid-piled, palletized, bin box, shelf, rack, and back-to-back shelf storage of Class I commodities not exceeding 12 ft (3.7 m)~~

~~Miscellaneous storage or storage facilities of solid-piled, palletized, bin box, shelf, rack, and back-to-back shelf storage of Class II commodities not exceeding 10 ft (3.0 m)~~

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Committee Statement

Committee Statement: The list items have been deleted because they are redundant to what is in Table 4.3.1.7.1.
Response Message:

Second Revision No. 303-NFPA 13-2017 [Section No. 4.3.4]

4.3.4* Ordinary Hazard (Group 2).

The following shall be protected with ~~ordinary hazard group 2~~ OH2 occupancy criteria in this standard:

(1) Spaces with moderate to high quantity and combustibility of contents

(2) Stockpiles of contents with moderate to high combustibility that do not exceed 12 ft (3.7 m)

~~Miscellaneous or low-piled storage of solid-piled, palletized, bin box, shelf, rack, and back-to-back shelf storage of Class II commodities more than 10 ft (3.0 m) and not exceeding 12 ft (3.7 m)~~

~~Miscellaneous or low-piled storage of solid-piled, palletized, bin box, shelf, rack, and back-to-back shelf storage of Class III commodities not exceeding 12 ft (3.7 m)~~

~~Miscellaneous or low-piled storage of solid-piled, palletized, bin box, shelf, rack, and back-to-back shelf storage of Class IV commodities not exceeding 10 ft (3.0 m)~~

~~Miscellaneous or low-piled storage of solid-piled, palletized, bin box, and shelf storage of Class IV commodities more than 10 ft (3.0 m) and not exceeding 12 ft (3.7 m) and a maximum ceiling height of 32 ft (9.8 m)~~

~~Miscellaneous or low-piled storage of solid-piled, palletized, bin box, shelf, rack, and back-to-back shelf storage of Group A commodities not exceeding 5 ft (1.5 m)~~

~~Miscellaneous storage of rack storage of Group A commodities more than 10 ft (3.0 m) and not exceeding 12 ft (3.7 m) and a maximum ceiling height of 32 ft (9.8 m) with the use of 1 level of in-rack sprinklers~~

~~Miscellaneous storage of rack storage of exposed expanded Group A commodities more than 5 ft (1.5 m) and not exceeding 10 ft (3.0 m) and a maximum ceiling height of 20 ft (5.1 m) with the use of 1 level of in-rack sprinklers~~

~~Miscellaneous tire storage stored on floor or in rack either on tread or on side not exceeding 5 ft (1.5 m)~~

~~Miscellaneous tire storage stored on a fixed single-row rack either on tread or on side more than 5 ft (1.5 m) and not exceeding 12 ft (3.7 m) and a maximum ceiling height of 32 ft (9.8 m) with the use of 1 level of in-rack sprinklers~~

~~Miscellaneous store of medium weight and heavyweight rolled paper stored on end not exceeding 10 ft (3.0 m) and a maximum ceiling height of 30 ft (9.1 m)~~

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Committee Statement

Committee Statement: The list items have been deleted because they are redundant to what is in Table 4.3.1.7.1.
Response Message:

Public Comment No. 275-NFPA 13-2017 [Section No. 4.3.4]

Second Revision No. 389-NFPA 13-2017 [Sections 4.3.5, 4.3.6]

4.3.5* Extra Hazard (Group 1) (EH1) .

The following shall be protected with ~~extra hazard group 1~~ EH1 occupancy criteria in this standard:

(1) Spaces with very high quantity and combustibility of contents

(2) Spaces where dust, lint, or other materials are present, introducing the probability of rapidly developing fires

~~Miscellaneous or low-piled storage of rack and back-to-back shelf storage of Class IV commodities more than 10 ft (3.0 m) and not exceeding 12 ft (3.7 m) and a maximum ceiling height of 32 ft (9.8 m)~~

~~Miscellaneous or low-piled storage of solid-piled, palletized, bin box, shelf, rack, and back-to-back shelf storage of cartoned Group A commodities more than 5 ft (1.5 m) and not exceeding 10 ft (3.0 m) and a maximum ceiling height of 15 ft (4.6 m)~~

~~Miscellaneous tire storage stored on floor on side or in single-row rack (portable and fixed) either on tread or on side more than 5 ft (1.5 m) and not exceeding 12 ft (3.7 m) and a maximum ceiling height of 32 ft (9.8 m)~~

~~Miscellaneous storage of tissue and lightweight rolled paper stored on end not exceeding 10 ft (3.0 m) and a maximum ceiling height of 30 ft (9.1 m)~~

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4.3.6* Extra Hazard (Group 2) (EH2).

The following shall be protected with ~~extra hazard group 2~~EH2 occupancy criteria in this standard:

(1) Spaces with very high quantity and combustibility of contents

(2) Spaces with substantial amounts of combustible or flammable liquids

(3) Spaces where shielding of combustibles is extensive

~~Miscellaneous or low-piled storage of solid-piled, palletized, bin box, shelf, rack, and back-to-back shelf storage of cartoned Group A commodities more than 5 ft (1.5 m) and not exceeding 10 ft (3.0 m) and a maximum ceiling height of 20 ft (6.1 m)~~

~~Miscellaneous or low-piled storage of solid-piled, palletized, bin box, shelf, rack, and back-to-back shelf storage of cartoned Group A commodities more than 10 ft (3.0 m) and not exceeding~~

~~Miscellaneous or low-piled storage of solid-piled, palletized, bin box, shelf, and back-to-back shelf storage of cartoned Group A commodities more than 10 ft (3.0 m) and not exceeding 12 ft (3.7 m) and a maximum ceiling height of 32 ft (9.8 m)~~

~~Miscellaneous or low-piled storage of solid-piled, palletized, bin box, shelf, and back-to-back shelf storage of exposed Group A commodities more than 5 ft (1.5 m) and not exceeding 8 ft (2.4 m) and a maximum ceiling height of 28 ft (8.5 m)~~

~~Miscellaneous storage of solid-piled, palletized, bin box, shelf, rack, and back-to-back shelf storage of exposed Group A commodities more than 5 ft (1.5 m) and not exceeding 10 ft (3.0 m) and a maximum ceiling height of 15 ft (4.6 m)~~

~~Miscellaneous storage of solid-piled, palletized, bin box, shelf, rack, and back-to-back shelf storage of exposed unexpanded Group A commodities more than 5 ft (1.5 m) and not exceeding 10 ft (3.0 m) and a maximum ceiling height of 20 ft (6.1 m)~~

~~Miscellaneous storage of solid-piled, palletized, bin box, shelf, and back-to-back shelf storage of exposed Group A commodities more than 10 ft (3.0 m) and not exceeding 12 ft (3.7 m) and a maximum ceiling height of 17 ft (5.2 m)~~

~~Miscellaneous storage of rack storage of exposed Group A commodities more than 10 ft (3.0 m) and not exceeding 12 ft (3.7 m) and a maximum ceiling height of 17 ft (5.2 m)~~

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Second Revision No. 384-NFPA 13-2017 [Section No. 4.5.2]

4.5.2

The floor area occupied by mezzanines shall ~~not be included in the area limits of 4.5.1~~ comply with 4.5.2.1 , 4.5.2.2 , or 4.5.2.3 .

4.5.2.1

In a building with only one sprinkler system, the floor area occupied by mezzanines shall not be included in the area limits of 4.5.1 .

4.5.2.2

In a building with more than one sprinkler system, if a mezzanine is located entirely within the same sprinkler system boundary as the sprinklers protecting the ceiling above, the floor area occupied by mezzanine(s) shall not be included in the area limits of 4.5.1 .

4.5.2.3

In a building with more than one sprinkler system, if any portion of the mezzanine floor area that is located outside the system boundary of the riser supplying the sprinklers under the mezzanine, the area of the mezzanine of the system boundary shall be added to the system area from which it is supplied, and the total system area shall meet the limits of 4.5.1 .

Submitter Information Verification

Submitter Full Name: AUT-SSD
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Thu Jul 13 11:48:47 EDT 2017

Committee Statement

Committee Statement: Without the acceptance of this proposal in a large multi-system building it is possible to have a single riser supplying a system of up to 52,000 sqft and also supply a mezzanine of unlimited size. It is not the intent to allow a single system riser to control an unlimited area.

This was submitted as a public proposal and resolved stating that this is addressed in the annex. This issue is not addressed in the annex. For example a single riser in a 1,000,000 sqft building may supply a 52,000 sqft roof system and also a 300,000 sqft mezzanine. I don't believe that it is the intend of the section to allow 352,000 sqft to be supplied by a single riser.

Response Message:

Public Comment No. 122-NFPA 13-2017 [Section No. 4.5.2]

Second Revision No. 385-NFPA 13-2017 [Section No. 4.5.4]

4.5.4

The area protected by a single in-rack system includes all of the floor area occupied by the racks, including aisles, regardless of the number of levels of in-rack sprinklers.

~~**4.5.4.2**~~

~~The area protected by a single in-rack system shall include all of the floor area occupied by the racks, including aisles, regardless of the number of levels of in-rack sprinklers.~~

~~**4.5.4.2.1**~~

~~Multiple buildings attached by canopies, covered breezeways, common roofs, or a common wall(s) shall be permitted to be supplied by a single fire sprinkler riser.~~

4.5.4.1

Multiple buildings attached by canopies, covered breezeways, common roofs, or a common wall(s) shall be permitted to be supplied by a single fire sprinkler riser.

4.5.5

The maximum system size shall comply with 4.5.1.

Submitter Information Verification

Submitter Full Name: AUT-SSD
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Thu Jul 13 11:59:57 EDT 2017

Committee Statement

Committee Statement: In the First Draft Report, the text of 4.5.4 and 4.5.4.1 is duplicated in 4.5.4.2 and 4.5.4.2.1. The redundant text should be deleted. Renumber remainder of Chapter accordingly.

Response Message:

Public Comment No. 230-NFPA 13-2017 [Section No. 4.5.4]

Second Revision No. 364-NFPA 13-2017 [Section No. 4.6]

27.1* Working Plans.

27.1.1*

Working plans shall be submitted for approval to the authority having jurisdiction before any equipment is installed or remodeled.

27.1.1.1

Working plan submittals shall include the following:

(1) Working plans of the system(s), per 27.1.3

(2) Hydraulic calculations where systems are required to be calculated

(3) Data sheets for the system components where required by the ~~AHJ~~ authority having jurisdiction

(4)* Signed owner's certificate

27.1.1.2

Submittals shall be permitted to be in electronic format when approved by the authority having jurisdiction.

27.1.1.3

A copy of the approved plans shall be given to the owner or owner's representative.

27.1.2

Deviation from approved plans shall require permission of the authority having jurisdiction.

27.1.3

Working plans shall be drawn to an indicated scale, on sheets of uniform size, with a plan of each floor, and shall show those items from the following list that pertain to the design of the system:

(1) Name of owner and occupant.

(2) Location, including street address.

(3) Point of compass.

(4) Full height cross section or schematic diagram, including structural member information if required for clarity and including ceiling construction and method of protection for nonmetallic piping.

(5) Ceiling/roof heights and slopes not shown in the full height cross section.

(6) Location of partitions.

(7) Location of fire walls.

(8) Occupancy class of each area or room.

(9) Location and size of concealed spaces, closets, attics, and bathrooms.

(10) Any small enclosures in which no sprinklers are to be installed.

(11) Size of city main in street and whether dead end or circulating; if dead end, direction and distance to nearest circulating main; and city main test results and system elevation relative to test hydrant.

(12) Other sources of water supply, with pressure or elevation.

(13) Make, type, model, and nominal K-factor of sprinklers, including sprinkler identification number.

(14) Temperature rating and location of high-temperature sprinklers.

(15) Total area protected by each system on each floor.

(16) Number of sprinklers on each riser per floor.

(17) Total number of sprinklers on each dry pipe system, preaction system, combined dry pipe–preaction system, or deluge system.

(18) Approximate capacity in gallons of each dry pipe system.

(19) Pipe type and schedule of wall thickness.

(20) Nominal pipe size and cutting lengths of pipe (or center-to-center dimensions). Where typical branch lines prevail, it shall be necessary to size only one typical line.

(21) Location and size of riser nipples.

(22) Type of fittings and joints and location of all welds and bends. The contractor shall specify on drawing any sections to be shop welded and the type of fittings or formations to be used.

(23) Type and locations of hangers, sleeves, braces, and methods of securing sprinklers when applicable.

(24) All control valves, check valves, drain pipes, and test connections.

(25) ~~Size~~ Make , ~~location~~ type , ~~and valve and piping arrangement for~~ model, and size of backflow prevention assembly, and means to forward flow test at system demand.

(26) Make, type, model, and size of alarm or dry pipe valve.

(27) Make, type, model, and size of preaction or deluge valve.

(28) Kind and location of alarm bells.

(29) Size and location of standpipe risers, hose outlets, hand hose, monitor nozzles, and related equipment.

(30) Private fire service main sizes, lengths, locations, weights, materials, point of connection to city main; the sizes, types and locations of valves, valve indicators, regulators, meters, and valve pits; and the depth that the top of the pipe is laid below grade.

(31) Piping provisions for flushing.

(32) Where the equipment is to be installed as an addition to an existing system, enough of the existing system indicated on the plans to make all conditions clear.

(33) For hydraulically designed systems, the information on the hydraulic data nameplate.

(34) A graphic representation of the scale used on all plans.

(35) Name, address, and phone number(s) of contractor.

(36) Hydraulic reference points shown on the plan that correspond with comparable reference points on the hydraulic calculation sheets.

(37) The minimum rate of water application (density or flow or discharge pressure), the design area of water application, in-rack sprinkler demand, and the water required for hose streams both inside and outside.

(38) The total quantity of water and the pressure required noted at a common reference point for each system.

(39) Relative elevations of sprinklers, junction points, and supply or reference points.

(40) If room design method is used, all unprotected wall openings throughout the floor protected.

(41) Calculation of loads for sizing and details of sway bracing.

(42) Zones of influence used in calculations for seismic bracing indicated on plans.

(43) The setting for pressure-reducing valves.

~~Information about backflow preventers (manufacturer, size, type).~~

(44) Information about listed antifreeze solution used (type and amount).

(45) Size and location of hydrants showing size and number of outlets and if outlets are to be equipped with independent gate valves. Whether hose houses and equipment are to be provided, and by whom, shall be indicated. Static and residual hydrants that were used in flow tests shall be shown.

~~Utility plans and/or plumbing plans necessary to show connection from water supply to fire sprinkler system.~~

(46) Size, location, and piping arrangement of fire department connections.

~~Ceiling/roof heights and slopes not shown in the full height cross section.~~

(47) Edition year of NFPA 13 to which the sprinkler system is designed.

27.1.4

A signed copy of the owner's certificate and the working plan submittal shall include the manufacturer's installation instructions for any specially listed equipment, including descriptions, applications, and limitations for any sprinklers, devices, piping, or fittings.

27.1.5* Working Plans for Automatic Sprinkler Systems with Non–Fire Protection Connections.

27.1.5.1

Special symbols shall be used and explained for auxiliary piping, pumps, heat exchangers, valves, strainers, and the like, clearly distinguishing these devices and piping runs from those of the sprinkler system.

27.1.5.2

Model number, type, and manufacturer's name shall be identified for each piece of auxiliary equipment.

Submitter Information Verification

Submitter Full Name: AUT-SSD
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Wed Jun 28 22:40:04 EDT 2017

Committee Statement

Committee Statement: The details regarding working plans are far too specific to be in a "General Requirements" chapter. They require the knowledge of many pieces of information that have not been determined by the user when they get to Chapter 4. This forces the user to circle back to Chapter 4 after reading other chapters in the book.

The rules for plans should not be separated from the rules for hydraulic calculation. Those rules were proposed for a different chapter, and I will be proposing to bring them together in the new Chapter 27. The rules for information that needs to be provided on working plans cannot be separated from hydraulic calculations. Just look at how much information in the proposed section 4.6 needs to come from the hydraulic calculations. They should be together in a chapter after the design approaches have been determined by the user.

Some of the revisions made to this section are redundant and according to my notes they were not accepted by the TC at the 1st Draft Meeting:

- The new Item 25 was edited to call for the details of the backflow preventer and provide better clarity. As written in the First Draft Report, it implies that every system requires a forward flow test connection, whereas it is only called for when there is a backflow preventer installed.

- Item 44 should be deleted, because with the new Item 25 it became redundant.

- Item 47 should be deleted, because the information is already called for in Item 30. Also, by referring to utility and plumbing plans, it suggests that the underground water service is not part of the sprinkler system.

- Item 49 should be deleted, because the information is already called for in the new Item 5.

Response Message:

Public Comment No. 67-NFPA 13-2017 [Section No. 4.6]

Public Comment No. 131-NFPA 13-2017 [Section No. 4.6.3]

Public Comment No. 320-NFPA 13-2017 [Section No. 4.6.3]

Second Revision No. 305-NFPA 13-2017 [Section No. 5.1.5.2]

5.1.5.2

Water supplies and environmental conditions shall be evaluated for conditions that contribute to unusual corrosive properties. Where conditions are found that contribute to unusual corrosive properties, the owner(s) shall notify the sprinkler system installer and a plan shall be developed to treat the system using one of the following methods:

(1) Install a water pipe that is corrosion resistant.

(2) Treat water that enters the system using a listed corrosion inhibitor.

(3) Implement an approved plan for monitoring the interior conditions of the pipe at established intervals and locations.

(4) Install corrosion monitoring station and monitor at established intervals.

(5) Fill dry-pipe or preaction systems with nitrogen as a supervisory gas to mitigate against corrosion.

(6) When using a generator, use an approved nitrogen generator.

Submitter Information Verification

Submitter Full Name: AUT-SSD
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Wed Jun 28 11:23:10 EDT 2017

Committee Statement

Committee Statement: The TC removed this section from the code, which removes all recommendations to treat the water with a corrosion inhibitor. NFPA 13 section 7.8.1 'Additives to the water supply intended for control of Microbiological or other corrosion shall be listed for use within fire sprinkler systems". UL and Huguenot Laboratories are in contract to produce a listed and approved inhibitor within the calendar year of 2017. Copies of the developed testing standard are being provided as verification of compliance that a listed inhibitor is forthcoming. Please return this section to the code now that a listing standard exists. A copy of the testing standard and contract between UL and Huguenot Laboratories are being provided as proof of compliance. Thank you.

Response Message:

Public Comment No. 35-NFPA 13-2017 [Section No. 5.1.5.2]

Second Revision No. 386-NFPA 13-2017 [Section No. 5.2.2.2.1]

5.2.2.2.1*

~~Where a waterflow test is conducted, the volume and pressure available for use for a fire protection system shall be determined in accordance with 5.2.2.2.1.1 . If knowledge of the water supply is unavailable, the volume and pressure shall be determined in accordance with 5.2.2.2.1.2 .~~ Water supply information shall be adjusted to account for seasonal and daily pressure fluctuations based on information from the water supply authority through testing or modeling and as approved by the authority having jurisdiction.

A.5.2.2.2.1

The adjustment should take into account the following variables, which will be applicable to different degrees depending on how and when the test or modeling was conducted:

(1) Maximum daily use of the water supply

(2) Peak hour demand of the water supply

(3) Water supply degradation due to planned development

(4) Time of day the test was conducted

(5) Time of year the test was conducted

(6) Elevation of the test location compared to the building where the sprinkler system will be installed

(7) Elevation of the water supply at the time of the test

(8) How close the flow generated during the test was to the system demand

There is no single specific adjustment that can be applied to every water supply that would be appropriate for every sprinkler system. The design professional needs to work in conjunction with the authority having jurisdiction to determine an appropriate adjustment. Where an authority having jurisdiction has already determined a specific buffer between test results and the demand of the sprinkler system, there is no intent to add an additional safety factor or safety margin due to this requirement. Instead, the buffer mandated by the authority having jurisdiction serves the purpose of this adjustment.

In the absence of information from the design professional and the authority having jurisdiction, it would be appropriate to make an adjustment to the raw data from a flow test by either obtaining information from the water utility or using an arbitrary adjustment. The value to use for an arbitrary adjustment should be determined through a conversation with the authority having jurisdiction.

It is important to note that not all water supplies have a linear relationship of flow to pressure. As flow demand increases, additional water can be provided into the system through multiple pumps, causing complex geometries to the pressure and flow relationship at any given point in the system. Creating multiple flow conditions during a test and getting as close as possible to the sprinkler system demand will help in gaining a complete understanding of the water supply.

5.2.2.2.2*

Water supply adjustments shall be based on knowledge of the water supply and engineering judgment, taking into account daily and seasonal fluctuations, not extreme conditions.

~~5.2.2.2.3*~~

~~If knowledge of the water supply is unavailable, the following formula shall be used to determine volume and pressure:~~

$$P = (P_R - P_S)\left(\frac{Q}{Q_R}\right)^{1.85} + P_L$$ ~~[5.2.2.2.1.2]~~

~~where:~~

~~P = pressure available from the water supply to use for a fire protection system that will be calculated for a given flow (Q)~~

~~P_R = residual pressure measured during the waterflow test while the flow Q_R was discharging from the water supply~~

~~P_S = static pressure measured during the waterflow test~~

~~Q = flow that will be used to calculate the available pressure from the water supply~~

~~Q_R = flow discharging from the water supply when PR was measured~~

~~P_L = expected low static pressure at the location of the test results accounting for daily and seasonal fluctuations (not extreme conditions) obtained from the water utility~~

A.5.2.2.2.1.2

Consider the following example: A waterflow test is conducted at a location where a city water main is going to be tapped for a new sprinkler system. During the test, the static pressure is measured at 70 psi (4.8 bar) the residual pressure is measured at 50 psi (3.5 bar) while 1300 gpm (4920 L/min) was discharging from a nearby hydrant. The water utility is contacted, and they indicate that a reasonable low static pressure accounting for typical daily and seasonal fluctuations in this area is 55 psi (3.8 bar). The following equation describes the water supply available for a fire sprinkler system :

$$P = (50 - 70)\left(\frac{Q}{1300}\right)^{1.85} + 55$$ **[A.5.2.2.2.1.2a]**

There are two ways to use this formula:

Assume two different values for Q , calculate P , and then draw a graph on log 1.85 paper. Any fire sprinkler system demand falling on or below the line on this graph would be acceptable in accordance with NFPA 13 to work with this water supply. In this case, the two easiest flows to pick for Q would be 0 and 1300 gpm (4920 L/min). Where Q = 0, P is simply 55 psi (3.8 bar). Where Q = 1300 gpm (4920 L/min), P = 35 psi (2.4 bar). These two points can be plotted on log 1.85 paper as shown in Figure A.5.2.2.2.1.2 .

Calculate the fire protection system and determine the flow necessary to make the system work. Plug this flow into the preceding formula to determine the available pressure from the water supply at that flow. For example, if a sprinkler system connected to this water supply had a demand of 580 gpm (2195 L/min) the available pressure from the water supply would be as follows:

$$P = (50 - 70)\left(\frac{580}{1300}\right)^{1.85} + 55$$ **[A.5.2.2.2.1.2b]**

$$P = (-20)(0.225) + 55$$
$$P = 50.5 \text{ psi}$$

So, as long as the sprinkler system has a pressure demand less than or equal to 50.5 psi (3.5 bar), it will work with this water supply.

Figure A.5.2.2.2.1.2 Available Water Supply Curve for Example in A.5.2.2.2.1.2.

5.2.2.2.4

Where the water authority does not provide a value for P_L , the value of P_L shall be calculated from the following formula:

$$P_L = P_S(0.9)$$ **[5.2.2.2.1.3]**

Submitter Information Verification

Submitter Full Name: AUT-SSD

Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Thu Jul 13 13:48:41 EDT 2017

Committee Statement

Committee Statement: It is difficult to provide a prescriptive safety factor that would apply to every water supply throughout the world. However, certain conditions should be considered or analyzed when determining if a water supply is adequate to meet the needs of a fire protection system. Safety factors should be the purview of local jurisdictions and where required adopted into an enforceable code amendment.

Response Message:

Public Comment No. 133-NFPA 13-2017 [Section No. 5.2.2.2]

Public Comment No. 302-NFPA 13-2017 [Section No. 5.2.2.2.1]

Public Comment No. 324-NFPA 13-2017 [Section No. 5.2.2.2.1]

Public Comment No. 134-NFPA 13-2017 [Section No. A.5.2.2.2.1.1]

Public Comment No. 135-NFPA 13-2017 [Section No. A.5.2.2.2.1.2]

Second Revision No. 1051-NFPA 13-2017 [Chapter 19 [Title Only]]

Design Approaches ~~and Calculations~~

Submitter Information Verification

Submitter Full Name: AUT-SSD
Organization: National Fire Protection Assoc
Street Address:
City:
State:
Zip:
Submittal Date: Mon Oct 16 14:31:39 EDT 2017

Committee Statement

Committee Statement: Calculations have been relocated to Chapter 27.
Response Message:

Second Revision No. 1052-NFPA 13-2017 [Section No. 19.1]

19.1 General.

Chapter 19 shall be utilized for design approaches ~~and calculation procedures~~ .

Submitter Information Verification

Submitter Full Name: AUT-SSD
Organization: National Fire Protection Assoc
Street Address:
City:
State:
Zip:
Submittal Date: Mon Oct 16 14:32:48 EDT 2017

Committee Statement

Committee Statement: Calculations have been relocated to Chapter 27.
Response Message:

Second Revision No. 306-NFPA 13-2017 [Section No. 19.2]

19.2 General Design Approaches.

The requirements of Section 19.2 shall apply to all sprinkler systems unless modified by a specific section of Chapter ~~11~~ 19 or Chapter ~~12~~ 20 .

19.2.1

A building or portion thereof shall be permitted to be protected in accordance with any applicable design approach at the discretion of the designer.

19.2.2* Adjacent Hazards or Design Methods.

For buildings with two or more adjacent hazards or design methods, the following shall apply:

(1) Where areas are not physically separated by a draft curtain, barrier, or partition capable of delaying heat from a fire in one area from fusing sprinklers in the adjacent area, the required sprinkler protection for the more demanding design basis shall extend 15 ft (4.6 m) beyond its perimeter.

(2) The requirements of 19.2.2(1) shall not apply where the areas are separated by a draft curtain, or barrier located above an aisle, where the aisle has a minimum 2 ft (600 mm) horizontal separation from the adjacent hazard on each side, or a partition that is capable of delaying heat from a fire in one area from fusing sprinklers in the adjacent area.

(3) The requirements of 19.2.2(1) shall not apply to the extension of more demanding criteria from an upper ceiling level to beneath a lower ceiling level where the difference in height between the ceiling levels is at least 2 ft (600 mm), located above an aisle, where the aisle has a minimum 2 ft (600 mm) horizontal separation from the adjacent hazard on each side.

19.2.3

For hydraulically calculated systems, the total system water supply requirements for each design basis shall be determined in accordance with the procedures of Section 27.2 unless modified by a section of Chapter ~~11~~ 19 or Chapter ~~12~~ 20 .

19.2.4 Water Demand.

19.2.4.1*

The water demand requirements shall be determined from the following:

(1) Occupancy hazard fire control approach and special design approaches of Chapter ~~11~~ 19

(2) Storage design approaches of Chapter ~~12~~ 20 through Chapter ~~20~~ 25

(3) Special occupancy approaches of Chapter ~~25~~ 26

19.2.4.2*

The minimum water demand requirements for a sprinkler system shall be determined by adding the hose stream allowance to the water demand for sprinklers.

19.2.5 Water Supplies.

19.2.5.1

The minimum water supply shall be available for the minimum duration specified in Chapter~~11~~ 19 .

19.2.5.2*

Tanks shall be sized to supply the equipment that they serve.

19.2.5.3*

Pumps shall be sized to supply the equipment that they serve.

19.2.6 Hose Allowance.

19.2.6.1 Systems with Multiple Hazard Classifications.

For systems with multiple hazard classifications, the hose stream allowance and water supply duration shall be in accordance with one of the following:

(1) The water supply requirements for the highest hazard classification within the system shall be used.

(2) The water supply requirements for each individual hazard classification shall be used in the calculations for the design area for that hazard.

(3)* For systems with multiple hazard classifications where the higher classification only lies within single rooms less than or equal to 400 ft^2 (37 m^2) in area with no such rooms adjacent, the water supply requirements for the principal occupancy shall be used for the remainder of the system.

19.2.6.2*

Water allowance for outside hose shall be added to the sprinkler requirement at the connection to the city main or a private fire hydrant, whichever is closer to the system riser.

19.2.6.3

Where inside hose connections are planned or are required, the following shall apply:

(1) A total water allowance of 50 gpm (190 L/min) for a single hose connection installation shall be added to the sprinkler requirements.

(2) A total water allowance of 100 gpm (380 L/min) for a multiple hose connection installation shall be added to the sprinkler requirements.

(3) The water allowance shall be added in 50 gpm (190 L/min) increments beginning at the most remote hose connection, with each increment added at the pressure required by the sprinkler system design at that point.

19.2.6.3.1

Where the system is a combined sprinkler/standpipe system (Class I or Class III) and the building is fully sprinklered in accordance with NFPA 13, no inside hose demand shall be required at any of the standpipe outlets.

19.2.6.4*

When hose valves for fire department use are attached to wet pipe sprinkler system risers in accordance with 16.15.2, the following shall apply:

(1) The sprinkler system demand shall not be required to be added to standpipe demand as determined from NFPA 14.

(2) Where the combined sprinkler system demand and hose stream allowance of Table 19.3.3.1.2 exceeds the requirements of NFPA 14, this higher demand shall be used.

(3) For partially sprinklered buildings, the sprinkler demand, not including hose stream allowance, as indicated in Figure 19.3.3.1.1 shall be added to the requirements given in NFPA 14.

19.2.7* High Volume Low Speed (HVLS) Fans.

The installation of HVLS fans in buildings equipped with sprinklers, including ESFR sprinklers, shall comply with the following:

(1) The maximum fan diameter shall be 24 ft (7.3 m).

(2) The HVLS fan shall be centered approximately between four adjacent sprinklers.

(3) The vertical clearance from the HVLS fan to sprinkler deflector shall be a minimum of 3 ft (0.9 m).

(4) All HVLS fans shall be interlocked to shut down immediately upon a waterflow alarm. Where the building is protected with a fire alarm system, this interlock shall be in accordance with the requirements of *NFPA 72*.

Submitter Information Verification

Submitter Full Name: AUT-SSD

Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Wed Jun 28 14:13:43 EDT 2017

Committee Statement

Committee Statement: In Sections 19.2, 19.2.3 and 19.2.4.1, the references are from the 2016 edition of the NFPA 13. These matters need to be revised to match the new chapter structure for the standard.

Response Message:

Public Comment No. 215-NFPA 13-2017 [Section No. 19.2]

Second Revision No. 1021-NFPA 13-2017 [Section No. 19.3.3.1.2.1]

~~19.3.3.1.2.1~~

~~The maximum design area for miscellaneous and low-piled storage shall be 3000 ft~~ ^{2} ~~(279 m~~ ^{2} ~~).~~

Submitter Information Verification

Submitter Full Name: AUT-SSD
Organization: National Fire Protection Assoc
Street Address:
City:
State:
Zip:
Submittal Date: Thu Aug 10 13:56:13 EDT 2017

Committee Statement

Committee Statement: This section has been deleted and the text has been relocated to Chapter 4.
Response Message:

Public Comment No. 172-NFPA 13-2017 [Section No. 19.3.3.1.2.1]

Second Revision No. 379-NFPA 13-2017 [Section No. 19.3.3.2.7]

19.3.3.2.7

Where K-11.2 (160) or larger sprinklers are used with ~~EH1 or EH2 design curves from Figure 13.2.1~~ Extra Hazard Group 1 or Extra Hazard Group 2 design curves and 19.3.3.1.1 , the design area shall be permitted to be reduced by 25 percent but not below 2000 ft^2 (186 m^2), regardless of temperature rating.

Submitter Information Verification

Submitter Full Name: AUT-SSD
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Thu Jun 29 15:07:39 EDT 2017

Committee Statement

Committee Statement: The exiting figure has been deleted and replaced with references in the standard.
Response Message:

Second Revision No. 309-NFPA 13-2017 [Section No. 19.3.3.2.3.1]

19.3.3.2.3.1

Where listed quick-response sprinklers, including extended coverage quick-response sprinklers, are used throughout a system or portion of a system having the same hydraulic design basis, the system area of operation shall be permitted to be reduced without revising the density as indicated in Figure 19.3.3.2.3.1 when all of the following conditions are satisfied:

(1) Wet pipe system

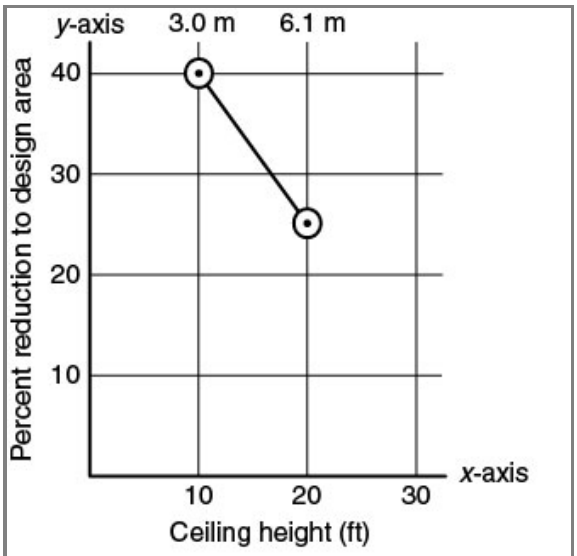
(2) Light hazard or ordinary hazard occupancy

(3) 20 ft (6.1 m) maximum ceiling height

(4) No unprotected ceiling pockets as allowed by 10.2.9 and ~~11.2.7~~ 11.2.8 exceeding 32 ft^2 (3.0 m^2)

(5) No unprotected areas above cloud ceilings as allowed by 9.2.7

Figure 19.3.3.2.3.1 Design Area Reduction for Quick-Response Sprinklers.



Note: $y = \frac{-3x}{2} + 55$ for U.S. Customary Uints

Note: $y = -4.8x + 54.6$ for S.I. Units

For ceiling height ≥10 ft and ≤20 ft, $y = \frac{-3x}{2} + 55$

For ceiling height <10 ft, $y = 40$

For ceiling height >20, $y = 0$

For SI units, 1 ft = 0.31 m.

Submitter Information Verification

Submitter Full Name: AUT-SSD
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Wed Jun 28 14:18:26 EDT 2017

Committee Statement

Committee Statement: In the figure that was re-drawn after the reorganization, the sign did not print correctly in the note, which alters the meaning of the figure incorrectly.

Response Message:

Public Comment No. 160-NFPA 13-2017 [Section No. 19.3.3.2.3.1]

Second Revision No. 1013-NFPA 13-2017 [Detail]

Relocate all of section 19.6, 19.7,19.8, and 19.9 to new Chapter 27 as request by the attached PC#68.

Supplemental Information

File Name	Description	Approved
13-SSD_SR-1013_order_for_new_Ch_27.docx	For staff use.	

Submitter Information Verification

Submitter Full Name: AUT-SSD
Organization: National Fire Protection Assoc
Street Address:
City:
State:
Zip:
Submittal Date: Tue Aug 01 08:03:21 EDT 2017

Committee Statement

Committee Statement: The hydraulic calculations should not be separated from the working plan requirements and should not be before the design approaches for storage. In the flow of the proposed new standard, the design approaches for storage are separated from the design approaches for light, ordinary and extra hazard occupancies by the calculation rules. That just does not flow correctly. It forces the user to circle backwards through the standard for storage protection.

Response Message:

Public Comment No. 68-NFPA 13-2017 [Sections 19.6, 19.7, 19.8, 19.9]

Second Revision No. 1003-NFPA 13-2017 [Section No. 20.5.2]

~~**20.5.2** Palletized Storage.~~

~~On floor storage of commodities on pallets or other storage aids that form horizontal spaces between tiers of storage shall be considered as palletized storage.~~

~~**20.5.2.1** Closed Array.~~

~~Where the vertical flues between pallet loads are 6 in. (152 mm) or less, the arrangement shall be considered closed array.~~

~~**20.5.2.2** Open Array.~~

~~Where the vertical flues between pallet loads are greater than 6 in. (152 mm), the arrangement shall be considered open array.~~

~~**20.5.2.3** Pile Stability, Stable Piles.~~

~~Those arrays where collapse, spillage of contents, or leaning of stacks across flue spaces is not likely to occur soon after initial fire development shall be considered as stable piles.~~

~~**20.5.2.4*** Pile Stability, Unstable Piles.~~

~~Those arrays where collapse, spillage of contents, or leaning of stacks across flue spaces occurs soon after initial fire development shall be considered as unstable piles.~~

~~**A.20.5.2.4**~~

~~Few commodities are anticipated to form unstable piles. An example of a commodity that has demonstrated in full-scale fire tests a behavior of progressively collapsing soon after a fire develops is uncartoned, empty, plastic, beverage bottles. Care should be exercised when applying the favorable protection allowance for unstable piles. Few commodities are likely to display unstable pile behavior.~~

Submitter Information Verification

Submitter Full Name: AUT-SSD
Organization: National Fire Protection Assoc
Street Address:
City:
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Zip:
Submittal Date: Fri Jul 28 10:03:30 EDT 2017

Committee Statement

Committee Statement: Duplicate From Chapter 3.3.8.1. Belongs in Chapter 3
Response Message:

Public Comment No. 238-NFPA 13-2017 [Section No. 20.5.2.4]
Public Comment No. 237-NFPA 13-2017 [Section No. 20.5.2.3]
Public Comment No. 235-NFPA 13-2017 [Section No. 20.5.2.1]
Public Comment No. 236-NFPA 13-2017 [Section No. 20.5.2.2]
Public Comment No. 233-NFPA 13-2017 [Section No. 20.5.2 [Excluding any Sub-Sections]]

Second Revision No. 310-NFPA 13-2017 [Section No. 20.3.1 [Excluding any Sub-Sections]]

Commodity classification and the corresponding protection requirements shall be determined based on the makeup of individual storage units~~, pallet load, or module held together in some manner and normally transported by material-handling equipment~~ .

Supplemental Information

File Name	Description	Approved
13_SSI_SR-310_A.20.3.1.docx	Annex changes	

Submitter Information Verification

Submitter Full Name: AUT-SSD
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Wed Jun 28 14:24:06 EDT 2017

Committee Statement

Committee Statement: The intent of this Comment is to return the text to that from the 2016 edition of NFPA 13. In the First Draft Report, Section 20.3.1 it states that a commodity must be held together and normally transported by material handling equipment. This is very limiting and does not match the reality of many typical storage configurations. Shelf storage, solid piles, loose cartons/containers placed on racks and bin box storage do not fit that profile, so the new text should not be accepted.

Response Message:

Public Comment No. 227-NFPA 13-2017 [Section No. 20.3.1 [Excluding any Sub-Sections]]

SR-310, SSD

A.20.3.1

~~Commodity classification and the corresponding protection requirements shall be determined based on the makeup of individual storage units.~~Unit loads and pallet loads are examples of individual storage units.

Second Revision No. 311-NFPA 13-2017 [Section No. 20.3.2.5]

20.3.2.5 Slave Pallet.

Where solid, flat-bottom, combustible pallets are used for rack storage of Class I through IV commodity up to 25 ft (7.6 m) in height in combination with CMDA sprinklers, ~~Section~~ 21.4.1.4.2 shall apply. *(See ~~Figure A.3.9.1.10.~~ Figure A.3.3.148.1 .)*

Submitter Information Verification

Submitter Full Name: AUT-SSD
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Street Address:
City:
State:
Zip:
Submittal Date: Wed Jun 28 14:29:29 EDT 2017

Committee Statement

Committee Statement: The reference in Chapter 20 did not seem correct. I believe that the intent was to reference the one section where we tell the user what to do with slave pallets, which ended up in Chapter 21. However, this section in Chapter 21 only applies to rack storage up to 25 ft in height of Class I - IV commodities. For other commodities, we have never required an increase in ceiling sprinkler design (probably because there were in-rack sprinklers involved). During the rewrite, there was a decision to insert a warning in the "General" chapter, but we should not make new requirements for all storage when we do that.

Response Message:

Public Comment No. 169-NFPA 13-2017 [Section No. 20.3.2.5]

Second Revision No. 394-NFPA 13-2017 [Section No. 20.3.3]

20.3.3 Open-Top Container.

A container of any shape that is entirely or partially open on the top and arranged so as to allow for the collection of discharging sprinkler water cascading through the storage array shall be considered outside the protection criteria of rack storage protection outlined in Chapters 21 through ~~24~~ 25.

Submitter Information Verification

Submitter Full Name: AUT-SSD
Organization: [Not Specified]
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City:
State:
Zip:
Submittal Date: Fri Jul 14 12:26:27 EDT 2017

Committee Statement

Committee Statement: Editorial revision.
Response Message:

Second Revision No. 312-NFPA 13-2017 [Section No. 20.3.5]

~~20.3.5~~ ~~Encapsulation.~~

Submitter Information Verification

Submitter Full Name: AUT-SSD
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Wed Jun 28 14:52:21 EDT 2017

Committee Statement

Committee Statement: Deleted section without requirements.
Response Message:

Second Revision No. 397-NFPA 13-2017 [Section No. 20.4.3.3]

20.4.3.3

Class III commodities containing a mix of both Group A expanded and nonexpanded plastics shall comply with Figure 20.4.3.3(a) where they are within cartons, boxes, or crates or with Figure 20.4.3.3(b) where they are exposed.

Figure 20.4.3.3(a) Commodities, Cartoned or Within a Wooden Container, Containing a Mixture of Expanded and Nonexpanded Group A Plastics.

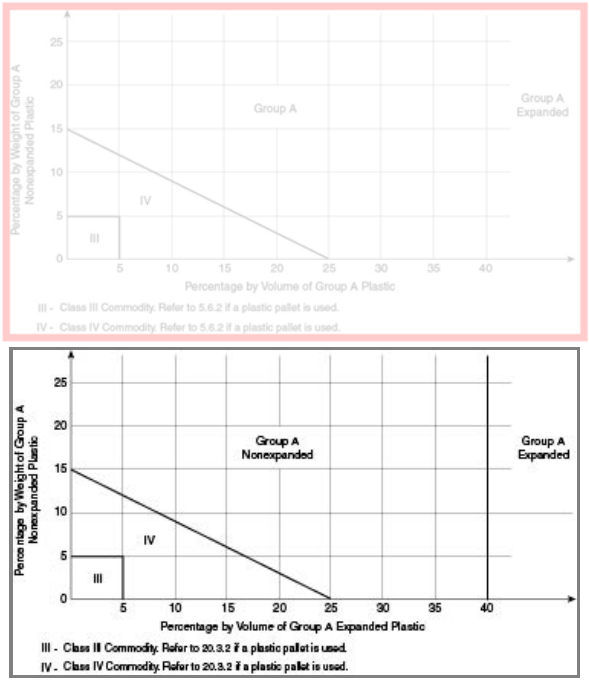
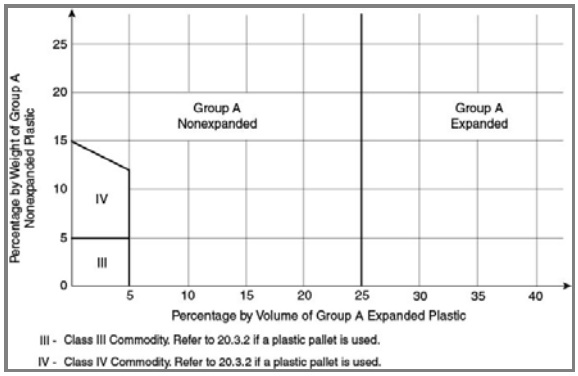


Figure 20.4.3.3(b) Exposed Commodities Containing a Mixture of Expanded and Nonexpanded Group A Plastics.



Supplemental Information

File Name	Description	Approved
Figure_20.4.3.3_a_and_Figure_20.4.3.3_b.docx	Figure_20.4.3.3_a_and_Figure_20.4.3.3_b--for staff use	

Submitter Information Verification

Submitter Full Name: AUT-SSD
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Street Address:
City:
State:
Zip:
Submittal Date: Fri Jul 14 14:37:28 EDT 2017

Committee Statement

Committee Statement: Align Figures with TIA 1183 and 1184 and as shown on attached word doc.
Response Message:

Second Revision No. 398-NFPA 13-2017 [Section No. 20.4.4.2]

20.4.4.2

The remaining materials shall be permitted to be ~~metal~~ noncombustible , wood, paper, natural ~~or synthetic~~ fibers, or Group B or Group C plastics.

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Submitter Full Name: AUT-SSD
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Street Address:
City:
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Zip:
Submittal Date: Fri Jul 14 14:51:32 EDT 2017

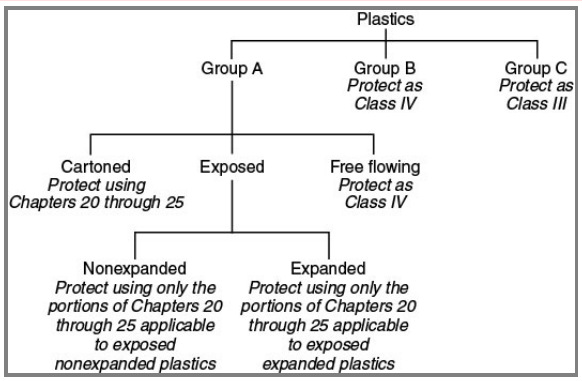
Committee Statement

Committee Statement: Editorial revision to align with TIA 1183 and 1184.
Response Message:

Second Revision No. 382-NFPA 13-2017 [Section No. 20.4.8 [Excluding any Sub-Sections]]

Plastic commodities shall be protected in accordance with Figure 20.4.8. *(See Section C.21.)*

Figure 20.4.8 Decision Tree.



Submitter Information Verification

Submitter Full Name: AUT-SSD
Organization: [Not Specified]
Street Address:
City:
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Zip:
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Committee Statement

Committee Statement: Revise figure reference Chapter 17 to Chapters 20 through 25 due to reorg of document.
Response Message:

Second Revision No. 341-NFPA 13-2017 [Section No. 20.5.3]

~~**20.5.3** Solid-Piled Storage.~~

~~Storage of commodities stacked on each other shall be considered as solid piled storage.~~

~~**20.5.3.1** Closed Array.~~

~~Where solid piled storage has vertical flues between the piles of 6 in. (152 mm) or less, the storage arrangement shall be considered as closed array.~~

~~**20.5.3.2** Open Array.~~

~~Where solid piled storage has vertical flues between the piles that are greater than 6 in. (152 mm), the storage arrangement shall be considered as open array.~~

~~**20.5.3.3** Pile Stability, Stable Piles.~~

~~Those arrays where collapse, spillage of content, or leaning of stacks across flue spaces is not likely to occur soon after initial fire development shall be considered as stable piles.~~

~~**20.5.3.4*** Pile Stability, Unstable Piles.~~

~~Those arrays where collapse, spillage of contents, or leaning of stacks across flue spaces occurs soon after initial fire development shall be considered as unstable piles.~~

~~**A.20.5.3.4**~~

~~Few commodities are anticipated to form unstable piles. An example of a commodity that has demonstrated in full-scale fire tests a behavior of progressively collapsing soon after a fire develops is uncartoned, empty, plastic, beverage bottles. Care should be exercised when applying the favorable protection allowance for unstable piles. Few commodities are likely to display unstable pile behavior.~~

Submitter Information Verification

Submitter Full Name: AUT-SSD
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Street Address:
City:
State:
Zip:
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Committee Statement

Committee Statement: All of these definitions are found in Chapter 3 and are duplicates. They belong in Chapter 3.
Response Message:

Public Comment No. 240-NFPA 13-2017 [Section No. 20.5.3]

Public Comment No. 239-NFPA 13-2017 [Section No. 20.5.3 [Excluding any Sub-Sections]]

Second Revision No. 342-NFPA 13-2017 [Section No. 20.5.4]

20.5.4 ~~Bin Box Storage.~~

~~Storage in five-sided wood, metal, or cardboard boxes with open face on the aisles in which boxes are self-supporting or supported by a structure so designed that little or no horizontal or vertical space exists around boxes shall be considered as bin box storage.~~

Submitter Information Verification

Submitter Full Name: AUT-SSD
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
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Committee Statement

Committee Statement: Duplicate From Chapter 3.3.18. Belongs in Chapter 3
Response Message:

Public Comment No. 241-NFPA 13-2017 [Section No. 20.5.4]

Second Revision No. 343-NFPA 13-2017 [Section No. 20.5.5]

20.5.5 ~~Shelf Storage.~~

~~Storage on structures up to and including 30 in. (0.76 m) deep and separated by aisles at least 30 in. (0.76 m) wide shall be considered as shelf storage.~~

Submitter Information Verification

Submitter Full Name: AUT-SSD
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Wed Jun 28 21:32:57 EDT 2017

Committee Statement

Committee Statement: Duplicate From Chapter 3.3.189. Belongs in Chapter 3
Response Message:

Public Comment No. 242-NFPA 13-2017 [Section No. 20.5.5]

Second Revision No. 344-NFPA 13-2017 [Section No. 20.5.6]

20.5.6 ~~Back-to-Back Shelf Storage.~~

~~Two solid or perforated shelves up to 30 in. (0.76 m) in depth each, not exceeding a total depth of 60 in. (1.52 m), separated by a longitudinal vertical barrier such as plywood, particleboard, sheet metal, or equivalent, with a maximum 0.25 in. (6.4 mm) diameter penetrations and no longitudinal flue space and a maximum storage height of 15 ft (4.57 m) shall be considered as back-to-back storage.~~

Submitter Information Verification

Submitter Full Name: AUT-SSD
Organization: [Not Specified]
Street Address:
City:
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Zip:
Submittal Date: Wed Jun 28 21:35:40 EDT 2017

Committee Statement

Committee Statement: Duplicate From Chapter 3.3.13. Belongs in Chapter 3
Response Message:

Public Comment No. 243-NFPA 13-2017 [Section No. 20.5.6]

Second Revision No. 345-NFPA 13-2017 [Section No. 20.5.7 [Excluding any Sub-Sections]]

~~Racks on fixed rails or guides that can be moved back and forth only in a horizontal, two-dimensional plane shall be protected as movable racks.~~ Rack storage in movable racks shall be protected in the same manner as multiple-row racks.

Submitter Information Verification

Submitter Full Name: AUT-SSD
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
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Committee Statement

Committee Statement: Duplicate From Chapter 3.3.126. Belongs in Chapter 3.
Response Message:

Public Comment No. 244-NFPA 13-2017 [Section No. 20.5.7 [Excluding any Sub-Sections]]

Second Revision No. 346-NFPA 13-2017 [Section No. 20.5.8.1]

~~**20.5.8.1** Open Rack.~~

~~Racks without shelving or with shelving in racks that are fixed in place with shelves having a solid surface and a shelf area equal to or less than 20 ft^2 (1.9 m^2) or with shelves having a wire mesh, slatted surface, or other material with openings representing at least 50 percent of the shelf area, including the horizontal area of rack members and where the flue spaces are maintained, shall be protected as open rack.~~

Submitter Information Verification

Submitter Full Name: AUT-SSD
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Wed Jun 28 21:38:45 EDT 2017

Committee Statement

Committee Statement: Duplicate From Chapter 3.3.141. Belongs in Chapter 3
Response Message:

Public Comment No. 246-NFPA 13-2017 [Section No. 20.5.8.1]

Second Revision No. 347-NFPA 13-2017 [Section No. 20.5.8.2]

20.5.3.1 Shelving.

20.5.3.1.1

Shelving material that is less than 50 percent open, or placement of loads that block openings that would otherwise serve as the required flue spaces, greater than 20 ft^2 (1.9 m^2) in area shall be treated as solid shelf racks.

20.5.3.1.2

Where multiple-row racks of any height have no longitudinal flue or where double-row racks with storage up 25 ft (7.6 m) in height have no longitudinal flue, the situation shall not be considered solid shelves where transverse flues exist at maximum 5 ft (1.5 m) intervals, and additional in-rack sprinklers shall not be required in accordance with ~~16.1.6.1~~ 25.6.3.1 and ~~16.1.6.2~~ 25.6.3.2 .

~~**20.5.8.2.1** Rack Shelf Area.~~

~~The area of the horizontal surface of a shelf in a rack defined by perimeter aisle(s) or nominal 6 in. (152 mm) flue spaces on all four sides, or by the placement of loads that block openings that would otherwise serve as the required flue spaces, shall be considered to determine the rack shelf area.~~

~~**20.5.8.2.2** Slatted Shelf Rack.~~

~~A rack where shelves are fixed in place with a series of narrow individual solid supports used as the shelf material and spaced apart with regular openings shall be protected as a slatted shelf rack.~~

~~**20.5.8.2.3** Solid Shelf Rack.~~

~~A rack that is not defined as an open rack where shelves are fixed in place with a solid, slatted, or wire mesh barrier used as the shelf material and having limited openings in the shelf area shall be protected as a solid shelf rack.~~

~~**20.5.8.2.4** Solid Shelving.~~

~~The area of a shelf shall be measured by perimeter aisle or flue space on all four sides or by the placement of loads that block openings that would otherwise serve as the required flue spaces.~~

Submitter Information Verification

Submitter Full Name: AUT-SSD
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Wed Jun 28 21:40:42 EDT 2017

Committee Statement

Committee Statement: Duplicate information in Chapter 3. Belongs in Chapter 3. Revisions to references to the correct locations.
Response Message:

Public Comment No. 248-NFPA 13-2017 [Section No. 20.5.8.2]

Second Revision No. 348-NFPA 13-2017 [Section No. 20.5.8.3.2]

~~**20.5.8.3.2** Aisle Width.~~

~~The horizontal dimension between the face of the loads in racks under consideration shall determine the aisle width for protection criteria.~~

Submitter Information Verification

Submitter Full Name: AUT-SSD
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Wed Jun 28 21:42:34 EDT 2017

Committee Statement

Committee Statement: Duplicate From Chapter 3.3.4. Belongs in Chapter 3.

Response Message:

Public Comment No. 257-NFPA 13-2017 [Section No. 20.5.8.3.2]

Second Revision No. 349-NFPA 13-2017 [Section No. 20.5.8.4.1 [Excluding any Sub-Sections]]

~~The space between rows of storage perpendicular to the direction of loading with a width not exceeding 24 in. (610 mm) between storage shall be considered as the longitudinal flue.~~

Submitter Information Verification

Submitter Full Name: AUT-SSD
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Wed Jun 28 21:44:21 EDT 2017

Committee Statement

Committee Statement: Duplicate From Chapter 3.3.118. Belongs in Chapter 3.
Response Message:

Public Comment No. 258-NFPA 13-2017 [Section No. 20.5.8.4.1 [Excluding any Sub-Sections]]

Second Revision No. 350-NFPA 13-2017 [Section No. 20.5.8.4.2 [Excluding any Sub-Sections]]

~~The space between rows of storage parallel to the direction of loading shall be considered as the transverse flue.~~ ~~*(See Figure A.3.9.3.6.)*~~

Submitter Information Verification

Submitter Full Name: AUT-SSD
Organization: [Not Specified]
Street Address:
City:
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Submittal Date: Wed Jun 28 21:46:20 EDT 2017

Committee Statement

Committee Statement: Duplicate From Chapter 3.3.221. Belongs in Chapter 3.
Response Message:

Public Comment No. 259-NFPA 13-2017 [Section No. 20.5.8.4.2 [Excluding any Sub-Sections]]

Second Revision No. 351-NFPA 13-2017 [Section No. 20.5.8.5]

~~**20.5.8.5** Bulkhead.~~

~~A vertical barrier across the rack shall be considered a bulkhead.~~

Submitter Information Verification

Submitter Full Name: AUT-SSD
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Wed Jun 28 21:47:52 EDT 2017

Committee Statement

Committee Statement: Duplicate from Chapter 3.3.20. Belongs in Chapter 3
Response Message:

Public Comment No. 260-NFPA 13-2017 [Section No. 20.5.8.5]

Second Revision No. 352-NFPA 13-2017 [Section No. 20.5.8.6]

~~20.5.8.6~~ ~~Horizontal Barrier.~~

~~A solid barrier in the horizontal position covering the entire rack, including all flue spaces at certain height increments, to prevent vertical fire spread shall be considered a horizontal barrier.~~

Submitter Information Verification

Submitter Full Name: AUT-SSD
Organization: [Not Specified]
Street Address:
City:
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Zip:
Submittal Date: Wed Jun 28 21:50:32 EDT 2017

Committee Statement

Committee Statement: Duplicate from Chapter 3.3.97. Belongs in Chapter 3
Response Message:

Public Comment No. 261-NFPA 13-2017 [Section No. 20.5.8.6]

Second Revision No. 353-NFPA 13-2017 [Section No. 20.5.8.7]

~~**20.5.8.7** Single-Row Racks.~~

~~Racks that have no longitudinal flue space and that have a depth up to 6 ft (1.8 m) with aisles having a width of at least 3.5 ft (1.1 m) between loads on racks shall be protected as single-row racks.~~

Submitter Information Verification

Submitter Full Name: AUT-SSD
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Wed Jun 28 21:52:31 EDT 2017

Committee Statement

Committee Statement: Duplicate from Chapter 3.3.192. Belongs in Chapter 3
Response Message:

Public Comment No. 262-NFPA 13-2017 [Section No. 20.5.8.7]

Second Revision No. 354-NFPA 13-2017 [Section No. 20.5.8.8]

~~**20.5.8.8** Double-Row Racks.~~

~~Racks less than or equal to 12 ft (3.7 m) in depth or single-row racks placed back to back having an aggregate depth up to 12 ft (3.7 m), with aisles having an aisle width of at least 3.5 ft (1.1 m) between loads on racks shall be protected as double-row racks.~~

Submitter Information Verification

Submitter Full Name: AUT-SSD
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Wed Jun 28 21:54:14 EDT 2017

Committee Statement

Committee Statement: Duplicate from Chapter 3.3.57. Belongs in Chapter 3
Response Message:

Public Comment No. 263-NFPA 13-2017 [Section No. 20.5.8.8]

Second Revision No. 355-NFPA 13-2017 [Section No. 20.5.8.9]

~~**20.5.8.9** Multiple-Row Racks.~~

~~Racks greater than 12 ft (3.7 m) in depth or single- or double-row racks separated by aisles less than 3.5 ft (1.1 m) wide having an overall width greater than 12 ft (3.7 m) shall be protected as multiple-row racks.~~

Submitter Information Verification

Submitter Full Name: AUT-SSD
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Wed Jun 28 21:56:05 EDT 2017

Committee Statement

Committee Statement: Duplicate from Chapter 3.3.128. Belongs in Chapter 3
Response Message:

Public Comment No. 264-NFPA 13-2017 [Section No. 20.5.8.9]

Second Revision No. 356-NFPA 13-2017 [Section No. 20.5.8.10]

~~**20.5.8.10** Movable Racks.~~

~~Racks on fixed rails or guides that can be moved back and forth only in a horizontal, two-dimensional plane shall be protected as movable racks.~~

Submitter Information Verification

Submitter Full Name: AUT-SSD
Organization: [Not Specified]
Street Address:
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State:
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Committee Statement

Committee Statement: Duplicate from Chapter 3.3.126. Belongs in Chapter 3
Response Message:

Public Comment No. 265-NFPA 13-2017 [Section No. 20.5.8.10]

Second Revision No. 357-NFPA 13-2017 [Section No. 20.5.8.11]

~~**20.5.8.11** Portable Racks.~~

~~Racks that are not fixed in place and can be arranged in any number of configurations shall be protected as portable racks.~~

Submitter Information Verification

Submitter Full Name: AUT-SSD
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Wed Jun 28 22:00:07 EDT 2017

Committee Statement

Committee Statement: Duplicate from Chapter 3.3.158. Belongs in Chapter 3
Response Message:

Public Comment No. 266-NFPA 13-2017 [Section No. 20.5.8.11]

Second Revision No. 358-NFPA 13-2017 [Section No. 20.5.9]

20.5.4 Rubber Tires.

~~Paragraphs 20.5.9.1 through 20.5.9.7 cover the general terms of rubber tire storage that identify which type of protection criteria shall be used in Chapters 21 to 24.~~

~~20.5.9.1~~ ~~Banded Tires.~~

~~When tires are strapped together, they shall be considered as banded.~~

~~20.5.9.2~~ ~~Horizontal Channel.~~

~~Any uninterrupted space in excess of 5 ft (1.5 m) in length between horizontal layers of stored tires shall be considered as the horizontal channel.~~

~~20.5.9.3~~ ~~Laced Tire Storage.~~

~~Tires stored where the sides of the tires overlap, creating a woven or laced appearance, shall be considered as laced tire storage. *[See Figure A.3.9.4.9(g).]*~~

~~20.5.9.4~~ ~~On-Side Tire Storage.~~

~~Tires stored horizontally or flat shall be considered as on-side storage.~~

~~20.5.9.5~~ ~~On-Tread Tire Storage.~~

~~Tires stored vertically or on their treads shall be considered as on-tread storage.~~

~~20.5.9.6~~ ~~Palletized Tire Storage.~~

~~Storage on portable racks of various types utilizing a conventional pallet as a base shall be considered as palletized storage.~~

~~20.5.9.7~~ ~~Pyramid Tire Storage.~~

~~On-floor storage in which tires are formed into a pyramid to provide pile stability shall be considered as pyramid storage.~~

20.5.4.1 Water Supplies.

Total water supplies shall be capable of providing flow for automatic sprinklers, hose streams, and foam systems (if provided) for the duration required in Table 20.12.2.6.

Submitter Information Verification

Submitter Full Name: AUT-SSD
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Wed Jun 28 22:02:17 EDT 2017

Committee Statement

Committee Statement: Duplicate definitions from Chapter 3. Belongs in Chapter 3
Response Message:

Public Comment No. 267-NFPA 13-2017 [Section No. 20.5.9]

Second Revision No. 359-NFPA 13-2017 [Section No. 20.5.10]

20.5.5 Roll Paper.

~~Paragraphs 20.5.9.1 through 20.5.9.11 cover the general terms of roll paper that identify which type of protection criteria shall be used in Chapters 21 through 24.~~

20.5.10.1 ~~Paper.~~

~~Storage of all kinds of felted sheets made from natural fibrous materials, usually vegetable but sometimes mineral or animal, and formed on a fine wire screen from water suspension, where stored in rolled form shall be protected as roll paper storage.~~

20.5.10.2 ~~Closed Array (Paper).~~

~~Where a vertical storage arrangement in which the distances between columns in both directions are short [not more than 2 in. (50 mm) in one direction and 1 in. (25 mm) in the other], the storage array shall be considered as closed array.~~

20.5.10.3 ~~Open Array (Paper).~~

~~Where a vertical storage arrangement in which the distance between columns in both directions is lengthy (all vertical arrays other than closed or standard), the storage array shall be considered as open array.~~

20.5.10.4 ~~Standard Array (Paper).~~

~~Where a vertical storage arrangement in which the distance between columns in one direction is short [1 in. (25 mm) or less] and is in excess of 2 in. (50 mm) in the other direction, the storage array shall be considered as standard array.~~

20.5.10.5 ~~Banded Roll Paper Storage.~~

~~Where rolls are provided with a circumferential steel strap [⅜ in. (9.5 mm) or wider] at each end of the roll, the rolls shall be considered banded.~~

20.5.10.6 ~~Column.~~

~~A single vertical stack of rolls shall be considered a column.~~

20.5.10.7 ~~Core.~~

~~The central tube around which paper is wound to form a roll shall be considered as the core.~~

20.5.10.8 ~~Horizontal Roll Paper Storage.~~

~~Rolls stored with the cores in the horizontal plane (on-side storage) shall be considered as horizontal storage.~~

20.5.10.9 ~~Vertical Roll Paper Storage.~~

~~Rolls stored with the cores in the vertical plane (on-end storage) shall be considered as vertical storage.~~

20.5.10.10 ~~Wrapped Roll Paper Storage.~~

~~Rolls provided with a complete heavy kraft covering around both sides and ends shall be considered as wrapped storage.~~

20.5.10.11 ~~Roll Paper Storage Height.~~

~~The maximum vertical distance above the floor at which roll paper is normally stored shall be considered as the storage height.~~

20.5.5.1* Protection Criteria for Roll Paper Storage.

20.5.5.2

Wet pipe systems shall be used in tissue storage areas.

20.5.5.2.1

The water supply design shall include the demand of the automatic sprinkler system plus the hose stream allowance plus, where provided, the high-expansion foam system for the duration specified in Table 20.12.2.6.

20.5.5.3

Horizontal storage of heavyweight or mediumweight paper shall be protected as a closed array.

20.5.5.4

Mediumweight paper shall be permitted to be protected as heavyweight paper where wrapped completely on the sides and both ends, or where wrapped on the sides only with steel bands. Wrapping material shall be either a single layer of heavyweight paper with a basis weight of 40 lb (18.1 kg) or two layers of heavyweight paper with a basis weight of less than 40 lb (18.1 kg).

20.5.5.5

Lightweight paper or tissue paper shall be permitted to be protected as mediumweight paper where wrapped completely on the sides and both ends, or where wrapped on the sides only with steel bands. Wrapping material shall be either a single layer of heavyweight paper with a basis weight of 40 lb (18.1 kg) or two layers of heavyweight paper with a basis weight of less than 40 lb (18.1 kg).

20.5.5.6

For purposes of sprinkler system design criteria, lightweight class paper shall be protected as tissue.

Submitter Information Verification

Submitter Full Name: AUT-SSD
Organization: [Not Specified]
Street Address:
City:
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Committee Statement

Committee Statement: Duplicate definitions from Chapter 3. Belongs in Chapter 3
Response Message:

Public Comment No. 268-NFPA 13-2017 [Section No. 20.5.10]

Second Revision No. 360-NFPA 13-2017 [Section No. 20.5.11]

20.5.6 Plastic Motor Vehicle Components.

Group A plastic automotive components and associated packaging material consisting of exposed, expanded Group A plastic dunnage, instrument panels, and plastic bumper fascia shall be permitted to be protected as defined in Chapter 23.

20.5.6.1

Automotive components covered in this section shall not include the storage of air bags, tires, and seats on portable racks. ~~Paragraphs 20.5.11.1 through 20.5.11.3 cover the general terms of plastic motor vehicle components that identify which protection criteria shall be used in Chapter 23.~~

~~**20.5.6.2** Automotive Components on Portable Racks.~~

~~Instrument panels, windshields, metal and plastic gasoline tanks, heater housings, door panels, interior trim, bumper fascia, wiring harnesses, sheet metal, body components, engines, driveline components, steering mechanisms, auxiliary motors, and lighting, all with or without expanded Group A plastic dunnage, shall be permitted to be protected as automotive components in Chapter 23.~~

~~**20.5.6.3** Closed Array.~~

~~Where portable racks have vertical flues between the racks that are 6 in. (152 mm) or less, the storage arrangement shall be considered as closed array.~~

Submitter Information Verification

Submitter Full Name: AUT-SSD
Organization: [Not Specified]
Street Address:
City:
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Submittal Date: Wed Jun 28 22:06:28 EDT 2017

Committee Statement

Committee Statement: Duplicate from Chapter 3. Belongs in Chapter 3
Response Message:

Public Comment No. 269-NFPA 13-2017 [Section No. 20.5.11]

Second Revision No. 361-NFPA 13-2017 [Section No. 20.5.12]

~~**20.5.7** Retail Display/Storage.~~

~~Paragraph 20.5.7.1 covers the general terms of retail display/storage that identify which type of protection criteria shall be used in Chapters 21 through 24.~~

Submitter Information Verification

Submitter Full Name: AUT-SSD
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Wed Jun 28 22:08:32 EDT 2017

Committee Statement

Committee Statement: This paragraph has no bearing in this location. Paragraph 20.5.7.1 deals with movable rack only, and is currently addressed.
Response Message:

Public Comment No. 270-NFPA 13-2017 [Section No. 20.5.12]

Second Revision No. 362-NFPA 13-2017 [Section No. 20.5.13]

~~**20.5.8** Baled Cotton Storage.~~

~~Paragraph 20.5.13.1 covers the general terms of baled cotton storage that identify which type of protection criteria shall be used in Chapter 21.~~

~~**20.5.8.1** Tiered Storage.~~

~~An arrangement in which bales are stored directly on the floor, two or more bales high, shall be considered as tiered storage.~~

Submitter Information Verification

Submitter Full Name: AUT-SSD
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Wed Jun 28 22:10:42 EDT 2017

Committee Statement

Committee Statement: Paragraph 20.5.13.1 is currently defined in Chapter 3. This definition belongs in Chapter 3. Chapter 21 defines the protection requirements.
Response Message:

Public Comment No. 271-NFPA 13-2017 [Section No. 20.5.13]

Second Revision No. 314-NFPA 13-2017 [Section No. 20.5.14]

~~**20.5.9** Cartoned Record Storage.~~

~~Paragraphs 20.5.14.1 and 20.5.14.2 cover the general terms of cartoned record storage that identify which type of rack and shelving criteria shall be used in Chapters 21 through 24.~~

~~**20.5.9.1** Cartoned Records Storage.~~

~~The protection criteria in Chapter 21 for cartoned records storage shall be based on a Class III commodity consisting predominantly of paper records in cardboard cartons.~~

~~**20.5.9.2*** Catwalk.~~

~~For the purposes of cartoned records storage, catwalks shall be considered a storage aid consisting of either open metal grating or solid horizontal barriers supported from a rack storage system that is utilized as a walkway for access to storage at elevated levels.~~

~~**A.20.5.14.2**~~

~~Catwalks are accessed using stairs and are not separate floors of a building.~~

Submitter Information Verification

Submitter Full Name: AUT-SSD
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
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Committee Statement

Committee Statement: The Protection Criteria is provided in Chapter 21 and Definitions are currently located in Chapter 3.

Response Message:

Public Comment No. 272-NFPA 13-2017 [Section No. 20.5.14]

Second Revision No. 313-NFPA 13-2017 [Section No. 20.6.4.2]

20.6.4.3

Protection of Class I through Class IV commodities ~~with excessive clearance from the top of storage to the ceiling sprinkler deflectors~~ using CMDA criteria that exceed the maximum allowable clearance in Table 20.6.4.2 shall be in accordance with Table 20.6.4.3.

Table 20.6.4.3 Class I Through Class IV Commodities

Storage Configuration	Where the clearance to ceiling exceeds	Protection is based upon the storage height that would result in a clearance to ceiling of…	In-rack Sprinklers*
Palletized, solid-piled, bin box, shelf, or back-to-back shelf storage	20 ft (6.1 m)	20 ft (6.1 m)	N/A
Rack storage up to and including 25 ft (7.6 m) in height	20 ft (6.1 m)	20 ft (6.1 m)	Permitted as alternative to presumed clearance of 20 ft (6.1 m)
Rack storage over 25 ft (7.6 m) in height	10 ft (3.1 m)	10 ft (3.1 m)	Permitted as alternative to presumed clearance of 10 ft (3.1 m)

*When applying the supplemental in-rack sprinkler option, the ceiling density is based upon the given storage height with an assumed acceptable clearance to ceiling. Provide one level of supplemental, quick response in-rack sprinklers located directly below the top tier of storage and at every flue space intersection.

Submitter Information Verification

Submitter Full Name: AUT-SSD
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
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Committee Statement

Committee Statement: This eliminates the use of the word "excessive", which is not enforceable and clarifies that this rule only applies to CMDA approaches. The Tables for CMSA and ESFR sprinklers handle the maximum clearance situation in a much better manner and do not need to be addressed in this general section.

Response Message:

Public Comment No. 186-NFPA 13-2017 [Section No. 20.6.4.2]

Second Revision No. 315-NFPA 13-2017 [Section No. 20.6.4.3]

20.6.4.4

Protection of plastic and rubber commodities with ~~excessive~~ CMDA criteria having clearance ~~from~~ exceeding the ~~top of storage to the ceiling sprinkler deflectors~~ allowable limits of Table 20.6.4.3 shall be in accordance with Table 20.6.4.4.

Table 20.6.4.4 Plastics and Rubber Commodities

Storage Configuration	Where the clearance to ceiling exceeds	Protection is based upon the storage height that would result in a clearance to ceiling of…	In-rack Sprinklers*
Palletized, solid-piled, bin box, shelf, or back-to-back shelf storage	20 ft (6.1 m)	20 ft (6.1 m)	N/A
Rack storage up to and including 25 ft (7.6 m) in height	10 ft (3.1 m)	10 ft (3.1 m)	Permitted as alternative to presumed clearance of 10 ft (3.1 m)
Rack storage over 25 ft (7.6 m) in height	10 ft (3.1 m)	N/A	Required

*If in-rack sprinklers are required for the actual storage height with an acceptable clearance to ceiling, in-rack sprinklers are installed as indicated by that criteria. Provide one level of supplemental, quick response in-rack sprinklers located directly below the top tier of storage and at every flue space intersection.

Submitter Information Verification

Submitter Full Name: AUT-SSD
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Wed Jun 28 15:05:01 EDT 2017

Committee Statement

Committee Statement: This eliminates the use of the word "excessive", which is not enforceable and clarifies that these maximum clearance rules only apply to spray sprinklers using CMDA criteria. The situation with CMSA and ESFR sprinklers is handled much better in the Tables in Chapters 22 and 23 and does not need to be addressed here. Also, this helps to clarify that it is the ceiling clearance being calculated here, not the sprinkler clearance. The difference can be about 22 inches depending on the type of construction of the ceiling, and we have gone to great lengths to tell people how to measure this in previous parts of this section.

Response Message:

Public Comment No. 190-NFPA 13-2017 [Section No. 20.6.4.3]

Second Revision No. 316-NFPA 13-2017 [Section No. 20.6.4.4]

20.6.4.2

For ~~spray sprinkler~~ CMDA criteria where the clearance to ceiling exceeds those identified in Table 20.6.4.2, the requirements of ~~20.6.4.5 through 20.6.4.10~~ Table 20.6.4.3 and Table 20.6.4.4 shall apply.

Table 20.6.4.2 Maximum Clearance from Top of Storage to Ceiling for CMDA Protection Criteria

Commodity	Class I to IV	Group A Plastic
Palletized, solid-piled, bin box, ~~Shelf~~ shelf, or back-to-back shelf storage	20 ft (6.1 m)	20 ft (6.1 m)
Rack storage up to 25 ft (7.6 m)	20 ft (6.1 m)	10 ft (3.1 m)
Rack storage >25 ft (7.6 m)	10 ft (3.1 m)	10 ft (3.1 m)

Submitter Information Verification

Submitter Full Name: AUT-SSD
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
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Committee Statement

Committee Statement: This table should come first. It establishes the maximum clearance for each type of storage protected by spray sprinklers using CMDA criteria.
Response Message:

Public Comment No. 183-NFPA 13-2017 [Section No. 20.6.4.4]

Second Revision No. 317-NFPA 13-2017 [Sections 20.6.4.5, 20.6.4.6, 20.6.4.7, 20.6.4.8, 20.6.4.9]

~~**20.6.4.5**~~

~~Where the clearance to ceiling exceeds 20 ft (6.1 m) for palletized, solid-piled, bin box, shelf, or back-to-back shelf storage, the protection shall be based on the storage height that would result in a clearance to ceiling of 20 ft (6.1 m).~~

~~**20.6.4.6**~~

~~Where the clearance to ceiling exceeds 20 ft (6.1 m) for rack storage of Class I through IV storage up to and including 25 ft (7.6 m) in height, the protection shall be based upon the storage height that would result in a clearance to ceiling of 20 ft (6.1 m) or providing one level of supplemental, quick-response in-rack sprinklers in accordance with Chapter 25.~~

~~**20.6.4.7**~~

~~Where the clearance to ceiling exceeds 10 ft (3.0 m) for rack storage of Class I to IV above 25 ft (7.6 m) in height or Group A plastic up to 25 ft (7.6 m) in height, protection shall be based upon the storage height that would result in a clearance to ceiling of 10 ft (3.0 m) or providing one level of supplemental, quick-response in-rack sprinklers in accordance with Chapter 25.~~

~~**20.6.4.8**~~

~~Where the clearance exceeds 10 ft (3.0 m) for rack storage of Group A plastic above 25 ft (7.6 m) in height,, protection shall be based on providing one level of supplemental, quick-response in-rack sprinklers in accordance with Chapter 25.~~

~~**20.6.4.9**~~

~~When applying the supplemental in-rack sprinkler option, the ceiling density shall be based upon the given storage height with an assumed acceptable clearance to ceiling.~~

Submitter Information Verification

Submitter Full Name: AUT-SSD
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Street Address:
City:
State:
Zip:
Submittal Date: Wed Jun 28 15:08:15 EDT 2017

Committee Statement

Committee Statement: All of this material is redundant with the tables earlier in 20.6.4.
Response Message:

Public Comment No. 182-NFPA 13-2017 [Sections 20.6.4.5, 20.6.4.6, 20.6.4.7, 20.6.4.8, 20.6.4.9]

Second Revision No. 318-NFPA 13-2017 [Section No. 20.6.4.10]

20.6.4.5

If in-rack sprinklers are required for the actual storage height with an acceptable clearance to ceiling, in-rack sprinklers shall be installed as indicated by that criteria.

Submitter Information Verification

Submitter Full Name: AUT-SSD
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Wed Jun 28 15:09:25 EDT 2017

Committee Statement

Committee Statement: This section is important and needs to stay. I intentionally did not include it in the proposal to remove many of the previous sections. While this renumbering would have probably happened without my submitting this comment, I wanted to be clear that I did not intend to omit this section.

Response Message:

Public Comment No. 191-NFPA 13-2017 [Section No. 20.6.4.10]

Second Revision No. 319-NFPA 13-2017 [Section No. 20.7.2]

20.7.2

The following unsprinklered combustible concealed spaces shall not require a minimum design area of sprinkler operation of 3000 ft^2 (280 m^2):

(1) Noncombustible and limited-combustible concealed spaces with minimal combustible loading having no access. The space shall be considered a concealed space even with small openings such as those used as return air for a plenum.

(2) Noncombustible and limited-combustible concealed spaces with limited access and not permitting occupancy or storage of combustibles. The space shall be considered a concealed space even with small openings such as those used as return air for a plenum.

(3) Combustible concealed spaces filled entirely with noncombustible insulation.

(4) Concealed spaces where rigid materials are used and the exposed surfaces have a flame spread index of 25 or less and the materials have been demonstrated to not propagate fire more than 10.5 ft (3.2 m) when tested in accordance with ASTM E84, *Standard Test Method for Surface Burning Characteristics of Building Materials,* or ~~ANSI/UL~~ UL 723, *Standard for Test for Surface Burning Characteristics of Building Materials,* extended for an additional 20 minutes in the form in which they are installed in the space.

(5) Concealed spaces in which the exposed materials are constructed entirely of fire retardant–treated wood as defined by NFPA 703.

(6) Concealed spaces over isolated small compartments not exceeding 55 ft^2 (5.1 m^2) in area.

(7) Vertical pipe chases under 10 ft^2 (0.9 m^2), provided that in multifloor buildings the chases are firestopped at each floor using materials equivalent to the floor construction. Such pipe chases shall contain no sources of ignition, piping shall be noncombustible, and pipe penetrations at each floor shall be properly sealed.

(8) Exterior columns under 10 ft^2 (0.9 m^2) in area formed by studs or wood joists, supporting exterior canopies that are fully protected with a sprinkler system.

(9) Cavities within unsprinklered wall spaces.

Submitter Information Verification

Submitter Full Name: AUT-SSD
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Wed Jun 28 15:12:43 EDT 2017

Committee Statement

Committee Statement: This needs to be consistent with Chapter 19, which accepted this chance at the First Draft. There are two other items that are in Chapter 19 that are not here, but I have not had time to compare them to see what else is missing.

Response Message:

Public Comment No. 194-NFPA 13-2017 [Section No. 20.7.2]

Second Revision No. 320-NFPA 13-2017 [Section No. 20.12.2.5]

20.12.2.5

When hose valves for fire department use are attached to wet pipe sprinkler system risers in accordance with 16.15.2, the following shall apply:

(1) The water supply shall not be required to be added to standpipe demand as determined from NFPA 14.

(2) Where the combined sprinkler system demand and hose stream allowance of ~~Chapter 12 and~~ Chapters ~~14 through~~ 20 through 25 exceeds the requirements of NFPA 14, this higher demand shall be used.

(3) For partially sprinklered buildings, the sprinkler demand, not including hose stream allowance, as indicated in ~~Chapter 12 and~~ Chapters ~~14 through~~ 20 through 25 shall be added to the requirements given in NFPA 14.

Submitter Information Verification

Submitter Full Name: AUT-SSD
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Wed Jun 28 15:15:04 EDT 2017

Committee Statement

Committee Statement: In Section 20.12.2.5 the references are from the 2016 edition of the NFPA 13. These matters need to be revised to match the new chapter structure for the standard.

Response Message:

Public Comment No. 228-NFPA 13-2017 [Section No. 20.12.2.5]

Second Revision No. 396-NFPA 13-2017 [Section No. 20.12.5]

20.12.5

Total system water supply requirements shall be determined in accordance with the hydraulic calculation procedures of Chapter 2723 .

Submitter Information Verification

Submitter Full Name: AUT-SSD
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Fri Jul 14 12:44:14 EDT 2017

Committee Statement

Committee Statement: Editorial revision.
Response Message:

Second Revision No. 801-NFPA 13-2017 [Section No. 20.12.3]

20.12.3

The minimum water supply requirements shall be determined by adding the hose stream allowance from ~~Section~~ 20.12.2 to the water supply for sprinklers as determined by ~~Chapter~~ ~~12~~ ~~through~~ Chapter 20 through 25 .

Submitter Information Verification

Submitter Full Name: AUT-SSD
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Mon Jul 17 14:43:15 EDT 2017

Committee Statement

Committee Statement: Editorial revision.
Response Message:

Second Revision No. 1024-NFPA 13-2017 [Chapter D]

Annex D Sprinkler System Information from the ~~2012~~ 2018 Edition of the *Life Safety Code*

This annex is not a part of the requirements of this NFPA document but is included for informational purposes only.

D.1 Introduction.

This annex is provided as an aid to the user of NFPA 13 by identifying those portions of the 2012 edition of NFPA *101* that pertain to sprinkler system design and installation. It is not intended that this annex provide complete information regarding all aspects of fire protection addressed by NFPA *101*. It is important to note that this information was copied from NFPA *101* but did not use NFPA's extract policy and is not intended to be a part of the requirements of NFPA 13.

D.1.1

The following sections cover situations where NFPA *101* provides different guidance on the design or installation of a fire sprinkler system from NFPA 13. In some cases, this different guidance is based on descriptions of unique situations handled by NFPA *101*. In other cases, this different guidance stems from the different objective for NFPA *101*, life safety of the occupant, rather than the property protection afforded by NFPA 13.

D.1.1.1 Features of Fire Protection.

D.1.1.1.1 Atriums.

Glass walls and inoperable windows shall be permitted in lieu of the fire barriers where all the following are met:

(1) Automatic sprinklers are spaced along both sides of the glass wall and the inoperable windows at intervals not to exceed 6 ft (1830 mm).

(2) The automatic sprinklers specified in 8.6.7(1)(c)(i) of NFPA *101* are located at a distance from the glass wall not to exceed 12 in. (305 mm) and arranged so that the entire surface of the glass is wet upon operation of the sprinklers.

(3) The glass wall is of tempered, wired, or laminated glass held in place by a gasket system that allows the glass framing system to deflect without breaking (loading) the glass before the sprinklers operate.

(4) The automatic sprinklers required by 8.6.7(1)(c)(i) of NFPA *101* are not required on the atrium side of the glass wall and the inoperable window where there is no walkway or other floor area on the atrium side above the main floor level. [***101*:**8.6.7(1)(c)]

D.1.1.2 Special Structures and High-Rise Buildings.

D.1.1.2.1

High-rise buildings shall be protected throughout by an approved, supervised automatic sprinkler system in accordance with NFPA *101*, Section 9.7. A sprinkler control valve and a waterflow device shall be provided for each floor. [***101*:**11.8.3.1]

D.1.1.3 Lodging or Rooming Houses.

D.1.1.3.1

In buildings sprinklered in accordance with NFPA 13, closets that contain equipment such as washers, dryers, furnaces, or water heaters shall be sprinklered regardless of size. [***101*:**~~26.3.6.3.5~~ 26.3.6.2.5]

D.1.1.3.2

In existing lodging or rooming houses, sprinkler installations shall not be required in closets not exceeding 24 ft^2 (2.2 m^2) and in bathrooms not exceeding 55 ft^2 (5.1 m^2). [***101*:**~~26.3.6.3.6~~ 26.3.6.2.6]

D.1.1.4 New Hotels and Dormitories.

D.1.1.4.1

The provisions for draft stops and closely spaced sprinklers in NFPA 13 shall not be required for openings complying with NFPA *101*, 8.6.9.1, where the opening is within the guest room or guest suite. [***101*:**28.3.5.4]

D.1.1.4.2

Listed quick-response or listed residential sprinklers shall be used throughout guest rooms and guest room suites. [***101*:**28.3.5.6]

D.1.1.5 Existing Hotels and Dormitories.

D.1.1.5.1

In guest rooms and in guest room suites, sprinkler installations shall not be required in closets not exceeding 24 ft^2 (2.2 m^2) and in bathrooms not exceeding 55 ft^2 (5.1 m^2). [***101*:**29.3.5.5]

D.1.1.6 New Apartment Buildings.

D.1.1.6.1

In buildings sprinklered in accordance with NFPA 13~~,~~ :

(1) ~~closets~~ Closets less than 12 ft^2 (1.1 m^2) ~~in area~~ in individual dwelling units shall not be required to be sprinklered.

(2) Closets that contain equipment such as washers, dryers, furnaces, or water heaters shall be sprinklered regardless of size.

[***101*:**30.3.5.3]

D.1.1.6.2

Listed quick-response or listed residential sprinklers shall be used throughout all dwelling units. [***101*:**~~30.3.5.5~~ 30.3.5.6]

D.1.1.6.3

The draft stop and closely spaced sprinkler requirements of NFPA 13 shall not be required for convenience openings complying with NFPA *101*, 8.6.9.1, where the convenience opening is within the dwelling unit. [***101*:**~~30.3.5.4~~ 30.3.5.5]

D.1.1.7 Existing Apartment Buildings.

D.1.1.7.1

In individual dwelling units, sprinkler installation shall not be required in closets not exceeding 24 ft^2 (2.2 m^2) and in bathrooms not exceeding 55 ft^2 (5.1 m^2). Closets that contain equipment such as washers, dryers, furnaces, or water heaters shall be sprinklered regardless of size. [***101*:**31.3.5.3]

D.1.1.7.2

In buildings sprinklered in accordance with NFPA 13, bathrooms not greater than 55 ft^2 (5.1 m^2) in individual dwelling units shall not be required to be sprinklered. [***101*** **:** 31.3.5.4]

D.1.1.7.3

The draft stop and closely spaced sprinkler requirements of NFPA 13 shall not be required for convenience openings complying with NFPA *101*, 8.6.9.1, where the convenience opening is within the dwelling unit. [***101*:**~~31.3.5.4~~ 31.3.5.5]

D.1.1.8 Existing Residential Board and Care Occupancies.

D.1.1.8.1

Standard-response sprinklers shall be permitted for use in hazardous areas in accordance with NFPA *101*, 33.2.3.2. [***101*:**33.2.2.2.4]

D.1.1.8.2

Where an automatic sprinkler system is installed, for either total or partial building coverage, all of the following requirements shall be met:

(1) The system shall be in accordance with NFPA *101*, Section 9.7, and shall initiate the fire alarm system in accordance with 33.2.3.4.1, as modified by 33.2.3.5.3.1 through 33.2.3.5.3.6 of NFPA *101*.

(2) The adequacy of the water supply shall be documented to the authority having jurisdiction.

[***101*:**33.2.3.5.3]

D.1.1.8.2.1

In prompt evacuation capability facilities, all of the following shall apply:

(1) An automatic sprinkler system in accordance with NFPA 13D shall be permitted.

(2) Automatic sprinklers shall not be required in closets not exceeding 24 ft^2 (2.2 m^2) and in bathrooms not exceeding 55 ft^2 (5.1 m^2), provided that such spaces are finished with lath and plaster or materials providing a 15-minute thermal barrier.

[***101*:**33.2.3.5.3.1]

D.1.1.8.2.2

In slow and impractical evacuation capability facilities, all of the following shall apply:

(1) An automatic sprinkler system in accordance with NFPA 13D with a 30-minute water supply, shall be permitted.

(2) All habitable areas and closets shall be sprinklered.

(3) Automatic sprinklers shall not be required in bathrooms not exceeding 55 ft^2 (5.1 m^2), provided that such spaces ~~ster~~ are finished with lath and plaster or materials providing a 15-minute thermal barrier.

[***101*:**33.2.3.5.3.2]

D.1.1.8.2.3

In prompt and slow evacuation capability facilities, where an automatic sprinkler system is in accordance with NFPA 13, sprinklers shall not be required in closets not exceeding 24 ft^2 (2.2 m^2) and in bathrooms not exceeding 55 ft^2 (5.1 m^2), provided that such spaces are finished with lath and plaster or materials providing a 15-minute thermal barrier. [***101*:**33.2.3.5.3.3]

D.1.1.8.2.4

In prompt and slow evacuation capability facilities in buildings four or fewer stories above grade plane, systems in accordance with NFPA 13R shall be permitted. [***101*:**33.2.3.5.3.4]

D.1.1.8.2.5

In impractical evacuation capability facilities in buildings four or fewer stories above grade plane, systems in accordance with NFPA 13R shall be permitted. All habitable areas and closets shall be sprinklered. Automatic sprinklers shall not be required in bathrooms not exceeding 55 ft^2 (5.1 m^2), provided that such spaces are finished with lath and plaster or materials providing a 15-minute thermal barrier. [***101*:**33.2.3.5.3.5]

D.1.1.8.2.6

Initiation of the fire alarm system shall not be required for existing installations in accordance with NFPA *101*, 33.2.3.5.6. [***101*:**33.2.3.5.3.6]

D.1.1.8.2.7

All impractical evacuation capability facilities shall be protected throughout by an approved, supervised automatic sprinkler system in accordance with NFPA *101*, 33.2.3.5.3. [***101*:**33.2.3.5.3.7]

D.1.1.9 New Mercantile Occupancies.

D.1.1.9.1 Protection of Vertical Openings.

Any vertical opening shall be protected in accordance with NFPA *101*, Section 8.6, except under the following conditions:

(1) In Class A or Class B mercantile occupancies protected throughout by an approved, supervised automatic sprinkler system in accordance with NFPA *101*, 9.7.1.1(1), unprotected vertical openings shall be permitted at one of the following locations:

(a) Between any two floors

(b) Among the street floor, the first adjacent floor below, and adjacent floor (or mezzanine) above

(2) In Class C mercantile occupancies, unprotected openings shall be permitted between the street floor and the mezzanine.

(3) The draft stop and closely spaced sprinkler requirements of NFPA 13 shall not be required for unenclosed vertical openings permitted in NFPA *101*, 36.3.1(1) and (2).

[***101*:**36.3.1]

D.1.1.9.2

Rooms housing building service equipment, janitor closets, and service elevators shall be permitted to open directly onto exit passageways, provided that all of the following criteria are met:

(1) The required fire resistance rating between such rooms or areas and the exit passageway shall be maintained in accordance with NFPA *101*, 7.1.3.2.

(2) Such rooms or areas shall be protected by an approved, supervised automatic sprinkler system in accordance with NFPA *101*, 9.7.1.1(1), but the exceptions in NFPA 13 allowing the omission of sprinklers from such rooms shall not be permitted.

[***101*:**~~36.4.4.6.2~~ 36.4.4.9.2]

D.1.1.10 Existing Mercantile Occupancies.

D.1.1.10.1 Protection of Vertical Openings.

Any vertical opening shall be protected in accordance with NFPA *101*, Section 8.6, except under any of the following conditions:

(1) In Class A or Class B mercantile occupancies protected throughout by an approved, supervised automatic sprinkler system in accordance with NFPA *101*, 9.7.1.1(1), unprotected vertical openings shall be permitted at one of the following locations:

(a) Between any two floors

(b) Among the street floor, the first adjacent floor below, and the adjacent floor (or mezzanine) above

(2) In Class C mercantile occupancies, unprotected openings shall be permitted between the street floor and the mezzanine.

(3) The draft stop and closely spaced sprinkler requirements of NFPA 13 shall not be required for unenclosed vertical openings permitted in NFPA *101*, ~~37.3.1(1)~~ 36.3.1(1) and (2).

[***101*:**37.3.1]

D.1.1.10.2

Rooms housing building service equipment, janitor closets, and service elevators shall be permitted to open directly onto exit passageways, provided that all of the following criteria are met:

(1) The required fire resistance rating between such rooms or areas and the exit passageway shall be maintained in accordance with NFPA *101*, 7.1.3.2.

(2) Such rooms or areas shall be protected by an approved automatic sprinkler system in accordance with NFPA *101*, 9.7.1.1(1) but the exceptions in NFPA 13 allowing the omission of sprinklers from such rooms shall not be permitted.

[***101*:**~~37.4.4.6.2~~ 37.4.4.9.2]

D.1.1.11 Industrial Occupancies.

D.1.1.11.1 Special Provisions — High-Rise Buildings.

The provisions of NFPA *101*, ~~11.8.5.2.4(2)~~ 11.8.5.3.4(2) for jockey pumps and NFPA *101*, ~~11.8.5.2.4(3)~~ 11.8.5.3.4(3) for air compressors serving dry-pipe and preaction systems shall not apply to special-purpose industrial occupancies. [***101*:**~~40.4.1~~ 40.4.2.2]

D.2 Life Safety Code.

D.2.1 Features of Fire Protection.

D.2.1.1 Design Requirements. (Reserved)

D.2.1.2 Installation Requirements.

D.2.1.2.1 Atriums.

Glass walls and inoperable windows shall be permitted in lieu of the fire barriers where all the following are met:

(1) Automatic sprinklers are spaced along both sides of the glass wall and the inoperable windows at intervals not to exceed 6 ft (1830 mm).

(2) The automatic sprinklers specified in NFPA *101*, 8.6.7(1)(c)(i) are located at a distance from the glass wall not to exceed 12 in. (305 mm) and arranged so that the entire surface of the glass is wet upon operation of the sprinklers.

(3) The glass wall is of tempered, wired, or laminated glass held in place by a gasket system that allows the glass framing system to deflect without breaking (loading) the glass before the sprinklers operate.

(4) The automatic sprinklers required by NFPA *101*, 8.6.7(1)(c)(i) are not required on the atrium side of the glass wall and the inoperable window where there is no walkway or other floor area on the atrium side above the main floor level. [***101*:**8.6.7(1)(c)]

D.2.2 Special Structures and High-Rise Buildings.

D.2.2.1 Design Criteria.

D.2.2.1.1

High-rise buildings shall be protected throughout by an approved, supervised automatic sprinkler system in accordance with NFPA *101*, Section 9.7. A sprinkler control valve and a waterflow device shall be provided for each floor. [***101*:**11.8.3.1]

D.2.3 New Assembly Occupancies.

D.2.3.1 Design Criteria.

D.2.3.1.1 Protection of Vertical Openings.

Any vertical opening shall be enclosed or protected in accordance with Section 8.6 of NFPA *101*, unless otherwise permitted by one of the following:

(1) Stairs or ramps shall be permitted to be unenclosed between balconies or mezzanines and main assembly areas located below, provided that the balcony or mezzanine is open to the main assembly area.

(2) Exit access stairs from lighting and access catwalks, galleries, and gridirons shall not be required to be enclosed.

(3) Assembly occupancies protected by an approved, supervised automatic sprinkler system in accordance with Section 9.7 of NFPA *101* shall be permitted to have unprotected vertical openings between any two adjacent floors, provided that such openings are separated from unprotected vertical openings serving other floors by a barrier complying with 8.6.5 of NFPA 101.

(4) Assembly occupancies protected by an approved, supervised automatic sprinkler system in accordance with Section 9.7 of NFPA *101* shall be permitted to have convenience stair openings in accordance with 8.6.9.2 of NFPA *101*.

[***101*:**12.3.1]

D.2.3.2 Installation Requirements. (Reserved)

D.2.4 Existing Assembly Occupancies.

D.2.4.1 Design Criteria.

D.2.4.1.1 Protection of Vertical Openings.

Any vertical opening shall be enclosed or protected in accordance with NFPA *101*, Section 8.6, unless otherwise permitted by one of the following:

(1) Stairs or ramps shall be permitted to be unenclosed between balconies or mezzanines and main assembly areas located below, provided that the balcony or mezzanine is open to the main assembly area.

(2) Exit access stairs from lighting and access catwalks, galleries, and gridirons shall not be required to be enclosed.

(3) Assembly occupancies protected by an approved, supervised automatic sprinkler system in accordance with NFPA *101*, Section 9.7, shall be permitted to have unprotected vertical openings between any two adjacent floors, provided that such openings are separated from unprotected vertical openings serving other floors by a barrier complying with NFPA *101*, 8.6.5.

(4) Assembly occupancies protected by an approved, supervised automatic sprinkler system in accordance with NFPA *101*, Section 9.7, shall be permitted to have convenience stair openings in accordance with NFPA *101*, 8.6.9.2.

[***101:***13.3.1]

D.2.4.2 Installation Requirements. (Reserved)

D.2.5 New Educational Occupancies. (Reserved)

D.2.6 Existing Educational Occupancies. (Reserved)

D.2.7 New Day-Care Occupancies. (Reserved)

D.2.8 Existing Day-Care Occupancies. (Reserved)

D.2.9 New Health Care Occupancies. (Reserved)

D.2.10 Existing Health Care Occupancies. (Reserved)

D.2.11 New Ambulatory Health Care Occupancies. (Reserved)

D.2.12 Existing Ambulatory Health Care Occupancies. (Reserved)

D.2.13 New Detention and Correctional Occupancies. (Reserved)

D.2.14 Existing Detention and Correctional Occupancies. (Reserved)

D.2.15 One- and Two-Family Dwellings. (Reserved)

D.2.16 Lodging or Rooming Houses.

D.2.16.1 Design Requirements. (Reserved)

D.2.16.2 Installation Requirements.

D.2.16.2.1

In buildings sprinklered in accordance with NFPA 13 closets that contain equipment such as washers, dryers, furnaces, or water heaters shall be sprinklered, regardless of size. [***101*:~~26.3.6.3.5~~ 26.3.6.2.5]

D.2.16.2.2

In existing lodging or rooming houses, sprinkler installations shall not be required in closets not exceeding 24 ft^2 (2.2 m^2) and in bathrooms not exceeding 55 ft^2 (5.1 m^2). [***101*:~~26.3.6.3.6~~ 26.3.6.2.6]

D.2.17 New Hotels and Dormitories.

D.2.17.1 Design Requirements. (Reserved)

D.2.17.2 Installation Requirements.

D.2.17.2.1

The provisions for draft stops and closely spaced sprinklers in NFPA 13 shall not be required for openings complying with NFPA *101*, 8.6.9.1, where the opening is within the guest room or guest suite. [***101*:**28.3.5.4]

D.2.17.2.2

Listed quick-response or listed residential sprinklers shall be used throughout guest rooms and guest room suites. [***101*:**28.3.5.6]

D.2.18 Existing Hotels and Dormitories.

D.2.18.1 Design Requirements. (Reserved)

D.2.18.2 Installation Requirements.

D.2.18.2.1

In guest rooms and in guest room suites, sprinkler installations shall not be required in closets not exceeding 24 ft^2 (2.2 m^2) and in bathrooms not exceeding 55 ft^2 (5.1 m^2). [***101*:**29.3.5.5]

D.2.19 New Apartment Buildings.

D.2.19.1 Design Requirements. (Reserved)

D.2.19.2 Installation Requirements.

D.2.19.2.1

In buildings sprinklered in accordance with NFPA 13~~,~~ :

(1) ~~closets~~ Closets less than 12 ft^2 (1.1 m^2) ~~in area~~ in individual dwelling units shall not be required to be sprinklered.

(2) Closets that contain equipment such as washers, dryers, furnaces, or water heaters shall be sprinklered regardless of size.

[***101*:**30.3.5.3]

D.2.19.2.2

Listed quick-response or listed residential sprinklers shall be used throughout all dwelling units. [***101*:**~~30.3.5.5~~ 30.3.5.6]

D.2.19.2.3

The draft stop and closely spaced sprinkler requirements of NFPA 13 shall not be required for convenience openings complying with NFPA *101*, 8.6.9.1, where the convenience opening is within the dwelling unit. [***101*:**~~30.3.5.4~~ 30.3.5.5]

D.2.20 Existing Apartment Buildings.

D.2.20.1 Design Requirements. (Reserved)

D.2.20.2 Installation Requirements.

D.2.20.2.1

In individual dwelling units, sprinkler installation shall not be required in closets not exceeding 24 ft^2 (2.2 m^2) and in bathrooms not exceeding 55 ft^2 (5.1 m^2). Closets that contain equipment such as washers, dryers, furnaces, or water heaters shall be sprinklered, regardless of size. [***101*:**31.3.5.3]

D.2.20.2.2

The draft stop and closely spaced sprinkler requirements of NFPA 13 shall not be required for convenience openings complying with NFPA *101*, 8.6.9.1, where the convenience opening is within the dwelling unit. [***101*:**~~31.3.5.4~~ 31.3.5.5]

D.2.21 New Residential Board and Care Occupancies. (Reserved)

D.2.22 Existing Residential Board and Care Occupancies.

D.2.22.1 Design Requirements. (Reserved)

D.2.22.2 Installation Requirements.

D.2.22.2.1

Standard-response sprinklers shall be permitted for use in hazardous areas in accordance with NFPA *101*, 33.2.3.2. [***101*:**33.2.2.2.4]

D.2.22.2.2

In prompt and slow evacuation facilities, where an automatic sprinkler system is in accordance with NFPA 13 sprinklers shall not be required in closets not exceeding 24 ft^2 (2.2 m^2) and in bathrooms not exceeding 55 ft^2 (5.1 m^2), provided that such spaces are finished with lath and plaster or materials providing a 15-minute thermal barrier. [***101*:**33.2.3.5.3.3]

D.2.23 New Mercantile Occupancies.

D.2.23.1 Design Requirements. (Reserved)

D.2.23.2 Installation Requirements.

D.2.23.2.1 Protection of Vertical Openings.

Any vertical opening shall be protected in accordance with NFPA *101*, Section 8.6, except under any of the following conditions:

(1) In Class A or Class B mercantile occupancies protected throughout by an approved, supervised automatic sprinkler system in accordance with NFPA *101*, 9.7.1.1(1), unprotected vertical openings shall be permitted at one of the following locations:

  (a) Between any two floors

  (b) Among the street floor, the first adjacent floor below, and adjacent floor (or mezzanine) above

(2) In Class C mercantile occupancies, unprotected openings shall be permitted between the street floor and the mezzanine.

(3) The draft stop and closely spaced sprinkler requirements of NFPA 13 shall not be required for unenclosed vertical openings permitted in NFPA *101*, 36.3.1(1) and (2).

[***101*:**36.3.1]

D.2.23.2.2

Rooms housing building service equipment, janitor closets, and service elevators shall be permitted to open directly onto exit passageways, provided that all of the following criteria are met:

(1) The required fire resistance rating between such rooms or areas and the exit passageway shall be maintained in accordance with NFPA *101*, 7.1.3.2.

(2) Such rooms or areas shall be protected by an approved, supervised automatic sprinkler system in accordance with NFPA *101*, 9.7.1.1(1) but the exceptions in NFPA 13 allowing the omission of sprinklers from such rooms shall not be permitted.

[***101*:**~~36.4.4.6.2~~ 36.4.4.9.2]

D.2.24 Existing Mercantile Occupancies.

D.2.24.1 Design Requirements. (Reserved)

D.2.24.2 Installation Requirements.

D.2.24.2.1 Protection of Vertical Openings.

Any vertical opening shall be protected in accordance with NFPA *101*, Section 8.6, except under any of the following conditions:

(1) In Class A or Class B mercantile occupancies protected throughout by an approved, supervised automatic sprinkler system in accordance with NFPA *101*, 9.7.1.1(1), unprotected vertical openings shall be permitted at one of the following locations:

  (a) Between any two floors

  (b) Among the street floor, the first adjacent floor below, and the adjacent floor (or mezzanine) above

(2) In Class C mercantile occupancies, unprotected openings shall be permitted between the street floor and the mezzanine.

(3) The draft stop and closely spaced sprinkler requirements of NFPA 13 shall not be required for unenclosed vertical openings permitted in NFPA *101*, ~~37.3.1(1)~~ 36.3.1(1) and (2). [***101*:**37.3.1]

D.2.24.2.2

Rooms housing building service equipment, janitor closets, and service elevators shall be permitted to open directly onto exit passageways, provided that all of the following criteria are met:

(1) The required fire resistance rating between such rooms or areas and the exit passageway shall be maintained in accordance with NFPA *101*, 7.1.3.2.

(2) Such rooms or areas shall be protected by an approved, supervised automatic sprinkler system in accordance with NFPA *101*, 9.7.1.1(1), but the exceptions in NFPA 13 allowing the omission of sprinklers from such rooms shall not be permitted.

[***101***:~~37.4.4.6.2~~ 37.4.4.9.2]

D.2.25 New Business Occupancies.

D.2.25.1 Design Requirements. (Reserved)

D.2.25.2 Installation Requirements. (Reserved)

D.2.26 Existing Business Occupancies.

D.2.26.1 Design Requirements. (Reserved)

D.2.26.2 Installation Requirements. (Reserved)

D.2.27 Industrial Occupancies. (Reserved)

D.2.27.1 Design Criteria.

D.2.27.1.1 Special Provisions — High-Rise Buildings.

The provisions of NFPA *101*, ~~11.8.5.2.4(2)~~ 11.8.5.3.4(2) , for jockey pumps and NFPA *101*, ~~11.8.5.2.4(3)~~ 11.8.5.3.4(3) , for air compressors serving dry-pipe and pre-action systems shall not apply to special-purpose industrial occupancies. [***101***:~~40.4.1~~ 40.2.2]

D.2.28 Storage Occupancies. (Reserved)

Supplemental Information

File Name	Description	Approved
Annex_D_Sprinkler_System_Information_from_the.docx	For staff use.	

Submitter Information Verification

Submitter Full Name: AUT-SSD
Organization: National Fire Protection Assoc
Street Address:
City:
State:
Zip:
Submittal Date: Wed Aug 16 10:39:15 EDT 2017

Committee Statement

Committee Statement: Updates extract information from the 2015 edition of the life Safety Code.
Response Message:

Second Revision No. 380-NFPA 13-2017 [Section No. 20.14.1.2 [Excluding any Sub-Sections]]

Wood pallets, where stored indoors, shall be protected in accordance with one of the following:

(1) Control mode density/area sprinkler protection as specified in Table 20.14.1.2(a).

(2) CMSA sprinkler protection in accordance with Table 20.14.1.2(b).

(3) ESFR sprinkler protection in accordance with Table 20.14.1.2(c).

(4) Control mode density/area sprinkler protection in accordance with the ~~OH2 curve of Figure 13.2.1 existing~~ Ordinary Hazard Group 2 curve and Figure 19.3.3.1.1 with a hose stream demand of at least 250 gpm (950 L/min) for a duration of at least 60 minutes when pallets are stored no higher than 6 ft (1.8 m) and each pile of no more than four stacks is separated from other pallet piles by at least 8 ft (2.4 m) of clear space or 25 ft (7.6 m) of commodity. The maximum clearance to ceiling of 20 ft (6.1 m) specified in 20.6.4 shall not apply to arrangement 20.14.1.2(4).

Table 20.14.1.2(a) Control Mode Density/Area Sprinkler Protection for Indoor Storage of Idle Wood Pallets

Type of Sprinkler	Location of Storage	Nominal K-Factor	Maximum Storage Height		Maximum Ceiling/Roof Height		Sprinkler Density		Areas of Operation	
			ft	m	ft	m	gpm/ft^2	mm/min	ft^2	m^2
Control mode density/area	On floor	8 (115) or larger	Up to 6	Up to 1.8	20	6.1	0.20	8.1	3000*	280*
	On floor	11.2 (160) or larger	Up to 8	Up to 2.4	30	9.1	0.45	18.3	2500	230
	On floor or rack without solid shelves	11.2 (160) or larger	8 to 12	2.4 to 3.7	30	9.1	0.6	24.4	3500	325
			12 to 20	3.7 to 6.1	30	9.1	0.6	24.4	4500	420
	On floor	16.8 (240) or larger	Up to 20	Up to 6.1	30	9.1	0.6	24.4	2000	185

*The area of sprinkler operation should be permitted to be reduced to 2000 ft^2 (186 m^2) when sprinklers having a nominal K-factor of 11.2 or larger are used or if high-temperature-rated sprinklers with a nominal K-factor of 8.0 are used.

Table 20.14.1.2(b) CMSA Sprinkler Protection for Indoor Storage of Idle Wood Pallets

Storage Arrangement	Commodity Class	Maximum Storage Height		Maximum Ceiling/Roof Height		K-Factor/ Orientation	Type of System	Number of Design Sprinklers	Minimum Operating Pressure	
		ft	m	ft	m				psi	bar
On floor	Idle wood pallets	20	6.1	30	9.1	11.2 (160) Upright	Wet	15	25	1.7
							Dry	25	25	1.7
						16.8 (240) Upright	Wet	15	15	1.0
							Dry	25	15	1.0
						19.6 (280) Pendent	Wet	15	16	1.1
				35	11	19.6 (280) Pendent	Wet	15	25	1.7
				40	12	19.6 (280) Pendent	Wet	15	30	2.1

Table 20.14.1.2(c) ESFR Sprinkler Protection for Indoor Storage of Idle Wood Pallets

Type of Sprinkler (Orientation)	Location of Storage	Nominal K-Factor	Maximum Storage Height	Maximum Ceiling/ Roof Height	Minimum Operating Pressure

			ft	m	ft	m	psi	bar
ESFR (pendent)	On floor or rack without solid shelves	14.0 (200)	25	7.6	30	9.1	50	3.4
			25	7.6	32	10	60	4.1
		16.8 (240)	25	7.6	30	9.1	35	2.4
			25	7.6	32	10	42	2.9
			35	11	40	12	52	3.6
		22.4 (320)	25	7.6	30	9.1	25	1.7
			30	9.1	35	11	35	2.4
			35	11	40	12	40	2.7
		25.2 (360)	25	7.6	30	9.1	15	1.0
			30	9.1	35	11	20	1.4
			35	11	40	12	25	1.7
ESFR (upright)	On floor	14.0 (200)	20	6.1	30	9.1	50	3.4
			20	6.1	35	11	75	5.2
		16.8 (240)	20	6.1	30	9.1	35	2.4
			20	6.1	35	11	52	3.6

Submitter Information Verification

Submitter Full Name: AUT-SSD
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Thu Jun 29 15:11:32 EDT 2017

Committee Statement

Committee Statement: The exiting figure has been deleted and replaced with references in the standard.
Response Message:

Second Revision No. 321-NFPA 13-2017 [Section No. 20.15.1 [Excluding any Sub-Sections]]

Where fireproofing of building columns is not provided and storage heights are in excess of 15 ft (4.6 m), protection of building columns located wholly or partially within the rack footprint inclusive of flue spaces or within 12 in. (300 mm) of the footprint shall be protected in accordance with one of the following:

(1) In-rack sprinklers

(2) Sidewall sprinklers at the 15 ft (4.6 m) elevation, pointed toward one side of the steel column

(3) Provision of ceiling sprinkler density for a minimum of 2000 ft^2 (186 m^2) with ordinary 165°F (74°C) or high-temperature 286°F (140°C) rated sprinklers as shown in Table 20.15.1 for storage heights above 15 ft (4.6 m), up to and including 20 ft (6.1 m)

(4) Provision of CMSA or ESFR ceiling sprinkler protection

Table 20.15.1 Ceiling Sprinkler Densities for Protection of Steel Building Columns

	Aisle Width			
	4 ft (1.2 m)		8 ft (2.4 m)	
Commodity Classification	gpm/ft^2	$(L/min)/m^2$	gpm/ft^2	$(L/min)/m^2$
Class I	0.37	15.1	0.33	13.4
Class II	0.44	17.9	0.37	15.1
Class III	0.49	20.0	0.42	17.1
Class IV and Group A plastics	0.68	27.7	0.57	23.2

Submitter Information Verification

Submitter Full Name: AUT-SSD
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Wed Jun 28 15:16:28 EDT 2017

Committee Statement

Committee Statement: In the First Draft Report, Section 20.15.1 only addresses Class I to IV commodities. Section 17.1.4 of the 2016 edition of NFPA 13, contains the provisions for column protection are provided of Group A plastics, which are the same as for Class IV. This Comment is to bring that information over into the new Chapter 20.

Response Message:

Public Comment No. 229-NFPA 13-2017 [Section No. 20.15.1 [Excluding any Sub-Sections]]

Second Revision No. 395-NFPA 13-2017 [Section No. 20.16]

20.16 Alternative Protection Scheme A.

Class I, II, III, IV commodities requiring a greater level of protection than is available from the overhead sprinkler system shall be permitted to be protected in accordance with 20.16.1.1 through 20.16.1.7 .

20.16.1

Class I, II, III, IV, and Group A plastic commodities requiring a greater level of protection than is available from the overhead sprinkler system shall be permitted to be protected in accordance with 20.16.1.1 through 20.16.1.7 .

20.16.1.1

Where the storage rack will not be solely dedicated to the storage of commodities requiring a greater level of protection than is available from the overhead sprinkler system, either of the following shall apply:

Extend the protection prescribed by Section 20.16 horizontally one pallet load in all directions beyond the commodity storage area requiring the higher level of protection.

Install a vertical barrier to segregate the commodities requiring the higher level of protection from any adjacent commodities.

20.16.1.2

Commodities that can be protected by the ceiling-level sprinkler system shall be permitted to be stored vertically above and horizontally adjacent to the portions of the storage rack equipped as prescribed by Section 20.16 .

20.16.1.3 Horizontal Barriers.

Horizontal barriers shall be installed at every tier level of the dedicated storage rack where the rack is equipped with solid shelves.

20.16.1.3.1

Where the dedicated storage rack is open-frame, horizontal barriers shall be installed at vertical increments not exceeding 12 ft (3.6 m).

20.16.1.3.2

The barriers shall span horizontally so that all flue spaces within the rack bay are covered.

20.16.1.3.3

A maximum 3 in. (75 mm) wide gap shall be permitted at rack uprights.

20.16.1.3.4

The solid barrier shall be installed on a horizontal plane within a rack, beneath which in-rack sprinklers shall be installed, as follows:

The barrier shall be constructed of minimum 22 gauge (0.7 mm) sheet metal or of minimum 3/8 in. (10 mm) plywood.

The barrier shall extend to both aisle faces of the racks, covering up both the longitudinal and the transverse flue spaces of the rack bays in which they are installed.

The barrier shall be fitted to within 3 in. (75 mm) of any vertical rack member or other equipment that would create an opening, such as vertical in-rack sprinkler pipe drops.

20.16.1.4 In-Rack Sprinklers.

Minimum K-8.0 (K-115) quick-response sprinklers (ceiling-level or in-rack) shall be installed beneath each horizontal barrier. The deflector of the sprinkler shall be located as close to the underside of the horizontal barrier as possible.

20.16.1.4.1 Single-Row Racks.

(A)

For single-row racks, sprinklers shall be installed at each rack upright and at each rack mid-bay as shown in Figure 20.16.1.4.1(A) .

Figure 20.16.1.4.1(A) Alternative Protection for Single-Row Racks.

(B)

The maximum linear spacing between sprinklers shall not exceed 5 ft (1.5 m).

20.16.1.4.2 Double-Row Racks.

~~(A)~~

~~For double-row racks, sprinklers shall be installed at each rack upright within the longitudinal flue space and at the face of the rack and at the mid-bay face of each rack bay as shown in Figure 20.16.1.4.2(A) .~~

~~Figure 20.16.1.4.2(A) Alternative Protection for Double-Row Racks.~~

~~(B)~~

~~The maximum linear spacing between sprinklers shall not exceed 5 ft (1.5 m) at the rack face and 10 ft (3.0 m) within the longitudinal flue space.~~

20.16.1.4.3 ~~Multiple-Row Racks.~~

(A)

For multiple-row racks, an alternating sprinkler arrangement shall be installed within adjacent transverse flue spaces as shown in Figure 20.16.1.4.3(A) , with sprinklers at the face of each flue space.

Figure 20.16.1.4.3(A) Alternative Protection for Multiple-Row Racks.

(B)

The maximum linear spacing between sprinklers at the face and at each alternating bay shall not exceed 5 ft (1.5 m) and shall not exceed 10 ft (3.0 m) between sprinklers at every other bay.

20.16.1.5

The design of an in-rack sprinkler system shall be based on a minimum flow of 60 gpm (230 L/min) from the most remote six sprinklers for single-row racks or the most remote eight sprinklers for both double-row and multiple-row racks.

20.16.1.6

The in-rack sprinkler demand shall not be required to be hydraulically balanced with the ceiling-level sprinkler system.

20.16.1.7 Ceiling Sprinkler System.

The ceiling-level sprinkler system shall be designed based on the highest commodity hazard not protected by the criteria prescribed by 20.16 .

Submitter Information Verification

Submitter Full Name: AUT-SSD

Organization: [Not Specified]

Street Address:

City:

State:

Zip:

Submittal Date: Fri Jul 14 12:35:09 EDT 2017

Committee Statement

Committee Statement: The text is redundant and can be found in Chapter 25 under Alternative In-Rack Sprinkler Protection Option 1.

Response Message:

Second Revision No. 1015-NFPA 13-2017 [Section No. 21.1.10]

21.1.10 Discharge Considerations.

21.1.10.1

The water supply for sprinklers only shall be determined either from the density/area requirements of Chapter ~~12~~ 20 through Chapter 25 or shall be based upon the room design method in accordance with Section 20.8, at the discretion of the designer.

21.1.10.2

The calculations shall satisfy any single point on appropriate density/area curves.

21.1.10.3

When using the density/area method, the design area shall meet the requirements of ~~19.6.4.2.1~~ 27.2.4.2.1 .

21.1.10.4

The minimum design density shall be not less than 0.15 gpm/ft^2 (6.1 mm/min) after all adjustments are made.

Submitter Information Verification

Submitter Full Name: AUT-SSD
Organization: National Fire Protection Assoc
Street Address:
City:
State:
Zip:
Submittal Date: Tue Aug 01 08:26:22 EDT 2017

Committee Statement

Committee Statement: Editorial revision.
Response Message:

Second Revision No. 381-NFPA 13-2017 [Section No. 21.3.3]

21.3.3*

Design areas and densities for the appropriate storage configuration shall be selected from Table 21.3.3(a) or Table 21.3.3(b) as appropriate.

Table 21.3.3(a) Design Densities for Palletized, Solid-Piled, Bin Box, or Shelf Storage of Group A Plastic Commodities (U.S. Customary Units)

Maximum Storage Height (ft)	Roof/Ceiling Height (ft)	Density (gpm/ft^2)				
		A	B	C	D	E
>5 to ≤12	Up to 15	0.2	EH2	0.3	EH1	EH2
	>15 to 20	0.3	0.6	0.5	EH2	EH2
	>20 to 32	0.4	0.8	0.6	0.45	0.7
15	Up to 20	0.3	0.6	0.5	0.4	0.45
	>20 to 25	0.4	0.8	0.6	0.45	0.7
	>25 to 35	0.45	0.9	0.7	0.55	0.85
20	Up to 25	0.4	0.8	0.6	0.45	0.7
	>25 to 30	0.45	0.9	0.7	0.55	0.85
	>30 to 35	0.6	1.2	0.85	0.7	1.1
25	Up to 30	0.45	0.9	0.7	0.55	0.85
	>30 to 35	0.6	1.2	0.85	0.7	1.1

Notes:

(1) Minimum clearance between sprinkler deflector and top of storage shall be maintained as required.

(2) Column designations correspond to the configuration of plastics storage as follows:

A: (1) Nonexpanded, unstable

(2) Nonexpanded, stable, solid unit load

B: Expanded, exposed, stable

C: (1) Expanded, exposed, unstable

(2) Nonexpanded, stable, cartoned

D: Expanded, cartoned, unstable

E: (1) Expanded, cartoned, stable

(2) Nonexpanded, stable, exposed

(3) EH1 = Density required by ~~Figure 13.2.1 for Curve EH1~~ Extra Hazard Group 1 design curve and 19.3.3.1.1

EH2 = Density required by ~~Figure 13.2.1 for Curve EH2~~ Extra Hazard Group 2 design curve and 19.3.3.1.1

(4) Roof/ceiling height >35 ft is not permitted.

Table 21.3.3(b) Design Densities for Palletized, Solid-Piled, Bin Box, or Shelf Storage of Group A Plastic Commodities (S.I. Units)

Maximum Storage Height (m)	Roof/Ceiling Height (m)	Density (mm/min)				
		A	B	C	D	E
>1.5 to ≤3.6	Up to 4.6	8.1	EH2	12.2	EH1	EH2
	>4.6 to 6.1	12.2	24.4	20.4	EH2	EH2
	>6.1 to 9.7	16.3	32.6	24.4	18.3	28.5
4.6	Up to 6.1	12.2	24.4	20.4	16.3	18.3
	>6.1 to 7.6	16.3	32.6	24.4	18.3	28.5
	>7.6 to 11	18.3	36.7	28.5	22.4	34.6
	Up to 7.6	16.3	32.6	24.4	18.3	28.5

Maximum Storage Height (m)	Roof/Ceiling Height (m)	Density (mm/min) A	B	C	D	E
6.1	>7.6 to 9.1	18.3	36.7	28.5	22.4	34.6
	>9.1 to 11	24.4	48.9	34.6	28.5	44.8
7.6	Up to 9.1	18.3	36.7	28.5	22.4	34.6
	>9.1 to 11	24.4	48.9	34.6	28.5	44.8

Notes:

(1) Minimum clearance between sprinkler deflector and top of storage shall be maintained as required.

(2) Column designations correspond to the configuration of plastics storage as follows:

A: (1) Nonexpanded, unstable

(2) Nonexpanded, stable, solid unit load

B: Expanded, exposed, stable

C: (1) Expanded, exposed, unstable

(2) Nonexpanded, stable, cartoned

D: Expanded, cartoned, unstable

E: (1) Expanded, cartoned, stable

(2) Nonexpanded, stable, exposed

(3) EH1 = Density required by ~~Figure 13.2.1 for Curve EH1~~ Extra Hazard Group 1 design curve and 19.3.3.1.1

EH2 = Density required by ~~Figure 13.2.1 for Curve EH2~~ Extra Hazard Group 1 design curve and 19.3.3.1.1

(4) Roof/ceiling height >35 ft is not permitted.

Detail SR-1058

21.3.3.1*

For Table 21.3.3(a) and Table 21.3.3(b), the design areas shall be as follows:

(1) The area shall be a minimum of 2500 ft^2 (232 m^2).

(2) Where Table 21.3.3(a) and Table 21.3.3(b) allow densities and areas to be selected in accordance with curve ~~EH1 and Curve EH2 of Figure 13.2.1, any density/area from the curves in Figure 13.2.1 shall be permitted. When selecting a point from the EH1 or EH2 density/area curves of Figure 13.2.1~~ Extra Hazard Group 1 and Group 2, including 19.3.3.1.1 , the following area reductions shall be permitted:

(a) For K-8.0 (115) sprinklers used with curve ~~EH1~~ Extra Hazard Group 1, the design area shall be permitted to be reduced by 25 percent, but not below 2000 ft^2 (186 m^2), where high temperature sprinklers are used.

(b) For K-11.2 (160) or larger sprinklers, the design area shall be permitted to be reduced by 25 percent, but not below 2000 ft^2 (186 m^2), regardless of temperature rating.

(3) For closed arrays, the area shall be permitted to be reduced to 2000 ft^2 (186 m^2).

21.3.3.2*

Interpolation of densities between storage heights shall be permitted.

~~**21.3.6.1**~~

~~Densities shall be based on the 2500 ft^2 (232 m^2) design area.~~

21.3.3.2.1

Interpolation of ceiling/roof heights shall not be permitted.

Submitter Information Verification

Submitter Full Name: AUT-SSD
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Thu Jun 29 15:15:12 EDT 2017

Committee Statement

Committee Statement: The exiting figure has been deleted and replaced with references in the standard.
Response Message:

Second Revision No. 322-NFPA 13-2017 [Section No. 21.3.4]

21.3.4

The ceiling-only protection criteria specified in Chapter ~~17~~ 21 for rack storage of Group A plastic commodities shall be permitted to be used for solid-piled and palletized storage of the same commodity at the same height and clearance to ceiling.

Submitter Information Verification

Submitter Full Name: AUT-SSD
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Wed Jun 28 15:56:11 EDT 2017

Committee Statement

Committee Statement: Corrected Chapter reference.
Response Message:

Public Comment No. 195-NFPA 13-2017 [Section No. 21.3.4]

Second Revision No. 1058-NFPA 13-2017 [Detail]

Move current 21.3.5 and 21.3.6 as subsections to 21.3.3:

21.3.3.1*

For Table 21.3.3(a) and Table 21.3.3(b), the design areas shall be as follows:

(1) The area shall be a minimum of 2500 ft^2 (232 m^2).

(2) Where Table 21.3.3(a) and Table 21.3.3(b) allow densities and areas to be selected in accordance with curve ~~EH1 and Curve EH2 of Figure 13.2.1, any density/area from the curves in Figure 13.2.1 shall be permitted. When selecting a point from the EH1 or EH2 density/area curves of Figure 13.2.1~~Extra Hazard Group 1 and Group 2, including 19.3.3.1.1, the following area reductions shall be permitted:

(a) For K-8.0 (115) sprinklers used with curve ~~EH1~~Extra Hazard Group 1, the design area shall be permitted to be reduced by 25 percent, but not below 2000 ft^2 (186 m^2), where high temperature sprinklers are used.

(b) For K-11.2 (160) or larger sprinklers, the design area shall be permitted to be reduced by 25 percent, but not below 2000 ft^2 (186 m^2), regardless of temperature rating.

(3) For closed arrays, the area shall be permitted to be reduced to 2000 ft^2 (186 m^2).

21.3.3.2*

Interpolation of densities between storage heights shall be permitted.

~~**21.3.6.1**~~

~~**Densities shall be based on the 2500 ft^2 (232 m^2) design area.**~~

21.3.3.2.1

Interpolation of ceiling/roof heights shall not be permitted.

Submitter Information Verification

Submitter Full Name: AUT-SSD
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Wed Oct 25 13:48:31 EDT 2017

Committee Statement

Committee Statement: Some of the information is redundant and can be eliminated. The rest of the information in 21.3.5 and 21.3.6 specifically applies to 21.3.3 and should be subsections to that sections, rather than after that section. Finally, section 21.3.7 needs to be renumbered to 21.3.5 since there is already a section 21.3.4.

Response Message:

Public Comment No. 197-NFPA 13-2017 [Sections 21.3.5, 21.3.6, 21.3.7]

Second Revision No. 1004-NFPA 13-2017 [Section No. 21.4.1.2]

21.4.1.2*

For single- or double-row racks for Class I, Class II, Class III, or Class IV commodities, encapsulated or nonencapsulated in single- or double-row racks, ceiling sprinkler water demand in terms of density [gpm/ft^2 (mm/min)] and area of sprinkler operation [ft^2 (m^2) of ceiling or roof] shall be selected from the density/area curves of Figure 21.4.1.2(a) through Figure 21.4.1.2(e)that are appropriate for each commodity and configuration as shown in Table 21.4.1.2 and shall be modified as appropriate by 21.4.1.4. These requirements shall apply to portable racks arranged in the same manner as single- or double-row racks.

Figure 21.4.1.2(a) Sprinkler System Design Curves — 20 ft (6.1 m) High Rack Storage — Class I Nonencapsulated Commodities — Conventional Pallets

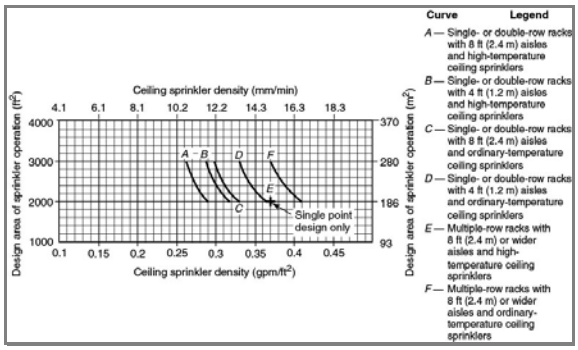


Figure 21.4.1.2(b) Sprinkler System Design Curves — 20 ft (6.1 m) High Rack Storage — Class II Nonencapsulated Commodities — Conventional Pallets.

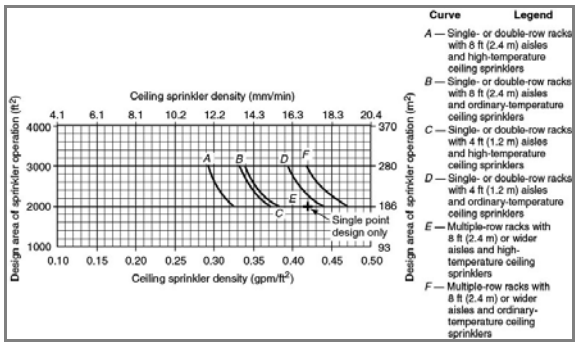


Figure 21.4.1.2(c) Sprinkler System Design Curves — 20 ft (6.1 m) High Rack Storage — Class III Nonencapsulated Commodities — Conventional Pallets.

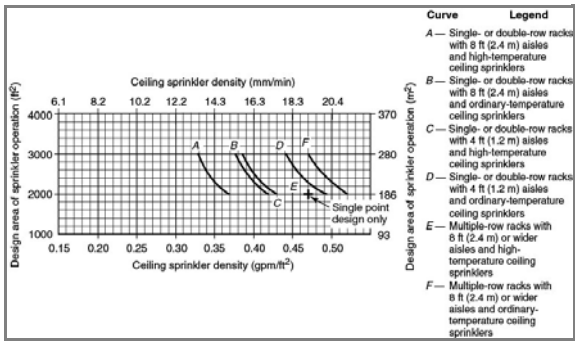


Figure 21.4.1.2(d) Sprinkler System Design Curves — 20 ft (6.1 m) High Rack Storage — Class IV Nonencapsulated Commodities — Conventional Pallets.

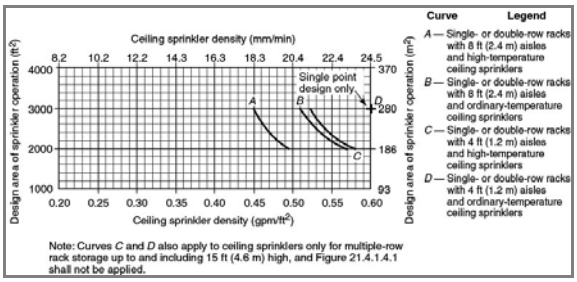


Figure 21.4.1.2(e) Single- or Double-Row Racks — 20 ft (6.1 m) High Rack Storage — Sprinkler System Design Curves — Class I and Class II Encapsulated Commodities — Conventional Pallets.

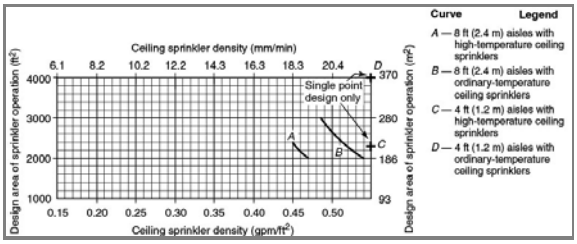


Table 21.4.1.2 Single- or Double-Row Racks — Storage Height Over 12 ft (3.7 m) Up to and Including 25 ft (7.6 m)

Height	Commodity Class	Encapsulated	Aisles* ft	Aisles* m	Sprinklers Mandatory In-Rack	With In-Rack Sprinklers: Figure	With In-Rack Sprinklers: Curves	With In-Rack Sprinklers: Apply Figure 16.2.1.3.4.1	Ceiling Sprinkler: Fi
Over 12 ft (3.7 m) up to and including 20 ft (6.1 m)	I	No	4	1.2	No	16.2.1.3.2(a)	C and D	Yes	16.2.1 21.4
			8	2.4			A and B		
		Yes	4	1.2	No	16.2.1.3.2(e)	C and D		16.2.1 21.4
			8	2.4			A and B		
	II	No	4	1.2	No	16.2.1.3.2(b)	C and D		16.2.1.3.2(b
			8	2.4			A and B		
		Yes	4	1.2	No	16.2.1.3.2(e)	C and D		16.2.1.3.2(e
			8	2.4			A and B		
	III	No	4	1.2	No	16.2.1.3.2(c)	C and D		16.2.1.3.2(c

Height	Commodity Class	Encapsulated	Aisles* ft	Aisles* m	With In-Rack Sprinklers: Sprinklers Mandatory In-Rack	With In-Rack Sprinklers: Figure	With In-Rack Sprinklers: Curves	With In-Rack Sprinklers: Apply Figure 16.2.1.3.4.1	Ceiling Sprinkler: Fi
			8	2.4			A and B		
		Yes	4	1.2	1 level	16.2.1.3.2(f)	C and D		In-rack required. S 2
			8	2.4			A and B		
			4	1.2			C and D		
		No			No	16.2.1.3.2(d)			16.2.1.3.2(
	IV		8	2.4			A and B		
		Yes	4	1.2	1 level	16.2.1.3.2(g)	C and D		In-rack required. S 2
			8	2.4			A and B		
			4	1.2			C and D		
		No			No	16.2.1.3.2(a)			16.2.1.3.2(
	I		8	2.4			A and B		
		Yes	4	1.2	1 level	16.2.1.3.2(e)	C and D		In-rack required. S 2
			8	2.4			A and B		
			4	1.2			C and D		
		No			No	16.2.1.3.2(b)			16.2.1.3.2(
Over 20 ft (6.1 m) up to and including 22 ft (6.7 m)	II		8	2.4			A and B		
		Yes	4	1.2	1 level	16.2.1.3.2(e)	C and D	No	In-rack required. S 2
			8	2.4			A and B		
			4	1.2			C and D		
		No			No	16.2.1.3.2(c)			16.2.1.3.2(
	III		8	2.4			A and B		
		Yes	4	1.2	1 level	16.2.1.3.2(f)	C and D		In-rack required. S 2
			8	2.4			A and B		
			4	1.2			C and D		
	IV	No			No	16.2.1.3.2(d)			16.2.1.3.2(
			8	2.4			A and B		

Height	Commodity Class	Encapsulated	Aisles* ft	Aisles* m	Sprinklers Mandatory In-Rack	With In-Rack Sprinklers Figure	With In-Rack Sprinklers Curves	Apply Figure 16.2.1.3.4.1	Ceiling Sprinkler Fi
Over 22 ft (6.7 m) up to and including 25 ft (7.6 m)	I	Yes	4	1.2	1 level	16.2.1.3.2(g)	C and D	No	In-rack required. S 2
			8	2.4			A and B		
		No	4	1.2	No	16.2.1.3.2(a)	C and D		16.2.1.3.2(a
			8	2.4			A and B		
	II	Yes	4	1.2	1 level	16.2.1.3.2(e)	C and D		In-rack required. S 2
			8	2.4			A and B		
		No	4	1.2	No	16.2.1.3.2(b)	C and D		16.2.1.3.2(b
			8	2.4			A and B		
	III	Yes	4	1.2	1 level	16.2.1.3.2(e)	C and D		In-rack required. S 2
			8	2.4			A and B		
		No	4	1.2	No	16.2.1.3.2(c)	C and D		16.2.1.3.2(c
			8	2.4			A and B		
	IV	Yes	4	1.2	1 level	16.2.1.3.2(f)	C and D		In-rack required. S 2
			8	2.4			A and B		
		No	4	1.2		16.2.1.3.2(d)	C and D		In-rack required. S 2
			8	2.4			A and B		
		Yes	4	1.2		16.2.1.3.2(g)	C and D		In-rack required. S 2
			8	2.4			A and B		

*See 16.2.1.3.2.1 21.4.1.2.1 for interpolation of aisle widths.

NA: Not applicable.

21.4.1.2.1*

Design densities for single- and double-row racks shall be selected to correspond to aisle width. *(See Section C.15.)*

(A)

For aisle widths between 4 ft (1.2 m) and 8 ft (2.4 m), the rules for 4 ft (1.2 m) aisle width shall be used or direct linear interpolation between the densities shall be permitted.

(B)

The density given for 8 ft (2.4 m) wide aisles shall be applied to aisles wider than 8 ft (2.4 m).

(C)

The density given for 4 ft (1.2 m) wide aisles shall be applied to aisles more narrow than 4 ft (1.2 m) down to 3½ ft (1.1 m).

(D)

Where aisles are more narrow than 3½ ft (1.1 m), racks shall be considered to be multiple-row racks.

Supplemental Information

File Name	Description	Approved
13_Table_21.4.1.2_With_Mark-Ups.docx	Revised Table 21.4.1.2. For staff use.	

Submitter Information Verification

Submitter Full Name: AUT-SSD
Organization: National Fire Protection Assoc
Street Address:
City:
State:
Zip:
Submittal Date: Sun Jul 30 17:37:43 EDT 2017

Committee Statement

Committee Statement: Table 21.4.1.2 has been revised showing ceiling only protection, for in-rack see Chapter 25.
Response Message:

Second Revision No. 811-NFPA 13-2017 [Section No. 21.4.1.3.1]

21.4.1.3.1 Multiple-Row Racks — Rack Depth Up to and Including 16 ft (4.9 m) with Aisles 8 ft (2.4 m) or Wider.

For Class I, Class II, Class III, or Class IV commodities, encapsulated or nonencapsulated, ceiling sprinkler water demand in terms of density [gpm/ft^2 (mm/min)] and area of sprinkler operation [ft^2 (m^2) of ceiling or roof] shall be selected from the density/area curves of Figure 21.4.1.2(a) through Figure 21.4.1.2(e) that are appropriate for each commodity and configuration as shown in Table 21.4.1.3.1 and shall be modified as appropriate by 21.4.1.4. The protection criteria shall apply to portable racks arranged in the same manner as multiple-row racks.

Table 21.4.1.3.1 Multiple-Row Racks — Rack Depth Up to and Including 16 ft (4.9 m), Aisles 8 ft (2.4 m) or Wider and Storage Height Over 12 ft (3.7 m) Up to 25 ft (7.6 m)

Height	Commodity Class	Encap-sulated	Sprinklers Mandatory In-Rack	Ceiling Sprinkler Wate				
				With In-Rack Sprinklers				
				Figure	Curves	Apply Figure 16.2.1.3.4.1	1.25 × Density	Figure
Over 12 ft (3.7 m) up to and including 15 ft (4.6 m)	I	No	No	16.2.1.3.2(a)	C and D	Yes	No	16.2.1.3.2(a) 21.4
		Yes		16.2.1.3.2(a)			Yes	16.2.1.3.2(a) 21.4
	II	No		16.2.1.3.2(b)			No	16.2.1.3.2(b) 21.4
		Yes		16.2.1.3.2(b)			Yes	16.2.1.3.2(b) 21.4
	III	No	No	16.2.1.3.2(c)			No	16.2.1.3.2(c) 21.4
		Yes	1 level	16.2.1.3.2(c)			Yes	In-rack sprink required. See C 25.
	IV	No	No	16.2.1.3.2(d)			No	16.2.1.3.2(d) In sprinklers require Chapter 25
		Yes	1 level	16.2.1.3.2(d)	A and B		1.50 × density	In-rack sprinklers required. See Ch 25.
Over 15 ft (4.6 m) up to and including 20 ft (6.1 m)	I	No	No	16.2.1.3.2(a)	C and D	Yes	No	16.2.1.3.2(a) 21.4
		Yes		16.2.1.3.2(a)			Yes	16.2.1.3.2(a) 21.4
	II	No		16.2.1.3.2(b)			No	16.2.1.3.2(b) 21.4
		Yes		16.2.1.3.2(b)			Yes	16.2.1.3.2(b) 21.4

								Ceiling Sprinkler Wate
				With In-Rack Sprinklers				
Height	Commodity Class	Encap-sulated	Sprinklers Mandatory In-Rack	Figure	Curves	Apply Figure 16.2.1.3.4.1	1.25 × Density	Figure
Over 20 ft (6.1 m) up to and including 25 ft (7.6 m)	III	No	No	16.2.1.3.2(c)		No	No	16.2.1.3.2(c) 21.4
		Yes	1 level	16.2.1.3.2(c)			Yes	NA In-rack sprir required. See Cl 25.
	IV	No	1 level	16.2.1.3.2(d)	A nd B		No	
		Yes		16.2.1.3.2(d)			1.50 × density	
	I	No	No	16.2.1.3.2(a)			No	16.2.1.3.2(a) 21.4
		Yes	1 level	16.2.1.3.2(a)			Yes	
	II	No	1 level	16.2.1.3.2(b)	C and D	No	No	NA In-rack sprir required. See Cl 25.
		Yes		16.2.1.3.2(b)			Yes	
	III	No		16.2.1.3.2(c)			No	
		Yes		16.2.1.3.2(c)			Yes	
	IV	No	2 levels	16.2.1.3.2(d)	A and B		No	
		Yes		16.2.1.3.2(d)			1.50 × density	

NA: Not applicable.

Supplemental Information

File Name	Description	Approved
13_Table_21.4.1.3.1_With_Mark-Ups.docx	Revised Table 21.4.1.3.1. For staff use.	

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Committee Statement

Committee Statement: Table 21.4.1.3.1 has been revised to represent ceiling only design, for in-rack design see Chapter 25.
Response Message:

Second Revision No. 812-NFPA 13-2017 [Section No. 21.4.1.3.2]

21.4.1.3.2 Multiple-Row Racks — Rack Depth Over 16 ft (4.9 m) or Aisles More Narrow Than 8 ft (2.4 m).

For Class I, Class II, Class III, or Class IV commodities, encapsulated or nonencapsulated, ceiling sprinkler water demand in terms of density [gpm/ft^2 (mm/min)] and area of sprinkler operation [ft^2 (m^2) of ceiling or roof] shall be selected from the density/area curves of Figure 21.4.1.2(a) through Figure 21.4.1.2(e) that are appropriate for each commodity and configuration as shown in Table 21.4.1.3.2 and shall be modified as appropriate by 21.4.1.4. The protection criteria shall apply to portable racks arranged in the same manner as multiple-row racks.

Table 21.4.1.3.2 Multiple-Row Racks — Rack Depth Over 16 ft (4.9 m) or Aisles Narrower Than 8 ft (2.4 m), Storage Height Over 12 ft (3.7 m) Up to and Including 25 ft (7.6 m)

Height	Commodity Class	Encap-sulated	Sprinklers Mandatory In-Rack	Ceiling Sprinkler Wate				
				With In-Rack Sprinklers				
				Figure	Curves	Apply Figure 16.2.1.3.4.1	1.25 × Density	Figure
Over 12 ft (3.7 m) up to and including 15 ft (4.6 m)	I	No	No	16.2.1.3.2(a)	C and D	Yes	No	16.2.1.3.2(a) 21.4
		Yes		16.2.1.3.2(a)			Yes	16.2.1.3.2(a) 21.4
	II	No		16.2.1.3.2(b)			No	16.2.1.3.2(b) 21.4
		Yes		16.2.1.3.2(b)			Yes	16.2.1.3.2(b) 21.4
	III	No		16.2.1.3.2(c)			No	16.2.1.3.2(c) 21.4
		Yes	1 level	16.2.1.3.2(c)			Yes	In-rack sprink required. See C 25.
	IV	No	No	16.2.1.3.2(d)			No	16.2.1.3.2(d) In sprinklers require Chapter 25
		Yes	1 level	16.2.1.3.2(d)			1.50 × density	In-rack sprink required. See C 25.
Over 15 ft (4.6 m) up to and including 20 ft (6.1 m)	I	No	1 level	16.2.1.3.2(a)	C and D	Yes	No	NA In-rack sprir required. See C 25.
		Yes		16.2.1.3.2(a)			Yes	
	II	No		16.2.1.3.2(b)			No	
		Yes		16.2.1.3.2(b)			Yes	
	III	No		16.2.1.3.2(c)			No	
		Yes		16.2.1.3.2(c)			Yes	
	IV	No		16.2.1.3.2(d)			No	
		Yes		16.2.1.3.2(d)			1.50 × density	
Over 20 ft (6.1 m) up to and	I	No	1 level	16.2.1.3.2(a)	C and D	No	No	NA In-rack sprir required. See C 25.
		Yes		16.2.1.3.2(a)			Yes	
	II	No		16.2.1.3.2(b)			No	

									Ceiling Sprinkler Wate
					With In-Rack Sprinklers				
Height	Commodity Class	Encap-sulated	Sprinklers Mandatory In-Rack	Figure	Curves	Apply Figure 16.2.1.3.4.1	1.25 × Density		Figure
including 25 ft (7.6 m)	III	Yes		16.2.1.3.2(b)			Yes		
		No		16.2.1.3.2(c)			No		
		Yes		16.2.1.3.2(c)			Yes		
		No		16.2.1.3.2(d)			No		
	IV	Yes	2 levels	16.2.1.3.2(d)			1.50 × density		

NA: Not applicable.

Supplemental Information

File Name	Description	Approved
13_Table_21.4.1.3.2_With_Mark-Ups.docx	Revise Table 21.4.1.3.2	

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Committee Statement

Committee Statement: Table 21.4.1.3.2 has been revised to represent ceiling only design, for in-rack design see Chapter 25.
Response Message:

Table 21.4.1.3.2 Multiple-Row Racks — Rack Depth Over 16 ft (4.9 m) or Aisles Narrower Than 8 ft (2.4 m), Storage Height Over 12 ft (3.7 m) Up to and Including 25 ft (7.6 m)

Height	Commodity Class	Encap-sulated	Sprinklers Mandatory In-Rack	Ceiling Sprinkler Water Demand							
				With In-Rack Sprinklers				Without In-Rack Sprinklers			
				Figure	Curves	Apply Figure 21.4.1.4.1 16.2.1.3.4.1	1.25 × Density	Figure	Curves	Apply Figure 21.4.1.4.1 16.2.1.3.4.1	1.25 × Density
Over 12 ft (3.7 m) up to and including 15 ft (4.6 m)	I	No	No	16.2.1.3.2(a)	C and D	Yes	No	21.4.1.2 16.2.1.3.2(a)	I and J	Yes	No
		Yes		16.2.1.3.2(a)			Yes	21.4.1.2 16.2.1.3.2(a)	I and J		Yes
	II	No		16.2.1.3.2(b)			No	21.4.1.2 16.2.1.3.2(b)	I and J	Yes	No
		Yes		16.2.1.3.2(b)			Yes	21.4.1.2 16.2.1.3.2(b)	I and J		Yes
	III	No		16.2.1.3.2(c)			No	21.4.1.2 16.2.1.3.2(c)	I and J	Yes	No
		Yes	1 level	16.2.1.3.2(c)			Yes	In-Rack Sprinklers Required. See Chapter 25	NA	NA	NA
	IV	No	No	16.2.1.3.2(d)			No	21.4.1.2 16.2.1.3.2(d)	C and D	No	No
		Yes	1 level	16.2.1.3.2(d)			1.50 × density	In-Rack Sprinklers Required. See Chapter 25	NA	NA	NA
Over 15 ft (4.6 m) up to and including 20 ft (6.1 m)	I	No	1 level	16.2.1.3.2(a)	C and D	Yes	No	In-Rack Sprinklers Required. See Chapter 25 NA	NA	NA	NA
		Yes		16.2.1.3.2(a)			Yes				
	II	No		16.2.1.3.2(b)			No				
		Yes		16.2.1.3.2(b)			Yes				
	III	No		16.2.1.3.2(c)			No				
		Yes		16.2.1.3.2(c)			Yes				
	IV	No		16.2.1.3.2(d)			No				
		Yes		16.2.1.3.2(d)			1.50 × density				
Over 20 ft (6.1 m) up to and including 25 ft (7.6 m)	I	No	1 level	16.2.1.3.2(a)	C and D	No	No	In-Rack Sprinklers Required. See Chapter 25 NA	NA	NA	NA
		Yes		16.2.1.3.2(a)			Yes				
	II	No		16.2.1.3.2(b)			No				
		Yes		16.2.1.3.2(b)			Yes				
	III	No		16.2.1.3.2(c)			No				
		Yes		16.2.1.3.2(c)			Yes				
	IV	No	2 levels	16.2.1.3.2(d)			No				
		Yes		16.2.1.3.2(d)			1.50 × density				

NA: Not applicable.

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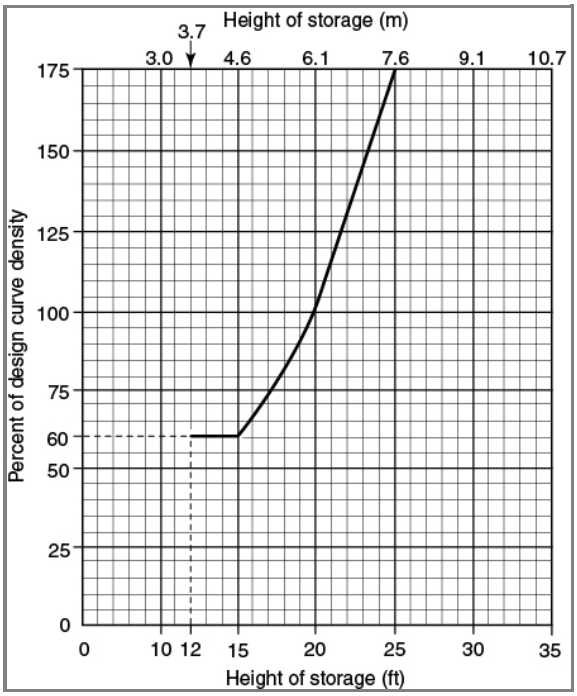
Second Revision No. 804-NFPA 13-2017 [Section No. 21.4.1.4]

21.4.1.4 Ceiling Sprinkler Density Adjustments.

21.4.1.4.1

For storage height over 12 ft (3.7 m) up to and including 25 ft (7.6 m) protected with ceiling sprinklers only ~~and for storage height over 12 ft (3.7 m) up to and including 20 ft (6.1 m) protected with ceiling sprinklers and minimum required in-rack sprinklers, densities obtained from design curves~~ , densities obtained from design curves shall be adjusted in accordance with Figure 21.4.1.4.1.

Figure 21.4.1.4.1 Ceiling Sprinkler Density vs. Storage Height.



~~**21.4.1.4.2**~~

~~For storage height over 20 ft (6.1 m) up to and including 25 ft (7.6 m) protected with ceiling sprinklers and minimum required in-rack sprinklers, densities obtained from design curves shall be used. Densities shall not be adjusted in accordance with Figure 21.4.1.4.1 .~~

21.4.1.4.3

For storage height over 12 ft (3.7 m) up to and including 20 ft (6.1 m) protected with ceiling sprinklers and with more than one level of in-rack sprinklers, but not in every tier, densities obtained from design curves and adjusted in accordance with Figure 21.4.1.4.1 shall be permitted to be reduced an additional 20 percent, as indicated in Table 21.4.1.4.3 .

Table 21.4.1.4.3 Adjustment to Ceiling Sprinkler Density for Storage Height and In-Rack Sprinklers

Storage Height	In-Rack Sprinklers	Apply Figure 16.2.1.3.4.1 for Storage Height Adjustment	Permitted Ceiling Sprinklers Density Adjustments Where In-Rack Sprinklers Are Installed
Over 12 ft (3.7 m) through 25 ft (7.6 m)	None	Yes	None
Over 12 ft (3.7 m) through 20 ft (6.1 m)	Minimum required	Yes	None
	More than minimum, but not in every tier	Yes	Reduce density 20% from that of minimum in-rack sprinklers
	In every tier except above the top tier	Yes	Reduce density 40% from that of minimum in-rack sprinklers
Over 20 ft (6.1 m) through 25 ft (7.3 m)	Minimum required	No	None
	More than minimum, but not in every tier	No	Reduce density 20% from that of minimum in-rack sprinklers
	In every tier except above the top tier	No	Reduce density 40% from that of minimum in-rack sprinklers

21.4.1.4.4

For storage height over 20 ft (6.1 m) up to and including 25 ft (7.6 m) protected with ceiling sprinklers and with more than the minimum required level of in-rack sprinklers, but not in every tier, densities obtained from design curves shall be permitted to be reduced 20 percent, as indicated in Table 21.4.1.4.3 . Densities shall not be adjusted in accordance with Figure 21.4.1.4.1 for storage height.

21.4.1.4.5*

For storage height over 12 ft (3.7 m) up to and including 20 ft (6.1 m) protected with ceiling sprinklers and in-rack sprinklers at each tier, densities obtained from design curves and adjusted in accordance with Figure 21.4.1.4.1 shall be permitted to be reduced an additional 40 percent, as indicated in Table 21.4.1.4.3 .

A.21.4.1.4.5

It is not the intent that an in-rack sprinkler be installed above the top-tier of storage when utilizing "in-rack sprinklers in every tier."

21.4.1.4.6

For storage height over 20 ft (6.1 m) up to and including 25 ft (7.6 m) protected with ceiling sprinklers and in-rack sprinklers at each tier except above the top tier, densities obtained from design curves shall be permitted to be reduced 40 percent, as indicated in Table 21.4.1.4.3 . Densities shall not be adjusted in accordance with Figure 21.4.1.4.1 for storage height.

21.4.1.4.2

Where solid, flat-bottom, combustible pallets (slave pallets) are used with storage height up to and including 25 ft (7.6 m), the densities that are indicated in the design curves shown in Figure 21.4.1.2(a) through Figure 21.4.1.2(e), based on conventional pallets, shall be increased 20 percent for the given area.

(A)

The percentage shall be applied to the density determined in accordance with 21.4.1.4.

(B)

The increase in density shall not apply where in-rack sprinklers are utilized in the design.

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City:
State:
Zip:
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Committee Statement

Committee Statement: This is redundant text that is covered by Chapter 25.
Response Message:

Second Revision No. 813-NFPA 13-2017 [Section No. 21.4.2.1 [Excluding any Sub-Sections]]

For single- and double-row racks, the water demand for nonencapsulated storage separated by aisles at least 4 ft (1.2 m) wide and with a clearance to ceiling up to and including 10 ft (3.0 m) shall be in accordance with Table 21.4.2.1 . The protection criteria requirements for rack storage of Class I through Class IV commodities stored over 25 ft (7.6 m) in height protected by CMDA sprinklers shall be in accordance with Chapter 25 .

Table 21.4.2.1 Single- or Double-Row Racks of Class I Through Class IV Commodities Stored Over 25 ft (7.6 m) in Height with Aisles 4 ft (1.2 m) or More in Width

Commodity Class	In-Rack Sprinklers Approximate Vertical Spacing at Tier Nearest the Vertical Distance and Maximum Horizontal Spacing a,b,c		Figure	Maximum Storage Height	Stagger	Ceiling Sprinkler Operating Area		Ceiling Sprinkl Ceiling U Ordinary Temperature	
	Longitudinal Flue d	Face e,f				ft 2	m 2	gpm/ft 2	mm/r
I	Vertical 20 ft (6.1 m) Horizontal 10 ft (3.0 m) under horizontal barriers	None	16.3.1.3.1.1(A)(a)	30 ft (9.1 m)	No	2000	186	0.25	10.2
	Vertical 20 ft (6.1 m) Horizontal 10 ft (3.0 m)	Vertical 20 ft (6.1 m) Horizontal 10 ft (3.0 m)	16.3.1.3.1.1(A)(b)	Higher than 25 ft (7.6 m)	Yes			0.25	10.2
I, II, III	Vertical 10 ft (3.0 m) or at 15 ft (4.6 m) and 25 ft (7.6 m)	None	16.3.1.3.1.1(A)(c)	30 ft (9.1 m)	Yes	2000	186	0.3	12.2
	Vertical 10 ft (3.0 m m) Horizontal 10 ft (3.0 m m)	Vertical 30 ft (9.1 m) Horizontal 10 ft (3.0 m)	16.3.1.3.1.1(A)(d)	Higher than 25 ft (7.6 m)	Yes			0.3	12.2
	Vertical 20 ft (6.1 m) Horizontal 10 ft (3.0 m)	Vertical 20 ft (6.1 m) Horizontal 5 ft (1.5 m)	16.3.1.3.1.1(A)(e)		Yes			0.3	12.2
	Vertical 25 ft (7.6 m) Horizontal 5 ft (1.5 m)	Vertical 25 ft (7.6 m) Horizontal 5 ft (1.5 m)	16.3.1.3.1.1(A)(f)		No			0.3	12.2
	Horizontal barriers at 20 ft (6.1 m) Vertical		16.3.1.3.1.1(A)(g)		Yes			0.3	12.2

Commodity Class	In-Rack Sprinklers Approximate Vertical Spacing at Tier Nearest the Vertical Distance and Maximum Horizontal Spacing [a,b,c] Longitudinal Flue [d]	Face [e,f]	Figure	Maximum Storage Height	Stagger	Ceiling Sprinkler Operating Area ft²	m²	Ceiling Sprinkl Ceiling U Ordinary Temperature gpm/ft²	mm/r
	~~intervals — two lines of sprinklers under barriers — maximum horizontal spacing 10 ft (3.0 m), staggered~~								
	~~Vertical 15 ft (4.6 m) Horizontal 10 ft (3.1 m)~~	~~Vertical 20 ft (6.1 m) Horizontal 10 ft (3.0 m)~~	~~16.3.1.3.1.1(A)(h)~~		~~Yes~~			~~0.35~~	~~14.3~~
	~~Vertical 20 ft (6.1 m) Horizontal 5 ft (1.5 m)~~	~~Vertical 20 ft (6.1 m) Horizontal 5 ft (1.5 m)~~	~~16.3.1.3.1.1(A)(i)~~		~~No~~			~~0.35~~	~~14.2~~
~~I, II, III, IV~~	~~Horizontal barriers at 15 ft (4.6 m) Vertical intervals — two lines of sprinklers under barriers — maximum horizontal spacing 10 ft (3.0 m), staggered~~			~~Higher than 25 ft (7.6 m)~~		~~2000~~	~~186~~		
			~~16.3.1.3.1.1(A)(j)~~		~~Yes~~			~~0.35~~	~~14.2~~

~~a Minimum in-rack sprinkler discharge, 30 gpm (114 L/min).~~

~~b Water shields required.~~

~~c All in-rack sprinkler spacing dimensions start from the floor.~~

~~d Install sprinklers at least 3 in. (75 mm)from uprights.~~

~~e Face sprinklers shall not be required for a Class I commodity consisting of noncombustible products on wood pallets (without combustible containers), except for arrays shown in Figure 16.3.1.3.1.1(A)(g) and Figure 16.3.1.3.1.1(A)(j).~~

~~f In Figure 16.3.1.3.1.1(A)(a) through Figure 16.3.1.3.1.1(A)(j), each square represents a storage cube that measures 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. to 10 ft (450 mm to 3.0 m). Therefore, there can be one load to six or seven loads between in-rack~~

~~sprinklers that are spaced 10 ft (3.0 m) apart vertically.~~

~~g~~ ~~For encapsulated commodity, increase density 25 percent.~~

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Street Address:
City:
State:
Zip:
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Committee Statement

Committee Statement: Table 21.4.2.1 has been deleted, for in-rack design see Chapter 25. A statement has been provided directing the user to Chapter 25.
Response Message:

Second Revision No. 814-NFPA 13-2017 [Section No. 21.4.2.2 [Excluding any Sub-Sections]]

~~For multiple-row racks, the water demand for nonencapsulated storage separated by aisles at least 4 ft (1.2 m) wide and with a clearance to ceiling up to and including 10 ft (3.0 m) shall be in accordance with Table 21.4.2.2 .~~

~~Table 21.4.2.2 Multiple-Row Racks of Class I Through Class IV Commodities Stored Over 25 ft (7.6 m) in Height~~

~~Commodity Class~~	~~Encapsulated~~	~~In-Rack Sprinklers a,b,c~~						~~Height Limit (ft)~~	~~Stagger~~	~~Figure~~	~~Maxi Spa from c Stor to Hig In-R Sprin~~	
		~~Maximum Vertical Spacing~~		~~Maximum Horizontal Spacing in A Flue~~		~~Maximum Horizontal Spacing across Flue~~						
		~~ft~~	~~m~~	~~ft~~	~~m~~	~~ft~~	~~m~~				~~ft~~	
~~I~~	~~No~~ ~~Yes~~	~~20~~	~~6.1~~	~~12~~	~~3.7~~	~~10~~	~~3.0~~	~~None~~	~~Between adjacent flues~~	~~16.3.1.3.1.3(A)(a)~~	~~10~~	
~~I, II, and III~~	~~No~~ ~~Yes~~	~~15~~	~~4.6~~	~~10~~	~~3.0~~	~~10~~	~~3.0~~			~~16.3.1.3.1.3(A)(b)~~	~~10~~	
~~I, II, III, and IV~~	~~No~~ ~~Yes~~	~~10~~	~~3.1~~	~~10~~	~~3.0~~	~~10~~	~~3.0~~			~~16.3.1.3.1.3(A)(c)~~	~~5~~	

~~For SI units, °C = 5/9 (°F-32); 1 gpm/ft^2 = 40.746 mm/min.~~

~~a All four rack faces shall be protected by sprinklers located within the racks and no more than 18 in. (450 mm) from the faces, as indicated in Figure 16.3.1.3.1.3(A)(a) through Figure 16.3.1.3.1.3(A)(c). It shall not be required for each sprinkler level to protect all faces.~~

~~b All in-rack sprinkler spacing dimensions start from the floor.~~

~~c In Figure 16.3.1.3.1.3(A)(a) through Figure 16.3.1.3.1.3(A)(c), each square represents a storage cube measuring 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. to 10 ft (450 mm to 3.0 m). Therefore, there could be as few as one load or as many as six or seven loads between in-rack sprinklers that are spaced 10 ft (3.1 m) apart vertically.~~

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City:
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Zip:
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Committee Statement

Committee Statement: Table 21.4.2.2 has been deleted, for in-rack design see Chapter 25.

Response Message:

Second Revision No. 383-NFPA 13-2017 [Section No. 21.5.1 [Excluding any Sub-Sections]]

Plastic commodities shall be protected in accordance with ~~Figure 21.5.1~~ this section . *(See Section C.21.)*

~~Figure 21.5.1 Decision Tree.~~

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City:
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Zip:
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Committee Statement

Committee Statement: The figure has been deleted as it is redundant, the figure can be found in Chapter 20.
Response Message:

Second Revision No. 815-NFPA 13-2017 [Section No. 21.5.1.1]

21.5.1.1

For Group A plastic commodities in cartons, encapsulated or nonencapsulated in single-, double-, and multiple-row racks and with a clearance to ceiling up to and including 10 ft (3.1 m), ceiling sprinkler water demand in terms of density [gpm/ft^2 (mm/min)] and area of operation [ft^2 (m^2)] shall be selected from Table 21.5.1.1.

Table 21.5.1.1 Control Mode Density/Area Sprinkler Protection Criteria for Single-, Double-, and Multiple-Row Racks for Group A Plastic Commodities in Cartons Stored Up to and Including 25 ft (7.6 m) in Height

Commodity	Storage height	Maximum Clearance from Top of Storage to Ceiling	Maximum Ceiling Height	~~In-Racks~~ Requirements	Ceiling Sprinklers Density Clearance to Ceiling Up to 10 ft	Ceiling Sprinkler Operating Area
-	ft (m)	ft (m)	ft (m)		gpm/ft^2(mm/min)	ft^2 (m^2)
Group A plastic commodities in cartons, encapsulated	5 ft to 10 ft (1.5 m to 3.1)	<5 ft (1.5 m)	<15 ft (~~3.1~~ 4.6 m)	~~Not Required~~	0.30 gpm/ft^2 (12.2 mm/min)	2000 ft^2 (186 m^2)
		5 ft to 10 ft (1.5 m to 3.1 m)	20 ft (6.1 m)	~~Not Required~~	0.45 gpm/ft^2 (18.3 mm/min)	
	15 ft (4.6 m)	~~5~~ ≥5 ft (1.5 m) ~~and up~~	22 ft (6.7 m)	~~Not Required~~	0.45 gpm/ft^2 (18.3 mm/min)	
		~~Up to 10~~ ≤10 ft (3.1 m)	25 ft (7.6 m)	~~Not Required~~	0.60 gpm/ft^2 (24.5 mm/min)	
				~~Figure 25.9.3.2(a)~~	~~0.30 gpm/ft^2 (12.2 mm/min)~~	
	20 ft (6.1 m)	<5 ft (1.5 m)	<25 ft (7.6 m)	~~Not Required 1,2~~	0.60 gpm/ft^2 (24.5 mm/min)[a,b]	
				~~Figure 25.9.3.2(b)~~	~~0.45 gpm/ft^2 (18.3 mm/min)~~	
				~~Figure 25.9.3.2(c)~~	~~0.30 gpm/ft^2 (12.2 mm/min)~~	
		5 ft to 10 ft (1.5 m to 3.1 m)	27 ft (8.2 m).	~~Not Required 1~~	0.60 gpm/ft^2 (24.5 mm/min)[a]	
			30 ft (9.1 m)	~~Figure 25.9.3.2(d)~~	~~0.45 gpm/ft^2 (18.3 mm/min)~~	
				~~Figure 25.9.3.2(e)~~	~~0.30 gpm/ft^2 (12.2 mm/min)~~	
				~~Figure 25.9.3.2(f)~~	~~0.30 gpm/ft^2 (12.2 mm/min)~~	
				~~Figure 25.9.3.2(g)~~	~~0.30 gpm/ft^2 (12.2 mm/min)~~	
	25 ft (7.6 m)	<5 ft (1.5 m)	30 ft (9.1 m)	~~Not Required 2~~	0.8 gpm/ft^2 (32.6 mm/min)[c]	
				~~Figure 25.9.3.2(h)~~	~~0.45 gpm/ft^2 (18.3 mm/min)~~	
				~~Figure 25.9.3.2(i)~~	~~0.30 gpm/ft^2 (12.2 mm/min)~~	

Commodity	Storage height	Maximum Clearance from Top of Storage to Ceiling	Maximum Ceiling Height	~~In-Racks Requirements~~	Ceiling Sprinklers Density Clearance to Ceiling Up to 10 ft	Ceiling Sprinkler Operating Area
-	ft (m)	ft (m)	ft (m)		gpm/ft^2(mm/min)	ft^2 (m^2)
		5 ft to 10 ft (1.5 m to 3.1 m)	35 ft (10.7 m)	~~Figure 25.9.3.2(j)~~	~~0.30 gpm/ft 2 (12.2 mm/min)~~	

~~Notes~~

~~(1)~~ [a] Ceiling-only protection is not permitted for this storage configuration except where K-11.2 or larger spray sprinklers listed for storage use are installed.

~~(2)~~ [b] For the protection of single- and double-row rack only.

~~(3)~~ [c] Ceiling-only protection shall not be permitted for this storage configuration except where K-16.8 spray sprinklers listed for storage use are installed.

Supplemental Information

File Name	Description	Approved
13_Table_21.5.1.1_With_Mark-Ups_.docx	Revised Table 21.5.1.1. For staff use.	

Submitter Information Verification

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Committee Statement

Committee Statement: Table 21.5.1.1 has been revised to represent ceiling only design, for in-rack design see Chapter 25.
Response Message:

Second Revision No. 1009-NFPA 13-2017 [Section No. 21.5.1.4.1]

~~**21.5.1.4.1**~~

~~The density/area criteria shall be applied to the ceiling sprinklers and the in-rack sprinklers shown in the option (if any) shall be provided.~~

~~**21.5.1.4.2**~~

~~Options that do not show multiple-row racks in the figures shall not be permitted to protect multiple-row rack storage.~~

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Committee Statement

Committee Statement: In-rack sprinklers are covered by Chapter 25. Delete section 21.5.1.4.2 as the figures no longer exist.
Response Message:

Second Revision No. 1010-NFPA 13-2017 [Section No. 21.5.1.4.3]

~~21.5.1.4.3~~

~~Notes in each figure shall be permitted to clarify options or to present additional options not shown in the figures.~~

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Committee Statement

Committee Statement: Delete section 21.5.1.4.3 as the figures no longer exist.
Response Message:

Second Revision No. 816-NFPA 13-2017 [Section No. 21.5.3]

Global SR-531

21.5.3

Exposed nonexpanded Group A plastics protected with control mode density/area sprinklers shall be protected in accordance with Table 21.5.3.

Table 21.5.3 Control Mode Density/Area Sprinkler Protection Criteria for Exposed ~~Unexpanded~~Nonexpanded Group A Plastics

Commodity	Storage height	Maximum Ceiling Height	~~In-Racks Requirements~~	Ceiling Sprinklers Density Clearance to Ceiling Up to 10 ft	Ceiling Sprinkler Operating Area
	ft (m)	ft (m)		gpm/ft^2 (mm/min)	ft^2 (m^2)
Exposed ~~Unexpanded~~nonexpanded Group A plastic	10 ft (3.1 m)	20 ft (6.1 m)	~~Not Required~~	0.80 gpm/ft^2 (32.6 mm/min)	2500 ft^2 (232 m^2)
			~~Figure 25.9.3.2(a)~~	~~0.45 gpm/ft^2 (18.3 mm/min)~~	~~2000 ft^2 (186 m^2)~~
			~~Figure 25.9.3.2(b)~~	~~0.30 gpm/ft^2 (12.2 mm/min)~~	
	~~15 ft (4.6 m)~~	~~25 ft (7.6 m)~~	~~Figure 25.9.3.2(c)~~	~~0.45 gpm/ft^2 (18.3 mm/min)~~	
			~~Figure 25.9.3.2(d)~~	~~0.30 gpm/ft^2 (12.2 mm/min)~~	
	~~20 ft (6.1 m)~~	~~25 ft (7.6 m)~~	~~Figure 25.9.3.2(e)~~	~~0.60 gpm/ft^2 (24.5 mm/min)~~	
			~~Figure 25.9.3.2(f)~~	~~0.45 gpm/ft^2 (18.3 mm/min)~~	
		~~30 ft (9.1 m)~~	~~Figure 25.9.3.2(g)~~	~~0.80 gpm/ft^2 (32.6 mm/min)~~	~~1500 ft^2 (139 m^2)~~
			~~Figure 25.9.3.2(h)~~	~~0.60 gpm/ft^2 (24.5 mm/min)~~	
			~~Figure 25.9.3.2(i)~~	~~0.30 gpm/ft^2 (12.2 mm/min)~~	~~2000 ft^2 (186 m^2)~~
	~~25 ft (7.6 m)~~	~~35 ft (10.7 m)~~	~~Figure 25.9.3.2(j)~~	~~0.80 gpm/ft^2 (32.6 mm/min)~~	~~1500 ft^2 (139 m^2)~~
			~~Figure 25.9.3.2(k)~~	~~0.30 gpm/ft^2 (12.2 mm/min)~~	~~2000 ft^2 (186 m^2)~~

Supplemental Information

File Name	Description	Approved

13_Table_21.5.3_With_Mark-Ups_.docx Revised Table 21.5.3. For staff use.

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Committee Statement

Committee Statement: Table 21.5.3 has been revised to represent ceiling only design, for in-rack design see Chapter 25.
Response Message:

Second Revision No. 1011-NFPA 13-2017 [Sections 21.5.4.1, 21.5.4.2, 21.5.4.3]

21.5.4.1

~~Protection of Group A plastics in cartons, expanded or nonexpanded, whether encapsulated or nonencapsulated and with a clearance to ceiling up to and including 10 ft (3.1 m), shall be permitted using control mode density/area sprinklers in accordance with 21.5.4 .~~ The protection criteria requirements for rack storage of Group A plastic commodities stored over 25 ft (7.6 m) in height protected by CMDA sprinklers shall be in accordance with Chapter 25 .

~~**21.5.4.2**~~

~~Protection of Group A plastics that are exposed and nonexpanded, whether encapsulated or nonencapsulated racks and with a clearance to ceiling up to and including 10 ft (3.1 m), shall be permitted only using in-rack sprinkler arrangements that are specifically permitted to be used with exposed unexpanded plastics.~~

~~**21.5.4.3***~~ ~~Ceiling Sprinkler Water Demand.~~

For Group A plastic commodities, encapsulated or nonencapsulated, ceiling sprinkler water demand in terms of density [gpm/ft^2 (mm/min)] and area of operation [ft^2 (m^2)] shall be selected from Table 21.5.4.3 where in-rack sprinklers are installed per Chapter 25.

Table 21.5.4.3 Control Mode Density/Area Sprinkler Discharge Criteria for Single , Double , and Multiple Row Racks of Group A Plastic Commodities with Storage Over 25 ft (7.6 m) in Height

Commodity	Rack Type	Storage height above top level of in-rack sprinklers	In-Racks Requirements	Ceiling Sprinklers Density Clearance to Ceiling Up to 10 ft	Ceiling Sprinkler Operating Area
-	ft (m)	ft (m)		gpm/ft^2 (mm/min)	ft2 (m^2)
Cartoned Unexpanded and Expanded Group A plastic	Single Row and Double Row Racks	up to 5 ft (1.5 m)	Figure 21.5.5.5(a) to (c) or Figure 21.5.5.7	0.30 gpm/ft^2 (12.2 mm/min)	2000 ft^2 (186 m^2)
	Single Row and Double Row Racks	>5 ft up to 10 ft (>1.5 m up to 3.1 m)	21.5.5.5(a) to (c) or Figure 21.5.5.7	0.45 gpm/ft^2 (18.3 mm/min)	2000 ft^2 (186 m^2)
	Multiple Row Racks	up to 5 ft (1.5 m)	Figure 21.5.5.8(a) to (f)	0.30 gpm/ft^2 (12.2 mm/min)	2000 ft^2 (186 m^2)
		up to and including 10 ft (3.1 m)		0.45 gpm/ft^2 (18.3 mm/min)	2000 ft^2 (186 m^2)
Exposed Unexpanded Group A Plastic	Single Row and Double Row Racks	up to and including 10 ft (3.1 m)	Figure 21.5.5.7	0.45 gpm/ft^2 (18.3 mm/min)	2000 ft^2 (186 m^2)
	Multiple Row Racks	up to 5 ft (1.5m)	Figure 21.5.5.8(a) to (f)	0.30 gpm/ft^2 (12.2 mm/min)	2000 ft^2 (186 m^2)
		up to and including 10 ft (3.1 m)		0.45 gpm/ft^2 (18.3 mm/min)	2000 ft^2 (186 m^2)

A.21.5.4.3

In this application ordinary-, intermediate-, or high-temperature sprinklers can be used. There are no data to support temperature rating restrictions for this section.

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Zip:

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Committee Statement

Committee Statement: In-rack criteria has been relocated to Chapter 25.

Response Message:

Second Revision No. 324-NFPA 13-2017 [Section No. 21.5.4.4]

~~21.5.4.4~~

~~The minimum water supply requirements for a hydraulically designed occupancy hazard fire control sprinkler system shall be determined by adding the hose stream allowance from Table 21.5.4.4 to the water supply for sprinklers determined in Section 17.3.~~

~~Table 21.5.4.4 Hose Stream Allowance and Water Supply Duration Requirements for Rack Storage of Group A Plastic Commodities Stored Over 25 ft (7.6 m) in Height~~

~~Commodity Classification~~	~~Storage Height~~		~~Inside Hose~~		~~Total Combined Inside and Outside Hose~~		~~Duration (minutes)~~
	~~ft~~	~~m~~	~~gpm~~	~~L/min~~	~~gpm~~	~~L/min~~	
~~Plastic~~	~~>25~~	~~>7.6~~	~~0, 50, or 100~~	~~0, 190, or 380~~	~~500~~	~~1900~~	~~120~~

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Committee Statement

Committee Statement: Section 21.5.4.4 and Table 21.5.4.4 are redundant. They deal with hose stream and water supply issues that are addressed in Section 20.12.2.6 and Table 20.12.2.6. Therefore, this redundat information should be deleted.

Response Message:

Public Comment No. 219-NFPA 13-2017 [Section No. 21.5.4.4]

Second Revision No. 1005-NFPA 13-2017 [Section No. 21.6.1]

21.6.1 Ceiling Systems.

Protection of rubber tire storage by ceiling-only sprinkler arrangements shall be selected from Table 21.6.1(a) or Table 21.6.1(b). or per Chapter 25 using ceiling and in-rack sprinkler arrangements.

Table 21.6.1(a) Protection Criteria for Rubber Tire Storage Using Control Mode Density/Area Sprinklers

Piling Method[d]	Pile Height [ft (m)]	Sprinkler Discharge Density[a] [gpm/ft^2 over ft^2(mm/min over m^2)] *(see Note 1)*	Areas of Application[a] [ft^2(m^2)] *(see Note 1)*	
			Ordinary Temperature	High Temperature[a] *(see Note 1)*
(1) On-floor storage	Up to 5 (1.5)	0.19 (0.72)	2000 (186)	2000 (186)
(a) Pyramid piles, on-side	Over 5 (1.5) to 12 (3.7)	0.30 (1.1)	2500 (232)	2500 (232)
(b) Other arrangements such that no horizontal channels are formed[b] *(see Note 2)*	Over 12 (3.7) to 18 (5.5)	0.60 (2.3)	Not allowed	2500 (232)
(2) On-floor storage	Up to 5 (1.5)	0.19 (0.72)	2000 (186)	2000 (186)
Tires, on-tread	Over 5 (1.5) to 12 (3.7)	0.30 (1.1)	2500 (232)	2500 (232)
(3) Palletized portable rack storage	Up to 5 (1.5)	0.19 (0.72)	2000 (186)	2000 (186)
On-side or on-tread	Over 5 (1.5) to 20 (6.1)	See Table 18.4(b)	—	—
	Over 20 (6.1) to 30 (9.1)	0.30 (1.1) plus high-expansion foam	3000 (280)	3000 (280)
(4) Palletized portable rack storage, on-side	Up to 5 (1.5)	0.19 (0.72)	2000 (186)	2000 (186)
	Over 5 (1.5) to 20 (6.1)	See Table 18.4(b)	—	—
	Over 20 (6.1) to 25 (7.6)	0.60 (2.2) and	Not allowed	5000 (465)
		0.90 (3.4)[c] *(see Note 3)* or	Not allowed	3000 (280)
		0.75 (2.8) with 1-hour fire-resistive rating of roof and ceiling assembly	Not allowed	4000 (370)
(5) Open portable rack storage, on-side or on-tread	Up to 5 (1.5)	0.19 (0.72)	2000 (186)	2000 (186)
	Over 5 (1.5) to 12 (3.7)	0.60 (2.2)	5000 (465)	3000 (280)
	Over 12 (3.7) to 20 (6.1)	0.60 (2.2) and	Not allowed	5000 (465)
		0.90 (3.4) *(see Note 3)* [c] or	Not allowed	3000 (280)

Piling Method[d]	Pile Height [ft (m)]	Sprinkler Discharge Density[a] [gpm/ft^2 over ft^2(mm/min over m^2)] ~~(see Note 1)~~	Areas of Application[a] [ft^2(m^2)]~~(see Note 1)~~ Ordinary Temperature	High Temperature[a] ~~(see Note 1)~~
		0.30 (1.1) plus high-expansion foam	3000 (280)	3000 (280)
(6) Open portable rack storage, laced	Over 12 (3.7) to 20 (6.1)	0.60 (2.2) and	Not allowed	5000 (465)
		0.90 (3.4)~~(see Notes 3 and 5)~~ c,d	Not allowed	3000 (280)
	Up to 5 (1.5)	0.19 (0.72)	2000 (186)	2000 (186)
(7) Single-, double-, and multiple-row fixed rack storage on pallets, on-side, or on-tread without shelves	Over 5 (1.5) to 20 (6.1)	See Table 18.4(b) or ~~0.40 (1.5) plus one level in-rack sprinklers or~~	~~3000 (280)~~	~~3000 (280)~~
		0.30 (1.1) plus high-expansion foam	3000 (280)	3000 (280)
	Over 20 (6.1) to 30 (9.1)	0.30 (1.1) plus high-expansion foam	Not allowed	3000 (280)
	Up to 5 (1.5)	0.19 (0.72)	2000 (186)	2000 (186)
	Over 5 (1.5) to 12 (3.7)	0.60 (2.2)	5000 (465)	3000 (280)
		~~0.40 (1.5) plus one level in-rack sprinklers~~	~~3000 (280)~~	~~3000 (280)~~
(8) Single-, double-, and multiple-row fixed rack storage without pallets or shelves, on-side or on-tread	Over 12 (3.7) to 20 (6.1)	0.60 (2.2) and	Not allowed	5000 (465)
		0.90 (3.4)~~(see Note 3)~~ c or	Not allowed	3000 (280)
		~~0.40 (1.5) plus one level in-rack sprinklers or~~	~~3000 (280)~~	~~3000 (280)~~
		0.30 (1.1) plus high-expansion foam	3000 (280)	3000 (280)
	Over 20 (6.1) to 30 (9.1)	0.30 (1.1) plus high-expansion foam	Not allowed	3000 (280)

Notes~~:~~ : Shelf storage of rubber tires shall be protected as solid rack shelving.

~~(1)~~ a Sprinkler discharge densities and areas of application are based on a maximum clearance to ceiling of 10 ft (3.0 m) with the maximum height of storage anticipated.

~~(2)~~ b Laced tires on-floor, vertical stacking on-side (typical truck tires), and off-road tires. Laced tires are not stored to a significant height by this method due to the damage inflicted on the tire (i.e., bead).

~~(3)~~ c Water supply shall fulfill both requirements.

~~(4)~~ d Shelf storage of rubber tires shall be protected as solid rack shelving.

~~(5)~~ e This protection scheme is for use with K-16.8 (240) or larger control mode sprinklers only. Maximum clearance to ceiling can be increased to 14 ft (4.3 m) with this scheme.

Table 21.6.1(b) Control Mode Density/Area Sprinklers System Density (gpm/ft^2 over ft^2) for Palletized Portable Rack Storage and Fixed Rack Storage of Rubber Tires with Pallets Over 5 ft (1.5 m) to 20 ft (3.7 m) in Height

Storage Height [ft (m)]	Sprinkler Temperature	
	High Temperature	Ordinary Temperature
>5 to 10 (1.5 to 3.0)	0.32/2000 (1.2/186)	0.32/2000 (1.2/186)
>10 to 12 (3.0 to 3.7)	0.39/2000 (1.5/186)	0.39/2600 (1.5/241)
>12 to 14 (3.7 to 4.3)	0.45/2000 (1.7/186)	0.45/3200 (1.7/300)
>14 to 16 (4.3 to 4.9)	0.5/2300 (1.9/214)	0.5/3700 (1.9/345)
>16 to 18 (4.9 to 5.5)	0.55/2600 (2.1/241)	0.55/4400 (2.1/410)
>18 to 20 (5.5 to 6.1)	0.6/3000 (2.3/280)	0.6/5000 (2.3/465)

Supplemental Information

File Name	Description	Approved
13_Table_21.6.1_a_With_Mark-Ups_.docx	Revised Table 21.6.1(a). For staff use.	

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Committee Statement

Committee Statement: Table 21.6.1(a) has been revised representing ceiling only protection, for in-rack design see Chapter 25.
Response Message:

Second Revision No. 325-NFPA 13-2017 [Section No. 21.8.1.2]

21.8.1.2

A wet pipe system that is designed to provide a minimum of 0.6 gpm/ft^2 (24.4 mm/min) density over a minimum area of 2000 ft^2 (186 m^2) shall be permitted to protect single-row and double-row racks with slatted rack shelving where all of the following conditions are met:

(1) Sprinklers shall be K-11.2 (160), K-14.0 (200), or K-16.8 (240) orifice spray sprinklers with a temperature rating of ordinary, intermediate, or high and shall be listed for storage occupancies.

(2) The protected commodities shall be limited to Class I through Class IV, Group B plastics, Group C plastics, cartoned (expanded and nonexpanded) Group A plastics, and exposed (nonexpanded) Group A plastics.

(3) Slats in slatted rack shelving shall be a minimum nominal 2 in. (50 mm) thick by maximum nominal 6 in. (150 mm) wide, with the slats held in place by spacers that maintain a minimum 2 in. (50 mm) opening between each slat.

(4) Where K-11.2 (160), K-14.0 (200), or K-16.8 (240) orifice sprinklers are used, there shall be no slatted shelf levels in the rack above 12 ft (3.7 m). Open rack shelving using wire mesh shall be permitted for shelf levels above 12 ft (3.7 m).

(5) Transverse flue spaces at least 3 in. (75 mm) wide shall be provided at least every 10 ft (3.0 m) horizontally.

(6) Longitudinal flue spaces at least 6 in. (150 mm) wide shall be provided for double-row racks.

(7) The aisle widths shall be at least 7½ ft (2.3 m).

(8) The maximum roof height shall be 27 ft (8.2 m).

(9) The maximum storage height shall be 20 ft (6.1 m).

(10) Solid plywood or similar materials shall not be placed on the slatted shelves so that they block the 2 in. (50 mm) spaces between slats, nor shall they be placed on wire mesh shelves.

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Committee Statement

Committee Statement: For slatted shelves in Section 21.8.1.2 the requirement for 6" longitudinal flues was deleted without and substantiation. Without any technical justification for the deletion, this requirement must be re-inserted.

Response Message:

Public Comment No. 220-NFPA 13-2017 [Section No. 21.8.1.2]

Second Revision No. 326-NFPA 13-2017 [Section No. 21.8.1.3]

~~**21.8.1.3** Reduced-Discharge Density.~~

~~Where high-expansion foam systems are installed in accordance with NFPA 11 , a reduction in sprinkler discharge density to one-half the density specified in Table 21.6.1(a) or 0.24 gpm/ft^2 (9.8 mm/min), whichever is higher, shall be permitted.~~

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Committee Statement

Committee Statement: Section 21.8.1.3 about reduced density with the use of Hi-X foam should be moved to 21.6.2 to go with the applicable subject of tire storage.
Response Message:

Public Comment No. 222-NFPA 13-2017 [Section No. 21.8.1.3]

Second Revision No. 1014-NFPA 13-2017 [Section No. 21.10]

21.10* Control Mode Density/Area Sprinkler Protection Criteria for Baled Cotton Storage.

A.21.10

For protection of baled cotton, fire tests and actual fire experience indicate an initial low heat release; thus, sprinklers in the ordinary-temperature range should offer some advantage by opening faster than those of intermediate- or high-temperature classifications under similar conditions.

21.10.1

For tiered or rack storage up to a nominal 15 ft (4.6 m) in height, sprinkler discharge densities and areas of application shall be in accordance with Table 21.10.1.

Table 21.10.1 Baled Cotton Storage Up to and Including 15 ft (4.6 m)

-	Discharge Density per Area [gpm/ft^2 over (ft^2 (mm/min over m^2)]		
System Type	Tiered Storage	Rack Storage	Untiered Storage
Wet	0.25/3000 (0.95/280)	0.33/3000 (1.2/280)	0.15/3000 (0.57/280)
Dry	0.25/3900 (0.95/360)	0.33/3900 (1.2/360)	0.15/3900 (0.57/360)

21.10.2

Where roof or ceiling heights would prohibit storage above a nominal 10 ft (3 m), the sprinkler discharge density shall be permitted to be reduced by 20 percent of that indicated in Table 21.10.1 but shall not be reduced to less than 0.15 gpm/ft^2 (6.1 mm/min).

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Committee Statement

Committee Statement: This comment proposes to move the the exiting annex not A.9.4.2.1 to the Annex of section 21.10. This note is in reference to Baled Cotton and is more appropriate in this section then in section 9.4.2.1 which deals with temperature rating of sprinklers.

Response Message:

Public Comment No. 99-NFPA 13-2017 [New Section after A.21.8.1.1]

Second Revision No. 327-NFPA 13-2017 [Section No. 21.11.6.2.1]

21.11.6.2.1

Ceiling sprinklers spaced to cover a maximum of 100 ft^2 (9.3 m^2) shall be standard-response spray sprinklers with K-factors ~~per~~ in accordance with Section ~~12.6~~ 21.1 .

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Committee Statement

Committee Statement: In Section 21.11.6.2.1 the reference to Section 20.6 is from the 2016 edition of the NFPA 13. This matter needs to be revised to match the new chapter structure for the standard.
Response Message:

Public Comment No. 223-NFPA 13-2017 [Section No. 21.11.6.2.1]

Second Revision No. 1012-NFPA 13-2017 [Sections 22.1.6, 22.1.7]

22.1.6*

The ceiling design criteria for single-, double-, and multiple-row racks in Chapter ~~16~~ 22 shall be based on open rack configurations as defined in 3.3.141.

22.1.7

CMSA sprinklers shall not be permitted to protect storage on solid shelf racks unless the solid shelf racks are protected with in-rack sprinklers in accordance with ~~16.1.6~~ Chapter 25 .

~~**22.1.7.1**~~

~~Where solid shelves are used, in-rack sprinklers shall be installed in every level below the highest solid shelf.~~

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Committee Statement

Committee Statement: Editorial revision.
Response Message:

Second Revision No. 390-NFPA 13-2017 [Section No. 22.2]

22.2 Palletized and Solid-Piled Storage of Class I Through Class IV Commodities.

Protection of palletized and solid-piled storage of Class I through Class IV commodities shall be in accordance with Table 22.2.

Table 22.2 CMSA Sprinkler Design Criteria for Palletized and Solid-Piled Storage of Class I Through Class IV Commodities (Encapsulated and Nonencapsulated)

Configuration	Commodity Class	Maximum Storage Height		Maximum Ceiling/Roof Height		K-Factor/ Orientation	Type of System	Number of Design Sprinklers	Minimum Operating Pressure	
		ft	m	ft	m				psi	bar
Palletized	Class I or II	~~20~~	~~6.1~~	~~30~~	~~9.1~~	~~25.2 (360) Pendent~~	~~Wet~~	~~15~~	~~10~~	~~0.7~~
				~~40~~	~~12.1~~	~~25.2 (360) Pendent~~	~~Wet~~	~~15~~	~~23~~	~~1.6~~
		25	7.6	30	9.1	11.2 (160) Upright	Wet	15	25	1.7
							Dry	25	25	1.7
						16.8 (240) Upright	Wet	15	10	0.7
							Dry	25	15	1.0
						19.6 (280) Pendent	Wet	15	16	1.1
						25.2 (360) Pendent	Wet	15	10	0.7
				35	11	11.2 (160) Upright	Wet	15	25	1.7
							Dry	25	25	1.7
						16.8 (240) Upright	Wet	15	15	1.0
							Dry	25	15	1.0
				40	12.1	25.2 (360) Pendent	Wet	15	23	1.6
		30	9.1	35	11	19.6 (280) Pendent	Wet	15	25	1.7
				40	12.1	25.2 (360) Pendent	Wet	15	23	1.6
		35	11	40	12	19.6 (280) Pendent	Wet	15	30	2.1
						25.2 (360) Pendent	Wet	15	23	1.6
	Class III	~~20~~	~~6.1~~	~~30~~	~~9.1~~	~~25.2 (360) Pendent~~	~~Wet~~	~~15~~	~~10~~	~~0.7~~
				~~40~~	~~12~~	~~25.2 (360) Pendent~~	~~Wet~~	~~15~~	~~23~~	~~1.6~~
		25	7.6	30	9.1	11.2 (160) Upright	Wet	15	25	1.7
							Dry	25	25	1.7
						16.8 (240) Upright	Wet	15	15	1.0
							Dry	25	15	1.0
						19.6 (280) Pendent	Wet	15	16	1.1
						25.2 (360) Pendent	Wet	15	~~16~~ 10	~~1.1~~ 0.7
				35	11	11.2 (160) Upright	Wet	15	25	1.7
							Dry	25	25	1.7

Configuration	Commodity Class	Maximum Storage Height		Maximum Ceiling/Roof Height		K-Factor/ Orientation	Type of System	Number of Design Sprinklers	Minimum Operating Pressure	
		ft	m	ft	m				psi	bar
						16.8 (240) Upright	Wet	15	15	1.0
							Dry	25	15	1.0
				40	12	25.2 (360) Pendent	Wet	15	23	1.6
				35	11	19.6 (280) Pendent	Wet	15	25	1.7
		30	9.1	40	12	25.2 (360) Pendent	Wet	15	23	1.6
				40	12	19.6 (280) Pendent	Wet	15	30	2.1
		35	11	40	12	25.2 (360) Pendent	Wet	15	23	1.6
	Class IV					11.2 (160) Upright	Wet	20	25	1.7
								15	50	3.4
						16.8 (240) Upright	Wet	20	15	1.0
				30	9.1			15	22	1.5
		20	6.1			19.6 (280) Pendent	Wet	15	16	1.1
						25.2 (360) Pendent	Wet	15	10	0.7
				40	12	25.2 (360) Pendent	Wet	15	23	1.6
						16.8 (240) Upright	Wet	15	22	1.5
				30	9.1	19.6 (280) Pendent	Wet	15	16	1.1
		25	7.6			25.2 (360) Pendent	Wet	15	10	0.7
				40	12	25.2 (360) Pendent	Wet	15	23	1.6
				35	11	19.6 (280) Pendent	Wet	15	25	1.7
		30	9.1	40	12	25.2 (360) Pendent	Wet	15	23	1.6
				40	12	19.6 (280) Pendent	Wet	15	30	2.1
		35	11			25.2 (360) Pendent	Wet	15	23	1.6
Solid piled	Class I or II					11.2 (160) Upright	Wet	15	25	1.7
							Dry	25	25	1.7
						16.8 (240) Upright	Wet	15	10	0.7
		20	6.1	30	9.1		Dry	25	15	1.0
						19.6 (280) Pendent	Wet	15	16	1.1
						25.2 (360) Pendent	Wet	15	10	0.7

Configuration	Commodity Class	Maximum Storage Height		Maximum Ceiling/Roof Height		K-Factor/ Orientation	Type of System	Number of Design Sprinklers	Minimum Operating Pressure	
		ft	m	ft	m				psi	bar
				40	12	25.2 (360) Pendent	Wet	15	23	1.6
						16.8 (240) Upright	Wet	15	10	0.7
				30	9.1	19.6 (280) Pendent	Wet	15	16	1.1
		25	7.6			25.2 (360) Pendent	Wet	15	10	0.7
				40	12	25.2 (360) Pendent	Wet	15	23	1.6
				35	11	19.6 (280) Pendent	Wet	15	25	1.7
		30	9.1	40	12	25.2 (360) Pendent	Wet	15	23	1.6
						19.6 (280) Pendent	Wet	15	30	2.1
		35	11	40	12	25.2 (360) Pendent	Wet	15	23	1.6
	Class III					11.2 (160) Upright	Wet	15	25	1.7
							Dry	25	25	1.7
						16.8 (240) Upright	Wet	15	15	1.0
				30	9.1		Dry	25	15	1.0
		20	6.1			19.6 (280) Pendent	Wet	15	16	1.1
						25.2 (360) Pendent	Wet	15	10	0.7
				40	12	25.2 (360) Pendent	Wet	15	23	1.6
						16.8 (240) Upright	Wet	15	22	1.5
				30	9.1	19.6 (280) Pendent	Wet	15	16	1.1
		25	7.6			25.2 (360) Pendent	Wet	15	10	0.7
				40	12	25.2 (360) Pendent	Wet	15	23	1.6
				35	11	19.6 (280) Pendent	Wet	15	25	1.7
		30	9.1	40	12	25.2 (360) Pendent	Wet	15	23	1.6
						19.6 (280) Pendent	Wet	15	30	2.1
		35	11	40	12	25.2 (360) Pendent	Wet	15	23	1.6
	Class IV	20	6.1	30	9.1	11.2 (160) Upright	Wet	15	50	3.4

Configuration	Commodity Class	Maximum Storage Height		Maximum Ceiling/Roof Height		K-Factor/ Orientation	Type of System	Number of Design Sprinklers	Minimum Operating Pressure	
		ft	m	ft	m				psi	bar
						16.8 (240) Upright	Wet	15	22	1.5
						19.6 (280) Pendent	Wet	15	16	1.1
						25.2 (360) Pendent	Wet	15	10	0.7
				40	12	25.2 (360) Pendent	Wet	15	23	1.6
						16.8 (240) Upright	Wet	15	22	1.5
				30	9.1	19.6 (280) Pendent	Wet	15	16	1.1
		25	7.6			25.2 (360) Pendent	Wet	15	10	0.7
				40	12	25.2 (360) Pendent	Wet	15	23	1.6
				35	11	19.6 (280) Pendent	Wet	15	25	1.7
		30	9.1	40	12	25.2 (360) Pendent	Wet	15	23	1.6
						19.6 (280) Pendent	Wet	15	30	2.1
		35	11	40	12	25.2 (360) Pendent	Wet	15	23	1.6

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Table_22.2.docx	Revised Table 22.2. For staff use.	

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Committee Statement

Committee Statement: Editorial revisions.
Response Message:

Second Revision No. 1022-NFPA 13-2017 [Section No. 22.3]

22.3 Palletized and Solid-Piled Storage of Nonexpanded and Expanded Group A Plastic Commodities.

Protection of palletized and solid-piled storage of nonexpanded and expanded Group A plastic commodities shall be in accordance with Table 22.3.

Table 22.3 CMSA Sprinkler Design Criteria for Palletized and Solid-Piled Storage of Group A Plastic Commodities

Storage Arrangement	Commodity Class	Maximum Storage Height		Maximum Ceiling/Roof Height		K-Factor/Orientation	Type of System	Number of Design Sprinklers	Minimu Operati Pressu	
		ft	m	ft	m				psi	b
Palletized	Cartoned nonexpanded plastics	20	6.1	30	9.1	11.2 (160) Upright	Wet	25	25	1
						16.8 (240) Upright	Wet	15	22	1
						19.6 (280) Pendent	Wet	15	16	1
						25.2 (360) Pendent	Wet	15	10	0
				40	12	25.2 (360) Pendent	Wet	15	23	1
		25	7.6	30	9.1	16.8 (240) Upright	Wet	15	22	1
						19.6 (280) Pendent	Wet	15	16	1
						25.2 (360) Pendent	Wet	15	10	0
				40	12	25.2 (360) Pendent	Wet	15	23	1
		30	9.1	35	11	19.6 (280) Pendent	Wet	15	25	1
				40	12.1	25.2 (360) Pendent	Wet	15	23	1
		35	11	40	12	19.6 (280) Pendent	Wet	15	30	2
						25.2 (360) Pendent	Wet	15	23	1
Solid piled	Cartoned nonexpanded plastics	20	6.1	30	9.1	11.2 (160) Upright	Wet	15	50	3
						16.8 (240) Upright	Wet	15	22	1
						19.6 (280) Pendent	Wet	15	16	1
						25.2 (360) Pendent	Wet	15	10	0
				40	12	25.2 (360) Pendent	Wet	15	23	1
		25	7.6	30	9.1	16.8 (240) Upright	Wet	15	22	1
						19.6 (280) Pendent	Wet	15	16	1
						25.2 (360) Pendent	Wet	15	10	0
				40	12	25.2 (360) Pendent	Wet	15	23	1
		30	9.1	35	11	19.6 (280) Pendent	Wet	15	25	1
				40	12	25.2 (360) Pendent	Wet	15	23	1
		35	11	40	12	19.6 (280) Pendent	Wet	15	30	2
						25.2 (360) Pendent	Wet	15	23	1
Palletized	Exposed nonexpanded plastics	20	6.1	30	9.1	11.2 (160) Upright	Wet	25	25	1
						16.8 (240) Upright	Wet	15	22	1
		25	7.6	30	9.1	16.8 (240) Upright	Wet	15	22	1
	Cartoned or exposed expanded plastics	18	5.5	26	7.9	11.2 (160) Upright	Wet	15	50	3
						16.8 (240) Upright	Wet	15	22	1
Solid piled	Cartoned or exposed nonexpanded plastics	20	6.1	30	9.1	11.2 (160) Upright	Wet	15	50	3
		25	7.6	30	9.1	16.8 (240) Upright	Wet	15	22	1

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Organization: National Fire Protection Assoc
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Zip:
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Committee Statement: Editorial revision.
Response Message:

Second Revision No. 1006-NFPA 13-2017 [Section No. 22.4]

22.4 Single-, Double-, and Multiple-Row Rack Storage for Class I Through Class IV Commodities.

Protection of single-, double-, and multiple-row rack storage for Class I through Class IV commodities shall be in accordance with Table 22.4.

Table 22.4 CMSA Sprinkler Design Criteria for Rack Storage of Class I Through Class IV Commodities (Encapsulated and Nonencapsulated)

Storage Arrangement	Commodity Class	Maximum Storage Height		Maximum Ceiling/Roof Height		K-Factor/ Orientation	Type of System	Number of Design Sprinklers	Minimum Operating Pressure	
		ft	m	ft	m				psi	bar
Single-, double-, and multiple-row racks (no open-top containers)	Class I or II	20	6.1	30	9.1	11.2 (160) Upright	Wet	15	25	1.7
							Dry	25	25	1.7
						16.8 (240) Upright	Wet	15	10	0.7
							Dry	25	15	1.0
						19.6 (280) Pendent	Wet	15	16	1.1
						25.2 (360) Pendent	Wet	15	10	0.7
				40	12.1	25.2 (360) Pendent	Wet	15	23	1.6
		25	7.6	30	9.1	11.2 (160) Upright	Wet	20	25	1.7
							Dry	30	25	1.7
						16.8 (240) Upright	Wet	15	10	0.7
							Dry	30	15	1.0
						19.6 (280) Pendent	Wet	15	16	1.1
						25.2 (360) Pendent	Wet	15	10	0.7
				40	12.1	25.2 (360) Pendent	Wet	15	23	1.6
	Class III	20	6.1	30	9.1	11.2 (160) Upright	Wet	15	25	1.7
							Dry	25	25	1.7
						16.8 (240) Upright	Wet	15	15	1.0
							Dry	25	15	1.0
						19.6 (280) Pendent	Wet	15	16	1.1
						25.2 (360) Pendent	Wet	15	10	0.7
				40	12.1	25.2 (360) Pendent	Wet	15	23	1.6
		25	7.6	30	9.1	11.2 (160) Upright	Wet	~~15 + 1 level of in-rack~~ *	~~25~~ NA	~~1.7~~ NA
							Dry	~~25 + 1 level of in-rack~~ *	~~25~~ NA	~~1.7~~ NA
						16.8 (240) Upright	Wet	15	22	1.5
							Dry	~~25 + 1 level of in-rack~~ *	~~15~~ NA	~~1.0~~ NA

Storage Arrangement	Commodity Class	Maximum Storage Height ft	Maximum Storage Height m	Maximum Ceiling/Roof Height ft	Maximum Ceiling/Roof Height m	K-Factor/ Orientation	Type of System	Number of Design Sprinklers	Minimum Operating Pressure psi	Minimum Operating Pressure bar
						19.6 (280) Pendent	Wet	15	16	1.1
						25.2 (360) Pendent	Wet	15	10	0.7
						11.2 (160) Upright	Wet	~~15 + 1 level of in-rack~~ *	~~25~~ NA	~~1.7~~ NA
							Dry	~~25 + 1 level of in-rack~~ *	~~25~~ NA	~~1.7~~ NA
				35	10.7	16.8 (240) Upright	Wet	~~15 + 1 level of in-rack~~ *	~~15~~ NA	~~1.0~~ NA
							Dry	~~25 + 1 level of in-rack~~ *	~~15~~ NA	~~1.0~~ NA
						19.6 (280) Pendent	Wet	15	25	1.7
						19.6 (280) Pendent	Wet	15	30	2.1
				40	12.2	25.2 (360) Pendent	Wet	15	23	1.6
						11.2 (160) Upright	Wet	15	50	3.4
				25	7.6	16.8 (240) Upright	Wet	15	22	1.5
						19.6 (280) Pendent	Wet	15	16	1.1
						11.2 (160) Upright	Wet	20	50	3.4
		20	6.1					15	75	5.2
						16.8 (240) Upright	Wet	15	22	1.5
				30	9.1	19.6 (280) Pendent	Wet	15	16	1.1
	Class IV					25.2 (360) Pendent	Wet	15	10	0.7
				40	12.1	25.2 (360) Pendent	Wet	15	23	1.6
						11.2 (160) Upright	Wet	~~15 + 1 level of in-rack~~ *	~~50~~ NA	~~3.4~~ NA
		25	7.6	30	9.1	16.8 (240) Upright	Wet	15	22	1.5
						19.6 (280) Pendent	Wet	15	16	1.1
						25.2 (360) Pendent	Wet	15	10	0.7

Storage Arrangement	Commodity Class	Maximum Storage Height ft	Maximum Storage Height m	Maximum Ceiling/Roof Height ft	Maximum Ceiling/Roof Height m	K-Factor/ Orientation	Type of System	Number of Design Sprinklers	Minimum Operating Pressure psi	Minimum Operating Pressure bar
						11.2 (160) Upright	Wet	~~20 + 1 level of in-rack~~ *	~~50~~ NA	~~3.4~~ NA
								~~15 + 1 level of in-rack~~ *	~~75~~ NA	~~5.2~~ NA
				35	10.7	16.8 (240) Upright	Wet	~~20 + 1 level of in-rack~~ *	~~22~~ NA	~~1.5~~ NA
								~~15 + 1 level of in-rack~~ *	~~35~~ NA	~~2.4~~ NA
						19.6 (280) Pendent	Wet	15	25	1.7
				40	12.2	19.6 (280) Pendent	Wet	15	30	2.1
						25.2 (360) Pendent	Wet	15	23	1.6

NA: Not applicable

*In-rack sprinklers required. See Chapter 25.

Supplemental Information

File Name	Description	Approved
13_Table_22.4_With_Mark-Ups_.docx	Revised Table 22.4. For staff use.	

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Committee Statement

Committee Statement: Table 22.4 has been revised to show ceiling only design, for in-rack design see Chapter 25.
Response Message:

Second Revision No. 391-NFPA 13-2017 [Section No. 22.5]

22.5 Single-, Double-, and Multiple-Row Racks of Group A Plastic Commodities.

Protection of single-, double-, and multiple-row rack storage for nonexpanded Group A plastic commodities shall be in accordance with Table 22.5.

Table 22.5 CMSA Sprinkler Design Criteria for Single-, Double-, and Multiple-Row Racks of Group A Plastic Commodities Stored Up and Including 25 ft (7.6 m) in Height

Storage Arrangement	Commodity Class	Maximum Storage Height		Maximum Ceiling/Roof Height		K-Factor/ Orientation	Type of System	Number of Design Sprinklers	Minimum Operating Pressure	
		ft	m	ft	m				psi	bar
Single-, double-, and multiple-row racks (no open-top containers)	Cartoned nonexpanded plastics	20	6.1	25	7.6	11.2 (160) Upright	Wet	15	50	3.4
						16.8 (240) Upright	Wet	15	22	1.5
						19.6 (280) Pendent	Wet	15	16	1.1
				30	9.1	11.2 (160) Upright	Wet Wet	30 20	50 75	3.4 5.2
						16.8 (240) Upright	Wet	15* †	22	1.5
						19.6 (280) Pendent	Wet	15	16	1.1
		25	7.6	30	9.1	11.2 (160) Upright	Wet	~~15 + 1 level of in-rack~~ *	~~50~~ NA	~~3.4~~ NA
						16.8 (240) Upright	Wet	15* †	22	1.5
						19.6 (280) Pendent	Wet	15	16	1.1
						25.2 (360) Pendent	Wet	15	10	0.7
		25	7.6	35	11	11.2 (160) Upright	Wet	~~30 + 1 level of in-rack~~ *	~~50~~ NA	~~3.4~~ NA
							Wet	~~20 + 1 level of in-rack~~ *	~~75~~ NA	~~5.2~~ NA
						16.8 (240) Upright	Wet	~~30 + 1 level of in-rack~~ *	~~22~~ NA	~~1.5~~ NA
							Wet	~~20 + 1 level of in-rack~~ *	~~35~~ NA	~~2.4~~ NA
						19.6 (280) Pendent	Wet	15	25	1.7
		35	10.6	40	12.1	25.2 (360) Pendent	Wet	15	10	0.7
	Exposed nonexpanded plastics	20	6.1	25	7.6	11.2 (160) Upright	Wet	15	50	3.4
						16.8 (240) Upright	Wet	15	22	1.5
		20	6.1	30	9.1	11.2 (160) Upright	Wet	30	50	3.4
							Wet	20	75	5.2

Storage Arrangement	Commodity Class	Maximum Storage Height ft	Maximum Storage Height m	Maximum Ceiling/Roof Height ft	Maximum Ceiling/Roof Height m	K-Factor/ Orientation	Type of System	Number of Design Sprinklers	Minimum Operating Pressure psi	Minimum Operating Pressure bar
						16.8 (240) Upright	Wet	15* †	22	1.5
		25	7.6	30	9.1	11.2 (160) Upright	Wet	~~15 + 1 level of in-rack~~ *	~~50~~ NA	~~3.4~~ NA
						16.8 (240) Upright	Wet	15* †	22	1.5
						11.2 (160) Upright	Wet	~~30 + 1 level of in-rack~~ *	~~50~~ NA	~~3.4~~ NA
		25	7.6	35	11		Wet	~~20 + 1 level of in-rack~~ *	~~75~~ NA	~~5.2~~ NA
						16.8 (240) Upright	Wet	~~30 + 1 level of in-rack~~ *	~~22~~ NA	~~1.5~~ NA
							Wet	~~20 + 1 level of in-rack~~ *	~~35~~ NA	~~2.4~~ NA

NA: Not applicable

*In-rack sprinklers required. See Chapter 25.

* † Minimum 8 ft (2.4 m) aisle.

Supplemental Information

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13_Table_22.5_With_Mark-Ups_.docx	Revised Table 22.5. For staff use.	

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Committee Statement

Committee Statement: Table 22.5 has been revised to show ceiling only design, for in-rack design see Chapter 25.
Response Message:

Second Revision No. 1053-NFPA 13-2017 [Section No. 22.6]

22.6 Rubber Tires.

Protection of rubber tires with CMSA sprinklers shall be in accordance with Table 22.6 .

Table 22.6 Control Mode Specific Application (CMSA) Protection for Rubber Tires

Piling Method	Maximum Storage Height		Maximum Ceiling/Roof Height		K-Factor	Type of System	Number of Sprinklers	Operating Pressure
	ft	m	ft	m				
Rubber tire storage, on-side or on-tread, in palletized portable racks, or open portable racks, or fixed racks without solid shelves	25	7.6	32	10	11.2 (160)	Wet	15	75 psi (5.2 bar)
	25	7.6	32	10	16.8 (240)	Wet	15	35 psi (2.4 bar)

Supplemental Information

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13_SSD_Table_22.6.docx	Table 22.6--for staff use	

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Committee Statement

Committee Statement: The section references a table that was not originally inserted. This is former Table 18.4(c) from the 2016 edition.
Response Message:

Second Revision No. 328-NFPA 13-2017 [Section No. 23.1.2.3]

~~**23.1.2.3** Temperature Ratings.~~

~~Sprinkler temperature ratings for ESFR sprinklers shall be ordinary unless 8.3.2 requires intermediate- or high-temperature ratings.~~

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Committee Statement

Committee Statement: In Section 23.1.2.3 the references are from the 2016 edition of the NFPA 13. These matters need to be revised to match the new chapter structure for the standard.
Response Message:

Public Comment No. 225-NFPA 13-2017 [Section No. 23.1.2.3]

Second Revision No. 329-NFPA 13-2017 [Section No. 23.1.4]

23.1.4

The ceiling design criteria for single-, double-, and multiple-row racks in Chapter 23 shall be based on open rack configurations as defined in ~~3.9.3.7.4~~ 3.3.141 .

23.1.4.1

ESFR sprinklers shall not be permitted to protect storage on solid shelf racks unless the solid shelf racks are protected with in-rack sprinklers in accordance with Chapter 25.

23.1.4.2

ESFR sprinklers shall not be permitted to protect ~~storage on solid shelf racks unless the solid shelf racks are protected with in-rack sprinklers in accordance with 16.1.6.~~ storage with open-top containers.

~~**23.1.4.2.1**~~

~~Where solid shelves are used, in-rack sprinklers shall be installed in every level below the highest solid shelf.~~

23.1.4.3

ESFR sprinklers shall ~~not be permitted to protect storage with open top containers.~~ be designed such that the minimum operating pressure is not less than that indicated in Table 23.5.1 for type of storage, commodity, storage height, and building height involved.

23.1.4.4

ESFR sprinkler systems shall be designed such that the minimum operating pressure is not less than that indicated in Table 23.5.1 for type of storage, commodity, storage height, and building height involved.

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Committee Statement: Revised to update the reference to the definition for open racks and to delete a duplicate line.
Response Message:

Public Comment No. 226-NFPA 13-2017 [Section No. 23.1.4]

Second Revision No. 1007-NFPA 13-2017 [Section No. 23.5.1]

23.5.1

Protection of single-, double-, and multiple-row rack storage of Class I through Class IV commodities shall be in accordance with Table 23.5.1.

Table 23.5.1 ESFR Sprinkler Protection of Rack Storage of Class I Through Class IV Commodities

Storage Arrangement	Commodity	Maximum Storage Height		Maximum Ceiling/Roof Height		Nominal K-Factor	Orientation	Minimum Operating Pressure		In-[illegible] Spr[illegible] Requi[illegible]
		ft	m	ft	m			psi	bar	
Single-row, double-row, and multiple-row racks (no open-top containers)	Class I, II, III, or IV, encapsulated or nonencapsultated	20	6.1	25	7.6	14 (200)	Upright/ pendent	50	3.4	N
						16.8 (240)	Upright/ pendent	35	2.4	N
						22.4 (320)	Pendent	25	1.7	N
						25.2 (360)	Pendent	15	1	N
				30	9.1	14 (200)	Upright/ pendent	50	3.4	N
						16.8 (240)	Upright/ pendent	35	2.4	N
						22.4 (320)	Pendent	25	1.7	N
						25.2 (360)	Pendent	15	1	N
				35	10.7	14 (200)	Upright/ pendent	75	5.2	N
						16.8 (240)	Upright/ pendent	52	3.6	N
						22.4 (320)	Pendent	35	2.4	N
						25.2 (360)	Pendent	20	1.4	N
				40	12.2	16.8 (240)	Pendent	52	3.6	N
						22.4 (320)	Pendent	40	2.8	N
						25.2 (360)	Pendent	25	1.7	N
				45	13.7	14 (200)	Pendent*	90 NA	6.2 NA	Y
						16.8 (240)	Pendent*	63 NA	4.4 NA	Y
						22.4 (320)	Pendent	40	2.8	N
						25.2 (360)	Pendent	40	2.8	N
		25	7.6	30	9.1	14 (200)	Upright/ pendent	50	3.4	N
						16.8 (240)	Upright/ pendent	35	2.4	N
						22.4 (320)	Pendent	25	1.7	N

Storage Arrangement	Commodity	Maximum Storage Height ft	Maximum Storage Height m	Maximum Ceiling/Roof Height ft	Maximum Ceiling/Roof Height m	Nominal K-Factor	Orientation	Minimum Operating Pressure psi	Minimum Operating Pressure bar	In-Rack Sprinkler Requirements
Single-, double-, and multiple-row rack (no open-top containers)	Class I, II, III, or IV, encapsulated or nonencapsulated	30	9.1	32	9.8	25.2 (360)	Pendent	15	1.0	N
						14 (200)	Upright/ pendent	60	4.1	N
						16.8 (240)	Upright/ pendent	42	2.9	N
						14 (200)	Upright/ pendent	75	5.2	N
				35	10.7	16.8 (240)	Upright/ pendent	52	3.6	N
						22.4 (320)	Pendent	35	2.4	N
						25.2 (360)	Pendent	20	1.4	N
						16.8 (240)	Pendent	52	3.6	N
				40	12.2	22.4 (320)	Pendent	40	2.8	N
						25.2 (360)	Pendent	25	1.7	N
						14 (200)	Pendent*	~~90~~ NA	~~6.2~~ NA	~~Y~~
						16.8 (240)	Pendent*	~~63~~ NA	~~4.3~~ NA	~~Y~~
				45	13.7	22.4 (320)	Pendent	40	2.8	N
						25.2 (360)	Pendent	40	2.8	N
						14 (200)	Upright/pendent	75	5.2	N
						16.8 (240)	Upright/ pendent	52	3.6	N
				35	10.7	22.4 (320)	Pendent	35	2.4	N
						25.2 (360)	Pendent	20	1.4	N
						16.8 (240)	Pendent	52	3.6	N
				40	12.2	22.4 (320)	Pendent	40	2.8	N
						25.2 (360)	Pendent	25	1.7	N
						14 (200)	Pendent*	~~90~~ NA	~~6.2~~ NA	~~Y~~
				45	13.7	16.8 (240)	Pendent*	~~63~~ NA	~~4.3~~ NA	~~Y~~

Storage Arrangement	Commodity	Maximum Storage Height ft	Maximum Storage Height m	Maximum Ceiling/Roof Height ft	Maximum Ceiling/Roof Height m	Nominal K-Factor	Orientation	Minimum Operating Pressure psi	Minimum Operating Pressure bar	~~In-~~ Spr Requi
						22.4 (320)	Pendent	40	2.8	~~N~~
						25.2 (360)	Pendent	40	2.8	~~N~~
						16.8 (240)	Pendent	52	3.6	~~N~~
				40	12.2	22.4 (320)	Pendent	40	2.8	~~N~~
						25.2 (360)	Pendent	25	1.7	~~N~~
		35	10.7			14 (200)	Pendent*	~~90~~ NA	~~6.2~~ NA	~~Y~~
						16.8 (240)	Pendent*	~~63~~ NA	~~4.3~~ NA	~~Y~~
				45	13.7	22.4 (320)	Pendent	40	2.8	~~N~~
						25.2 (360)	Pendent	40	2.8	~~N~~
						16.8 (240)	Pendent*	~~63~~ NA	~~4.3~~ NA	~~Y~~
		40	12	45	13.7	22.4 (320)	Pendent	40	2.8	~~N~~
						25.2 (360)	Pendent	40	2.8	~~N~~

*In-rack sprinklers required. See Chapter 25.

NA: Not applicable

Supplemental Information

File Name	Description	Approved
13_Table_23.5.1_With_Mark-Ups_.docx	Revised Table 23.5.1. For staff use.	

Submitter Information Verification

Submitter Full Name: AUT-SSD
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Street Address:
City:
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Submittal Date: Sun Jul 30 19:39:07 EDT 2017

Committee Statement

Committee Statement: Table 23.5.1 has been revised to show ceiling only design, for in-rack design see Chapter 25.

Response Message:

Second Revision No. 1008-NFPA 13-2017 [Section No. 23.6.1 [Excluding any Sub-Sections]]

Protection of single-, double-, and multiple-row rack storage of cartoned or exposed nonexpanded Group A plastic and cartoned expanded Group A plastic shall be in accordance with Table 23.6.1.

Table 23.6.1 ESFR Protection of Rack Storage of Group A Plastic Commodities

Storage Arrangement	Commodity	Maximum Storage Height		Maximum Ceiling/Roof Height		Nominal K-Factor	Orientation	Minimum Operating Pressure		In-Rack Sprinkler Requirements
		ft	m	ft	m			psi	bar	
Single-, double-, and multiple-row racks (no open-top containers)	Cartoned nonexpanded	20	6.1	25	7.6	14 (200)	Upright/ pendent	50	3.4	No
						16.8 (240)	Upright/ pendent	35	2.4	No
						22.4 (320)	Pendent	25	1.7	No
						25.2 (360)	Pendent	15	1	No
				30	9.1	14 (200)	Upright/ pendent	50	3.4	No
						16.8 (240)	Upright/ pendent	35	2.4	No
						22.4 (320)	Pendent	25	1.7	No
						25.2 (360)	Pendent	15	1	No
				35	11	14 (200)	Upright/ pendent	75	5.2	No
						16.8 (240)	Upright/ pendent	52	3.6	No
						22.4 (320)	Pendent	35	2.4	No
						25.2 (360)	Pendent	20	1.4	No
				40	12	16.8 (240)	Pendent	52	3.6	No
						22.4 (320)	Pendent	40	2.7	No
						25.2 (360)	Pendent	25	1.7	No
				45	14	14 (200)	Pendent	90	6.2	Yes
						16.8 (240)	Pendent	63	4.3	Yes
						22.4 (320)	Pendent	40	2.7	No
						25.2 (360)	Pendent	40	2.7	No
		25	7.6	30	9.1	14 (200)	Upright/	50	3.4	No

Storage Arrangement	Commodity	Maximum Storage Height ft	Maximum Storage Height m	Maximum Ceiling/Roof Height ft	Maximum Ceiling/Roof Height m	Nominal K-Factor	Orientation	Minimum Operating Pressure psi	Minimum Operating Pressure bar	~~In-Rack Sprinkler Requirements~~
							pendent			
						16.8 (240)	Upright/ pendent	35	2.4	~~No~~
						22.4 (320)	Pendent	25	1.7	~~No~~
						25.2 (360)	Pendent	15	1	~~No~~
						14 (200)	Upright/ pendent	60	4.1	~~No~~
				32	10	16.8 (240)	Upright/ pendent	42	2.9	~~No~~
						14 (200)	Upright/ pendent	75	5.2	~~No~~
						16.8 (240)	Upright/ pendent	52	3.6	~~No~~
				35	11	22.4 (320)	Pendent	35	2.4	~~No~~
						25.2 (360)	Pendent	20	1.4	~~No~~
						16.8 (240)	Pendent	52	3.6	~~No~~
				40	12	22.4 (320)	Pendent	40	2.7	~~No~~
						25.2 (360)	Pendent	25	1.7	~~No~~
						14 (200)	Pendent*	~~90~~	~~6.2~~	~~Yes~~
						16.8 (240)	Pendent*	~~63~~	~~4.3~~	~~Yes~~
				45	14	22.4 (320)	Pendent	40	2.7	~~No~~
						25.2 (360)	Pendent	40	2.7	~~No~~
						14 (200)	Upright/ pendent	75	5.2	~~No~~
		30	9.1	35	11	16.8 (240)	Upright/ pendent	52	3.6	~~No~~
						22.4 (320)	Pendent	35	2.4	~~No~~
						25.2	Pendent	20	1.4	~~No~~

Storage Arrangement	Commodity	Maximum Storage Height ft	Maximum Storage Height m	Maximum Ceiling/Roof Height ft	Maximum Ceiling/Roof Height m	Nominal K-Factor	Orientation	Minimum Operating Pressure psi	Minimum Operating Pressure bar	~~In-Rack Sprinkler Requirements~~
						(360)				
						16.8 (240)	Pendent	52	3.6	~~No~~
				40	12	22.4 (320)	Pendent	40	2.7	~~No~~
						25.2 (360)	Pendent	25	1.7	~~No~~
						14 (200)	Pendent*	~~90~~	~~6.2~~	~~Yes~~
						16.8 (240)	Pendent*	~~63~~	~~4.3~~	~~Yes~~
				45	14	22.4 (320)	Pendent	40	2.7	~~No~~
						25.2 (360)	Pendent	40	2.7	~~No~~
						16.8 (240)	Pendent	52	3.6	~~No~~
				40	12	25.2 (360)	Pendent	25	1.7	~~No~~
						14 (200)	Pendent*	~~90~~	~~6.2~~	~~Yes~~
		35	11			16.8 (240)	Pendent*	~~63~~	~~4.3~~	~~Yes~~
				45	14	22.4 (320)	Pendent	40	2.7	~~No~~
						25.2 (360)	Pendent	40	2.7	~~No~~
						14 (200)	Pendent*	~~90~~	~~6.2~~	~~Yes~~
		40	12	45	14	16.8 (240)	Pendent*	~~63~~	~~4.3~~	~~Yes~~
						22.4 (320)	Pendent	40	2.7	~~No~~
						25.2 (360)	Pendent	40	2.7	~~No~~
						14 (200)	Upright/ pendent	50	3.4	~~No~~
	Cartoned Expanded	20	6.1	25	7.6	16.8 (240)	Upright/ pendent	35	2.4	~~No~~
				30	9.1	14 (200)	Upright/ pendent	50	3.4	~~No~~

Storage Arrangement	Commodity	Maximum Storage Height ft	Maximum Storage Height m	Maximum Ceiling/Roof Height ft	Maximum Ceiling/Roof Height m	Nominal K-Factor	Orientation	Minimum Operating Pressure psi	Minimum Operating Pressure bar	~~In-Rack Sprinkler Requirements~~
						16.8 (240)	Upright/ pendent	35	2.4	~~No~~
						14 (200)	Upright/ pendent	50	3.4	~~No~~
				30	9.1	16.8 (240)	Upright/ pendent	35	2.4	~~No~~
		25	7.6			14 (200)	Pendent	60	4.1	~~No~~
				32	10	16.8 (240)	Upright/ pendent	42	2.9	~~No~~
						14 (200)	Pendent	50	3.4	~~No~~
				25	7.6	16.8 (240)	Pendent	35	2.4	~~No~~
						14 (200)	Pendent	50	3.4	~~No~~
				30	9.1	16.8 (240)	Pendent	35	2.4	~~No~~
		20	6.1			14 (200)	Pendent	75	5.2	~~No~~
				35	11	16.8 (240)	Pendent	52	3.6	~~No~~
				40	12	16.8 (240)	Pendent	52	3.6	~~No~~
	Exposed nonexpanded					14 (200)	Pendent*	~~90~~	~~6.2~~	~~Yes~~
				45	14	16.8 (240)	Pendent*	~~63~~	~~4.3~~	~~Yes~~
						14 (200)	Pendent	50	3.4	~~No~~
				30	9.1	16.8 (240)	Pendent	35	2.4	~~No~~
						14 (200)	Pendent	60	4.1	~~No~~
		25	7.6	32	10	16.8 (240)	Pendent	42	2.9	~~No~~
						14 (200)	Pendent	75	5.2	~~No~~
				35	11	16.8 (240)	Pendent	52	3.6	~~No~~
				40	12	16.8	Pendent	52	3.6	~~No~~

Storage Arrangement	Commodity	Maximum Storage Height ft	Maximum Storage Height m	Maximum Ceiling/Roof Height ft	Maximum Ceiling/Roof Height m	Nominal K-Factor	Orientation	Minimum Operating Pressure psi	Minimum Operating Pressure bar	~~In-Rack Sprinkler Requirements~~
						(240)				
						22.4 (320)	Pendent	50	3.4	~~No~~
						25.2 (360)	Pendent	50	3.4	~~No~~
						14 (200)	Pendent*	~~90~~	~~6.2~~	~~Yes~~
				45	14	16.8 (240)	Pendent*	~~63~~	~~4.3~~	~~Yes~~
						14 (200)	Pendent	75	5.2	~~No~~
				35	10.7	16.8 (240)	Pendent	52	3.6	~~No~~
						16.8 (240)	Pendent	52	3.6	~~No~~
		30	9.1	40	11	22.4 (320)	Pendent	50	3.4	~~No~~
						25.2 (360)	Pendent	50	3.4	~~No~~
						14 (200)	Pendent*	~~90~~	~~6.2~~	~~Yes~~
				45	12	16.8 (240)	Pendent*	~~63~~	~~4.3~~	~~Yes~~
						16.8 (240)	Pendent	52	3.6	~~No~~
				40	12	22.4 (320)	Pendent	50	3.4	~~No~~
		35	11			25.2 (360)	Pendent	50	3.4	~~No~~
						14 (200)	Pendent	90	6.2	~~Yes~~
				45	14	16.8 (240)	Pendent	63	4.3	~~Yes~~
						14 (200)	Pendent	90	6.2	~~Yes~~
		40	12	45	14	16.8 (240)	Pendent	63	4.3	~~Yes~~

*In-rack sprinklers required. See Chapter 25.

NA: Not applicable

Supplemental Information

File Name	Description	Approved
13_Table_23.6.1_With_Mark-Ups_.docx	Revised Table 23.6.1. For staff use.	

Submitter Information Verification

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Street Address:
City:
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Zip:
Submittal Date: Sun Jul 30 19:43:09 EDT 2017

Committee Statement

Committee Statement: Table 23.6.1 has been revised to ceiling only design, for in-rack design see Chapter 25.
Response Message:

Second Revision No. 805-NFPA 13-2017 [Section No. 23.6.1.2 [Excluding any Sub-Sections]]

ESFR sprinklers shall not be permitted to protect storage on solid shelf racks unless the solid shelf racks are protected with in-rack sprinklers in accordance with ~~17.1.5~~ Section 25.6 .

Submitter Information Verification

Submitter Full Name: AUT-SSD
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City:
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Submittal Date: Tue Jul 18 08:48:34 EDT 2017

Committee Statement

Committee Statement: Editorial revision.
Response Message:

Second Revision No. 806-NFPA 13-2017 [Section No. 23.6.1.2.1]

~~23.6.1.2.1~~

~~Where solid shelves are used, in-rack sprinklers shall be installed in every level below the highest solid shelf.~~

Submitter Information Verification

Submitter Full Name: AUT-SSD
Organization: [Not Specified]
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City:
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Zip:
Submittal Date: Tue Jul 18 08:51:51 EDT 2017

Committee Statement

Committee Statement: This is redundant text that is covered by Chapter 25, 25.6.
Response Message:

Second Revision No. 808-NFPA 13-2017 [Section No. 23.6.4]

~~**23.6.4** In-Rack Sprinkler Requirements Where ESFR Sprinklers Are Used at Ceiling.~~

~~**23.6.4.1**~~

~~Where required by Table 23.6.1 , in-rack sprinklers shall be installed at the first tier level at or above one-half of the storage height.~~

~~**23.6.4.2**~~

~~In-rack sprinklers shall be K-8.0 (115) or K-11.2 (160) quick-response, ordinary-temperature sprinklers.~~

~~**23.6.4.3**~~

~~The minimum of 6 in. (150 mm) vertical clear space shall be maintained between the sprinkler deflectors and the top of a tier of storage.~~

~~**(A)**~~

~~Sprinkler discharge shall not be obstructed by horizontal rack members.~~

~~**23.6.4.4**~~

~~The maximum horizontal distance between in-rack sprinklers shall be 5 ft (1.5 m).~~

~~**23.6.4.5**~~

~~In-rack sprinklers shall be located at an intersection of transverse and longitudinal flues while not exceeding the maximum spacing rules.~~

~~**23.6.4.6**~~

~~Where distances between transverse flues exceed the maximum allowable distances, sprinklers shall be installed at the intersection of the transverse and longitudinal flues, and additional sprinklers shall be installed between transverse flues to meet the maximum distance rules.~~

~~**23.6.4.7**~~

~~Where no transverse flues exist, in-rack sprinklers shall not exceed the maximum spacing rules.~~

~~**23.6.4.8**~~

~~The water demand for sprinklers installed in racks shall be based on simultaneous operation of the most hydraulically remote eight sprinklers.~~

~~**23.6.4.9**~~

~~Each of the in-rack sprinklers described in 23.6.4.8 shall discharge at a minimum of 60 gpm (227 L/min).~~

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Committee Statement

Committee Statement: This is redundant text that can be found in Chapter 25.

Response Message:

Second Revision No. 330-NFPA 13-2017 [Section No. 23.13]

23.13 Slatted Shelves.

23.13.1*

Slatted rack shelves shall be considered equivalent to solid rack shelves where the shelving is not considered open rack shelving or where the requirements of 23.13.1 are not met. *(See Section C.20 .)*

A.23.13.1

Slatting of decks or walkways or the use of open grating as a substitute for automatic sprinkler thereunder is not acceptable.

In addition, where shelving of any type is employed, it is for the basic purpose of providing an intermediate support between the structural members of the rack. As a result, it becomes almost impossible to define and maintain transverse flue spaces across the rack as required.

23.13.2

A wet pipe system that is designed to provide K-14.0 (200) ESFR sprinklers operating at a minimum of 50 psi (3.4 bar), K-16.8 (240) sprinklers operating at a minimum of 32 psi (2.2 bar), or K-25.2 (360) ESFR sprinklers operating at a minimum of 15 psi (1.0 bar) shall be permitted to protect single- and double-row racks with slatted rack shelving racks where all of the following conditions are met:

(1) Sprinklers shall be K-14.0 (200), K-16.8 (240), or K-25.2 (360) ESFR.

(2) The protected commodities shall be limited to Class I through Class IV, Group B plastics, Group C plastics, cartoned (expanded and nonexpanded) Group A plastics, and exposed (nonexpanded) Group A plastics.

(3) Slats in slatted rack shelving shall be a minimum nominal 2 in. (50 mm) thick by maximum nominal 6 in. (150 mm) wide with the slats held in place by spacers that maintain a minimum 2 in. (50 mm) opening between each slat.

(4) Longitudinal flue spaces shall not be required.

(5) Transverse flue spaces at least 3 in. (75 mm) wide shall be provided at least every 10 ft (3.0 m) horizontally.

(6) The aisle widths shall be at least 7 ½ ft (2.3 m).

(7) The maximum roof height shall be 30 ft (9.1 m).

(8) The maximum storage height shall be 20 ft (6.1 m).

(9) Solid plywood or similar materials shall not be placed on the slatted shelves so that they block the 2 in. (50 mm) spaces between slats, nor shall they be placed on the wire mesh shelves.

Submitter Information Verification

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Organization: [Not Specified]
Street Address:
City:
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Zip:
Submittal Date: Wed Jun 28 17:08:06 EDT 2017

Committee Statement

Committee Statement: In the First Draft Report, Chapter 23, Section 23.13 for Slatted Shelves consists of just a title line. ESFR protection of slatted shelves is covered in 16.2.4.1 and 17.2.4.1 of NFPA 13-2016, so that information needs to be brought forward into this new ESFR chapter.

Response Message:

Public Comment No. 224-NFPA 13-2017 [Section No. 23.13]

Public Comment No. 179-NFPA 13-2017 [New Section after 23.13]

Second Revision No. 331-NFPA 13-2017 [Sections 24.1.2, 24.1.3]

24.1.2

The requirements of Chapters ~~12 through~~ 20through 23 and 25 shall apply unless modified by this chapter.

24.1.2.1

Sprinklers having standard coverage areas that require up to 20 sprinklers to be included in the hydraulic calculation shall be installed in accordance with 14.2.3, 14.2.4, 14.2.4.1 and ~~21.12.6~~ 20.6.5 .

24.1.2.1.1

Quick-response sprinklers shall also be installed in accordance with 14.2.5.1 and 14.2.5.2.

24.1.2.2

Sprinklers having extended coverage areas that require up to 10 sprinklers to be included in the hydraulic calculation shall be installed in accordance with 14.2.3, 14.2.4, 14.2.4.1 and ~~21.12.6~~ 20.6.5 .

24.1.2.2.1

Quick-response sprinklers shall also be installed in accordance with 14.2.5.1 and 14.2.5.2.

24.1.3

The in-rack protection requirements of ~~Chapters 12 through 20~~ Chapter 25 shall apply when storage racks are equipped with solid shelves, and in-rack sprinklers are required per the applicable chapter.

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Zip:
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Committee Statement

Committee Statement: In Sections 24.1.2 and 24.1.3, the references are from the 2016 edition of the NFPA 13. These matters need to be revised to match the new chapter structure for the standard.

Response Message:

Public Comment No. 217-NFPA 13-2017 [Sections 24.1.2, 24.1.3]

Second Revision No. 393-NFPA 13-2017 [Sections 24.3.2, 24.3.3]

24.3.2

Protection of Class I through Class IV and cartoned nonexpanded plastic commodities stored on single-, double-, or multiple-row racks without solid shelves or solid-piled, palletized, shelf, or bin-box storage arrangements shall be permitted to be protected in accordance with Table 24.3.2(a) or Table 24.3.2(b) .

Table 24.3.2(a) CMSA K-25.2 ~~Pendant~~ Upright Standard Coverage Sprinkler Design Criteria for Single-, Double-, and Multiple-Row Racks Without Solid Shelves and Solid-Piled, Palletized Storage Arrangement of Class I Through IV and Cartoned Nonexpanded Plastic Commodities

Storage Arrangement	Commodity Class	Maximum Storage Height		Maximum Ceiling/Roof Height		K-Factor Orientation	System Type	Number of Design Sprinklers	Minimum Operating Pressure
		ft	m	ft	m				
Solid-piled, palletized, and single-, double-, and multiple-row racks without solid shelves (no open-top containers)	Class I–IV encapsulated and nonencapsulated, and cartoned nonexpanded plastics	25	7.6	30	9.1	25.2 (360) ~~Pendant~~ Upright	Wet	12	20 psi (1.4 bar)

Table 24.3.2(b) CMSA K-25.2 ~~Pendant~~ Pendent Standard Coverage Sprinkler Design Criteria for Single-, Double-, and Multiple-Row Racks Without Solid Shelves and Solid-Piled, Palletized Storage Arrangement of Class I Through IV and Cartoned Nonexpanded Plastic Commodities

Storage Arrangement	Commodity Class	Maximum Storage Height		Maximum Ceiling/Roof Height		K-Factor Orientation	System Type	Number of Design Sprinklers	Minimu Operati Pressu
		ft	m	ft	m				
Solid-piled, palletized, and single-, double-, and multiple-row racks without solid shelves (no open-top containers)	Class I–IV encapsulated and nonencapsulated, and cartoned nonexpanded plastics	25	7.6	30	9.1	25.2 (360) ~~Pendant~~ Pendent	Wet	12	15 psi (1 bar)

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Zip:
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Committee Statement

Committee Statement: Editorial revision.

Response Message:

Second Revision No. 392-NFPA 13-2017 [New Section after 24.3.3]

24.3.3

~~Protection of Class I through Class IV and cartoned nonexpanded plastic commodities stored on single-, double-, or multiple-row racks without solid shelves or solid-piled, palletized, shelf, or bin-box storage arrangements shall be permitted to be protected in accordance with Table 24.3.2(b)~~ Protection of open rack storage of Class I through Class III commodities with dry pipe systems using standard response upright sprinkler design criteria using high-temperature-rated sprinklers shall be in accordance with Table 24.3.3 .

Table 24.3.3 Standard Response Upright Sprinkler Design Criteria for Open Rack Storage of Class I Through Class III Commodities (Using High-Temperature-Rated Sprinklers)

Storage Arrangement	Commodity Class	Maximum Storage Height		Maximum Ceiling/Roof Height		K-Factor/Orientation	Type of System	Number of Design Sprinklers	Minim Opera Press
		ft	m	ft	m				psi
Rack storage without solid shelves (no open-top containers)	Class I, II, or III	35	10.6	40	12.1	25.2 (360)/Upright	Dry	24	15*
		40	12.1	45	13.6	25.2 (360)/Upright	Dry	12	50†

*25 second water delivery time maximum

†20 second water delivery time maximum

24.3.3.1

For protection criteria using a minimum operating pressure of 15 psi (1 bar), a maximum water delivery time of 25 seconds shall be used.

24.3.3.2

For protection criteria using a minimum operating pressure of 50 psi (3.4 bar), a maximum water delivery time of 20 seconds shall be used.

24.3.4

Protection of solid-piled, palletized, shelf, bin box, or open frame rack storage of Class I through Class IV and cartoned nonexpanded plastic commodities with standard response upright sprinkler design criteria using ordinary-temperature-rated sprinklers shall be in accordance with Table 24.3.4 .

Table 24.3.4 Standard Response Upright Sprinkler Design Criteria for Solid-Piled, Palletized, Shelf, Bin Box, or Open Frame Rack Storage of Class I Through Class IV and Cartoned Nonexpanded Plastic Commodities (Using Ordinary-Temperature-Rated Sprinklers)

Storage Arrangement	Commodity Class	Maximum Storage Height		Maximum Ceiling/Roof Height		K-Factor/Orientation	Type of System	Number of Design Sprinklers	Minim Operat Pressu	
		ft	m	ft	m				psi	b
Solid-piled, palletized, shelf, bin box, and rack storage without solid shelves (no open-top containers)	Class I through Class IV and cartoned nonexpanded plastic	25	7.6	30	9.1	25.2 (360)/Upright	Wet	12	20	1

Supplemental Information

File Name	Description	Approved
New_Tables_24.3.3_and_24.3.4_-_Kevin_Kelly.xlsx	New Tables 24.3.3 and 24.3.4. For staff use.	

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Submitter Full Name: AUT-SSD
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
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Committee Statement

Committee Statement: These tables represent successful fire test results at FM.
Response Message:

Second Revision No. 807-NFPA 13-2017 [Section No. 24.6]

~~**24.6** In-Rack Sprinkler Protection Criteria for Open-Frame Rack Storage of Class I Through Class IV and Plastic Commodities.~~

~~**24.6.1**~~

~~Protection of closed-top Class I through Class IV and plastic commodities stored on single-, double-, or multiple-row racks without solid shelves shall be permitted to be protected in accordance with this section.~~

~~**24.6.2**~~

~~In-rack sprinkler systems shall be wet-pipe only.~~

~~**24.6.3**~~

~~In-rack sprinklers shall be standard-coverage, quick-response, pendent, and 160ºF (70ºC) nominally rated.~~

~~**24.6.3.1**~~

~~Minimum K-14.0 (K-200) sprinklers shall be installed where the minimum required flow is 100 gpm (380 L/min) or less.~~

~~**24.6.3.2**~~

~~Minimum K-22.4 (K-320) sprinklers shall be installed where the minimum required flow exceeds 100 gpm (380 L/min).~~

~~24.6.4~~

Depending on the type of storage rack being protected, in-rack sprinklers shall be positioned horizontally in accordance with Figure 24.6.4(a) through Figure 24.6.4(f) and the following:

The minimum horizontal distance between in-rack sprinklers shall be 27 in. (700 mm), with the maximum horizontal distance being 4.5 ft (1.4 m), unless shown otherwise in the applicable figures.

Except as shown in Figure 24.6.4(c) , all in-rack sprinklers shall be located within the footprint of the rack structure.

All face sprinklers shall be positioned so that the horizontal distance between the face of the storage rack and the outer edge of storage, if it protrudes into the storage aisle, does not exceed 18 in. (450 mm).

Figure 24.6.4(a) Plan View of In-Rack Sprinkler Arrangement for Open-Frame Single-Row Racks Up to 3 ft (0.9 m) Deep.

Figure 24.6.4(b) Plan View of In-Rack Sprinkler Arrangement for Open-Frame Single-Row Racks Up to 6 ft (1.8 m) Deep.

Figure 24.6.4(c) Plan View of In-Rack Sprinkler Arrangement for Open-Frame Single-Row Racks Up to 6 ft (1.8 m) Deep Located Against a Wall.

Figure 24.6.4(d) Plan View of In-Rack Sprinkler Arrangement for Open-Frame Double-Row Racks Up to 9 ft (2.7 m) Deep.

Figure 24.6.4(e) Plan View of In-Rack Sprinkler Arrangement for Open-Frame Double-Row Racks Up to 12 ft (3.7 m) Deep.

Figure 24.6.4(f) Plan View of In-Rack Sprinkler Arrangement for Open-Frame Multiple-Row Racks.

24.6.5

The maximum allowable vertical distance between in-rack sprinklers for cartoned expanded plastics, exposed nonexpanded plastics, and exposed expanded plastics shall be 30 ft (9.1 m).

24.6.5.1

The maximum allowable vertical distance between in-rack sprinklers for Class I through Class IV and cartoned nonexpanded plastics shall be 40 ft (12.2 m).

24.6.5.2

A minimum 6 in. (150 mm) vertical distance between the top of storage and the in-rack sprinkler deflector shall be maintained.

24.6.6

Regardless of the number of in-rack sprinkler levels installed, the number of sprinkler levels for the in-rack sprinkler system design shall be based on the single most hydraulically remote in-rack sprinkler level and the minimum number of in-rack sprinklers for this level in accordance with Table 24.6.6 .

Table 24.6.6 Number of Sprinklers in the In-Rack Sprinkler Design

IRAS Installation Arrangement; Figure	Number of Sprinklers in the In-Rack Design	
	Class I through IV and Cartoned Plastics	Exposed Plastics
Single-row racks uo to 3 ft (0.9 m) Deep; Figure 21.6.4(a)	4	4
Single-row racks up to 6 ft (1.8 m) deep; Figures 21.6.4(b) and 21.6.4(c)	5	5
Double- and multiple-row racks; Figures 21.6.4(e) and 21.6.4(f)	6	6 and 6*

*This represents 6 sprinklers in the most remote rack as well as 6 sprinklers in the nearest adjacent rack. See Figures 21.6.4(d), 21.6.4(e) and 21.6.4(f) to determine which 6 sprinklers to account for in the in-rack sprinkler design for double- and multiple-row racks.

24.6.7

The minimum flow required in the system design shall be from the most remote in-rack sprinkler in accordance with Table 24.6.7 .

Table 24.6.7 Minimum Flow in the In-Rack Sprinkler Design

Maximum Vertical IRAS Installation Increment, ft (m)	Commodity Hazard	Min. K-Factor	Minimum Flow from Most Remote IRAS, gpm (L/min)
30 (9.1)	Class I through IV and cartoned nonexpanded plastic	14.0 (200)	65 (250)
	Cartoned expanded plastic	14.0 (200)	100 (380)
	Exposed plastic	22.4 (320)	120 (455)
40 (12.2)	Class I through IV and cartoned nonexpanded plastic	22.4 (320)	121 (455)

24.6.8

A hose stream allowance of 250 gpm (950 L/min) shall be included as part of the in-rack sprinkler system design obtained from Section 24.6 .

24.6.9

The water supply requirements obtained from Section 24.6 shall be available for a minimum of 60 minutes.

24.6.10*

The water supply for the in-rack sprinkler system shall be capable of providing the required in-rack sprinkler system design obtained from Section 24.6 independent of the design requirements of the ceiling sprinkler system protecting this same area.

A.24.6.10

Hydraulically balancing the in-rack system with the ceiling sprinkler system or accounting for them flowing simultaneously, is not required.

24.6.11

The ceiling sprinkler system shall be designed and installed in accordance with the guidelines outlined in Chapters 16 or 17, depending on the commodity hazard, except as modified in Section 24.6 .

24.6.11.1

Where the in-rack sprinkler system is designed and installed in accordance with Section 24.6 , the top level of in-rack sprinklers shall be considered to be a floor for design purposes of the ceiling sprinkler system.

24.6.11.2

As a result, the storage height above the top level of in-rack sprinklers shall be permitted to be in excess of 10 ft (3.0 m).

24.6.12*

The water supply for the ceiling system shall be capable of providing the required ceiling sprinkler system design obtained from either Chapter 16 or Chapter 17 independent of the design requirements of the in-rack sprinkler system obtained from Section 24.6 and protecting this same area.

Submitter Information Verification

Submitter Full Name: AUT-SSD

Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Tue Jul 18 08:55:02 EDT 2017

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Public Comment No. 325-NFPA 13-2017 [Section No. 24.6.3]

Second Revision No. 809-NFPA 13-2017 [Chapter 25]

Chapter 25 Protection of Rack Storage Using In-Rack Sprinklers

25.1 General Requirements of In-Rack Sprinklers.

25.1.1 Scope.

This chapter shall apply where rack storage of Class I through Class IV commodities, Group A plastic commodities, or rubber tires will be protected with in-rack sprinklers. Applicable sections shall include the following:

(1) See Section 25.2 for the ceiling-level sprinkler design criteria applicable to designs with in-rack sprinklers.

(2) See Section 25.3 for in-rack sprinkler characteristics.

(3) See Section 25.4 for vertical spacing and location of in-rack sprinklers.

(4) See Section 25.5 for horizontal location and spacing of in-rack sprinklers.

(5) See Section 25.6 for protection of racks with solid shelves.

(6) See Section 25.7 for horizontal barriers in combination with in-rack sprinklers.

(7) See Section 25.8 for in-rack sprinkler arrangements and designs independent of ceiling-level sprinklers.

(8) See Section 25.9 for in-rack sprinkler arrangements in combination with CMDA sprinklers at ceiling level.

(9) See Section 25.10 for in-rack sprinkler arrangements in combination with CMSA sprinklers at ceiling level.

(10) See Section 25.11 for in-rack sprinkler arrangements in combination with ESFR sprinklers at ceiling level.

(11) See Section 25.12 for design criteria for in-rack sprinklers in combination with ceiling-level sprinklers.

25.1.2 Open Rack Storage.

25.1.2.1

The in-rack sprinkler arrangements as well as the ceiling and in-rack sprinkler design criteria for rack storage in this chapter shall be based on open rack configurations as defined in 3.3.141 unless indicated otherwise.

25.1.3 In-Rack Sprinkler System.

25.1.3.1 In-Rack Sprinkler System Size.

The area protected by a single in-rack sprinkler system shall not exceed 40,000 ft^2 (3720 m^2) of floor area occupied by the racks, including aisles, regardless of the number of in-rack sprinkler levels.

25.1.3.2* In-Rack Sprinkler System Control Valves.

A.25.1.3.2

In-rack sprinklers and ceiling sprinklers selected for protection should be controlled by at least two separate indicating valves and drains. In higher rack arrangements, consideration should be given to providing more than one in-rack control valve to limit the extent of any single impairment.

25.1.3.2.1

Unless the requirements of 25.1.3.2.2 or 25.1.3.2.3 are met, separate indicating control valves and drains shall be provided and arranged so that ceiling and in-rack sprinkler systems can be controlled independently.

25.1.3.2.2

A separate indicating control valve shall not be required where 20 or fewer in-rack sprinklers are supplied by any one ceiling sprinkler system.

25.1.3.2.3

The separate indicating valves shall be permitted to be arranged as sectional control valves supplied from the ceiling sprinkler system where in-rack sprinklers are required and the racks, including the adjacent aisles, occupy 8000 ft^2 (740 m^2) or less of the area protected by the ceiling sprinklers.

25.1.3.3* Sprinkler Waterflow Alarm for In-Rack Sprinklers.

See Section C.4 .

A.25.1.3.3

See A.16.11.2 .

25.1.4 Building Steel Protection.

Where in-rack sprinklers are installed in accordance with this chapter, building steel shall not require special protection.

25.2 Ceiling-Level Sprinkler Design Criteria in Combination with In-Rack Sprinklers.

25.2.1 General.

25.2.1.1

This section shall apply to storage of Class I through Class IV and Group A plastic commodities as well as rubber tires, representing the broad range of combustibles stored in racks that are being protected by in-rack sprinklers. The requirements of Chapter 20 shall apply unless modified by this chapter. *(See Section C.9 .)*

25.2.1.2*

Ceiling-level sprinkler design criteria for single-, double-, and multiple-row racks in Section 25.2 shall be based on open rack configurations as defined in 3.3.141 .

A.25.2.1.2

Solid shelf racks as defined in 3.3.199 or obstructions resulting in solid shelf requirements could require additional in-rack sprinklers that could affect the ceiling design requirements.

25.2.1.3*

Ceiling-level sprinkler design criteria for Group A plastic commodities in this chapter shall be permitted for the protection of the same storage height and configuration of Class I, II, III, and IV commodities.

A.25.2.1.3

Information for the protection of Classes I, II, III, and IV commodities was extrapolated from full-scale fire tests that were performed at different times than the tests that were used to develop the protection for Group A plastic commodities. It is possible that, by selecting certain points from the tables (and after applying the appropriate modifications), the protection specified by 25.2.3.2.4 for Class I through Class IV commodities exceeds the requirements for Group A plastic commodities. In such situations, the protection specified for plastics, although less than that required by the tables, can adequately protect Class I, II, III, and IV commodities. This section also allows storage areas that are designed to protect Group A plastic commodities to store Class I, II, III, and IV commodities without a re-evaluation of fire protection systems.

25.2.1.4

Ceiling-level sprinkler design criteria for single- and double-row rack storage of Group A plastic commodities shall be applicable where aisles are 3.5 ft (1.1 m) or greater in width.

25.2.1.5

Ceiling-level sprinkler design criteria for rack storage of Group A plastic commodities shall be protected as multiple-row racks where aisles are less than 3.5 ft (1.1 m) in width.

25.2.1.6

The minimum water supply requirements for a hydraulically designed occupancy hazard ceiling-level sprinkler system shall be determined by adding the hose stream allowance from Table 20.12.2.6 to the water supply for in-rack sprinklers determined in Section 25.12 , unless indicated otherwise.

25.2.2 Miscellaneous and Low-Piled Storage.

25.2.2.1 Miscellaneous Storage.

25.2.2.1.1

This section shall apply to any of the following situations:

(1) Miscellaneous rack storage of Class I through Class IV commodities up to and including 12 ft (3.7 m) in height

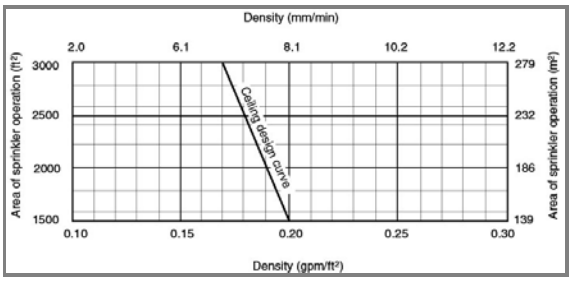
(2) Miscellaneous rack storage of Group A plastic commodities up to and including 12 ft (3.7 m) in height

(3) Miscellaneous rack storage of rubber tires up to and including 12 ft (3.7 m) in height

25.2.2.1.2

Where in-rack sprinklers are installed in accordance with Section 25.4 through Section 25.7 to protect miscellaneous rack storage of Class I through Class IV and Group A plastic commodities, as well as miscellaneous rack storage of rubber tires, up to and including 12 ft (3.7 m) in height under a maximum 32 ft (10.0 m) high ceiling, the ceiling-level sprinkler design criteria shall be in accordance with Figure 25.2.2.1.2 .

Figure 25.2.2.1.2 CMDA Ceiling-Level Sprinkler Design Criteria for Miscellaneous Storage Protected with One Level of In-Rack Sprinklers.



25.2.2.1.3

Installation criteria as permitted by NFPA 13 and design criteria and modifiers as permitted by the density/area method of Section 19.2 for ordinary hazard Group 2 occupancies shall be applicable.

25.2.2.1.4 Hose Connections.

Hose connections shall not be required for the protection of miscellaneous storage.

25.2.2.2 Low-Piled Rack Storage.

25.2.2.2.1

This section shall apply to any of the following situations:

(1) Rack storage of Class I through Class IV commodities up to and including 12 ft (3.7 m) in height

(2)* Rack storage of Group A plastic commodities up to and including 5 ft (1.5 m) in height

A.25.2.2.2.1(2)

All rack fire tests of Group A plastic commodities were run with an approximate 10 ft (3.0 m) maximum clearance to ceiling.

25.2.2.2.2

Where in-rack sprinklers are installed in accordance with Sections 25.4 through 25.7 to protect low-piled rack storage that does not meet the definition of miscellaneous storage, of Class I through Class IV and Group A plastic commodities, the ceiling-level design shall be in accordance with Figure 25.2.2.1.2 .

25.2.2.2.3

For low-piled rack storage that does not meet the definition of miscellaneous storage, with solid shelves of Class I through Class IV commodities up to and including 12 ft (3.7 m) in height, in-rack sprinklers shall be provided in accordance with Section 25.6 , and the ceiling-level sprinkler design shall be in accordance with Figure 25.2.2.1.2 .

25.2.2.2.4

For low-piled rack storage that does not meet the definition of miscellaneous storage, with solid shelves of Group A plastic commodities up to and including 5 ft (1.5 m) in height, in-rack sprinklers shall be provided in accordance with Section 25.6 , and the ceiling-level sprinkler design shall be in accordance with Figure 25.2.2.1.2 .

25.2.3 CMDA Ceiling-Level Sprinkler Design Criteria in Combination with In-Rack Sprinklers.

25.2.3.1 General.

25.2.3.1.1

Ceiling-level sprinkler design criteria in combination with in-rack sprinklers for the rack storage of Class I through Class IV commodities shall be in accordance with 25.2.3.2 for storage over 12 ft (3.7 m) and up to and including 25 ft (7.6 m) in height and 25.2.3.3 for storage over 25 ft (7.6 m) in height.

25.2.3.1.2

Ceiling-level sprinkler design criteria in combination with in-rack sprinklers for the rack storage of Group A plastic commodities shall be in accordance with 25.2.3.4 for storage over 5 ft (1.5 m) and up to and including 25 ft (7.6 m) in height and 25.2.3.5 for storage over 25 ft (7.6 m) in height.

25.2.3.2 Rack Storage of Class I Through Class IV Commodities Stored Over 12 ft (3.7 m) and Up to and Including 25 ft (7.6 m) in Height.

25.2.3.2.1* Single- and Double-Row Racks.

For single- or double-row rack storage of Class I through Class IV commodities, encapsulated or nonencapsulated, stored over 12 ft (3.7 m) and up to and including 25 ft (7.6 m) in height, Table 25.2.3.2.1 shall be used to determine the appropriate figure for determining ceiling-level sprinkler design criteria with the provision of one level of in-rack sprinklers.

Table 25.2.3.2.1 Determining Appropriate Ceiling-Level Protection Criteria Figure for Single- or Double-Row Racks of Class I Through Class IV Commodities — Storage Height Over 12 ft (3.7 m) Up to and Including 25 ft (7.6 m)

Storage Height	Commodity Class	Encapsulated	Aisle Width*		No. of In-Rack Sprinkler Levels	Appropriate Figure and Curves		
			ft	m		Figure	Curves	Apply Figure 25.2.3.2.4.1
Over 12 ft (3.7 m) and up to and including 20 ft (6.1 m)	I	No	4	1.2	1 Level	25.2.3.2.3.1(a)	C and D	Yes
			8	2.4			A and B	
		Yes	4	1.2		25.2.3.2.3.1(e)	C and D	
			8	2.4			A and B	
	II	No	4	1.2		25.2.3.2.3.1(b)	C and D	
			8	2.4			A and B	
		Yes	4	1.2		25.2.3.2.3.1(e)	C and D	
			8	2.4			A and B	
	III	No	4	1.2		25.2.3.2.3.1(c)	C and D	
			8	2.4			A and B	
		Yes	4	1.2		25.2.3.2.3.1(f)	C and D	
			8	2.4			A and B	
	IV	No	4	1.2		25.2.3.2.3.1(d)	C and D	
			8	2.4			A and B	
		Yes	4	1.2		25.2.3.2.3.1(g)	C and D	
			8	2.4			A and B	
Over 20 ft (6.1 m) and up to and including 22 ft (6.7 m)	I	No	4	1.2	1 Level	25.2.3.2.3.1(a)	C and D	No
			8	2.4		-	A and B	
		Yes	4	1.2		25.2.3.2.3.1(e)	C and D	
			8	2.4		-	A and B	
	II	No	4	1.2		25.2.3.2.3.1(b)	C and D	
			8	2.4		-	A and B	
		Yes	4	1.2		25.2.3.2.3.1(e)	C and D	
			8	2.4		-	A and B	
	III	No	4	1.2		25.2.3.2.3.1(c)	C and D	
			8	2.4		-	A and B	
		Yes	4	1.2		25.2.3.2.3.1(f)	C and D	
			8	2.4		-	A and B	
	IV	No	4	1.2		25.2.3.2.3.1(d)	C and D	
			8	2.4		-	A and B	
		Yes	4	1.2		25.2.3.2.3.1(g)	C and D	
			8	2.4		-	A and B	
Over 22 ft (6.7 m)	I	No	4	1.2	1 Level	25.2.3.2.3.1(a)	C and D	No
			8	2.4		-	A and B	

Storage Height	Commodity Class	Encapsulated	Aisle Width* ft	Aisle Width* m	No. of In-Rack Sprinkler Levels	Appropriate Figure and Curves: Figure	Appropriate Figure and Curves: Curves	Apply Figure 25.2.3.2.4.1
and up to and including 25 ft (7.6 m)	II	Yes	4	1.2		25.2.3.2.3.1(e)	C and D	
			8	2.4		_	A and B	
		No	4	1.2		25.2.3.2.3.1(b)	C and D	
			8	2.4		_	A and B	
	III	Yes	4	1.2		25.2.3.2.3.1(e)	C and D	
			8	2.4		_	A and B	
		No	4	1.2		25.2.3.2.3.1(c)	C and D	
			8	2.4		_	A and B	
		Yes	4	1.2		25.2.3.2.3.1(f)	C and D	
			8	2.4		_	A and B	
	IV	No	4	1.2		25.2.3.2.3.1(d)	C and D	
			8	2.4		_	A and B	
		Yes	4	1.2		25.2.3.2.3.1(g)	C and D	
			8	2.4		_	A and B	

*See 25.2.3.2.1.1 for interpolation of aisle widths.

A.25.2.3.2.1

Bulkheads are not a substitute for sprinklers in racks. Their installation does not justify reduction in sprinkler densities or design operating areas as specified in the design curves.

25.2.3.2.1.1*

Design densities for single- and double-row racks shall be selected to correspond to aisle width. *(See Section C.15 .)*

A.25.2.3.2.1.1

The aisle width and the depth of racks are determined by material-handling methods. The widths of aisles should be considered in the design of the protection system. Storage in aisles can render protection ineffective and should be discouraged.

(A)

For aisle widths between 4 ft (1.2 m) and 8 ft (2.4 m), the rules for 4 ft (1.2 m) wide aisles shall be used or direct linear interpolation between the densities shall be permitted.

(B)

The density given for 8 ft (2.4 m) wide aisles shall be applied to aisles wider than 8 ft (2.4 m).

(C)

The density given for 4 ft (1.2 m) wide aisles shall be applied to aisles more narrow than 4 ft (1.2 m) down to 3 ½ ft (1.1 m).

(D)

Where aisles are more narrow than 3 ½ ft (1.1 m), racks shall be considered multiple-row racks.

25.2.3.2.2 Multiple-Row Racks.

25.2.3.2.2.1

For multiple-row racks, having a rack depth up to and including 16 ft (4.9 m) with aisles 8 ft (2.4 m) or wider, storing Class I through Class IV commodities, encapsulated or nonencapsulated, over 12 ft (3.7 m) and up to and including 25 ft (7.6 m) in height, Table 25.2.3.2.2.1 shall be used to determine the appropriate figure for determining ceiling-level sprinkler design criteria with the provision of in-rack sprinklers.

Table 25.2.3.2.2.1 Determining Appropriate Ceiling-Level Protection Criteria Figure for Multiple-Row Racks of Class I Through Class IV Commodities — Rack Depth Up to and Including 16 ft (4.9 m), Aisles 8 ft (2.4 m) or Wider, and Storage Height Over 12 ft (3.7 m) Up to 25 ft (7.6 m)

Storage Height	Commodity Class	Encapsulated	No. of In-Rack Sprinkler Levels	Appropriate Figure and Curves		
				Figure	Apply Figure 25.2.3.2.4.1	Density Multiplier
Over 12 ft (3.7 m) and up to and including 15 ft (4.6 m)	I	No	1 Level	25.2.3.2.3.1(a)	Yes	1.0
		Yes				1.25
	II	No		25.2.3.2.3.1(b)		1.0
		Yes				1.25
	III	No		25.2.3.2.3.1(c)		1.0
		Yes				1.25
	IV	No		25.2.3.2.3.1(d)		1.0
		Yes				1.5
Over 15 ft (4.6 m) and up to and including 20 ft (6.1 m)	I	No	1 Level	25.2.3.2.3.1(a)	Yes	1.0
		Yes				1.25
	II	No		25.2.3.2.3.1(b)		1.0
		Yes				1.25
	III	No		25.2.3.2.3.1(c)		1.0
		Yes				1.25
	IV	No		25.2.3.2.3.1(d)		1.0
		Yes				1.5
Over 20 ft (6.1 m) and up to and including 25 ft (7.6 m)	I	No	1 Level	25.2.3.2.3.1(a)	No	1.0
		Yes				1.25
	II	No		25.2.3.2.3.1(b)		1.0
		Yes				1.25
	III	No		25.2.3.2.3.1(c)		1.0
		Yes				1.25
	IV	No	2 Levels	25.2.3.2.3.1(d)		1.0
		Yes	2 Levels			1.5

25.2.3.2.2.2

For multiple-row racks, having a rack depth over 16 ft (4.9 m) or aisles less than 8 ft (2.4 m) wide, storing Class I through Class IV commodities, encapsulated or nonencapsulated, over 12 ft (3.7 m) and up to and including 25 ft (7.6 m) in height, Table 25.2.3.2.2.2 shall be used to determine the appropriate figure for determining ceiling-level sprinkler design criteria with the provision of in-rack sprinklers.

Table 25.2.3.2.2.2 Determining Appropriate Ceiling-Level Protection Criteria Figure for Multiple-Row Racks of Class I Through Class IV Commodities — Rack Depth Over 16 ft (4.9 m) or Aisles Narrower than 8 ft (2.4 m), Storage Height Over 12 ft (3.7 m) Up to and Including 25 ft (7.6 m)

Storage Height	Commodity Class	Encapsulated	No. of In-Rack Sprinkler Levels	Appropriate Figure and Curves			
				Figure	Curves	Apply Figure 25.2.3.2.4.1	Density Multiplier
Over 12 ft (3.7 m) and up to and including 15 ft (4.6 m)	I	No	1 Level	25.2.3.2.3.1(a)	C and D	Yes	1.0
		Yes					1.25
	II	No		25.2.3.2.3.1(b)			1.0
		Yes					1.25
	III	No		25.2.3.2.3.1(c)			1.0
		Yes					1.25
	IV	No		25.2.3.2.3.1(d)			1.0
		Yes					1.5
Over 15 ft (4.6 m) and up to and including 20 ft (6.1 m)	I	No	1 Level	25.2.3.2.3.1(a)	C and D	Yes	1.0
		Yes					1.25
	II	No		25.2.3.2.3.1(b)			1.0
		Yes					1.25
	III	No		25.2.3.2.3.1(c)			1.0
		Yes					1.25
	IV	No		25.2.3.2.3.1(d)			1.0
		Yes					1.5
Over 20 ft (6.1 m) and up to and including 25 ft (7.6 m)	I	No	1 Level	25.2.3.2.3.1(a)	C and D	No	1.0
		Yes					1.25
	II	No		25.2.3.2.3.1(b)			1.0
		Yes					1.25
	III	No		25.2.3.2.3.1(c)			1.0
		Yes					1.25
	IV	No	2 Levels	25.2.3.2.3.1(d)			1.0
		Yes					1.5

25.2.3.2.3 Ceiling-Level Protection, Used in Combination with In-Rack Sprinklers, Criteria Figures.

25.2.3.2.3.1*

The ceiling-level sprinkler design criteria in terms of density [gpm/ft^2 (mm/min)] and area of sprinkler operation [ft^2 (m^2) of ceiling or roof sprinklers] obtained from the appropriate density/area curves of Figure 25.2.3.2.3.1(a) through Figure 25.2.3.2.3.1(g) shall be modified as appropriate by 25.2.3.2.4. These requirements shall apply to portable racks arranged in the same manner as single-, double-, or multiple-row racks. *(See Section C.14.)*

Figure 25.2.3.2.3.1(a) CMDA Sprinkler System Design Curves — 20 ft (6.1 m) High Rack Storage —Class I Nonencapsulated Commodities — Conventional Pallets.

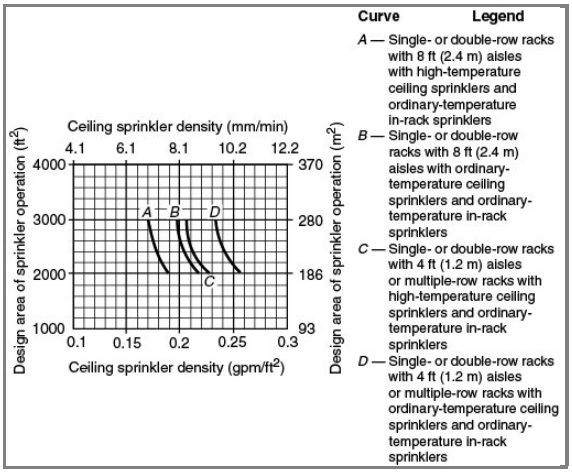


Figure 25.2.3.2.3.1(b) CMDA Sprinkler System Design Curves — 20 ft (6.1 m) High Rack Storage — Class II Nonencapsulated Commodities — Conventional Pallets.

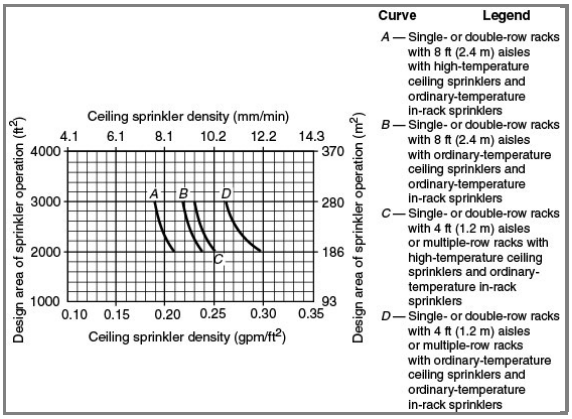


Figure 25.2.3.2.3.1(c) CMDA Sprinkler System Design Curves — 20 ft (6.1 m) High Rack Storage — Class III Nonencapsulated Commodities — Conventional Pallets.

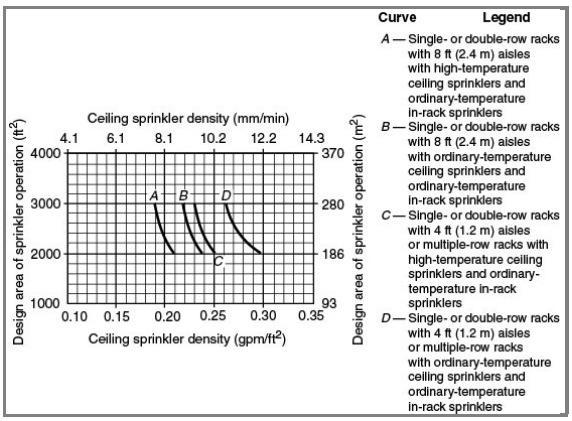


Figure 25.2.3.2.3.1(d) CMDA Sprinkler System Design Curves — 20 ft (6.1 m) High Rack Storage — Class IV Nonencapsulated Commodities — Conventional Pallets.

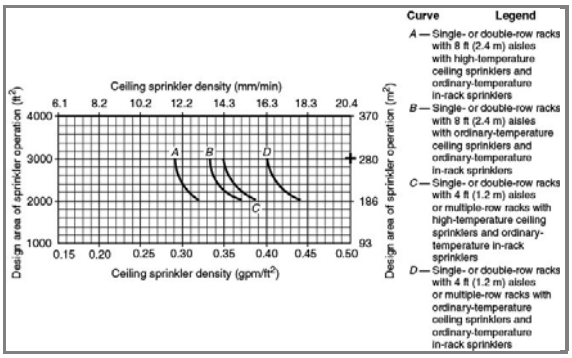


Figure 25.2.3.2.3.1(e) CMDA Sprinkler System Design Curves — Single- or Double-Row Racks — 20 ft (6.1 m) High Rack Storage — Class I and Class II Encapsulated Commodities — Conventional Pallets.

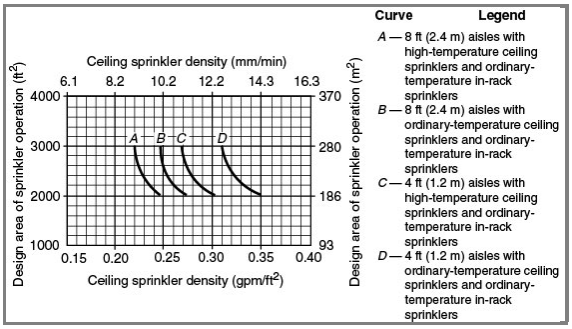


Figure 25.2.3.2.3.1(f) CMDA Sprinkler System Design Curves — Single- or Double-Row Racks — 20 ft (6.1 m) High Rack Storage — Class III Encapsulated Commodities — Conventional Pallets.

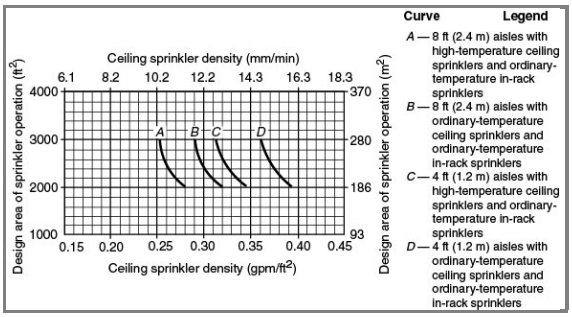
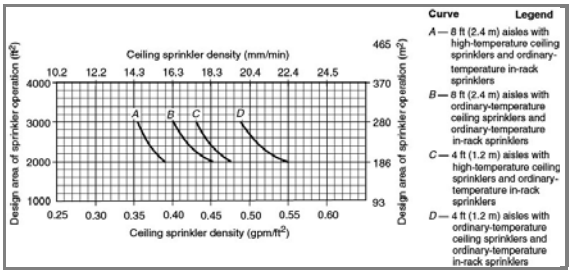


Figure 25.2.3.2.3.1(g) CMDA Sprinkler System Design Curves — Single- or Double-Row Racks — 20 ft (6.1 m) High Rack Storage — Class IV Encapsulated Commodities — Conventional Pallets.



A.25.2.3.2.3.1

Data indicate that the sprinkler protection criteria in Figure 25.2.3.2.3.1(a) through Figure 25.2.3.2.3.1(g) are ineffective, by themselves, for rack storage with solid shelves, if the required flue spaces are not maintained. Use of Figure 25.2.3.2.3.1(a) through Figure 25.2.3.2.3.1(g), along with the additional provisions that are required by this standard, can provide acceptable protection.

25.2.3.2.4* Ceiling Sprinkler Density Adjustments.

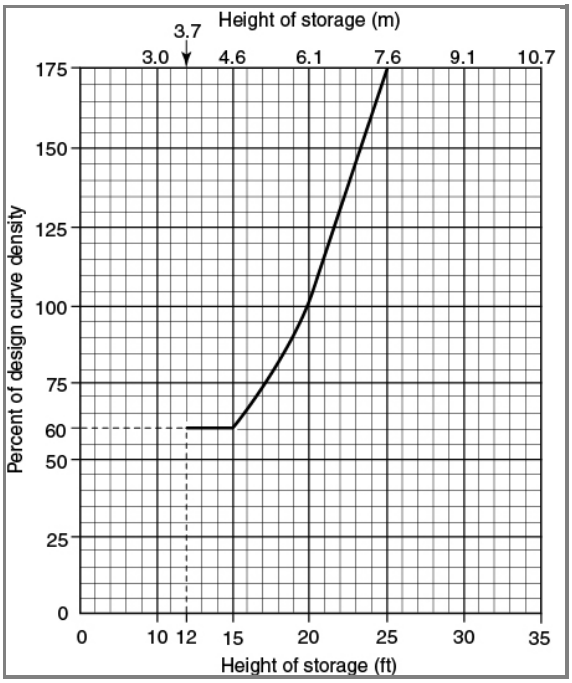
A.25.2.3.2.4

The adjustments in 25.2.3.2.4 apply to solid shelves where the minimum required level of in-rack sprinklers from an open rack option is exceeded.

25.2.3.2.4.1

Where in-rack sprinklers are being installed within racks of Class I through Class IV commodities stored over 12 ft (3.7 m) up to and including 20 ft (6.1 m) protected with CMDA sprinklers at ceiling level along with the minimum number of required in-rack sprinkler levels, densities obtained from design curves shall be adjusted in accordance with Figure 25.2.3.2.4.1 .

Figure 25.2.3.2.4.1 Adjustment to Ceiling-Level Sprinkler Density Due to Storage Height.



25.2.3.2.4.2

Where in-rack sprinklers are being installed within racks of Class I through Class IV commodities stored over 12 ft (3.7 m) and up to and including 20 ft (6.1 m) in height protected with CMDA sprinklers at ceiling level along with more than one level of in-rack sprinklers, but not in every tier, densities obtained from design curves and adjusted in accordance with Figure 25.2.3.2.4.1 shall be permitted to be reduced an additional 20 percent, as indicated in Table 25.2.3.2.4.2 .

Table 25.2.3.2.4.2 Adjustment to Ceiling-Level Sprinkler Density Due to Storage Height and In-Rack Sprinklers

Storage Height	In-Rack Sprinklers	Apply Figure 25.2.3.2.4.1	Permitted Ceiling-Level Sprinkler Density Adjustment Due to In-Rack Sprinklers
Over 12 ft (3.7 m) and up to and including 20 ft (6.1 m)	Minimum required	Yes	None
	More than required but not in every tier	Yes	Reduce density 20% from that for minimum in-rack sprinklers
	Every tier level	Yes	Reduce density 40% from that for minimum in-rack sprinklers
Over 20 ft (6.1 m) and up to and including 25 ft (7.6 m)	Minimum required	No	None
	More than required but not in every tier	No	Reduce density 20% from that for minimum in-rack sprinklers
	Every tier level	No	Reduce density 40% from that for minimum in-rack sprinklers

25.2.3.2.4.3*

Where in-rack sprinklers are being installed within racks of Class I through Class IV commodities stored over 12 ft (3.7 m) and up to and including 20 ft (6.1 m) in height protected with CMDA sprinklers at ceiling level along with in-rack sprinklers at each tier level, densities obtained from design curves and adjusted in accordance with Figure 25.2.3.2.4.1 shall be permitted to be reduced an additional 40 percent, as indicated in Table 25.2.3.2.4.2 .

A.25.2.3.2.4.3

It is not the intent that an in-rack sprinkler be installed above the top-tier of storage when utilizing “in-rack sprinklers at each tier level.”

25.2.3.2.4.4

Where in-rack sprinklers are being installed within racks of Class I through Class IV commodities stored over 20 ft (6.1 m) and up to and including 25 ft (7.6 m) in height protected with CMDA sprinklers at ceiling level along with the minimum number of required in-rack sprinkler levels, densities obtained from design curves shall be used. Densities shall not be adjusted in accordance with Figure 25.2.3.2.4.1 .

25.2.3.2.4.5

Where in-rack sprinklers are being installed within racks of Class I through Class IV commodities stored over 20 ft (6.1 m) and up to and including 25 ft (7.6 m) in height protected with CMDA sprinklers at ceiling level along with more than the minimum required level of in-rack sprinklers, but not in every tier, densities obtained from design curves shall be permitted to be reduced 20 percent, as indicated in Table 25.2.3.2.4.2 . Densities shall not be adjusted in accordance with Figure 25.2.3.2.4.1 for storage height.

25.2.3.2.4.6

Where in-rack sprinklers are being installed within racks of Class I through Class IV commodities stored over 20 ft (6.1 m) and up to and including 25 ft (7.6 m) in height protected with CMDA sprinklers at ceiling level along with in-rack sprinklers at each tier level, except above the top tier, densities obtained from design curves shall be permitted to be reduced 40 percent, as indicated in Table 25.2.3.2.4.2 . Densities shall not be adjusted in accordance with Figure 25.2.3.2.4.1 for storage height.

25.2.3.3 Rack Storage of Class I Through Class IV Commodities Over 25 ft (7.6 m) in Height.

25.2.3.3.1* Single- and Double-Row Racks.

Where in-rack sprinklers are being installed within single- and double-row racks separated by aisles at least 4 ft (1.2 m) wide and with a clearance to ceiling up to and including 10 ft (3.0 m) of Class I through Class IV commodities stored over 25 ft (7.6 m) in height protected by CMDA sprinklers at ceiling level, the ceiling sprinkler designs shall be in accordance with Table 25.2.3.3.1 .

Table 25.2.3.3.1 CMDA Ceiling-Level Sprinkler Design Criteria for Single- or Double-Row Racks of Class I Through Class IV Commodities Stored Over 25 ft (7.6 m) in Height with Aisles 4 ft (1.2 m) or More in Width, Clearance to Ceiling Up to and Including 10 ft (3.0 m) Supplemented with In-Rack Sprinklers

Commodity Class	Applicable In-Rack Sprinkler Installation Figures	Encapsulated	Ceiling Sprinkler Density, Clearance to Ceiling Up to 10 ft (3.0 m)				Ceiling Sprinkler Operating Area	
			Ordinary Temperature		High Temperature			
			gpm/ft^2	mm/min	gpm/ft^2	mm/min	ft^2	m^2
I	25.9.2.2.1(a)–(b)	No	0.25	10.2	0.35	14.3	2000	186
		Yes	0.31	12.8	0.44	17.9		
I, II, III	25.9.2.2.1(c)–(g)	No	0.3	12.2	0.4	16.3		
		Yes	0.37	15.3	0.5	20.4		
I, II, III, IV	25.9.2.2.1(h)–(j)	No	0.35	14.2	0.45	18.3		
		Yes	0.44	17.8	0.56	22.8		

A.25.2.3.3.1

Water demand for storage height over 25 ft (7.6 m) on racks separated by aisles at least 4 ft (1.2 m) wide and with more than 10 ft (3.0 m) between the top of storage and the sprinklers should be based on sprinklers in a 2000 ft^2 (186 m^2) operating area for double-row racks and a 3000 ft^2 (279 m^2) operating area for multiple-row racks discharging a minimum of 0.18 gpm/ft^2 (7.3 mm/min) for Class I commodities, 0.21 gpm/ft^2 (8.5 mm/min) for Class II and Class III commodities, and 0.25 gpm/ft^2 (10.2 mm/min) for Class IV commodities for ordinary temperature–rated sprinklers or a minimum of 0.25 gpm/ft^2 (10.2 mm/min) for Class I commodities, 0.28 gpm/ft^2 (11.4 mm/min) for Class II and Class III commodities, and 0.32 gpm/ft^2 (13 mm/min) for Class IV commodities for high temperature–rated sprinklers. *(See A.25.9.2.3.1 .)* Where such storage is encapsulated, ceiling sprinkler density should be 25 percent greater than for nonencapsulated storage. Data indicate that the sprinkler protection criteria in 25.2.3.3.1.1 are ineffective, by themselves, for rack storage with solid shelves if the required flue spaces are not maintained. Use of 25.2.3.3.1.1, along with the additional provisions that are required by this standard, can provide acceptable protection.

25.2.3.3.2 Multiple-Row Racks.

Where in-rack sprinklers are being installed within multiple-row racks separated by aisles at least 4 ft (1.2 m) wide and with a clearance to ceiling up to and including 10 ft (3.0 m) of Class I through Class IV commodities stored over 25 ft (7.6 m) in height protected by CMDA sprinklers at ceiling level, the ceiling sprinkler designs shall be in accordance with Table 25.2.3.3.2 .

Table 25.2.3.3.2 CMDA Ceiling-Level Sprinkler Design Criteria for Multiple-Row Racks of Class I Through Class IV Commodities Stored Over 25 ft (7.6 m) in Height, Clearance to Ceiling Up to and Including 10 ft (3.0 m) Supplemented with In-Rack Sprinklers

Commodity Class	Encapsulated	Maximum Allowable Storage Height Above Top In-Rack Sprinkler Level		Ceiling Sprinkler Density, Clearance to Ceiling Up to 10 ft (3.0 m)				Ceiling Sprinkler Operating Area	
				Ordinary Temperature		High Temperature			
		ft	m	gpm/ft^2	mm/min	gpm/ft^2	mm/min	ft^2	m^2
I	No	10	3.0	0.25	10.2	0.35	14.3	2000	186
	Yes			0.31	12.6	0.44	17.9		
I, II, III	No	10	3.0	0.3	12.2	0.4	16.3		
	Yes			0.37	15.1	0.5	20.4		
I, II, III, IV	No	5	1.5	0.35	14.2	0.45	18.3		
	Yes			0.44	17.9	0.56	22.8		

25.2.3.4 Rack Storage of Group A Plastic Commodities Stored Over 5 ft (1.5 m) and Up to and Including 25 ft (7.6 m) in Height.

25.2.3.4.1 Cartoned Group A Plastic Commodities.

25.2.3.4.1.1

Where rack storage of cartoned Group A plastic commodities, encapsulated or nonencapsulated, having a clearance to ceiling up to and including 10 ft (3.0 m) is protected by in-rack sprinklers, ceiling-level sprinkler designs in terms of density [gpm/ft^2 (mm/min)] and area of operation [ft^2 (m^2)] shall be selected from Figure 25.9.3.1(a) through Figure 25.9.3.1(e) .

25.2.3.4.1.2

Linear interpolation of design densities and areas of application shall be permitted between storage heights with the same clearance to ceiling.

25.2.3.4.1.3

No interpolation between clearance to ceiling shall be permitted.

25.2.3.4.2 2 Exposed Nonexpanded Group A Plastic Commodities.

Where in-rack sprinkler protection is installed to protect rack storage of exposed nonexpanded Group A plastic commodities, encapsulated or nonencapsulated, stored over 5 ft (1.5 m) and up to and including 25 ft (7.6 m) in height protected by CMDA sprinklers at ceiling level, the ceiling sprinkler design shall be in accordance with one of the following:

(1) Where in-rack sprinklers are installed in accordance with Figure 25.9.3.3(a) for storage up to 10 ft (3.0 m) high in a building up to 20 ft (6.1 m) high, the ceiling-level sprinkler design shall be a minimum 0.45 gpm/ft^2 (18.3 mm/min) density over a 2000 ft^2 (186 m^2) demand area.

(2) Where in-rack sprinklers are installed in accordance with Figure 25.9.3.3(b) for storage up to 10 ft (3.0 m) high in a building up to 20 ft (6.1 m) high, the ceiling-level sprinkler design shall be a minimum 0.30 gpm/ft^2 (12.2 mm/min) density over a 2000 ft^2 (186 m^2) demand area.

(3) Where in-rack sprinklers are installed in accordance with Figure 25.9.3.3(c) for storage up to 15 ft (4.6 m) high in a building up to 25 ft (7.6 m) high, the ceiling-level sprinkler design shall be a minimum 0.45 gpm/ft^2 (18.3 mm/min) density over a 2000 ft^2 (186 m^2) demand area.

(4) Where in-rack sprinklers are installed in accordance with Figure 25.9.3.3(d) for storage up to 15 ft (4.6 m) high in a building up to 25 ft (7.6 m) high, the ceiling-level sprinkler design shall be a minimum 0.30 gpm/ft^2 (12.2 mm/min) density over a 2000 ft^2 (186 m^2) demand area.

(5) Where in-rack sprinklers are installed in accordance with Figure 25.9.3.3(e) for storage up to 20 ft (6.1 m) high in a building up to 25 ft (7.6 m) high, the ceiling-level sprinkler design shall be a minimum 0.6 gpm/ft^2 (24.4 mm/min) density over a 2000 ft^2 (186 m^2) demand area.

(6) Where in-rack sprinklers are installed in accordance with Figure 25.9.3.3(f) for storage up to 20 ft (6.1 m) high in a building up to 25 ft (7.6 m) high, the ceiling-level sprinkler design shall be a minimum 0.45 gpm/ft^2 (18.3 mm/min) density over a 2000 ft^2 (186 m^2) demand area.

(7) Where in-rack sprinklers are installed in accordance with Figure 25.9.3.3(g) for storage up to 20 ft (6.1 m) high in a building up to 30 ft (9.1 m) high, the ceiling-level sprinkler design shall be a minimum 0.8 gpm/ft^2 (32.6 mm/min) density over a 1500 ft^2 (139 m^2) demand area.

(8) Where in-rack sprinklers are installed in accordance with Figure 25.9.3.3(h) for storage up to 20 ft (6.1 m) high in a building up to 30 ft (9.1 m) high, the ceiling-level sprinkler design shall be a minimum 0.6 gpm/ft^2 (24.4 mm/min) density over a 1500 ft^2 (139 m^2) demand area.

(9) Where in-rack sprinklers are installed in accordance with Figure 25.9.3.3(i) for storage up to 20 ft (6.1 m) high in a building up to 30 ft (9.1 m) high, the ceiling-level sprinkler design shall be a minimum 0.30 gpm/ft^2 (12.2 mm/min) density over a 2000 ft^2 (186 m^2) demand area.

(10) Where in-rack sprinklers are installed in accordance with Figure 25.9.3.3(j) for storage up to 25 ft (7.6 m) high in a building up to 35 ft (10.7 m) high, the ceiling-level sprinkler design shall be a minimum 0.8 gpm/ft^2 (32.6 mm/min) density over a 1500 ft^2 (139 m^2) demand area.

(11) Where in-rack sprinklers are installed in accordance with Figure 25.9.3.3(k) for storage up to 25 ft (7.6 m) high in a building up to 35 ft (10.7 m) high, the ceiling-level sprinkler design shall be a minimum 0.30 gpm/ft^2 (12.2 mm/min) density over a 2000 ft^2 (186 m^2) demand area.

25.2.3.5* Rack Storage of Group A Plastic Commodities Stored Over 25 ft (7.6 m) in Height.

Where rack storage of Group A plastic commodities, encapsulated or nonencapsulated, over 25 ft (7.6 m) in height are protected by in-rack sprinklers in accordance with 25.9.4 , ceiling-level sprinkler designs, in terms of density [gpm/ft^2 (mm/min)] and area of operation [ft^2 (m^2)], shall be selected from Table 25.2.3.5 based on the storage height of commodity above the top level of in-rack sprinklers.

Table 25.2.3.5 CMDA Ceiling-Level Sprinkler Design Criteria for Rack Storage of Group A Plastic Commodities with Storage Over 25 ft (7.6 m) in Height, Clearance to Ceiling Up to and Including 10 ft (3.0 m) Supplemented with In-Rack Sprinklers

Storage Height Above Top Level of In-Rack Sprinklers		**Ceiling-Level Sprinkler Design Criteria**	
ft	**m**	**gpm/ft^2 over ft^2**	**mm/min over m^2**
Up to and including 5 ft	Up to and including 1.5 m	0.30/2000	12.2/186
Over 5 ft and up to and including 10 ft	Over 1.5 m and up to and including 3.0 m	0.45/2000	18.3/186

A.25.2.3.5

In this application ordinary-, intermediate-, or high-temperature ceiling-level sprinklers can be used. There are no data to support temperature rating restrictions for this section.

25.2.3.6 Rack Storage of Rubber Tires Stored Over 12 ft (3.7 m) in Height.

25.2.3.6.1 General.

The requirements of Chapter 20 shall apply unless modified in this section.

25.2.3.6.2 Ceiling Systems.

Where rack storage of rubber tires on pallets, either on-side or on-tread, over 5 ft (1.5 m) and up to and including 20 ft (6.1 m) in height protected by CMDA sprinklers at ceiling level with a maximum clearance to ceiling of 10 ft (3.0 m) along with one level of in-rack sprinklers, the ceiling-level sprinkler system design density and area of application shall be a minimum 0.40 gpm/ft^2 (16.3 mm/min) density over a 3000 ft^2 (279 m^2) demand area. *(See A.21.6 .)*

25.2.3.6.3 Reduced-Discharge Density.

Where high-expansion foam systems are installed in accordance with NFPA 11 to protect rack storage of rubber tires, either on-side or on-tread, over 5 ft (1.5 m) and up to and including 20 ft (6.1 m) in height protected by CMDA sprinklers at ceiling level with a maximum clearance to ceiling of 10 ft (3.0 m) and one level of in-rack sprinklers, the ceiling-level sprinkler system design density shall be permitted to be reduced from 0.40 gpm/ft^2 (16.3 mm/min) to 0.24 gpm/ft^2 (9.8 mm/min).

25.2.3.6.4 Water Supplies.

Total water supplies shall be capable of providing flow for automatic sprinklers, hose streams, and foam systems (if provided) for the duration required in Table 20.12.2.6 .

25.2.4 CMSA Ceiling-Level Sprinkler Design Criteria in Combination with In-Rack Sprinklers.

25.2.4.1 General.

25.2.4.1.1 Open Wood Joist Construction with CMSA Sprinklers at Ceiling Level.

25.2.4.1.1.1

Where CMSA sprinklers are installed under open wood joist construction, firestopping in accordance with 25.2.4.1.1.2 shall be provided or the minimum operating pressure of the sprinklers shall be 50 psi (3.4 bar) for a K-11.2 (160) sprinkler or 22 psi (1.5 bar) for a K-16.8 (240) sprinkler.

25.2.4.1.1.2

Where each joist channel of open wood joist construction is fully firestopped to its full depth at intervals not exceeding 20 ft (6.1 m), the lower pressures specified in Table 25.2.4.2.1 shall be permitted to be used.

25.2.4.1.2 Preaction Systems for CMSA Sprinklers.

For the purpose of using Table 25.2.4.2.1 , preaction systems shall be classified as dry pipe systems.

25.2.4.2 Rack Storage of Class I Through Class IV Commodities.

25.2.4.2.1

Where rack storage of Class I through Class IV commodities is protected by CMSA sprinklers at ceiling level along with one level of in-rack sprinklers, the ceiling-level sprinkler design criteria shall be in accordance with Table 25.2.4.2.1 .

Table 25.2.4.2.1 CMSA Ceiling-Level Sprinkler Design Criteria for Rack Storage of Class I Through Class IV Commodities (Encapsulated and Nonencapsulated) Supplemented with In-Rack Sprinklers

Storage Arrangement	Commodity Class	Maximum Storage Height		Maximum Ceiling/Roof Height		K-Factor/Orientation	Type of System	No. of Ceiling Sprinklers in the Design	No. o Requir Levels In-Rac Sprinkl
		ft	m	ft	m				
Single-, double-, and multiple-row racks (no open-top containers)	I or II	30	9.1	35	10.7	11.2 (160) Upright	Wet	20	One lev
							Dry	30	One lev
						16.8 (240) Upright	Wet	20	One lev
							Dry	30	One lev
	III	25	7.6	30	9.1	11.2 (160) Upright	Wet	15	One lev
							Dry	25	One lev
						16.8 (240) Upright	Dry	25	One lev
				35	10.7	11.2 (160) Upright	Wet	15	One lev
							Dry	25	One lev
						16.8 (240) Upright	Wet	15	One lev
							Dry	25	One lev
	IV	25	7.6	30	9.1	11.2 (160) Upright	Wet	15	One lev
				35	10.7	11.2 (160) Upright	Wet	20	One lev
								15	One lev
						16.8 (240) Upright	Wet	20	One lev
								15	One lev

25.2.4.2.2

Protection shall be provided as specified in Table 25.2.4.2.1 or appropriate NFPA standards in terms of minimum operating pressure and the number of ceiling-level sprinklers to be included in the design area.

25.2.4.3 Rack Storage of Group A Plastic Commodities.

25.2.4.3.1

Where rack storage of nonexpanded, cartoned and exposed, Group A plastic commodities is protected by CMSA sprinklers at ceiling level along with one level of in-rack sprinklers, the ceiling-level sprinkler system design criteria shall be in accordance with Table 25.2.4.3.1 .

Table 25.2.4.3.1 CMSA Ceiling-Level Sprinkler Design Criteria for Rack Storage of Group A Plastic Commodities Stored Up to and Including 25 ft (7.6 m) in Height Supplemented with In-Rack Sprinklers

Storage Arrangement	Commodity Class	Maximum Storage Height		Maximum Ceiling/Roof Height		K-Factor/Orientation	Type of System	No. of Ceiling Sprinklers in the Design	No. of Requi Levels In-Ra Sprink
		ft	m	ft	m				
Single-, double-, and multiple-row racks (no open-top containers)	Cartoned nonexpanded plastics and exposed nonexpanded plastics	25	7.6	30	9.1	11.2 (160) upright	Wet	15	One lev
				35	10.7	11.2 (160) upright	Wet	30	One lev
							Wet	20	One lev
						16.8 (240) upright	Wet	30	One lev
							Wet	20	One lev

25.2.4.3.2

Protection shall be provided as specified in Table 25.2.4.3.1 or appropriate NFPA standards in terms of minimum operating pressure and the number of ceiling-level sprinklers to be included in the design area.

25.2.5 ESFR Ceiling-Level Sprinkler Design Criteria in Combination with In-Rack Sprinklers.

25.2.5.1 Rack Storage of Class I Through Class IV and Group A Plastic Commodities.

25.2.5.1.1

Where rack storage of Class I through Class IV and Group A plastic commodities is protected by ESFR sprinklers at ceiling level along with one level of in-rack sprinklers, the ceiling-level sprinkler design criteria shall be in accordance with Table 25.2.5.1.1 .

Table 25.2.5.1.1 ESFR Ceiling-Level Sprinkler Design Criteria for Rack Storage of Class I Through Class IV and Group A Plastic Commodities (Encapsulated and Nonencapsulated) Supplemented with In-Rack Sprinklers

Storage Arrangement	Commodity Class	Maximum Storage Height		Maximum Ceiling/Roof Height		K-Factor	Orientation	No. of Ceiling Sprinklers in the Design	No. of Required Levels of In-Rack Sprinklers
		ft	m	ft	m				
Single-, double-, and multiple-row racks (no open-top containers)	Class I, II, III or IV, encapsulated or nonencapsulated, cartoned nonexpanded and exposed nonexpanded plastics	25	7.6	45	13.7	14.0 (200)	Pendent	12	One level
						16.8 (240)	Pendent	12	One level

25.2.5.1.2

ESFR sprinkler systems, when supplemented with in-rack sprinklers, shall be designed such that the minimum operating pressure is not less than that indicated in Table 25.2.5.1.1 for type of storage, commodity, storage height, and building height involved.

25.2.5.1.3

The design area applicable to the ceiling-level design options listed in Table 25.2.5.1.1 shall consist of the most hydraulically demanding area of 12 sprinklers, consisting of 4 sprinklers on each of three branch lines.

25.3 In-Rack Sprinkler Characteristics.

25.3.1

In-rack sprinklers shall be pendent or upright, standard- or quick-response, ordinary-temperature-rated and have a nominal K-factor of K-5.6 (80), K-8.0 (115), or K-11.2 (160).

25.3.2

In-rack sprinklers protecting open rack storage where ESFR sprinklers are installed at ceiling level shall be quick-response, ordinary-temperature-rated, and either K-8.0 (115) or K-11.2 (160).

25.3.3

In-rack sprinklers with intermediate- and high-temperature ratings shall be used near heat sources as required by 9.4.2 .

25.3.4

In-rack sprinklers shall be permitted to have a different RTI rating from the ceiling sprinklers under which they are installed.

25.3.5 In-Rack Sprinkler Water Shields.

25.3.5.1 In-Rack Sprinkler Water Shields for Storage of Class I Through Class IV Commodities.

Water shields shall be provided directly above in-rack sprinklers, or listed intermediate level/rack storage sprinklers shall be used where there is more than one level, if not shielded by horizontal barriers. *(See Section C.3 .)*

25.3.5.2 In-Rack Sprinkler Water Shields for Group A Plastic Storage.

Where in-rack sprinklers are not shielded by horizontal barriers, water shields shall be provided above the sprinklers, or listed intermediate level/rack storage sprinklers shall be used.

25.4 Vertical Spacing and Location of In-Rack Sprinklers.

25.4.1

In-rack sprinklers shall not be required to meet the obstruction criteria and clearance from storage requirements of Section 9.5 .

25.4.2

A minimum 6 in. (150 mm) vertical clear space shall be maintained between in-rack sprinkler deflectors and the top of storage located below them.

25.4.2.1*

Where in-rack sprinklers are being installed within single- and double-row racks of Class I through Class IV commodities up to and including 20 ft (6.1 m) in height, the vertical clear space of in-rack sprinkler deflectors with respect to the top of storage located below them shall be permitted to be less than 6 in. (150 mm). *(See Section C.16 .)*

A.25.4.2.1

Where possible, it is recommended that in-rack sprinkler deflectors be located at least 6 in. (150 mm) vertically above the top of storage located below them.

25.4.3

In-rack sprinkler discharge shall not be obstructed by horizontal rack members

25.4.4*

Where one level of in-rack sprinklers are required by the guidelines of this chapter and the vertical location of the in-rack sprinklers is not indicated in an applicable figure, in-rack sprinklers shall be installed at the first tier level at or above one-half of the highest expected storage height.

A.25.4.4

Where one level of in-rack sprinklers are required by the guidelines in Chapter 25 , in-rack sprinklers for multiple-row rack storage up to and including 25 ft (7.6 m) of Class I through Class IV commodities should be installed at the first tier level nearest one-half to two-thirds of the highest expected storage height.

25.4.5

Where two levels of in-rack sprinklers are required by the guidelines of this chapter and the vertical location of the in-rack sprinklers is not indicated in an applicable figure, in-rack sprinklers shall be installed at the first tier level at or above one-third and two-thirds of the highest expected storage height.

25.4.6 Maximum Storage Height Above Top In-Rack Sprinkler Level.

25.4.6.1

Where in-rack sprinklers are required for single- and double-row rack storage of Class I through Class IV commodities over 25 ft (7.6 m) in height and protected by CMDA sprinklers at ceiling level, storage above the top level of in-rack sprinklers shall not exceed 10 ft (3.0 m).

25.4.6.2

Where in-rack sprinklers are required for multiple-row rack storage of Class I through Class IV commodities over 25 ft (7.6 m) in height and protected by CMDA sprinklers at ceiling level, storage above the top level of in-rack sprinklers shall not exceed 10 ft (3.0 m) for Class I, Class II, or Class III commodities or 5 ft (1.5 m) for Class IV commodities.

25.4.6.3

Where in-rack sprinklers are required for rack storage of Group A plastic commodities over 25 ft (7.6 m) in height and protected by CMDA sprinklers at ceiling level, storage above the top level of in-rack sprinklers shall not exceed 10 ft (3.0 m).

25.4.7 Staggering of In-Rack Sprinklers for Class I Through Class IV Commodities Over 25 ft (7.6 m) in Height.

25.4.7.1

Where single-, double-, and multiple-row rack storage of Class I through Class IV commodities is over 25 ft (7.6 m) in height and protected by CMDA sprinklers at ceiling level, in-rack sprinklers shall be staggered vertically where installed in accordance with Table 25.9.2.1.1 , Figure 25.9.2.2.1(a) through Figure 25.9.2.2.1(j) , and Figure 25.9.2.1.1(a) through Figure 25.9.2.1.1(e) .

25.5 Horizontal Location and Spacing of In-Rack Sprinklers.

25.5.1 Horizontal Location of In-Rack Sprinklers.

25.5.1.1

In-rack sprinklers shall not be required to meet the obstruction criteria and clearance from storage requirements of Section 9.5 .

25.5.1.2*

Where in-rack sprinklers are installed in longitudinal flues, they shall be located at an intersection of transverse and longitudinal flues while not exceeding the maximum horizontal spacing rules.

A.25.5.1.2

In-rack sprinklers have proven to be the most effective way to fight fires in rack storage. To accomplish this, however, in-rack sprinklers must be located where they will operate early in a fire as well as direct water where it will do the most good. Simply maintaining a minimum horizontal spacing between sprinklers does not achieve this goal. This is because fires in rack storage develop and grow in transverse and longitudinal flues, and in-rack sprinklers do not operate until flames actually impinge on them. To ensure early operation and effective discharge, in-rack sprinklers in the longitudinal flue of open racks must be located at transverse flue intersections.

25.5.1.3

Where horizontal distances between transverse flues exceed the maximum allowable horizontal linear spacing for in-rack sprinklers, in-rack sprinklers shall be installed at the intersection of the transverse and longitudinal flues, and additional in-rack sprinklers shall be installed between transverse flues to meet the maximum allowable horizontal linear spacing rules for in-rack sprinklers.

25.5.1.4

Where no transverse flues exist, horizontal spacing of in-rack sprinklers shall not exceed the maximum allowable spacing rules.

25.5.1.5

Where in-rack sprinklers are installed to protect a higher-hazard commodity that occupies only a portion of the length of a rack, in-rack sprinklers shall be extended a minimum of 8 ft (2.4 m) or one bay, whichever is greater, in each direction along the rack on either side of the higher hazard. The in-rack sprinklers protecting the higher hazard shall not be required to extend across the aisle.

25.5.1.6*

Where rack storage is over 25 ft (7.6 m) in height, in-rack sprinklers shall be a minimum 3 in. (75 mm) radially from the side of rack uprights.

A.25.5.1.6

Where rack storage is up to and including 25 ft (7.6 m) in height, in-rack sprinklers should be a minimum 3 in. (75 mm) radially from the side of rack uprights.

25.5.1.6.1

Where rack storage of Class I through Class IV commodities is up to and including 25 ft (7.6 m), in-rack sprinklers shall be permitted to be installed horizontally without regard to rack uprights. *(See Section C.17 .)*

25.5.1.7

Where rack storage is over 25 ft (7.6 m) in height and requires face sprinklers, the face sprinklers shall be located within the rack a minimum 3 in. (75 mm) from rack uprights and no more than 18 in. (450 mm) from the aisle face of storage.

25.5.1.8

Where single- and double-row rack storage of Class I through Class IV commodities is over 25 ft (7.6 m) in height and protected by CMDA sprinklers at ceiling level, in-rack sprinklers shall be staggered horizontally where installed in accordance with Table 25.9.2.1.1 and Figure 25.9.2.1.1(a) through Figure 25.9.2.1.1(e) for single-row racks or Table 25.9.2.2.1 and Figure 25.9.2.2.1(a) through Figure 25.9.2.2.1(j) for double-row racks.

25.5.1.9

Where multiple-row rack storage of Class I through Class IV commodities is over 25 ft (7.6 m) in height and protected by CMDA sprinklers at ceiling level, in-rack sprinklers shall be staggered horizontally where installed in accordance with Table 25.9.2.3.1 and Figure 25.9.2.3.1(a) through Figure 25.9.2.3.1(c) .

25.5.1.10

Where rack storage of Group A plastic commodities is over 25 ft (7.6 m) in height, in-rack sprinklers in longitudinal flues shall be installed with the deflector located at or below the bottom of horizontal load beams or above or below other adjacent horizontal rack members.

25.5.2 Horizontal Spacing of In-Rack Sprinklers.

25.5.2.1 General.

25.5.2.1.1

Unless specified elsewhere in this standard, the maximum allowable horizontal spacing of in-rack sprinklers shall be in accordance with 25.5.2.1.2 through 25.5.2.1.4 .

25.5.2.1.2

In-rack sprinklers shall be permitted to be installed horizontally less than 6 ft (1.8 m) apart.

25.5.2.1.3

For rack storage of rubber tires, the maximum allowable horizontal spacing of in-rack sprinklers shall be 8 ft (2.4 m).

25.5.2.1.4

The maximum allowable horizontal spacing of in-rack sprinklers for Class IV and Group A plastic commodities in miscellaneous, low-piled, and rack storage shall be 10 ft (3.0 m).

25.5.2.2 CMDA Sprinklers Installed at Ceiling Level.

25.5.2.2.1*

Where single- and double-row rack storage of Class I through Class IV commodities is up to and including 25 ft (7.6 m) in height and protected by CMDA sprinklers at ceiling level, the maximum allowable horizontal spacing of in-rack sprinklers shall be in accordance with Table 25.5.2.2.1 .

Table 25.5.2.2.1 In-Rack Sprinkler Horizontal Spacing for Class I, II, III, and IV Commodities Stored in Single- or Double-Row Racks Up to 25 ft (7.6 m) in Height Protected by CMDA Sprinklers at Ceiling Level

Commodity Class	Aisle Width		Encapsulated	Maximum Allowable Linear Spacing	
	ft	m		ft	m
I, II	8	2.4	No	12	3.7
			Yes	8	2.4
	4	1.2	No	12	3.7
			Yes	8	2.4
III	8	2.4	No	12	3.7
			Yes	8	2.4
	4	1.2	No	10	3
			Yes	8	2.4
IV	8	2.4	No	10	3
			Yes	8	2.4
	4	1.2	No	10	3
			Yes	8	2.4

A.25.5.2.2.1

Spacing of sprinklers on branch lines in racks in the various tests demonstrates that maximum spacing as specified is proper.

25.5.2.2.2

Where multiple-row rack storage of Class I through Class IV commodities is up to and including 25 ft (7.6 m) in height and protected by CMDA sprinklers at ceiling level, the maximum allowable horizontal spacing of in-rack sprinklers shall be in accordance with Table 25.5.2.2.2 .

Table 25.5.2.2.2 In-Rack Sprinkler Horizontal Spacing for Class I, II, III, and IV Commodities Stored in Multiple-Row Racks Up to 25 ft (7.6 m) in Height Protected by Control Mode Density/Area Sprinklers at Ceiling Level

Commodity Class	Linear Spacing		Area Spacing	
	ft	m	ft^2	m^2
I, II, III	12	3.7	100	9.3
IV	8	2.4	80	7.4

(A)

The rack plan view shall be considered in determining the area covered by each sprinkler.

(B)

The aisles shall not be included in area calculations.

25.5.2.2.3*

For horizontal spacing of in-rack sprinklers not addressed by 25.5.2.2.1 or 25.5.2.2.2 , the maximum allowable horizontal spacing of in-rack sprinklers shall be in accordance with Table 25.5.2.2.3 .

Table 25.5.2.2.3 Horizontal Spacing for In-Rack Sprinklers in Combination with CMDA Ceiling Sprinklers That Are Represented by Figures

Commodity Class	Storage Rack Type	Storage Height		Applicable Table and/or Figure for Horizontal Spacing of In-Rack Sprinklers
		ft	m	
Class I through IV	Single-row	Over 25	Over 7.6	Table 25.9.2.1.1 and Figures 25.9.2.1.1(a)–(e)
	Double-row	Over 25	Over 7.6	Table 25.9.2.2.1 and Figures 25.9.2.2.1(a)–(j)
	Multiple-row	Over 25	Over 7.6	Table 25.9.2.3.1 and Figures 25.9.2.3.1(a)–(c)
Group A plastics	Single-, double-, and multiple-row	Up to 25	Up to 7.6	Figures 25.9.3.1(a)–(e)
Group A plastics, cartoned	Single-row	Over 25	Over 7.6	Figures 25.9.4.1.1(a)–(d)
	Double-row	Over 25	Over 7.6	Figures 25.9.4.2.1(a)–(c)
	Multiple-row	Over 25	Over 7.6	Figures 25.9.4.3.1(a)–(f)
Group A plastics, exposed nonexpanded	Single-row, maximum 3 ft (0.9 m) deep	Over 25	Over 7.6	Figure 25.9.4.1.3
	Multiple-row	Over 25	Over 7.6	Figures 25.9.4.3.1(a)–(f)

A.25.5.2.2.3

The protection area per sprinkler under barriers should be no greater than 80 ft^2 (7.4 m^2) in Figure 25.9.4.3.1(a) and Figure 25.9.4.3.1(b) . The protection area per sprinkler under barriers should be no greater than 50 ft^2 (4.6 m^2) in Figure 25.9.4.3.1(c) through Figure 25.9.4.3.1(f) .

25.5.2.3 CMSA Sprinklers Installed at Ceiling Level.

25.5.2.3.1

Where rack storage of Class I through Class IV commodities is up to and including 25 ft (7.6 m) in height and protected by CMSA sprinklers at ceiling level, the maximum allowable horizontal spacing of in-rack sprinklers shall be 8 ft (2.4 m).

25.5.2.3.2

Where rack storage of plastic commodities is up to and including 25 ft (7.6 m) in height and protected by CMSA sprinklers at ceiling level, the maximum allowable horizontal spacing of in-rack sprinklers shall be 5 ft (1.5 m).

25.5.2.3.3

Where rack storage of Class I through Class IV commodities is over 25 ft (7.6 m) in height and protected by CMSA sprinklers at ceiling level, the maximum allowable horizontal spacing of in-rack sprinklers shall be 5 ft (1.5 m).

25.5.2.4 ESFR Sprinklers Installed at Ceiling Level.

Where rack storage is protected by ESFR sprinklers at ceiling level, the maximum allowable horizontal spacing of in-rack sprinklers shall be 5 ft (1.5 m).

25.6 Protection of Racks with Solid Shelves.

25.6.1 General.

The requirements in this chapter for the installation of in-rack sprinklers shall apply to racks with solid shelves except as modified in this section.

25.6.2

Ceiling-level sprinkler design criteria for CMDA, CMSA, and ESFR sprinklers shall be an applicable option for open racks combined with in-rack sprinklers installed in accordance with the criteria for solid shelving.

25.6.3 Vertical Spacing and Location of In-Rack Sprinklers in Racks with Solid Shelves.

25.6.3.1

Where CMDA sprinklers are at ceiling level protecting racks with solid shelving that exceeds 20 ft^2 (1.9 m^2) in area but not 64 ft^2 (5.9 m^2), in-rack sprinklers shall not be required below every shelf but shall be installed below shelves at intermediate levels not more than 6 ft (1.8 m) apart vertically. *(See Section C.11.)*

25.6.3.2

Where CMDA sprinklers are at ceiling level protecting racks with solid shelving that exceeds 64 ft^2 (5.9 m^2) in area or where the levels of storage exceed 6 ft (1.8 m), in-rack sprinklers shall be installed below each level of shelving.

25.6.3.3

Where CMSA sprinklers are at ceiling level and protect racks with solid shelving, in-rack sprinklers shall be installed beneath all tiers under the highest solid shelf.

25.6.3.4

Where ESFR sprinklers are at ceiling level and protect racks with solid shelving, in-rack sprinklers shall be installed beneath all tiers under the highest solid shelf.

25.6.3.5

Where racks with solid shelves obstruct only a portion of an open rack, in-rack sprinklers shall be installed vertically as follows:

(1) In accordance with 25.6.3.1 and 25.6.3.2 where CMDA sprinklers are installed at ceiling level

(2) In accordance with 25.6.3.3 where CMSA sprinklers are installed at ceiling level

(3) In accordance with 25.6.3.4 where ESFR sprinklers are installed at ceiling level

25.6.4 Horizontal Location and Spacing of In-Rack Sprinklers in Racks with Solid Shelves.

25.6.4.1

Where racks with solid shelves contain storage of Class I through Class IV commodities, the maximum allowable horizontal spacing of in-rack sprinklers shall be 10 ft (3.0 m).

25.6.4.2

Where racks with solid shelves contain storage of Group A plastic commodities, the maximum allowable horizontal spacing of in-rack sprinklers shall be 5 ft (1.5 m).

25.6.4.3

Where racks with solid shelves obstruct only a portion of an open rack, in-rack sprinklers shall be extended beyond the end of the solid shelf a minimum of 4 ft (1.2 m) to the nearest flue space intersection.

25.7 Horizontal Barriers in Combination with In-Rack Sprinklers.

25.7.1*

Where required by sections of this chapter, horizontal barriers used in combination with in-rack sprinklers to impede vertical fire development shall be constructed of sheet metal, wood, or similar material and shall extend the full length and depth of the rack.

A.25.7.1

Barriers should be of sufficient strength to avoid sagging that interferes with loading and unloading operations.

25.7.2

Barriers shall be fitted within 2 in. (50 mm) horizontally around rack uprights.

25.8 Alternative In-Rack Sprinkler Protection Options That Are Independent of the Ceiling Sprinkler Design.

25.8.1 In-Rack Sprinkler Protection for Class I Through Class IV and Group A Plastic Commodities That Are Independent of the Ceiling Sprinkler Design, Option 1.

25.8.1.1

Where Class I, II, III, IV, and Group A plastic commodities are protected in accordance with the guidelines of this section, the in-rack sprinkler system shall not be required to be hydraulically balanced with the ceiling-level sprinkler system.

25.8.1.2

Where a storage rack will not be solely dedicated to the in-rack sprinkler system outlined in this section, either of the following shall apply:

(1) Extend the protection outlined in this section horizontally one pallet load in all directions beyond the commodity storage area that is being protected by the alternative in-rack sprinkler arrangement.

(2) Install a vertical barrier to segregate the commodities that are being protected by the alternative in-rack sprinkler arrangement.

25.8.1.3

Where a storage rack is partially protected by the in-rack sprinkler system outlined in this section, commodities that can be protected by the ceiling-level sprinkler system shall be permitted to be stored vertically above and horizontally adjacent to the portions of the storage rack protected in accordance with this section.

25.8.1.4 Horizontal Barriers for Alternative In-Rack Sprinkler Protection Option 1.

25.8.1.4.1

The barrier shall be constructed of minimum 22 gauge (0.8 mm) sheet metal or of minimum $^{3}/_{8}$ in. (10 mm) plywood.

25.8.1.4.2

The barrier shall span horizontally to both aisle faces of the rack, covering up all flue spaces of the rack bays in which they are installed.

25.8.1.4.3

A maximum 3 in. (75 mm) wide horizontal gap shall be permitted at rack uprights or other equipment that would create an opening, such as vertical in-rack sprinkler pipe drops.

25.8.1.4.4

Where the dedicated storage is in open racks, horizontal barriers shall be installed at vertical increments not exceeding 12 ft (3.6 m).

25.8.1.4.5

Where the dedicated storage is in racks with solid shelves, horizontal barriers shall be installed at every tier level of the dedicated storage rack.

25.8.1.5

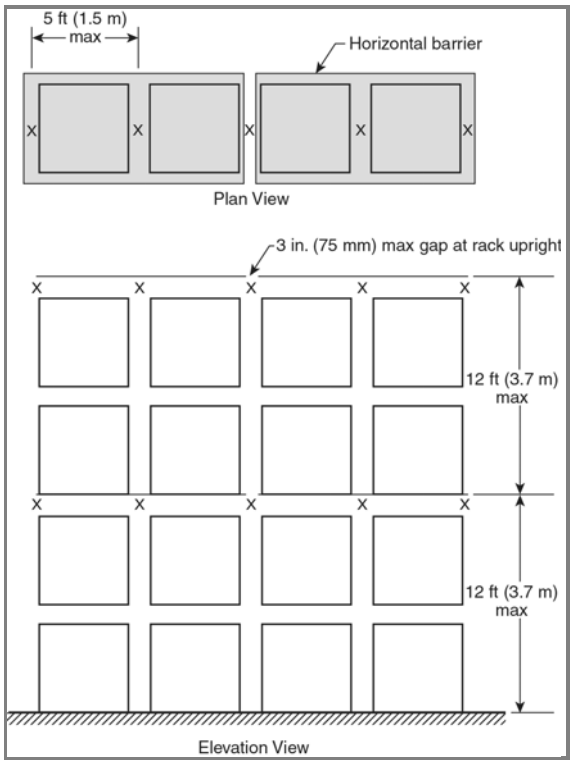
In-rack sprinklers shall be quick-response, minimum K-8.0 (K-115) installed as close to the underside of the horizontal barrier as possible.

25.8.1.6 Alternative In-Rack Sprinkler Protection Option 1 for Single-Row Racks.

25.8.1.6.1

For single-row racks, in-rack sprinklers shall be installed beneath horizontal barriers at each rack upright and within the rack bay as shown in Figure 25.8.1.6.1 .

Figure 25.8.1.6.1 Alternative In-Rack Sprinkler Protection Option 1 for Single-Row Racks.



25.8.1.6.2

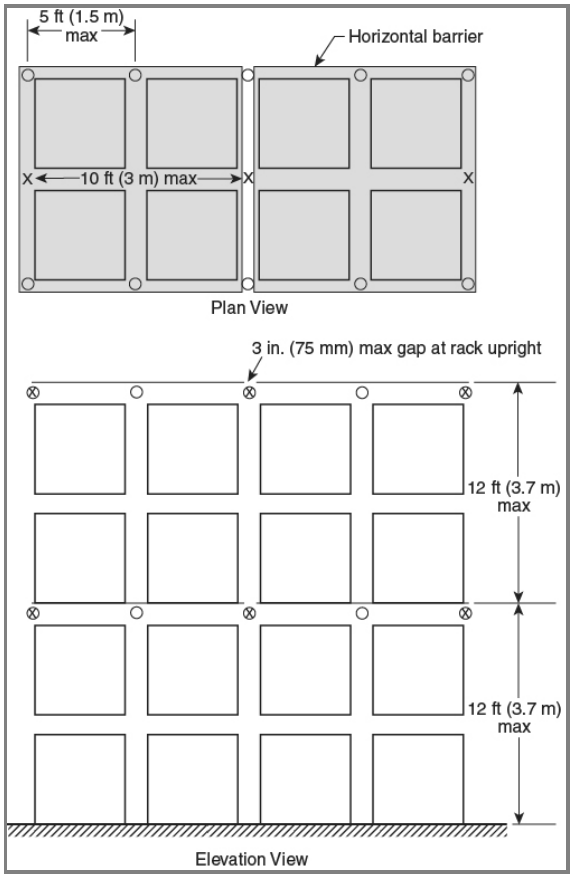
The maximum allowable horizontal spacing between in-rack sprinklers shall not exceed 5 ft (1.5 m).

25.8.1.7 Alternative In-Rack Sprinkler Protection Option 1 for Double-Row Racks.

25.8.1.7.1

For double-row racks, in-rack sprinklers shall be installed beneath horizontal barriers at each rack upright within the longitudinal flue space and at the face of the rack as well as at the face of each rack bay as shown in Figure 25.8.1.7.1 .

Figure 25.8.1.7.1 Alternative In-Rack Sprinkler Protection Option 1 for Double-Row Racks.



25.8.1.7.2

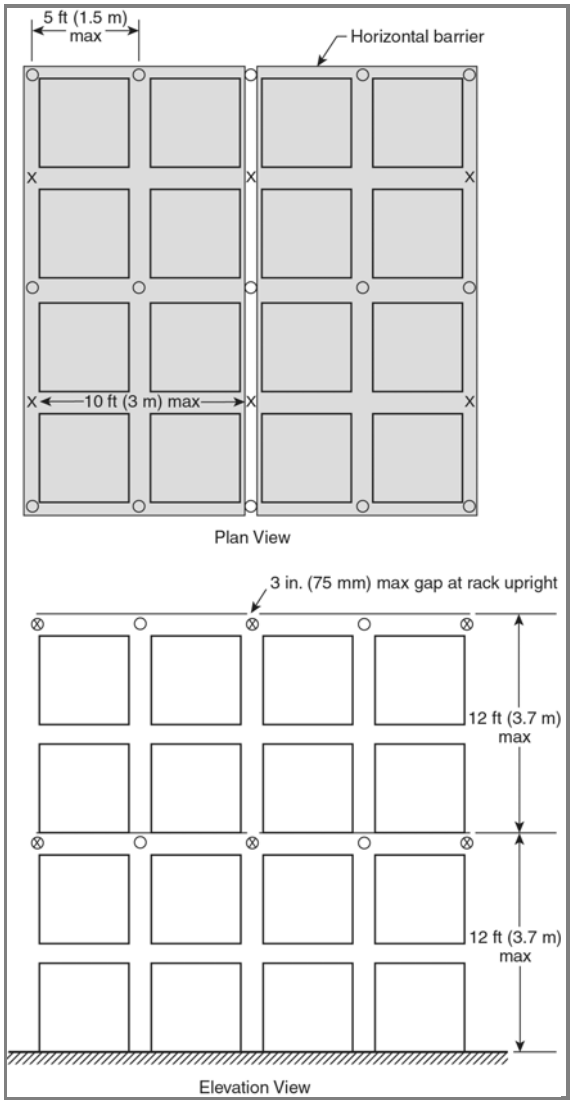
The maximum allowable horizontal spacing between in-rack sprinklers shall not exceed 5 ft (1.5 m) at the rack face and 10 ft (3.0 m) within the longitudinal flue space.

25.8.1.8 Alternative In-Rack Sprinkler Protection Option 1 for Multiple-Row Racks.

25.8.1.8.1

For multiple-row racks, an alternating in-rack sprinkler arrangement shall be installed within adjacent transverse flue spaces and with sprinklers at the face of each flue space as shown in Figure 25.8.1.8.1 .

Figure 25.8.1.8.1 Alternative In-Rack Sprinkler Protection Option 1 for Multiple-Row Racks.



25.8.1.8.2

The maximum allowable horizontal spacing between in-rack sprinklers at the face and at each alternating rack bay shall not exceed 5 ft (1.5 m) and shall not exceed 10 ft (3.0 m) between in-rack sprinklers at every other rack bay.

25.8.1.9 In-Rack Sprinkler System Design.

The in-rack sprinkler system design outlined in this section shall be based on a minimum flow of 60 gpm (230 L/min) from the most remote six in-rack sprinklers for single-row racks or the most remote eight in-rack sprinklers for both double-row and multiple-row racks.

25.8.1.10 Ceiling-Level Sprinkler System Design.

The ceiling-level sprinkler system shall be designed based on the highest commodity hazard not protected by the in-rack sprinkler system outlined in this section.

25.8.2 In-Rack Sprinkler Protection for Class I Through Class IV and Group A Plastic Commodities That Are Independent of the Ceiling Sprinkler Design, Option 2.

25.8.2.1

Protection of closed-top Class I through Class IV and Group A plastic commodities (i.e., no open-top containers) stored on single-, double-, or multiple-row racks without solid shelves shall be permitted to be protected in accordance with this section.

25.8.2.2

In-rack sprinkler systems shall be wet-pipe only.

25.8.2.3

In-rack sprinklers shall be ESFR, pendent, and ordinary-temperature-rated.

25.8.2.3.1

Minimum K-14.0 (K-200) ESFR sprinklers shall be installed where the minimum required flow is 100 gpm (380 L/min) or less.

25.8.2.3.2

Minimum K-22.4 (K-320) ESFR sprinklers shall be installed where the minimum required flow exceeds 100 gpm (380 L/min).

25.8.2.4

Depending on the type of storage rack being protected, in-rack sprinklers shall be positioned horizontally in accordance with Figure 25.8.2.4(a) through Figure 25.8.2.4(f) and the following:

(1) The minimum horizontal distance between in-rack sprinklers shall be 27 in. (700 mm), with the maximum horizontal distance being 4.5 ft (1.4 m), unless shown otherwise in the applicable figures.

(2) Except as shown in Figure 25.8.2.4(c) , all in-rack sprinklers shall be located within the footprint of the rack structure.

(3) All face sprinklers shall be positioned so that the horizontal distance between the face of the storage rack and the outer edge of storage, if it protrudes into the storage aisle, does not exceed 18 in. (450 mm).

Figure 25.8.2.4(a) Plan View of In-Rack Sprinkler Arrangement for Open Single-Row Racks Up to 3 ft (0.9 m) Deep.

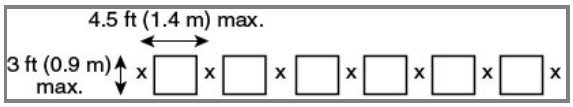


Figure 25.8.2.4(b) Plan View of In-Rack Sprinkler Arrangement for Open Single-Row Racks Up to 6 ft (1.8 m) Deep.

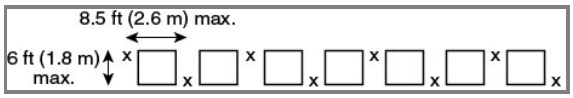


Figure 25.8.2.4(c) Plan View of In-Rack Sprinkler Arrangement for Open Single-Row Racks Up to 6 ft (1.8 m) Deep Located Against a Wall.

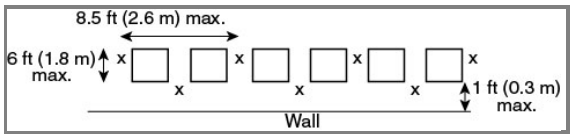


Figure 25.8.2.4(d) Plan View of In-Rack Sprinkler Arrangement for Open Double-Row Racks Up to 9 ft (2.7 m) Deep.

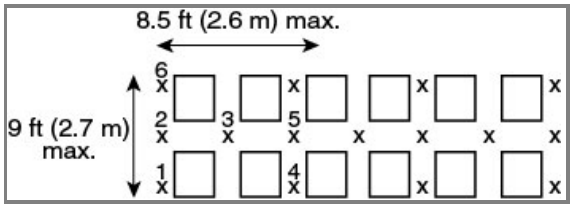


Figure 25.8.2.4(e) Plan View of In-Rack Sprinkler Arrangement for Open Double-Row Racks Up to 12 ft (3.7 m) Deep.

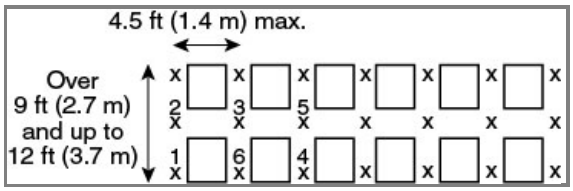
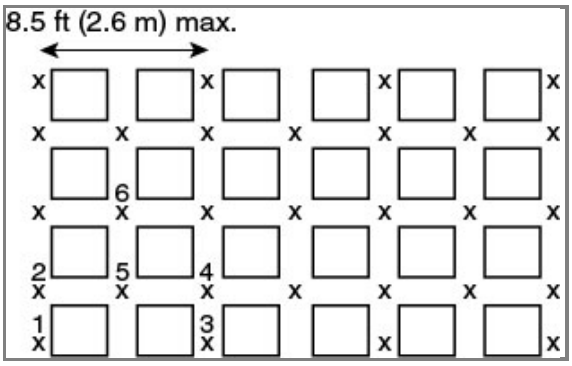


Figure 25.8.2.4(f) Plan View of In-Rack Sprinkler Arrangement for Open Multiple-Row Racks.



25.8.2.5

The maximum allowable vertical distance between in-rack sprinklers for cartoned expanded Group A plastics, exposed nonexpanded Group A plastics, and exposed expanded Group A plastics shall be 30 ft (9.1 m).

25.8.2.5.1

The maximum allowable vertical distance between in-rack sprinklers for Class I through Class IV and cartoned nonexpanded Group A plastics shall be 40 ft (12.2 m).

25.8.2.5.2

A minimum 6 in. (150 mm) vertical distance between the top of storage and the in-rack sprinkler deflector shall be maintained.

25.8.2.6

Regardless of the number of in-rack sprinkler levels installed, the number of sprinkler levels for the in-rack sprinkler system design shall be based on the single most hydraulically remote in-rack sprinkler level and the minimum number of in-rack sprinklers for this level in accordance with Table 25.8.2.6 .

Table 25.8.2.6 Number of Sprinklers in the In-Rack Sprinkler Design

IRAS Installation Arrangement; Figure	Number of Sprinklers in the In-Rack Design	
	Class I Through IV and Cartoned Group A Plastics	Exposed Group A Plastics
Single-row racks up to 3 ft (0.9 m) deep; Figure 25.8.2.4(a)	4	4
Single-row racks up to 6 ft (1.8 m) deep; Figures 25.8.2.4(b) and 25.8.2.4(c)	5	5
Double- and multiple-row racks; Figures 25.8.2(d), 25.8.2.4(e) and 25.8.2.4(f)	6	6 and 6*

*This represents 6 sprinklers in the most remote rack as well as 6 sprinklers in the nearest adjacent rack. See Figures 25.8.2.4(d), 25.8.2.4(e), and 25.8.2.4(f) to determine which 6 sprinklers to account for in the in-rack sprinkler design for double- and multiple-row racks.

25.8.2.7

The minimum flow required in the system design shall be from the most remote in-rack sprinkler in accordance with Table 25.8.2.7 .

Table 25.8.2.7 Minimum Flow in the In-Rack Sprinkler Design

Maximum Vertical IRAS Installation Increment, ft (m)	Commodity Hazard	Min. K-Factor	Minimum Flow from Most Remote IRAS, gpm (L/min)
30 (9.1)	Class I through IV and cartoned nonexpanded Group A plastic	14.0 (200)	65 (250)
	Cartoned expanded Group A plastic	14.0 (200)	100 (380)
	Exposed Group A plastic	22.4 (320)	120 (455)
40 (12.2)	Class I through Class IV and cartoned nonexpanded Group A plastic	22.4 (320)	120 (455)

25.8.2.8

A hose stream allowance per Table 20.12.2.6 shall be included as part of the in-rack sprinkler system design.

25.8.2.9

The water supply requirements shall be available for a minimum duration as required in Table 20.12.2.6 .

25.8.2.10

The water supply for the in-rack sprinkler system shall be capable of providing the required in-rack sprinkler system design obtained from 25.8.2 independent of the design requirements of the ceiling sprinkler system protecting this same area.

25.8.2.11

The ceiling sprinkler system shall be designed and installed in accordance with the guidelines outlined in Chapters 21 , 22 , or 23 , depending on the commodity hazard and the ceiling-level sprinkler, except as modified in 25.8.2 .

25.8.2.11.1*

Where the in-rack sprinkler system is designed and installed in accordance with 25.8.2 , the top level of in-rack sprinklers shall be considered to be a floor for design purposes of the ceiling sprinkler system.

A.25.8.2.11.1

The design for the ceiling sprinkler system can treat the top level of in-rack sprinklers as a floor, thus allowing for storage heights above the top in-rack sprinkler level that exceed 10 ft (3.0 m). For example, if open rack storage of cartoned Group A plastics was stored to 70 ft (21.3 m) high under an 80 ft (24.4 m) ceiling and one level of in-rack sprinklers was installed per 25.8.2 at the 40 ft (12.2 m) level, then the ceiling sprinkler system could be designed based on 30 ft (9.1 m) high storage being maintained under a 40 ft (12.2 m) high ceiling.

25.8.2.12

The water supply for the ceiling system shall be capable of providing the required ceiling sprinkler system design obtained from Chapters 21 , 22 , or 23 independent of the design requirements of the in-rack sprinkler system obtained from 25.8.2 and protecting this same area.

25.8.3 In-Rack Sprinkler Protection for Class I Through Class IV and Group A Plastic Commodities That Are Independent of the Ceiling Sprinkler Design, Option 3.

25.8.3.1

Class I through Class IV and Group A plastic commodities requiring a greater level of protection than is available from the overhead sprinkler system shall be permitted to be protected in accordance with this section.

25.8.3.1.1

Where the storage rack will not be solely dedicated to the storage of commodities requiring a greater level of protection than is available from the overhead sprinkler system, either of the following shall apply:

(1) Extend the protection prescribed by this section horizontally one pallet load in all directions beyond the commodity storage area requiring the higher level of protection.

(2) Install a vertical barrier to segregate the commodities requiring the higher level of protection from any adjacent commodities.

25.8.3.1.2

Commodities that can be protected by the ceiling-level sprinkler system shall be permitted to be stored vertically above and horizontally adjacent to the portions of the storage rack equipped as prescribed by this section.

25.8.3.2 Horizontal Barriers.

Horizontal barriers shall be installed at every tier level of the dedicated storage rack where the rack is equipped with solid shelves.

25.8.3.2.1

Where dedicated storage of Class I through IV and cartoned Group A plastic commodity is in open racks, horizontal barriers shall be installed at vertical increments not exceeding 30 ft (9.1 m).

25.8.3.2.2

Where dedicated storage of exposed Group A plastic commodity is in open racks, horizontal barriers shall be installed at vertical increments not exceeding 20 ft (6.1 m).

25.8.3.2.3

The barriers shall span horizontally so that all flue spaces within the rack bay are covered.

25.8.3.2.4

A maximum 3 in. (75 mm) wide gap shall be permitted at rack uprights.

25.8.3.2.5

The solid barrier shall be installed on a horizontal plane within a rack, beneath which in-rack sprinklers shall be installed, as follows:

(1) The barrier shall be constructed of minimum 22 gauge (0.8 mm) sheet metal or of minimum ⅜ in. (10 mm) plywood.

(2) The barrier shall extend to both ends and both aisle faces of the racks covering up both the longitudinal and transverse flue spaces of the rack bays in which they are installed.

(3) The barrier shall be fitted to within 3 in. (75 mm) of any vertical rack member or other equipment that would create an opening, such as vertical in-rack sprinkler pipe drops.

25.8.3.3 In-Rack Sprinklers.

Intermediate-temperature extended-coverage CMDA pendent storage sprinklers with a nominal K-factor of K-25.2 (360) shall be installed beneath each horizontal barrier. The deflector of the sprinkler shall be located as close to the underside of the horizontal barrier as possible with the deflector a minimum of 6 in. (150 mm) above the top of the commodity.

25.8.3.3.1 Single-Row Racks.

(A)

For single-row racks, sprinklers shall be installed at each rack mid-bay as shown in Figure 25.8.3.3.1(A)(a) for Class I through Class IV and cartoned Group A plastic commodity and Figure 25.8.3.3.1(A)(b) for exposed Group A plastic commodity.

Figure 25.8.3.3.1(A)(a) Alternative In-Rack Sprinkler Protection for Class I Through Class IV and Cartoned Group A Plastic Commodities in Single-Row Racks, Option 3.

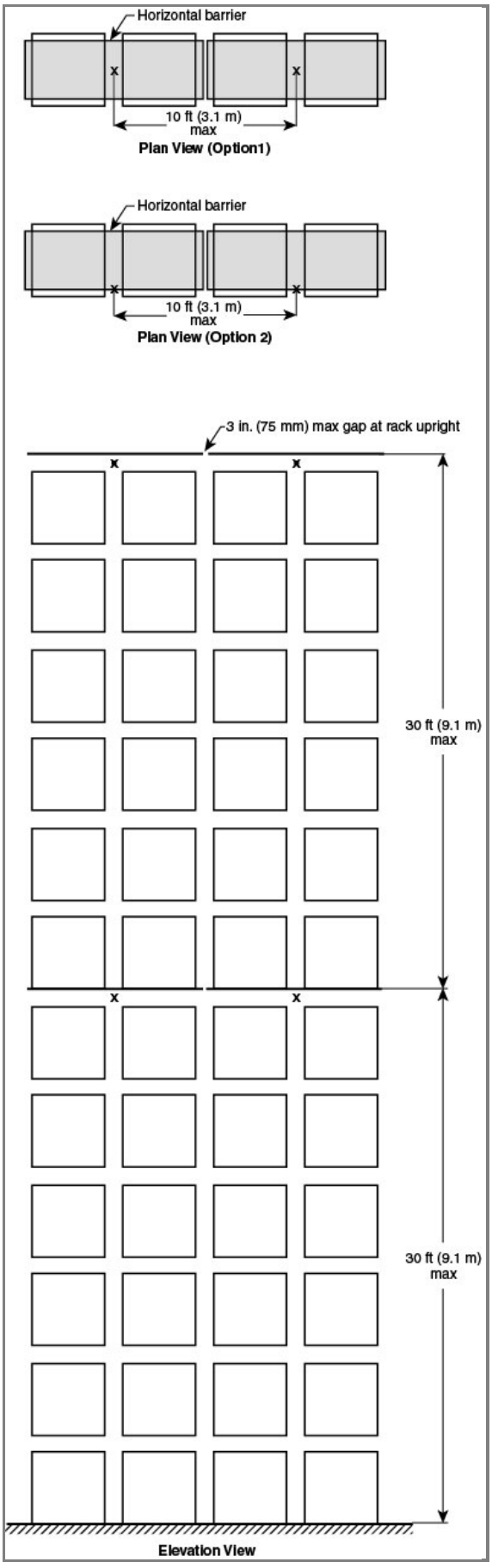
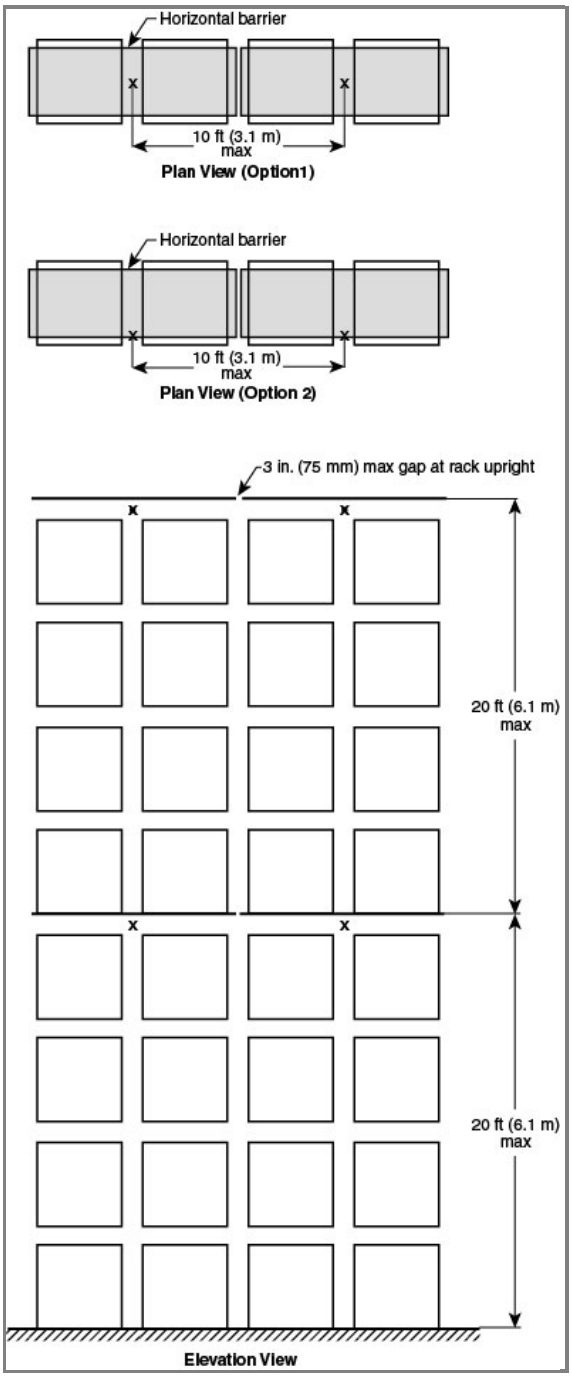

Horizontal barrier
10 ft (3.1 m) max
Plan View (Option1)
Horizontal barrier
10 ft (3.1 m) max
Plan View (Option 2)
3 in. (75 mm) max gap at rack upright
30 ft (9.1 m) max
30 ft (9.1 m) max
Elevation View

Figure 25.8.3.3.1(A)(b) Alternative In-Rack Sprinkler Protection for Exposed Group A Plastic Commodities in Single-Row Racks, Option 3.



(B)

The maximum linear spacing between sprinklers shall not exceed 10 ft (3.1 m).

25.8.3.3.2 Double-Row Racks.

(A)

For double-row racks, sprinklers shall be installed within the longitudinal flue space at each rack mid-bay as shown in Figure 25.8.3.3.2(A)(a) for Class I through Class IV and cartoned Group A plastic commodity and Figure 25.8.3.3.2(A)(b) for exposed Group A plastic commodity.

Figure 25.8.3.3.2(A)(a) Alternative In-Rack Sprinkler Protection for Class I Through Class IV and Cartoned Group A Plastic Commodities in Double-Row Racks, Option 3.

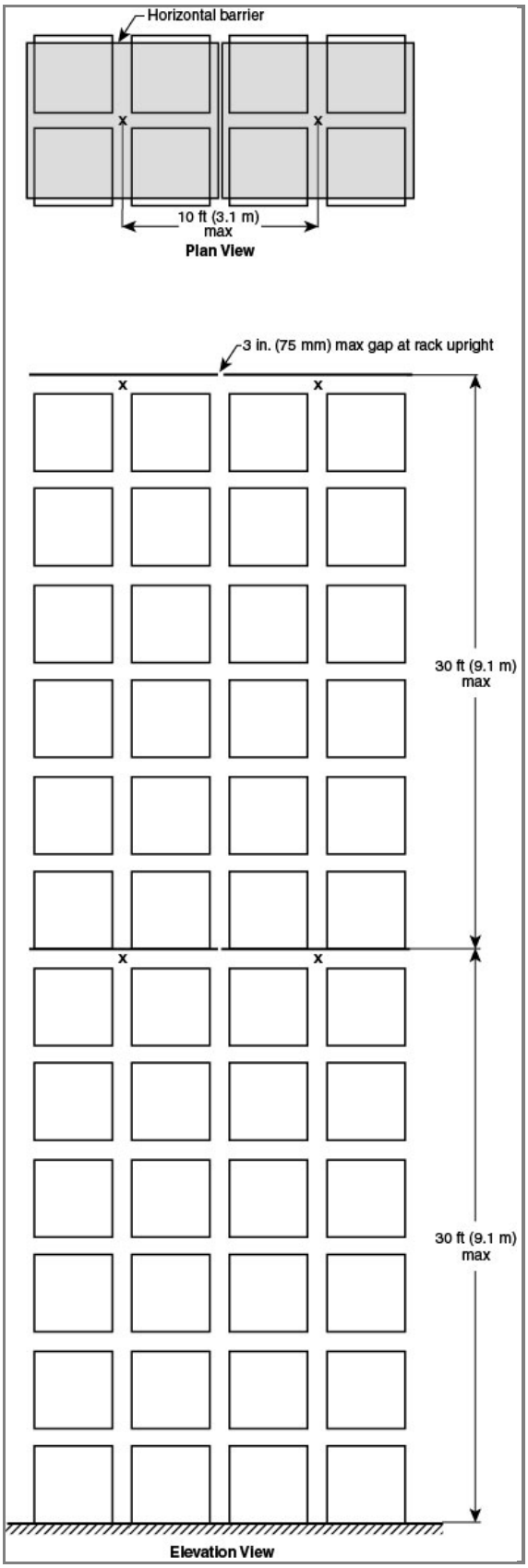
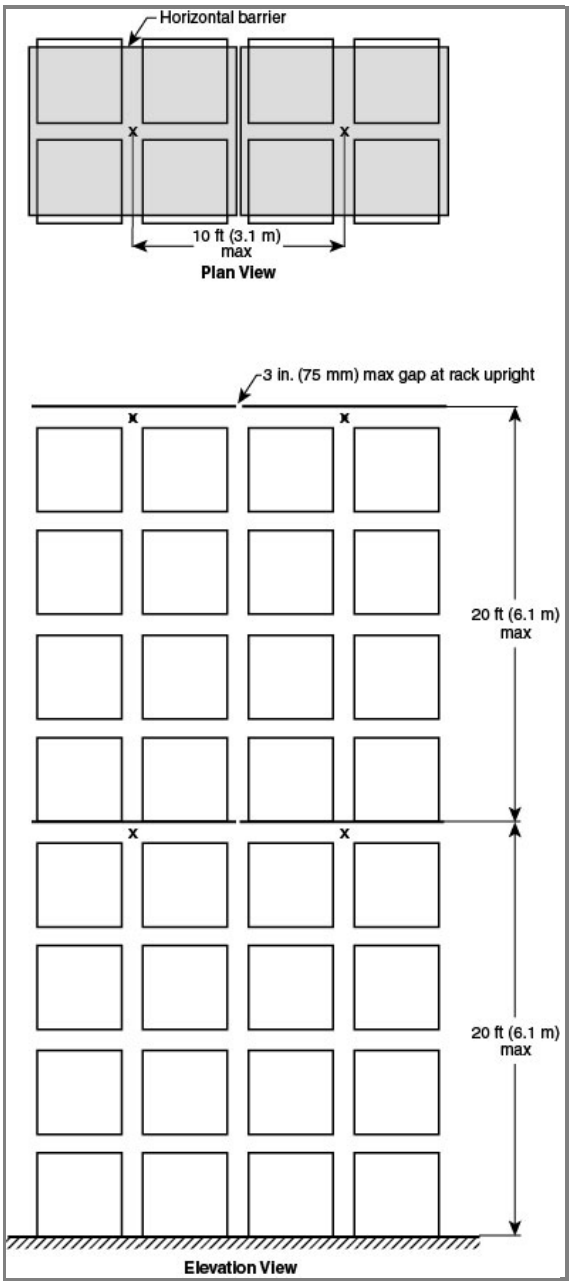


Figure 25.8.3.3.2(A)(b) Alternative In-Rack Sprinkler Protection for Exposed Group A Plastic Commodities in Double-Row Racks, Option 3.



(B)

The maximum linear spacing between sprinklers shall not exceed 10 ft (3.1 m).

25.8.3.3.3 Multiple-Row Racks.

(A)

For multiple-row racks with an overall depth between aisles not exceeding 15 ft 6 in. (4.7 m), an alternating sprinkler arrangement shall be installed within adjacent transverse flue spaces as shown in Figure 25.8.3.3.3(A)(a) for Class I through Class IV and cartoned Group A plastic commodity and Figure 25.8.3.3.3(A)(b) for exposed Group A plastic commodity.

Figure 25.8.3.3.3(A)(a) Alternative In-Rack Sprinkler Protection for Class I Through Class IV and Cartoned Group A Plastic Commodities in Multiple-Row Racks, Option 3.

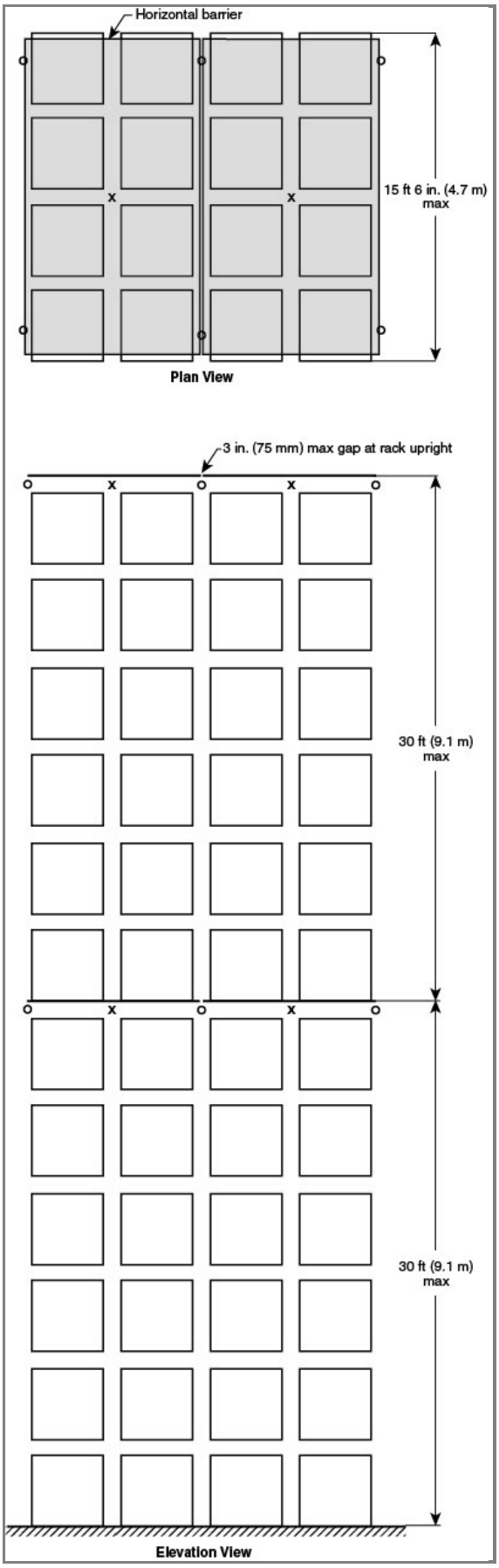
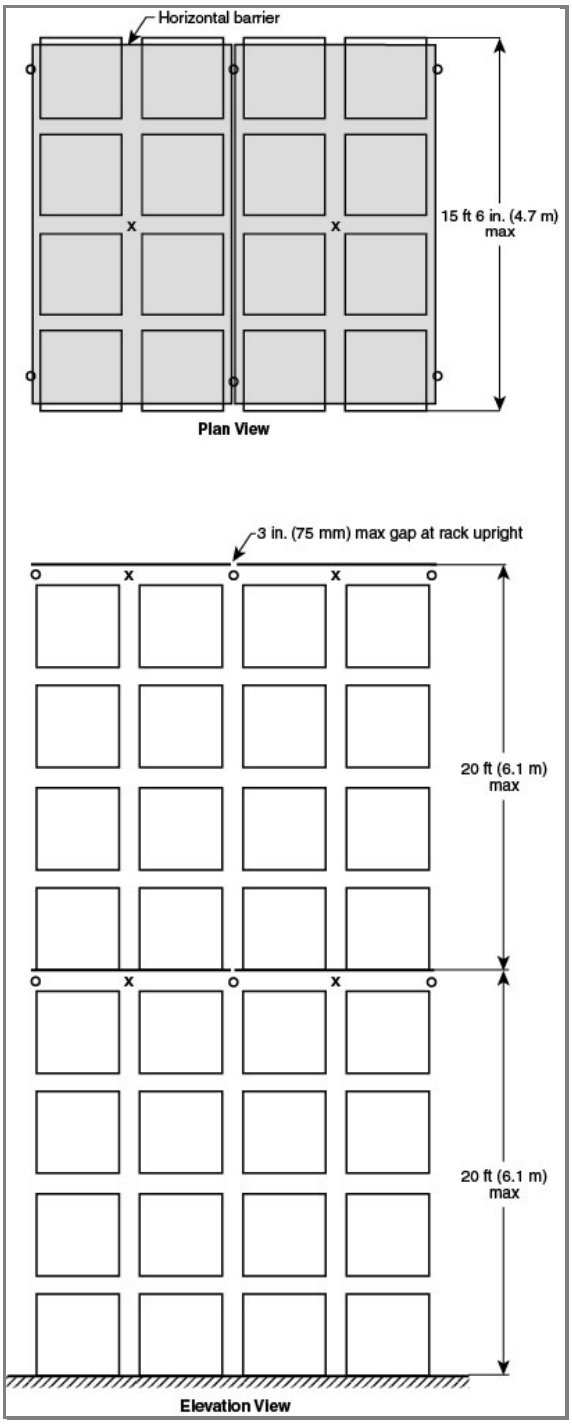


Figure 25.8.3.3.3(A)(b) Alternative In-Rack Sprinkler Protection for Exposed Group A Plastic Commodities in Multiple-Row Racks, Option 3.



(B)

The maximum linear spacing between sprinklers at the face shall not exceed 10 ft (3.1 m) and shall not exceed 10 ft (3.1 m) between sprinklers at every other bay.

25.8.3.4

The design of the in-rack sprinkler system shall be based on a minimum flow of 138 gpm (520 L/min) from each of the four most remote sprinklers for single-row and double-row racks or each of the eight most remote in-rack sprinklers (three at each face and two in-between) for multiple-row racks.

25.8.3.5

The in-rack sprinkler demand shall not be required to be hydraulically balanced with the ceiling-level sprinkler system.

25.8.3.6 Ceiling Sprinkler System.

The ceiling-level sprinkler system shall be designed based on the highest commodity hazard not protected by the criteria prescribed by this section.

25.9 In-Rack Sprinkler Arrangements in Combination with CMDA Sprinklers at Ceiling Level.

25.9.1 Rack Storage of Class I Through Class IV Commodities Up to and Including 25 ft (7.6 m) in Height.

The in-rack arrangements for rack storage up to and including 25 ft (7.6 m) in height shall be in accordance with the guidelines outlined in Sections 25.4 through 25.7 as applicable.

25.9.2 Rack Storage of Class I Through Class IV Commodities Over 25 ft (7.6 m) in Height.

25.9.2.1 Single-Row Racks.

25.9.2.1.1*

In single-row racks with a maximum of 10 ft (3.0 m) between the top of storage and the ceiling, in-rack sprinklers shall be installed in accordance with Table 25.9.2.1.1 and Figure 25.9.2.1.1(a) through Figure 25.9.2.1.1(e) .

Table 25.9.2.1.1 Single-Row Racks of Class I Through Class IV Commodities Stored Over 25 ft (7.6 m) in Height with Aisles 4 ft (1.2 m) or More in Width Protected by CMDA Sprinklers at Ceiling Level

Commodity Class	In-Rack Sprinklers Approximate Vertical Spacing at Tier Nearest the Vertical Distance and Maximum Horizontal Spacing [a, b]	Figure	Maximum Storage Height	Stagger
	Center of Rack [c, d]			
I, II, III	Vertical 20 ft (6.1 m), Horizontal 5 ft (1.5 m)	25.9.2.1.1(a)	Higher than 25 ft (7.6 m)	No
	Vertical 20 ft (6.1 m), Horizontal 10 ft (3.0 m) with horizontal barriers	25.9.2.1.1(b)		No
I, II, III, IV	Vertical 15 ft (4.6 m), Horizontal 5 ft (1.5 m)	25.9.2.1.1(c)		No
	Vertical 15 ft (4.6 m), Horizontal 10 ft (3.0 m) with horizontal barriers	25.9.2.1.1(d)		No
	Vertical 10 ft (3.0 m), Horizontal 10 ft (3.0 m)	25.9.2.1.1(e)		Yes

[a] Water shields required.

[b] All in-rack sprinkler spacing dimensions start from the floor.

[c] Install sprinklers at least 3 in. (75 mm) from uprights.

[d] In Figure 25.9.2.1.1(a) through Figure 25.9.2.1.1(e), each square represents a storage cube that measures 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. to 10 ft (450 mm to 3.0 m). Therefore, there can be one load to six or seven loads between in-rack sprinklers that are spaced 10 ft (3.0 m) apart vertically.

Figure 25.9.2.1.1(a) In-Rack Sprinkler Arrangement, Class I, II, or III Commodities, Single-Row Racks, Storage Height Over 25 ft (7.6 m) — Option 1.

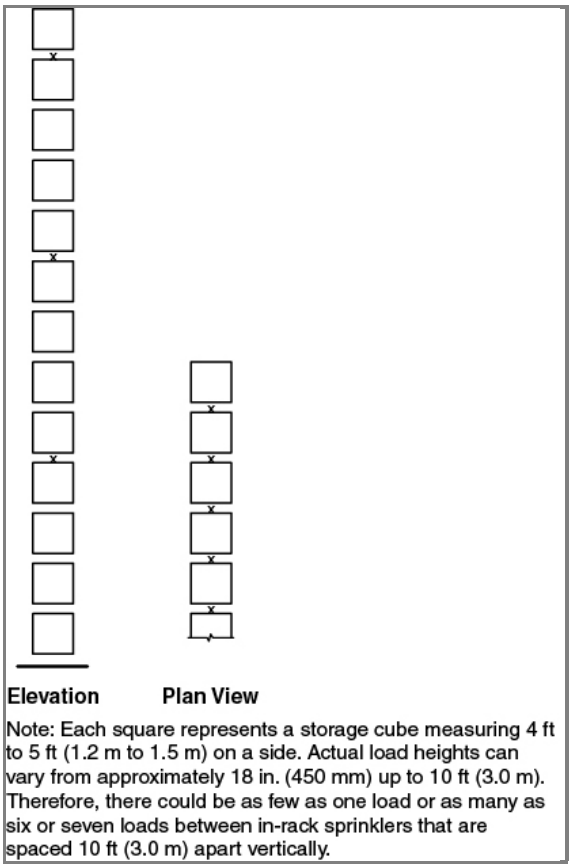
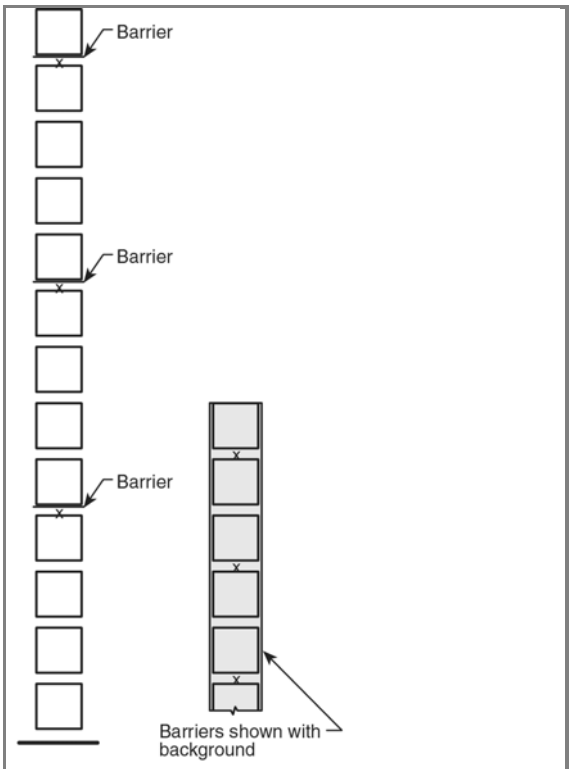


Figure 25.9.2.1.1(b) In-Rack Sprinkler Arrangement, Class I, II, or III Commodities, Single-Row Racks, Storage Height Over 25 ft (7.6 m) — Option 2.



Note: Each square represents a storage cube measuring 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. (450 mm) up to 10 ft (3.0 m). Therefore, there could be as few as one load or as many as six or seven loads between in-rack sprinklers that are spaced 10 ft (3.0 m) apart vertically.

Figure 25.9.2.1.1(c) In-Rack Sprinkler Arrangement, Class I, II, III, or IV Commodities, Single-Row Racks, Storage Height Over 25 ft (7.6 m) — Option 1.

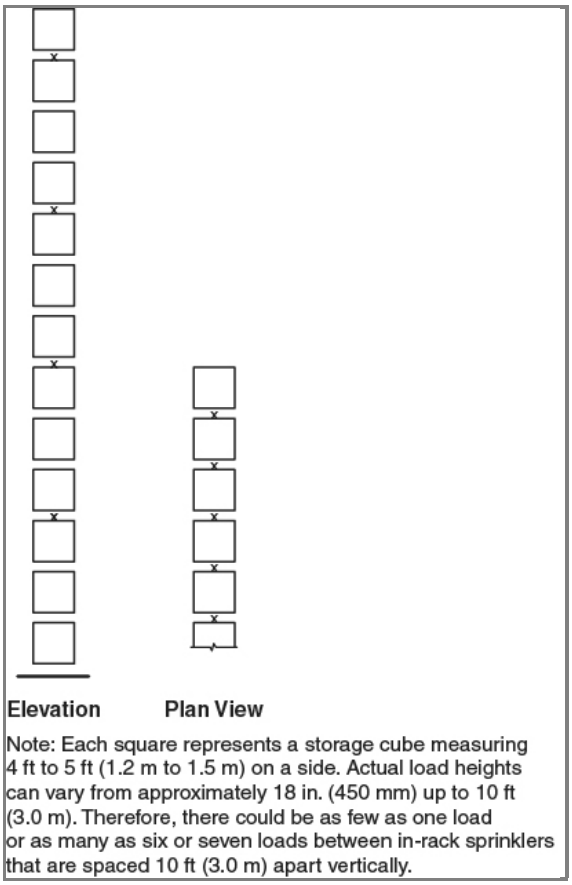


Figure 25.9.2.1.1(d) In-Rack Sprinkler Arrangement, Class I, II, III, or IV Commodities, Single-Row Racks, Storage Height Over 25 ft (7.6 m) — Option 2.

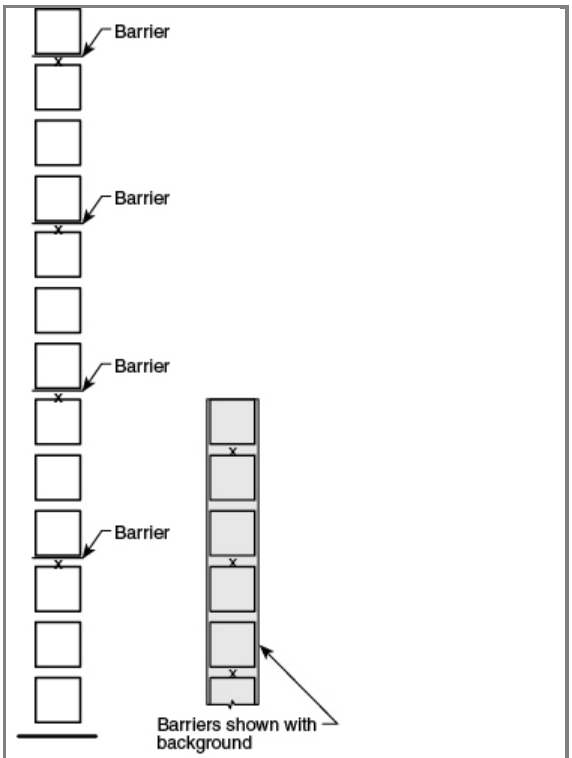
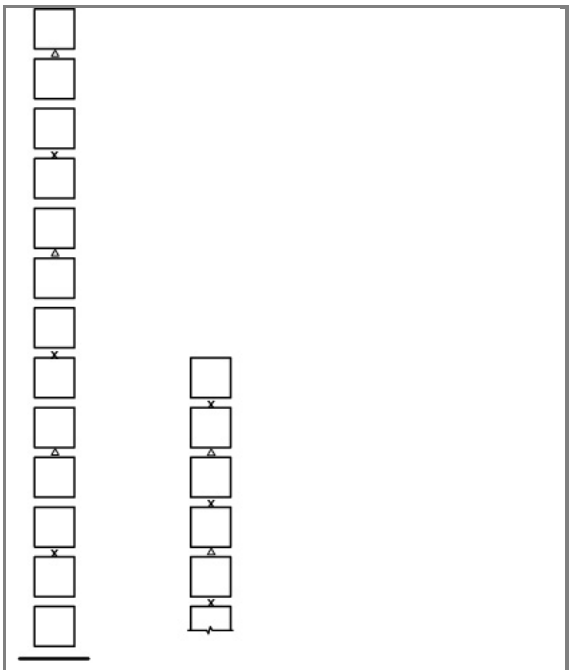


Figure 25.9.2.1.1(e) In-Rack Sprinkler Arrangement, Class I, II, III, or IV Commodities, Single-Row Racks, Storage Height Over 25 ft (7.6 m) — Option 3.



Elevation Plan View

Notes:
1. For all storage heights, sprinklers shall be installed in every other tier and staggered as indicated.
2. Symbol Δ or x indicates sprinklers on vertical or horizontal stagger.
3. Each square represents a storage cube measuring 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. (450 mm) up to 10 ft (3.0 m). Therefore, there could be as few as one load or as many as six or seven loads between in-rack sprinklers that are spaced 10 ft (3.0 m) apart vertically.

A.25.9.2.1.1

In single-row racks with more than 10 ft (3.0 m) between the top of storage and the ceiling, a horizontal barrier should be installed above storage with one line of sprinklers under the barrier.

25.9.2.1.2

Where a single-row rack is located against a wall, the in-rack sprinkler arrangement shall be permitted to be in accordance with Figure 25.9.2.2.1(a) through Figure 25.9.2.2.1(j) .

25.9.2.1.3

Where in-rack sprinkler arrangement figures for single-row racks show in-rack sprinklers in transverse flue spaces centered between the rack faces, it shall be permitted to position these in-rack sprinklers in the transverse flue at any point between the load faces.

25.9.2.2 Double-Row Racks.

25.9.2.2.1*

In double-row racks with a maximum of 10 ft (3.0 m) between the top of storage and the ceiling, in-rack sprinklers shall be installed in accordance with Table 25.9.2.2.1 and Figure 25.9.2.2.1(a) through Figure 25.9.2.2.1(j) .

Table 25.9.2.2.1 Double-Row Racks of Class I Through Class IV Commodities Stored Over 25 ft (7.6 m) in Height with Aisles 4 ft (1.2 m) or More in Width Protected by CMDA Sprinklers at Ceiling Level

Commodity Class	In-Rack Sprinklers Approximate Vertical Spacing at Tier Nearest the Vertical Distance and Maximum Horizontal Spacing [a,b]		Figure	Maximum Storage Height	Stagger
	Longitudinal Flue [c]	Face [d,e]			
I	Vertical 20 ft (6.1 m), Horizontal 10 ft (3.0 m) under horizontal barriers	None	25.9.2.2.1(a)	30 ft (9.1 m)	No
	Vertical 20 ft (6.1 m), Horizontal 10 ft (3.0 m)	Vertical 20 ft (6.1 m), Horizontal 10 ft (3.0 m)	25.9.2.2.1(b)	Higher than 25 ft (7.6 m)	Yes
I, II, III	Vertical at 10 ft (3.0 m) or at 15 ft (4.6 m) and at 25 ft (7.6 m)	None	25.2.2.1(c)	30 ft (9.1 m)	Yes
	Vertical 10 ft (3.0 m), Horizontal 10 ft (3.0 m)	Vertical 30 ft (9.1 m), Horizontal 10 ft (3.0 m)	25.9.2.2.1(d)	Higher than 25 ft (7.6 m)	Yes
	Vertical 20 ft (6.1 m), Horizontal 10 ft (3.0 m)	Vertical 20 ft (6.1 m), Horizontal 5 ft (1.5 m)	25.9.2.2.1(e)		Yes
	Vertical 25 ft (7.6 m), Horizontal 5 ft (1.5 m)	Vertical 25 ft (7.6 m), Horizontal 5 ft (1.5 m)	25.9.2.2.1(f)		No
	Vertical 20 ft (6.1 m), Horizontal 10 ft (3.0 m) under horizontal barriers with two lines of staggered in-rack sprinklers	-	25.9.2.2.1(g)		Yes
I, II, III, IV	Vertical 15 ft (4.6 m), Horizontal 10 ft (3.0 m)	Vertical 20 ft (6.1 m), Horizontal 10 ft (3.0 m)	25.9.2.2.1(h)		Yes
	Vertical 20 ft (6.1 m), Horizontal 5 ft (1.5 m)	Vertical 20 ft (6.1 m), Horizontal 5 ft (1.5 m)	25.9.2.2.1(i)		No
	Vertical 15 ft (4.6 m), Horizontal 10 ft (3.0 m) under horizontal barriers with two lines of staggered in-rack sprinklers	-	25.9.2.2.1(j)		Yes

[a] Water shields required.

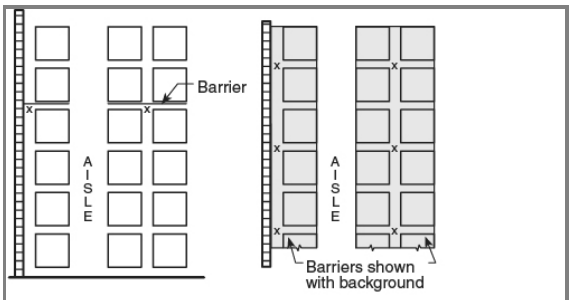
[b] All in-rack sprinkler spacing dimensions start from the floor.

[c] Install sprinklers at least 3 in. (75 mm) from uprights.

[d] Face sprinklers shall not be required for a Class I commodity consisting of noncombustible products on wood pallets (without combustible containers), except for arrays shown in Figure 25.9.2.2.1(g) and Figure 25.9.2.2.1(j).

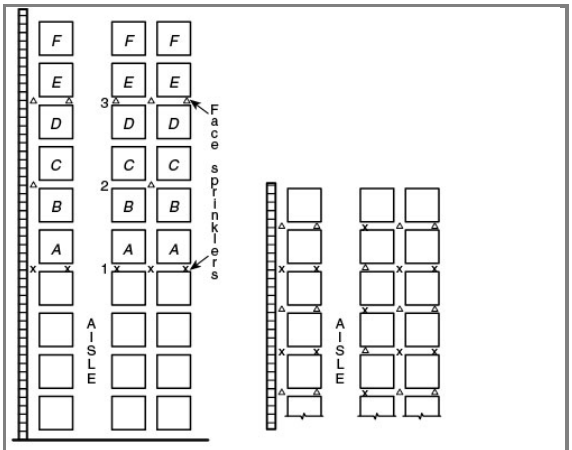
e In Figure 25.9.2.2.1(a) through Figure 25.9.2.2.1(j), each square represents a storage cube that measures 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. to 10 ft (450 mm to 3.0 m). Therefore, there can be one load to six or seven loads between in-rack sprinklers that are spaced 10 ft (3.0 m) apart vertically.

Figure 25.9.2.2.1(a) In-Rack Sprinkler Arrangement, Class I Commodities, Storage Height 25 ft to Maximum 30 ft (7.6 m to Maximum 9.1 m).



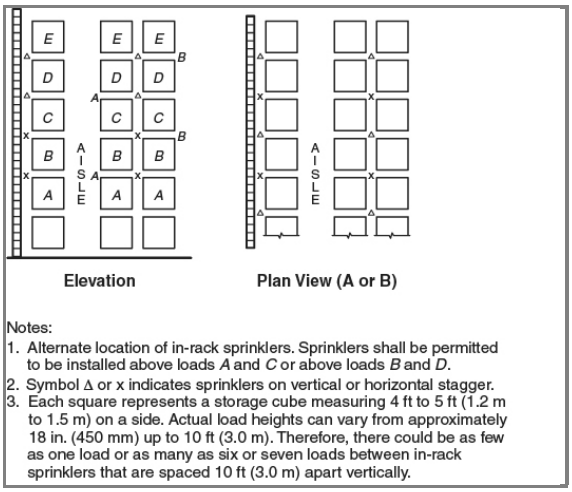
Notes:
1. Symbol x indicates in-rack sprinklers.
2. Each square represents a storage cube measuring 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. (450 mm) up to 10 ft (3.0 m). Therefore, there could be as few as one load or as many as six or seven loads between in-rack sprinklers that are spaced 10 ft (3.0 m) apart vertically.

Figure 25.9.2.2.1(b) In-Rack Sprinkler Arrangement, Class I Commodities, Storage Height Over 25 ft (7.6 m).



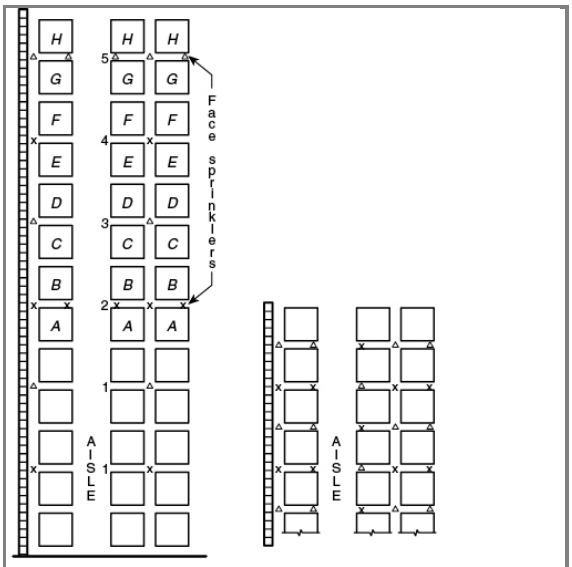
Notes:
1. Sprinklers labeled 1 (the selected array from Table 25.9.2.2.1) shall be required where loads labeled *A* or *B* represent top of storage.
2. Sprinklers labeled 1 and 2 shall be required where loads labeled *C* or *D* represent top of storage.
3. Sprinklers labeled 1 and 3 shall be required where loads labeled *E* or *F* represent top of storage.
4. For storage higher than represented by loads labeled *F*, the cycle defined by Notes 2 and 3 is repeated, with stagger as indicated.
5. Symbol Δ or x indicates sprinklers on vertical or horizontal stagger.
6. Each square represents a storage cube measuring 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. (450 mm) up to 10 ft (3.0 m). Therefore, there could be as few as one load or as many as six or seven loads between in-rack sprinklers that are spaced 10 ft (3.0 m) apart vertically.

Figure 25.9.2.2.1(c) In-Rack Sprinkler Arrangement, Class I, II, or III Commodities, Storage Height 25 ft to Maximum 30 ft (7.6 m to Maximum 9.1 m).



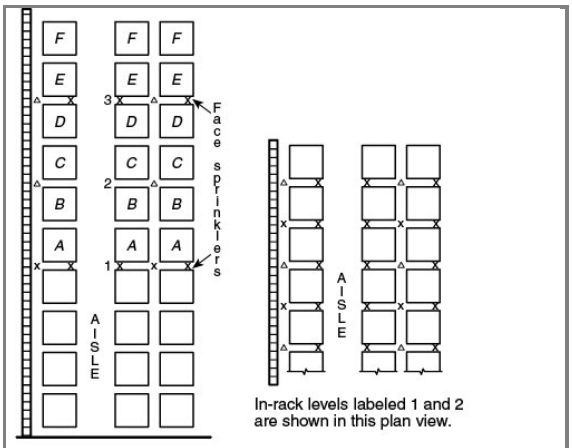
Notes:
1. Alternate location of in-rack sprinklers. Sprinklers shall be permitted to be installed above loads *A* and *C* or above loads *B* and *D*.
2. Symbol Δ or x indicates sprinklers on vertical or horizontal stagger.
3. Each square represents a storage cube measuring 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. (450 mm) up to 10 ft (3.0 m). Therefore, there could be as few as one load or as many as six or seven loads between in-rack sprinklers that are spaced 10 ft (3.0 m) apart vertically.

Figure 25.9.2.2.1(d) In-Rack Sprinkler Arrangement, Class I, II, or III Commodities, Storage Height Over 25 ft (7.6 m) — Option 1.



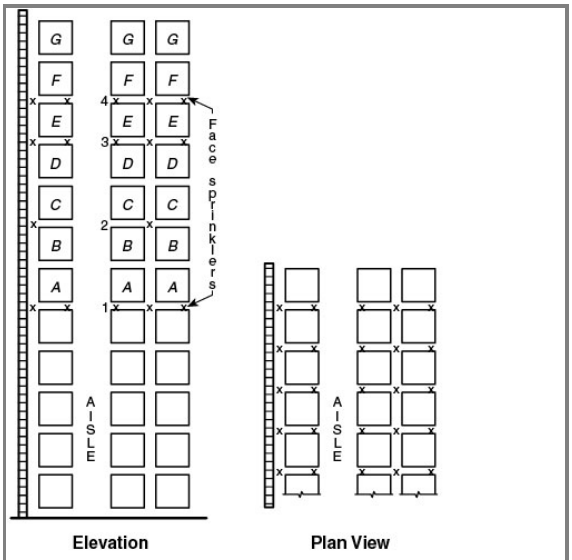
Notes:
1. Sprinklers labeled 1 shall be required where loads labeled *A* represent the top of storage.
2. Sprinklers labeled 1 and 2 shall be required where loads labeled *B* or *C* represent top of storage.
3. Sprinklers labeled 1, 2, and 3 shall be required where loads labeled *D* or *E* represent top of storage.
4. Sprinklers labeled 1, 2, 3, and 4 shall be required where loads labeled *F* or *G* represent top of storage.
5. Sprinklers labeled 1, 2, 3, 4, and 5 shall be required where loads labeled *H* represent top of storage.
6. For storage higher than represented by loads labeled *H*, the cycle defined by Notes 3, 4, and 5 is repeated with stagger as indicated.
7. The indicated face sprinklers shall be permitted to be omitted where commodity consists of unwrapped or unpackaged metal parts on wood pallets.
8. Symbol Δ or x indicates sprinklers on vertical or horizontal stagger.
9. Each square represents a storage cube measuring 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. (450 mm) up to 10 ft (3.0 m). Therefore, there could be as few as one load or as many as six or seven loads between in-rack sprinklers that are spaced 10 ft (3.0 m) apart vertically.

Figure 25.9.2.2.1(e) In-Rack Sprinkler Arrangement, Class I, II, or III Commodities, Storage Height Over 25 ft (7.6 m) — Option 2.



Notes:
1. Sprinklers labeled 1 (the selected array from Table 25.9.2.2.1) shall be required where loads labeled *A* or *B* represent top of storage.
2. Sprinklers labeled 1 and 2 shall be required where loads labeled *C* or *D* represent top of storage.
3. Sprinklers labeled 1 and 3 shall be required where loads labeled *E* or *F* represent top of storage.
4. For storage higher than represented by loads labeled *F*, the cycle defined by Notes 2 and 3 is repeated, with stagger as indicated.
5. Symbol Δ or x indicates sprinklers on vertical or horizontal stagger.
6. Each square represents a storage cube measuring 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. (450 mm) up to 10 ft (3.0 m). Therefore, there could be as few as one load or as many as six or seven loads between in-rack sprinklers that are spaced 10 ft (3.0 m) apart vertically.

Figure 25.9.2.2.1(f) In-Rack Sprinkler Arrangement, Class I, II, or III Commodities, Storage Height Over 25 ft (7.6 m) — Option 3.



Notes:
1. Sprinklers labeled 1 (the selected array from Table 25.9.2.2.1) shall be required where loads labeled *A* or *B* represent top of storage.
2. Sprinklers labeled 1 and 2 shall be required where loads labeled *C* or *D* represent top of storage.
3. Sprinklers labeled 1 and 3 shall be required where loads labeled *E* represent top of storage.
4. Sprinklers labeled 1 and 4 shall be required where loads labeled *F* or *G* represent top of storage.
5. For storage higher than represented by loads labeled *G*, the cycle defined by Notes 2, 3, and 4 is repeated.
6. Symbol x indicates face and in-rack sprinklers.
7. Each square represents a storage cube measuring 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. (450 mm) up to 10 ft (3.0 m). Therefore, there could be as few as one load or as many as six or seven loads between in-rack sprinklers that are spaced 10 ft (3.0 m) apart vertically.

Figure 25.9.2.2.1(g) In-Rack Sprinkler Arrangement, Class I, II, or III Commodities, Storage Height Over 25 ft (7.6 m) — Option 4.

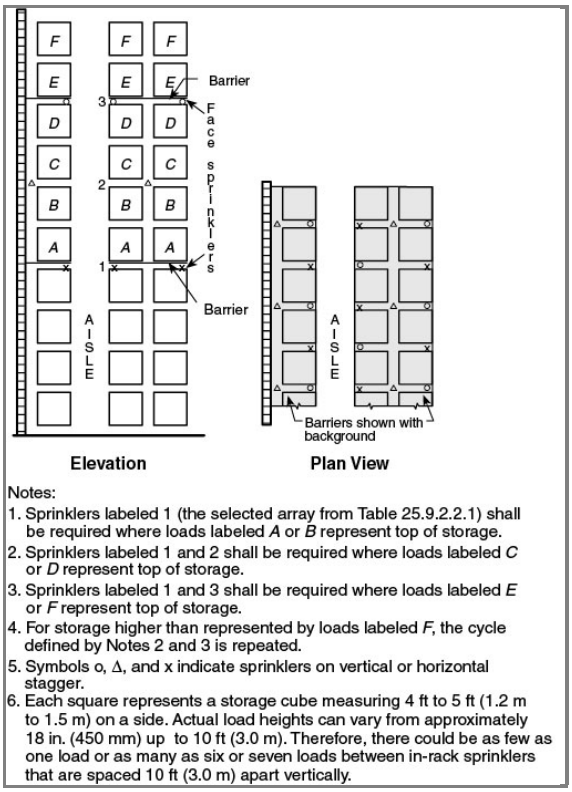
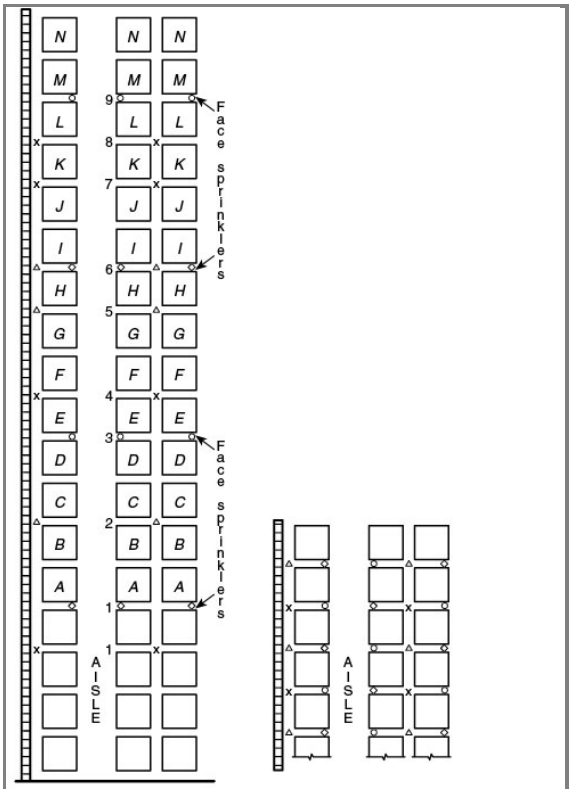


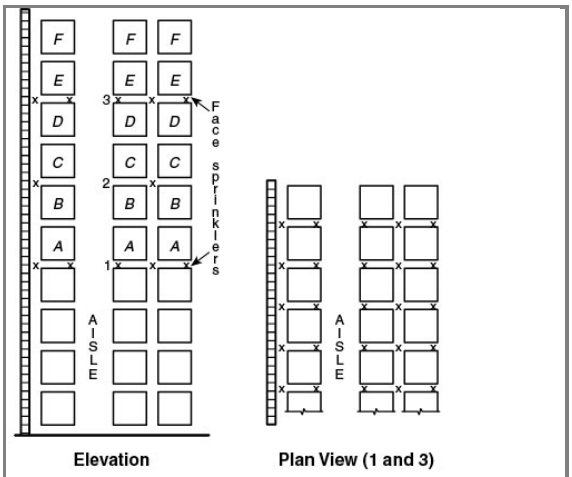
Figure 25.9.2.2.1(h) In-Rack Sprinkler Arrangement, Class I, II, III, or IV Commodities, Storage Height Over 25 ft (7.6 m) — Option 1.



Notes:

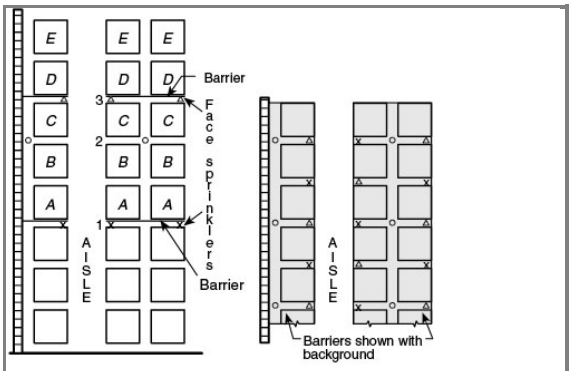
1. Sprinklers labeled 1 (the selected array from Table 25.9.2.2.1) shall be required where loads labeled *A* or *B* represent top of storage.
2. Sprinklers labeled 1 and 2 shall be required where loads labeled *C* or *D* represent top of storage.
3. Sprinklers labeled 1, 2, and 3 shall be required where loads labeled *E* or *F* represent top of storage.
4. Sprinklers labeled 1, 2, 3, and 4 shall be required where loads labeled *G* represent top of storage.
5. Sprinklers labeled 1, 2, 3, 4, and 5 shall be required where loads labeled *H* represent top of storage.
6. Sprinklers labeled 1, 2, 3, 4, and 6 (not 5) shall be required where loads labeled *I* or *J* represent top of storage.
7. Sprinklers labeled 1, 2, 3, 4, 6, and 7 shall be required where loads labeled *K* represent top of storage.
8. Sprinklers labeled 1, 2, 3, 4, 6, and 8 shall be required where loads labeled *L* represent top of storage.
9. Sprinklers labeled 1, 2, 3, 4, 6, 8, and 9 shall be required where loads labeled *M* or *N* represent top of storage.
10. For storage higher than represented by loads labeled *N*, the cycle defined by Notes 1 through 9 is repeated, with stagger as indicated. In the cycle, loads labeled *M* are equivalent to loads labeled *A*.
11. Symbols o, x, and Δ indicate sprinklers on vertical or horizontal stagger.
12. Each square represents a storage cube measuring 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. (450 mm) up to 10 ft (3.0 m). Therefore, there could be as few as one load or as many as six or seven loads between in-rack sprinklers that are spaced 10 ft (3.0 m) apart vertically.

Figure 25.9.2.2.1(i) In-Rack Sprinkler Arrangement, Class I, II, III, or IV Commodities, Storage Height Over 25 ft (7.6 m) — Option 2.



Notes:
1. Sprinklers labeled 1 (the selected array from Table 25.9.2.2.1) shall be required where loads labeled *A* or *B* represent top of storage.
2. Sprinklers labeled 1 and 2 shall be required where loads labeled *C* or *D* represent top of storage.
3. Sprinklers labeled 1 and 3 shall be required where loads labeled *E* or *F* represent top of storage.
4. For storage higher than represented by loads labeled *F*, the cycle defined by Notes 2 and 3 is repeated.
5. Symbol x indicates face and in-rack sprinklers.
6. Each square represents a storage cube measuring 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. (450 mm) up to 10 ft (3.0 m). Therefore, there could be as few as one load or as many as six or seven loads between in-rack sprinklers that are spaced 10 ft (3.0 m) apart vertically.

Figure 25.9.2.2.1(j) In-Rack Sprinkler Arrangement, Class I, II, III, or IV Commodities, Storage Height Over 25 ft (7.6 m) — Option 3.



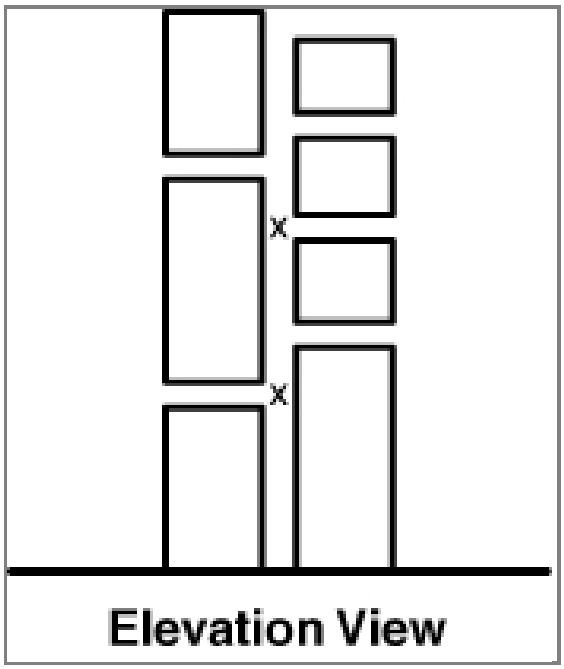
Notes:
1. Sprinklers labeled 1 (the selected array from Table 25.9.2.2.1) shall be required where loads labeled *A* or *B* represent top of storage.
2. Sprinklers labeled 1 and 2 and barrier labeled 1 shall be required where loads labeled *C* represent top of storage.
3. Sprinklers and barriers labeled 1 and 3 shall be required where loads labeled *D* or *E* represent top of storage.
4. For storage higher than represented by loads labeled *E*, the cycle defined by Notes 2 and 3 is repeated.
5. Symbol Δ or x indicates sprinklers on vertical or horizontal stagger.
6. Symbol o indicates longitudinal flue space sprinklers.
7. Each square represents a storage cube measuring 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. (450 mm) up to 10 ft (3.0 m). Therefore, there could be as few as one load or as many as six or seven loads between in-rack sprinklers that are spaced 10 ft (3.0 m) apart vertically.

A.25.9.2.2.1

In double-row racks with more than 10 ft (3.0 m) between the top of storage and the ceiling, a horizontal barrier should be installed above storage with one line of sprinklers under the barrier.

Where storage tiers are not the same size on each side of the longitudinal flue, one side of the flue should be protected with sprinklers at the proper elevation above the load. The next level of sprinklers should protect the other side of the flue with the sprinklers at the proper elevation above that load as indicated in Figure A.25.9.2.2.1 . The vertical spacing requirements for in-rack sprinklers specified in Table 25.9.2.2.1 and Section 25.4 for Group A plastic commodities should be followed.

Figure A.25.9.2.2.1 Placement of In-Rack Sprinklers Where Rack Levels Have Varying Heights.



25.9.2.3 Multiple-Row Racks.

25.9.2.3.1*

In multiple-row racks with a maximum of 10 ft (3.0 m) between the top of storage and the ceiling, in-rack sprinklers shall be in accordance with Table 25.9.2.3.1 and Figure 25.9.2.3.1(a) through Figure 25.9.2.3.1(c) .

Table 25.9.2.3.1 Multiple-Row Racks of Nonencapsulated Class I Through Class IV Commodities Stored Over 25 ft (7.6 m) in Height Protected by CMDA Sprinklers at Ceiling Level

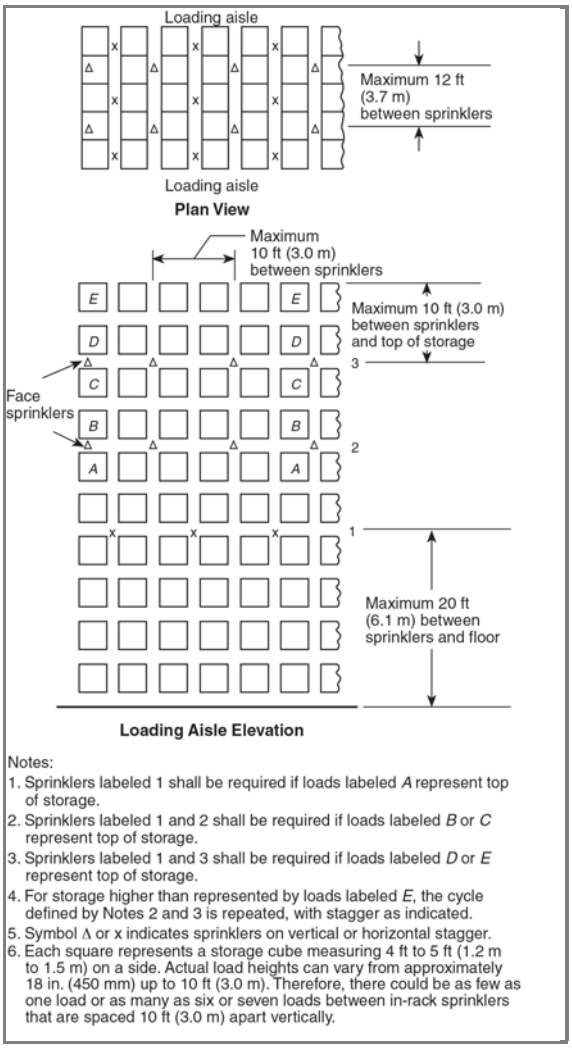
Commodity Class	In-Rack Sprinklers a,b,c						Stagger	Figure	Maximum Allowable Storage Height Above Top In-Rack Sprinkler Level	
	Maximum Vertical Spacing		Maximum Horizontal Spacing in a Flue		Maximum Horizontal Spacing across Flue					
	ft	m	ft	m	ft	m			ft	m
I	20	6.1	12	3.7	10	3	Between adjacent flues	25.9.2.3.1(a)	10	3
I, II, III	15	4.6	10	3	10	3		25.9.2.3.1(b)	10	3
I, II, III, IV	10	3	10	3	10	3		25.9.2.3.1(c)	5	1.5

aAll four rack faces shall be protected by sprinklers located within the racks and no more than 18 in. (450 mm) from the faces, as indicated in Figure 25.9.2.3.1(a) through 25.9.2.3.1(c). It shall not be required for each sprinkler level to protect all faces.

bAll in-rack sprinkler spacing dimensions start from the floor.

cIn Figure 25.9.2.3.1(a) through Figure 25.9.2.3.1(c), each square represents a storage cube that measures 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. to 10 ft (450 mm to 3.0 m). Therefore, there can be one load to six or seven loads between in-rack sprinklers that are spaced 10 ft (3.0 m) apart vertically.

Figure 25.9.2.3.1(a) In-Rack Sprinkler Arrangement, Class I Commodities, Multiple-Row Racks, Storage Height Over 25 ft (7.6 m).



Notes:
1. Sprinklers labeled 1 shall be required if loads labeled *A* represent top of storage.
2. Sprinklers labeled 1 and 2 shall be required if loads labeled *B* or *C* represent top of storage.
3. Sprinklers labeled 1 and 3 shall be required if loads labeled *D* or *E* represent top of storage.
4. For storage higher than represented by loads labeled *E*, the cycle defined by Notes 2 and 3 is repeated, with stagger as indicated.
5. Symbol Δ or x indicates sprinklers on vertical or horizontal stagger.
6. Each square represents a storage cube measuring 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. (450 mm) up to 10 ft (3.0 m). Therefore, there could be as few as one load or as many as six or seven loads between in-rack sprinklers that are spaced 10 ft (3.0 m) apart vertically.

Figure 25.9.2.3.1(b) In-Rack Sprinkler Arrangement, Class I, II, or III Commodities, Multiple-Row Racks, Storage Height Over 25 ft (7.6 m).

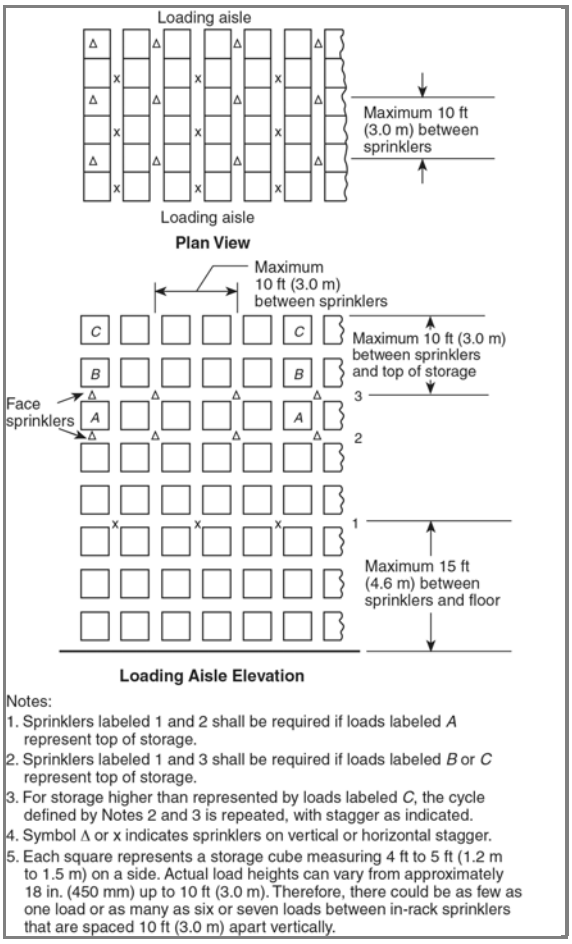
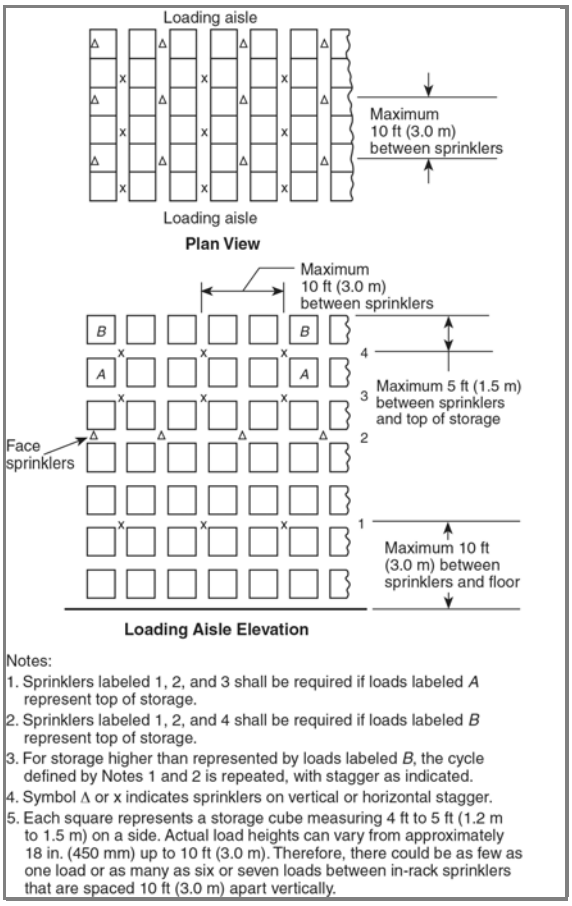


Figure 25.9.2.3.1(c) In-Rack Sprinkler Arrangement, Class I, II, III, or IV Commodities, Multiple-Row Racks, Storage Height Over 25 ft (7.6 m).



Notes:
1. Sprinklers labeled 1, 2, and 3 shall be required if loads labeled *A* represent top of storage.
2. Sprinklers labeled 1, 2, and 4 shall be required if loads labeled *B* represent top of storage.
3. For storage higher than represented by loads labeled *B*, the cycle defined by Notes 1 and 2 is repeated, with stagger as indicated.
4. Symbol Δ or x indicates sprinklers on vertical or horizontal stagger.
5. Each square represents a storage cube measuring 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. (450 mm) up to 10 ft (3.0 m). Therefore, there could be as few as one load or as many as six or seven loads between in-rack sprinklers that are spaced 10 ft (3.0 m) apart vertically.

A.25.9.2.3.1

In multiple-row racks with more than 10 ft (3.0 m) between the maximum height of storage and ceiling, a horizontal barrier should be installed above storage with a level of sprinklers, spaced as stipulated for in-rack sprinklers, installed directly beneath the barrier. In-rack sprinklers should be installed as indicated in Figure 25.9.2.3.1(a) through Figure 25.9.2.3.1(c) . Data indicate that the sprinkler protection criteria in 25.9.2.3 are ineffective, by themselves, for rack storage with solid shelves if the required flue spaces are not maintained. Use of Table 25.9.2.3.1 , along with the additional provisions that are required by this standard, can provide acceptable protection.

25.9.3 Rack Storage of Group A Plastic Commodities Up to and Including 25 ft (7.6 m) in Height.

25.9.3.1

Where rack storage of cartoned Group A plastic commodities, encapsulated or nonencapsulated, having a clearance to ceiling up to and including 10 ft (3.1 m) require in-rack sprinklers, in-rack sprinkler arrangements shall be selected from Figure 25.9.3.1(a) through Figure 25.9.3.1(e) .

Figure 25.9.3.1(a) In-Rack Sprinkler Arrangement, Cartoned Group A Plastic Storage Up to 15 ft (4.6 m) in Height with Up to 10 ft (3.0 m) Clearance to Ceiling.

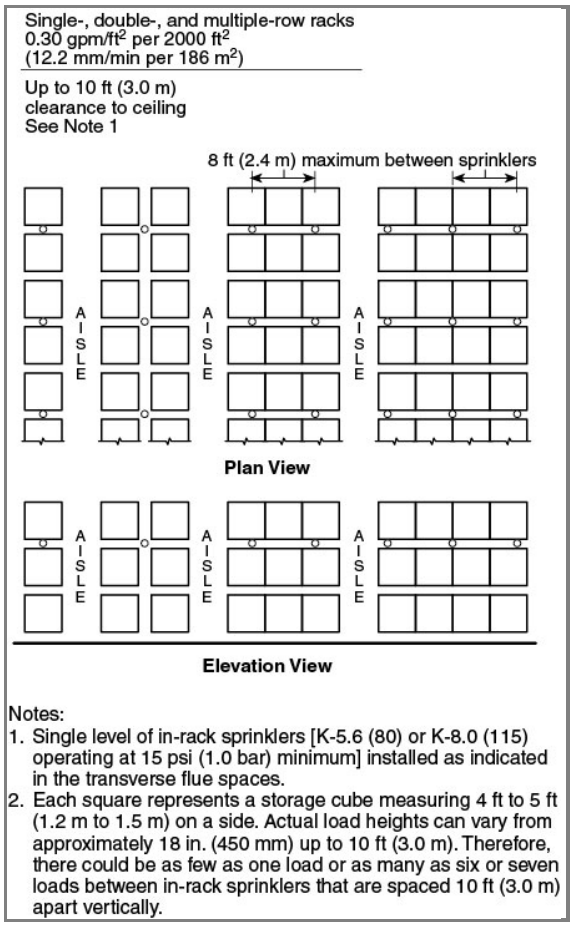


Figure 25.9.3.1(b) In-Rack Sprinkler Arrangement, Cartoned Group A Plastic Storage Up to 20 ft (6.1 m) in Height with <5 ft (1.5 m) Clearance to Ceiling.

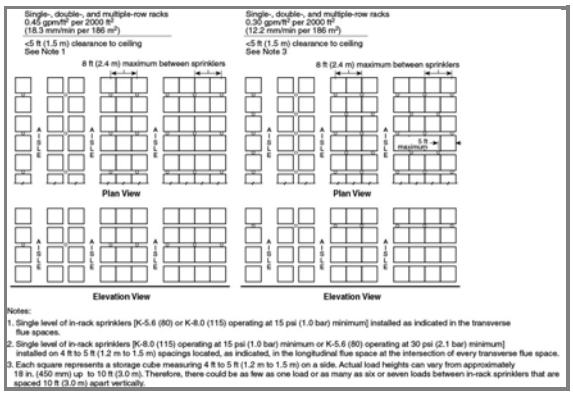


Figure 25.9.3.1(c) In-Rack Sprinkler Arrangement, Cartoned Group A Plastic Storage Up to 20 ft (6.1 m) in Height with 5 ft to 10 ft (1.5 m to 3.0 m) Clearance to Ceiling.

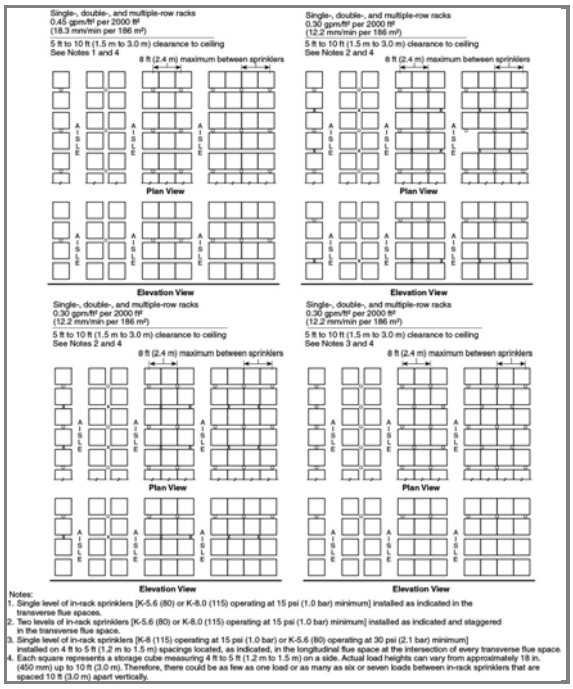


Figure 25.9.3.1(d) In-Rack Sprinkler Arrangement, Cartoned Group A Plastic Storage Up to 25 ft (7.6 m) in Height with <5 ft (1.5 m) Clearance to Ceiling.

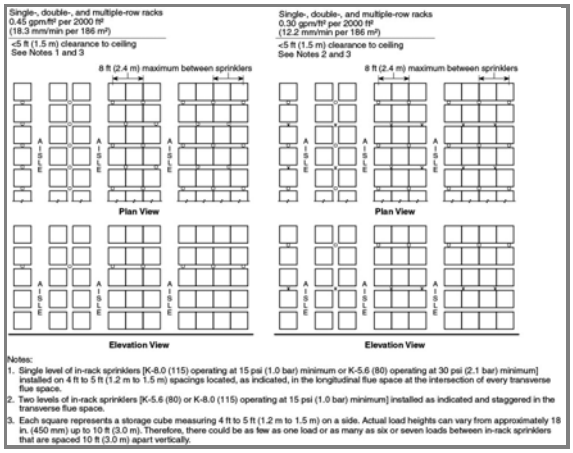
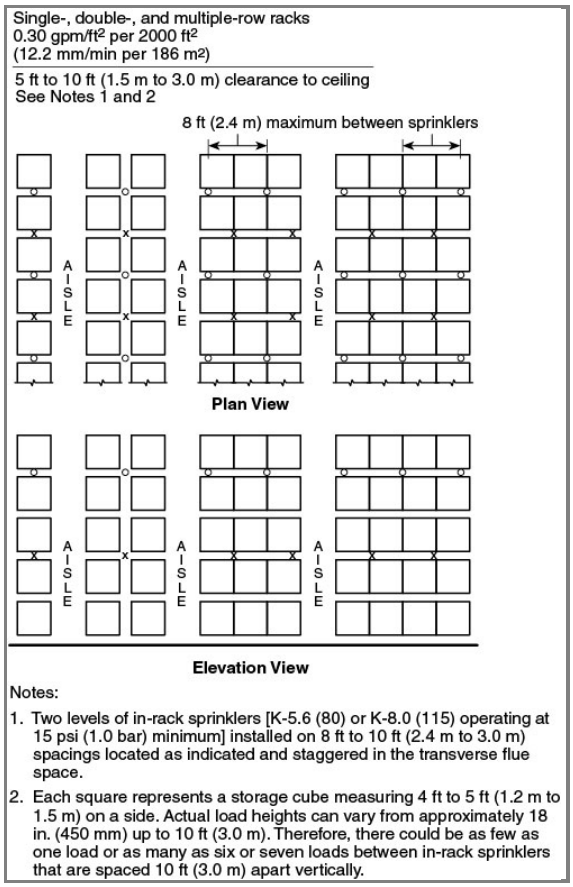


Figure 25.9.3.1(e) In-Rack Sprinkler Arrangement, Cartoned Group A Plastic Storage Up to 25 ft (7.6 m) in Height with 5 ft to 10 ft (1.5 m to 3.0 m) Clearance to Ceiling.



25.9.3.2*

Notes in each figure shall be permitted to clarify options.

A.25.9.3.2

In most of Figure 25.9.3.1(a) through Figure 25.9.3.1(e), the designer is presented with multiple options from which to choose. The single column of boxes in the elevation view represents single-row rack storage. The double column of boxes in the elevation view represents double-row rack storage, and the options with three or four columns of boxes represent different arrangements of multiple-row rack storage. The “o” and “x” characters in the elevation and plan views represent different rows of in-rack sprinklers. The “o” and “x” characters in the elevation view show the vertical spacing of in-rack sprinklers while the characters in the plan view show the horizontal spacing of in-rack sprinklers. Different symbols are used so that the upper and lower levels of in-rack sprinklers can be determined when looking at the plan view.

25.9.3.3*

Where rack storage of exposed nonexpanded Group A plastic commodities, encapsulated or nonencapsulated, require in-rack sprinklers, in-rack sprinkler arrangements shall be selected from Figure 25.9.3.3(a) through Figure 25.9.3.3(k) .

Figure 25.9.3.3(a) In-Rack Sprinkler Arrangement, Exposed Nonexpanded Group A Plastic Commodities Up to 10 ft (3.0 m) in Height in Up to a 20 ft (6.1 m) High Building — Option 1.

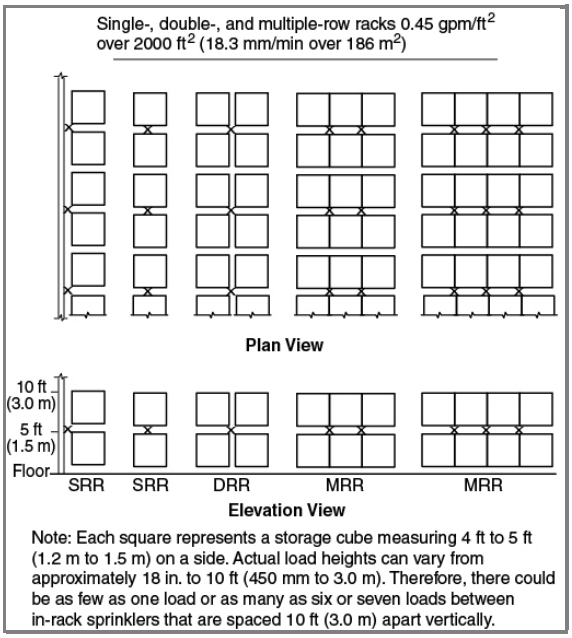


Figure 25.9.3.3(b) In-Rack Sprinkler Arrangement, Exposed Nonexpanded Group A Plastic Commodities Up to 10 ft (3.0 m) in Height in Up to a 20 ft (6.1 m) High Building — Option 2.

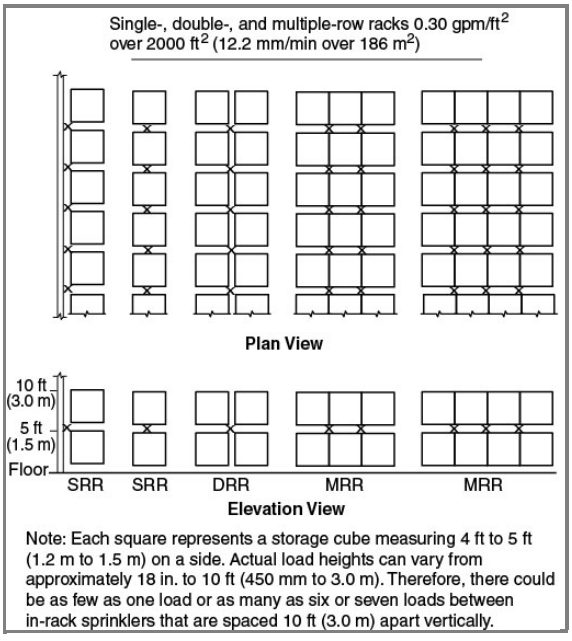


Figure 25.9.3.3(c) In-Rack Sprinkler Arrangement, Exposed Nonexpanded Group A Plastic Commodities Up to 15 ft (4.6 m) in Height in Up to a 25 ft (7.6 m) High Building — Option 1.

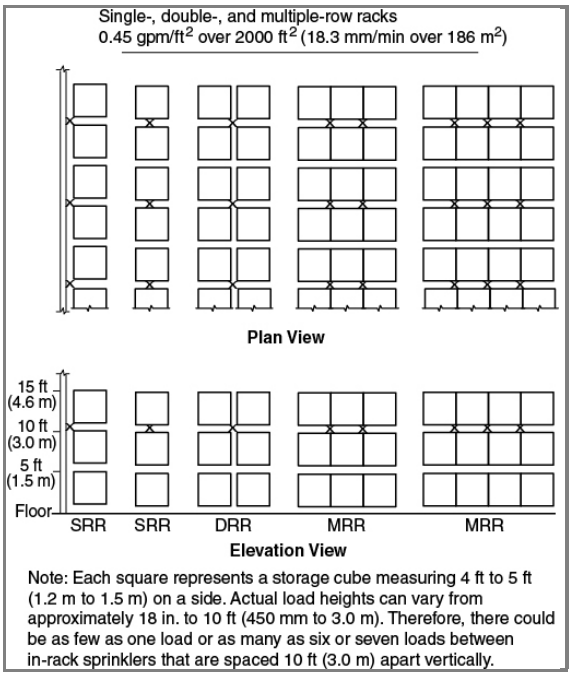


Figure 25.9.3.3(d) In-Rack Sprinkler Arrangement, Exposed Nonexpanded Group A Plastic Commodities Up to 15 ft (4.6 m) in Height in Up to a 25 ft (7.6 m) High Building — Option 2.

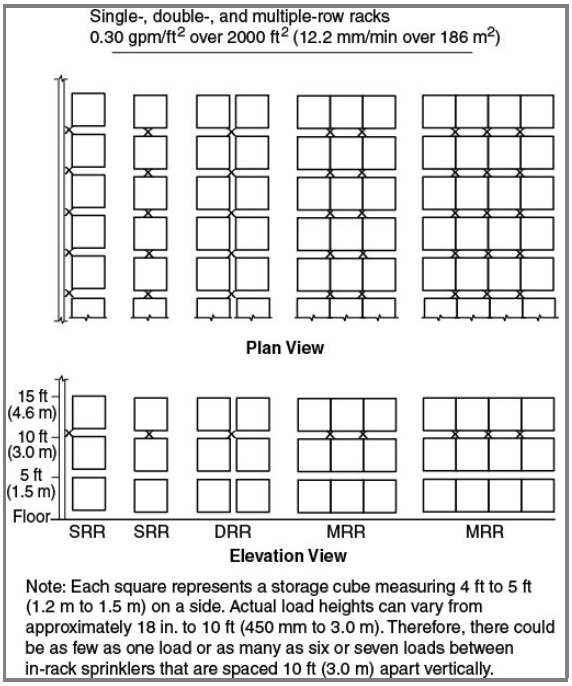


Figure 25.9.3.3(e) In-Rack Sprinkler Arrangement, Exposed Nonexpanded Group A Plastic Commodities Up to 20 ft (6.1 m) in Height in Up to a 25 ft (7.6 m) High Building — Option 1.

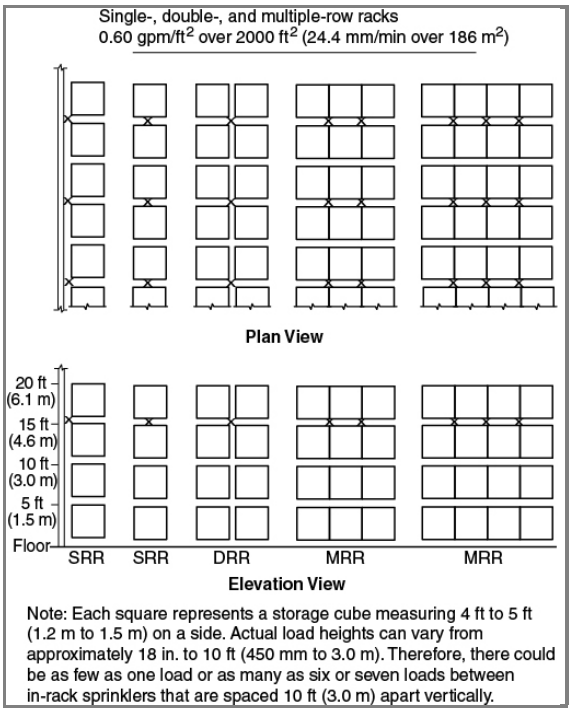


Figure 25.9.3.3(f) In-Rack Sprinkler Arrangement, Exposed Nonexpanded Group A Plastic Commodities Up to 20 ft (6.1 m) in Height in Up to a 25 ft (7.6 m) High Building — Option 2.

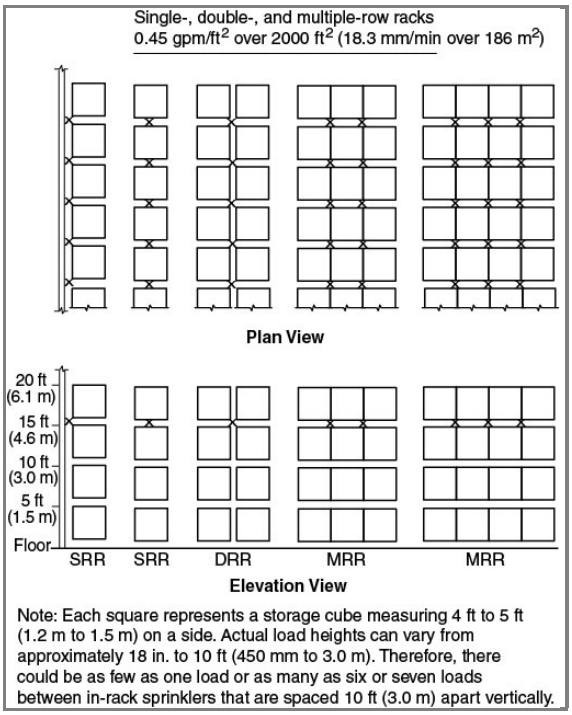


Figure 25.9.3.3(g) In-Rack Sprinkler Arrangement, Exposed Nonexpanded Group A Plastic Commodities Up to 20 ft (6.1 m) in Height in Up to a 30 ft (9.1 m) High Building — Option 1.

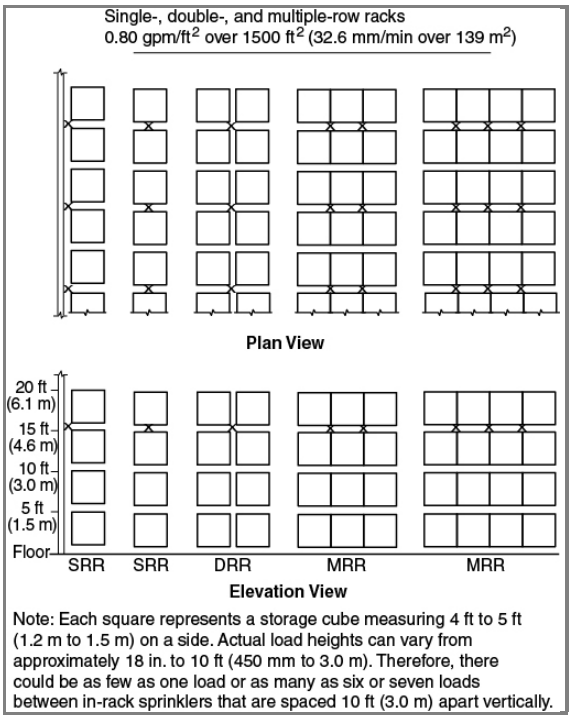


Figure 25.9.3.3(h) In-Rack Sprinkler Arrangement, Exposed Nonexpanded Group A Plastic Commodities Up to 20 ft (6.1 m) in Height in Up to a 30 ft (9.1 m) High Building — Option 2.

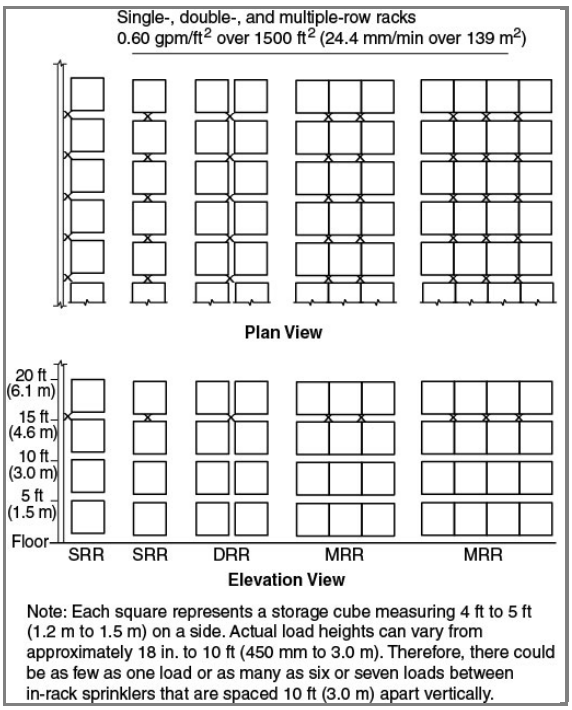


Figure 25.9.3.3(i) In-Rack Sprinkler Arrangement, Exposed Nonexpanded Group A Plastic Commodities Up to 20 ft (6.1 m) in Height in Up to a 30 ft (9.1 m) High Building — Option 3.

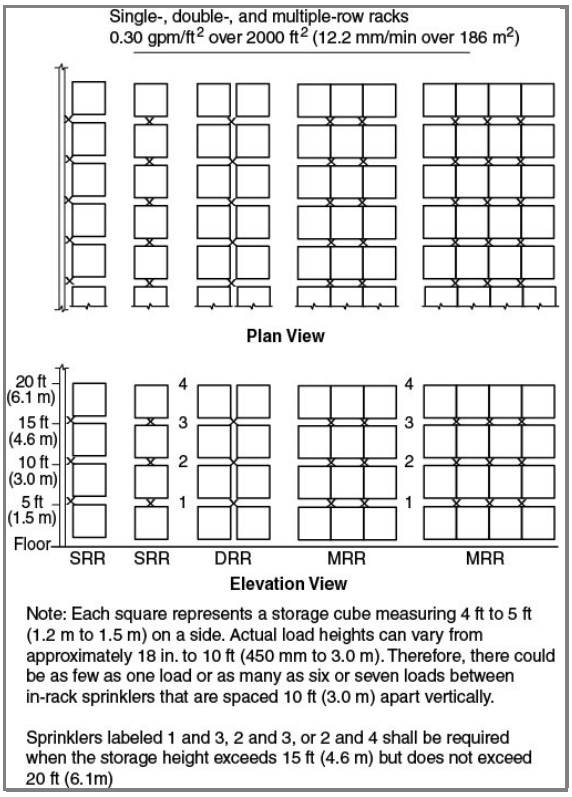


Figure 25.9.3.3(j) In-Rack Sprinkler Arrangement, Exposed Nonexpanded Group A Plastic Commodities Up to 25 ft (7.6 m) in Height in Up to a 35 ft (10.7 m) High Building — Option 1.

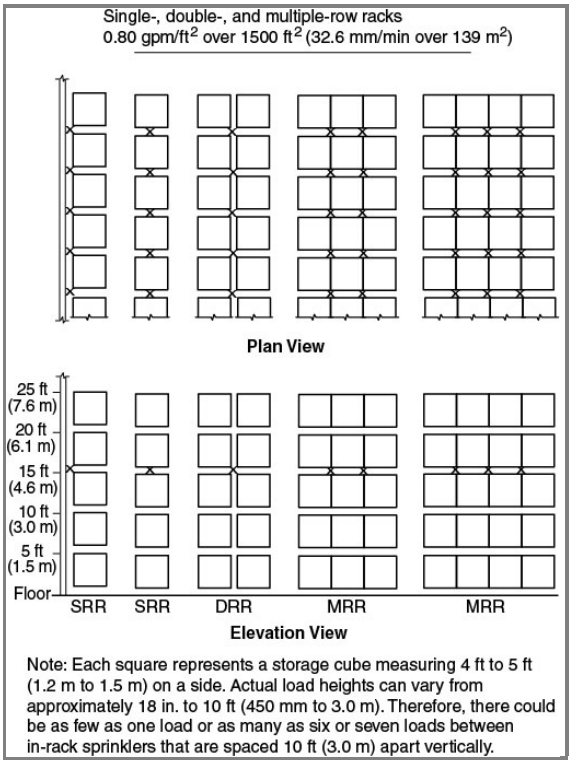
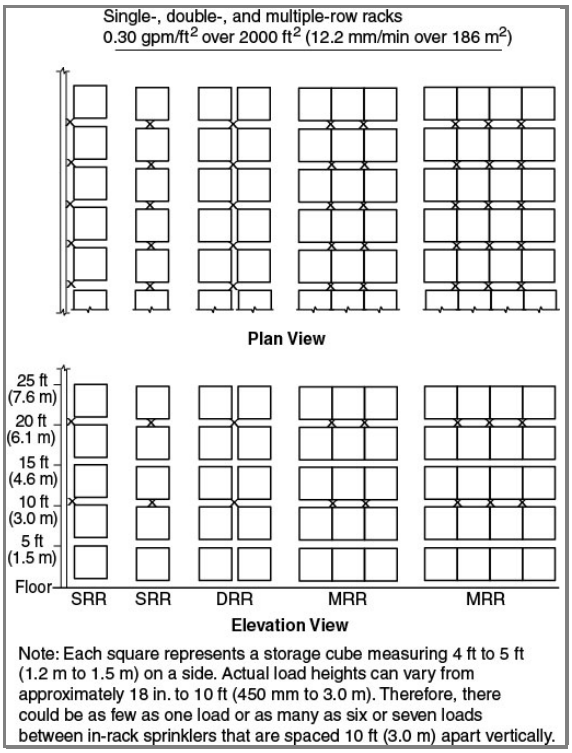


Figure 25.9.3.3(k) In-Rack Sprinkler Arrangement, Exposed Nonexpanded Group A Plastic Commodities Up to 25 ft (7.6 m) in Height in Up to a 35 ft (10.7 m) High Building — Option 2.



A.25.9.3.3

Each of the figures in 25.9.3.3 shows a variety of different potential rack arrangements. The first single-row rack (SRR) to the left in each figure shows a rack against a wall. The second SRR shows a single-row rack with aisles on each side. The double-row rack (DRR) is in the center of the figure. The first multiple-row rack (MRR) shows the in-rack sprinkler position for racks up to 15 ft (4.6 m) long in the dimension parallel to the transverse flue. The second MRR shows longer rack structures where the in-rack sprinkler pattern would repeat.

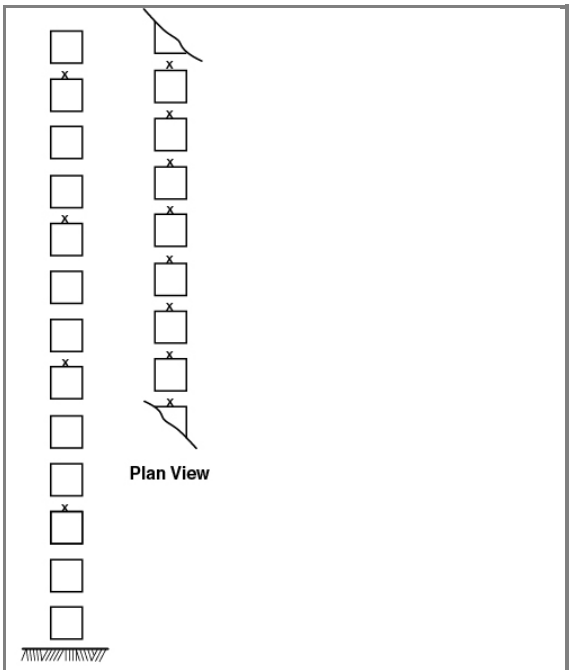
25.9.4 Rack Storage of Group A Plastic Commodities Over 25 ft (7.6 m) in Height.

25.9.4.1 Single-Row Racks.

25.9.4.1.1

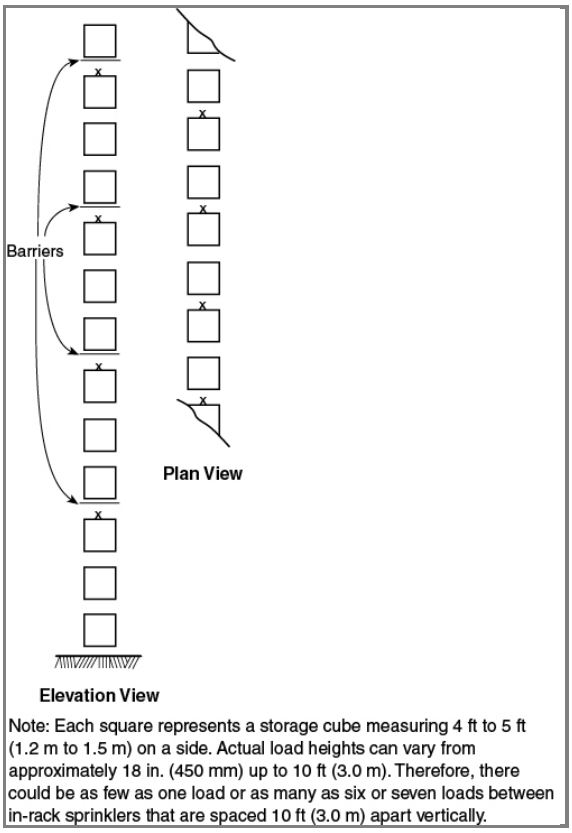
Where single-row rack storage of cartoned Group A plastic commodities, expanded or nonexpanded, encapsulated or nonencapsulated, is over 25 ft (7.6 m) in height, in-rack sprinklers shall be arranged in accordance with one of the options in Figure 25.9.4.1.1(a) through Figure 25.9.4.1.1(d) .

Figure 25.9.4.1.1(a) In-Rack Sprinkler Arrangement, Cartoned Group A Plastic Commodities, Single-Row Racks, Storage Height Over 25 ft (7.6 m) — Option 1.



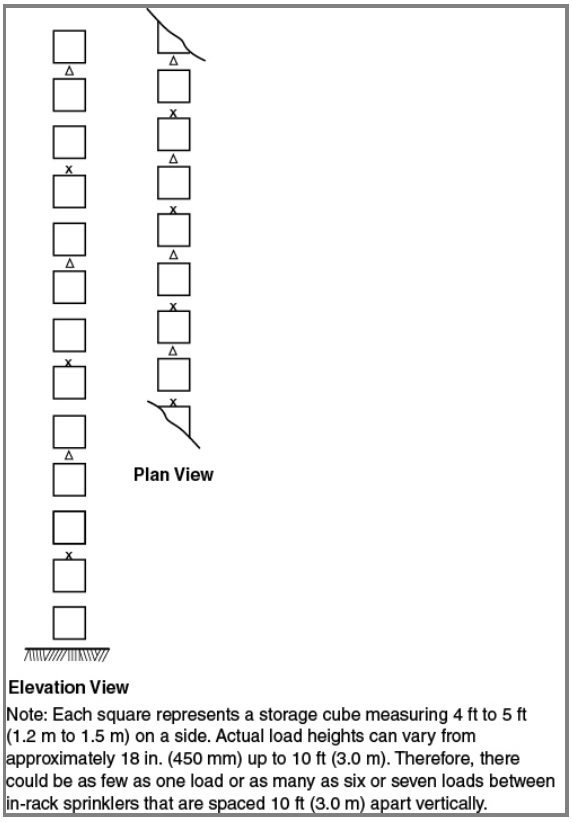
Note: Each square represents a storage cube measuring 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. (450 mm) up to 10 ft (3.0 m). Therefore, there could be as few as one load or as many as six or seven loads between in-rack sprinklers that are spaced 10 ft (3.0 m) apart vertically.

Figure 25.9.4.1.1(b) In-Rack Sprinkler Arrangement, Cartoned Group A Plastic Commodities, Single-Row Racks, Storage Height Over 25 ft (7.6 m) — Option 2.



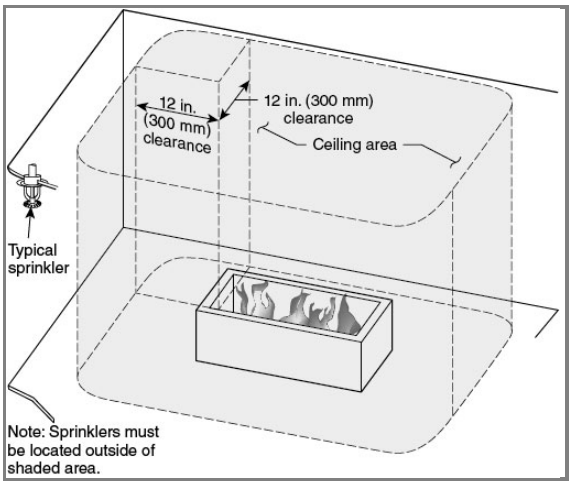
Note: Each square represents a storage cube measuring 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. (450 mm) up to 10 ft (3.0 m). Therefore, there could be as few as one load or as many as six or seven loads between in-rack sprinklers that are spaced 10 ft (3.0 m) apart vertically.

Figure 25.9.4.1.1(c) In-Rack Sprinkler Arrangement, Cartoned Group A Plastic Commodities, Single-Row Racks, Storage Height Over 25 ft (7.6 m) — Option 3.



Note: Each square represents a storage cube measuring 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. (450 mm) up to 10 ft (3.0 m). Therefore, there could be as few as one load or as many as six or seven loads between in-rack sprinklers that are spaced 10 ft (3.0 m) apart vertically.

Figure 25.9.4.1.1(d) In-Rack Sprinkler Arrangement, Cartoned Group A Plastic Commodities, Single-Row Racks, Storage Height Over 25 ft (7.6 m) — Option 4.



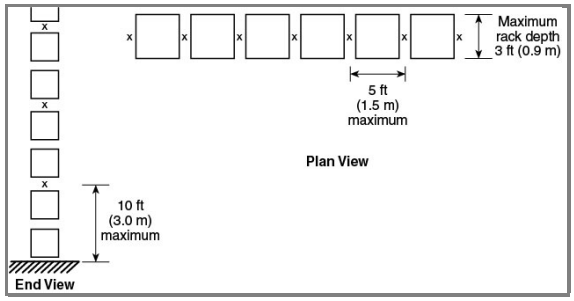
25.9.4.1.2

Where a single-row rack of cartoned Group A plastic commodities is located against a wall, the in-rack sprinkler arrangement shall be permitted to be in accordance with Figure 25.9.4.2.1(a) or Figure 25.9.4.2.1(b) .

25.9.4.1.3

Where single-row rack storage of exposed nonexpanded Group A plastic commodities, encapsulated or nonencapsulated, is over 25 ft (7.6 m) in height and the rack depth is a maximum 3 ft (0.9 m), in-rack sprinklers shall be arranged in accordance with Figure 25.9.4.1.3 .

Figure 25.9.4.1.3 In-Rack Sprinkler Arrangement, Exposed, Nonexpanded Group A Plastic Commodities, Single-Row Racks Up to 3 ft (0.9 m) Deep, Storage Height Over 25 ft (7.6 m).



25.9.4.1.3.1

The highest level of in-rack sprinklers shall not be more than 10 ft (3.0 m) below the top of storage.

25.9.4.1.3.2

Where Figure 25.9.4.1.3 is used, aisles shall be at least 4 ft (1.2 m) wide and the ceiling sprinklers shall be designed for a minimum discharge density of 0.45 gpm/ft^2 over 2000 ft^2 (18.3 mm/min over 186 m^2).

25.9.4.1.4

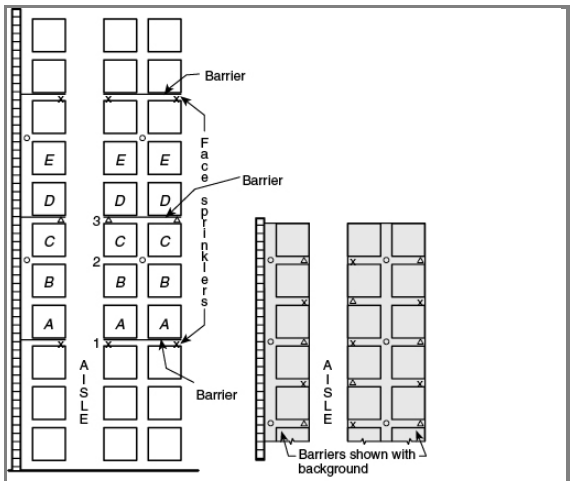
Where single-row rack storage of exposed nonexpanded Group A plastic commodities, encapsulated or nonencapsulated, is over 25 ft (7.6 m) in height and the rack depth is greater than 3 ft (0.9 m), in-rack sprinklers shall be arranged in accordance with Section 25.8 .

25.9.4.2 Double-Row Racks.

25.9.4.2.1

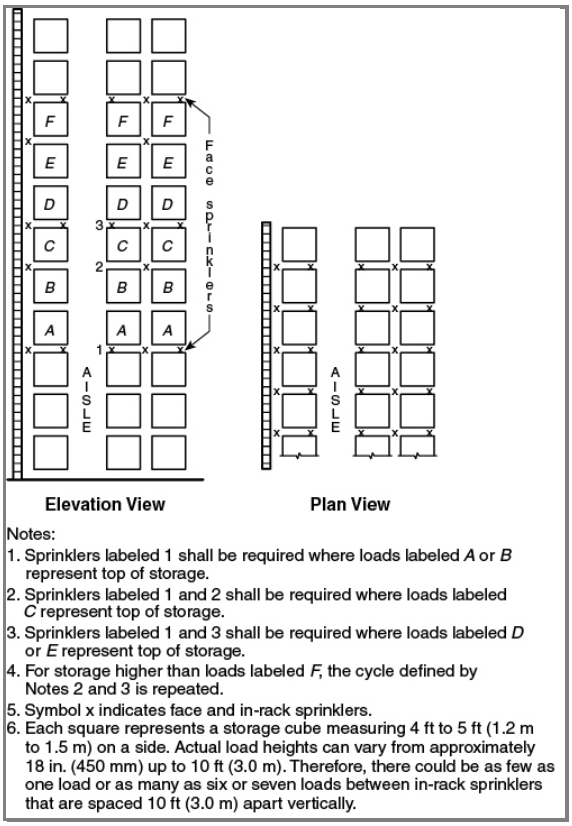
Where double-row rack storage of cartoned Group A plastic commodities, expanded or nonexpanded, encapsulated or nonencapsulated, is over 25 ft (7.6 m) in height, in-rack sprinklers shall be arranged in accordance with one of the options in Figure 25.9.4.2.1(a) or Figure 25.9.4.2.1(b) . Figure 25.9.4.2.1(c) shall be permitted to be used as an option for double-row racks up to 9 ft (2.7 m) deep.

Figure 25.9.4.2.1(a) In-Rack Sprinkler Arrangement, Cartoned Group A Plastic Commodities, Double-Row Racks, Storage Height Over 25 ft (7.6 m) — Option 1.



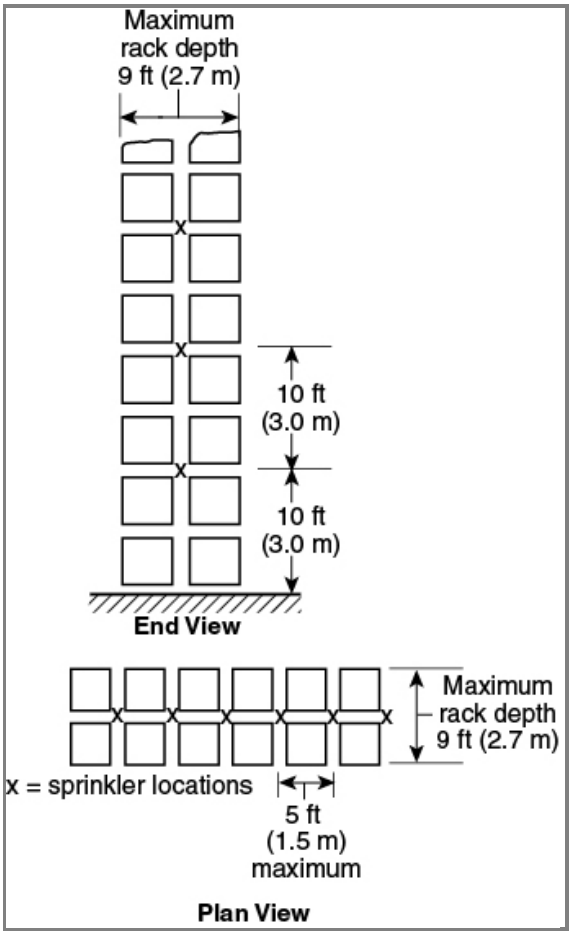
Notes:
1. Sprinklers and barriers labeled 1 shall be required where loads labeled *A* or *B* represent top of storage.
2. Sprinklers labeled 1 and 2 and barriers labeled 1 shall be required where loads labeled *C* represent top of storage.
3. Sprinklers and barriers labeled 1 and 3 shall be required where loads labeled *D* or *E* represent top of storage.
4. For storage higher than represented by loads labeled *E*, the cycle defined by Notes 2 and 3 is repeated.
5. Symbol Δ or x indicates face sprinklers on vertical or horizontal stagger.
6. Symbol o indicates longitudinal flue space sprinklers.
7. Each square represents a storage cube measuring 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. (450 mm) up to 10 ft (3.0 m). Therefore, there could be as few as one load or as many as six or seven loads between in-rack sprinklers that are spaced 10 ft (3.0 m) apart vertically.

Figure 25.9.4.2.1(b) In-Rack Sprinkler Arrangement, Cartoned Group A Plastic Commodities, Double-Row Racks, Storage Height Over 25 ft (7.6 m) — Option 2.



Notes:
1. Sprinklers labeled 1 shall be required where loads labeled *A* or *B* represent top of storage.
2. Sprinklers labeled 1 and 2 shall be required where loads labeled *C* represent top of storage.
3. Sprinklers labeled 1 and 3 shall be required where loads labeled *D* or *E* represent top of storage.
4. For storage higher than loads labeled *F*, the cycle defined by Notes 2 and 3 is repeated.
5. Symbol x indicates face and in-rack sprinklers.
6. Each square represents a storage cube measuring 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. (450 mm) up to 10 ft (3.0 m). Therefore, there could be as few as one load or as many as six or seven loads between in-rack sprinklers that are spaced 10 ft (3.0 m) apart vertically.

Figure 25.9.4.2.1(c) In-Rack Sprinkler Arrangement, Cartoned Group A Plastic Commodities, Double-Row Racks, Storage Height Over 25 ft (7.6 m) — Option 3.



25.9.4.2.2*

Where double-row rack storage of exposed nonexpanded Group A plastic commodities, whether encapsulated or nonencapsulated, is over 25 ft (7.6 m) in height and has minimum 4 ft (1.2 m) wide aisles, in-rack sprinklers shall be arranged in accordance with Section 25.8 .

A.25.9.4.2.2

All arrangements of exposed nonexpanded Group A plastic commodities cannot be protected with all types of sprinklers. Only certain combinations of ceiling sprinklers and in-rack sprinklers have been found to provide acceptable protection.

25.9.4.2.3

Protection of Group A plastic commodities that are exposed and nonexpanded, whether encapsulated or nonencapsulated racks and with a clearance to ceiling up to and including 10 ft (3.1 m), shall be permitted to only use in-rack sprinkler arrangements that are specifically permitted to be used with exposed nonexpanded Group A plastic commodities.

25.9.4.3 Multiple-Row Racks.

25.9.4.3.1*

Where multiple-row rack storage of exposed nonexpanded Group A plastic commodities, encapsulated or nonencapsulated, or cartoned Group A plastic commodities, expanded or nonexpanded, encapsulated or nonencapsulated, is over 25 ft (7.6 m) in height, in-rack sprinklers shall be arranged in accordance with one of the options in Figure 25.9.4.3.1(a) through Figure 25.9.4.3.1(f) .

Figure 25.9.4.3.1(a) In-Rack Sprinkler Arrangement, Cartoned Group A Plastic and Exposed Nonexpanded Group A Plastic Commodities, Multiple-Row Racks, Storage Height Over 25 ft (7.6 m) — Option 1 [10 ft (3.0 m) Maximum Spacing].

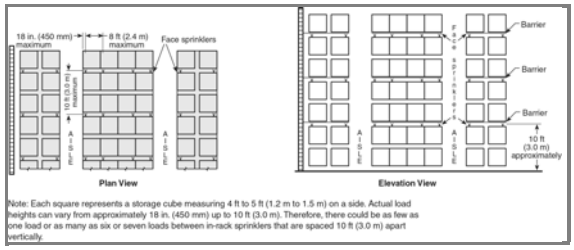


Figure 25.9.4.3.1(b) In-Rack Sprinkler Arrangement, Cartoned Group A Plastic and Exposed Nonexpanded Group A Plastic Commodities, Multiple-Row Racks, Storage Height Over 25 ft (7.6 m) — Option 2 [10 ft (3.0 m) Maximum Spacing].

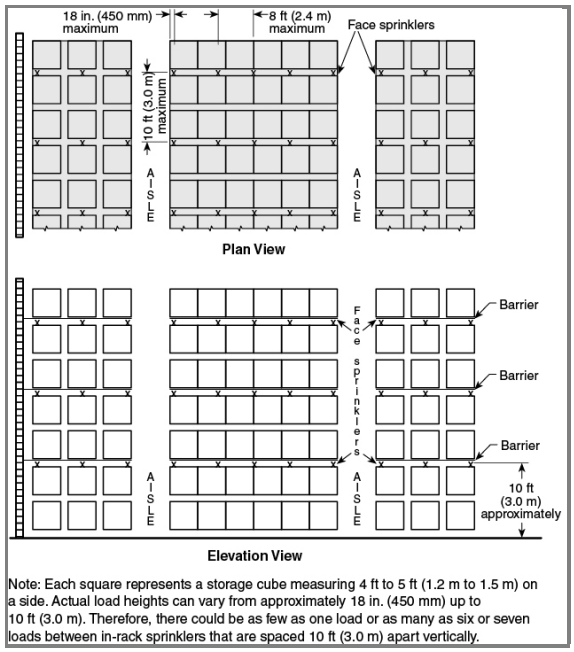


Figure 25.9.4.3.1(c) In-Rack Sprinkler Arrangement, Cartoned Group A Plastic and Exposed Nonexpanded Group A Plastic Commodities, Multiple-Row Racks, Storage Height Over 25 ft (7.6 m) — Option 1 [5 ft (1.5 m) Maximum Spacing].

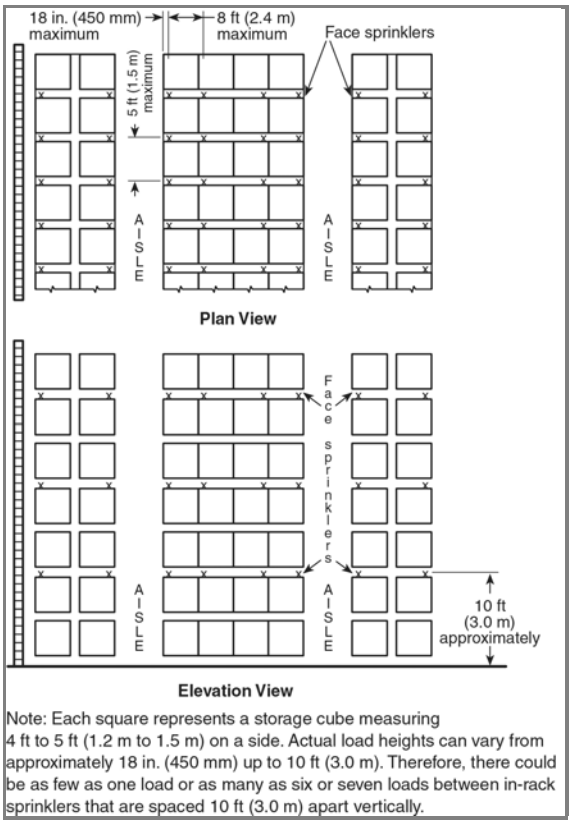


Figure 25.9.4.3.1(d) In-Rack Sprinkler Arrangement, Cartoned Group A Plastic and Exposed Nonexpanded Group A Plastic Commodities, Multiple-Row Racks, Storage Height Over 25 ft (7.6 m) — Option 2 [5 ft (1.5 m) Maximum Spacing].

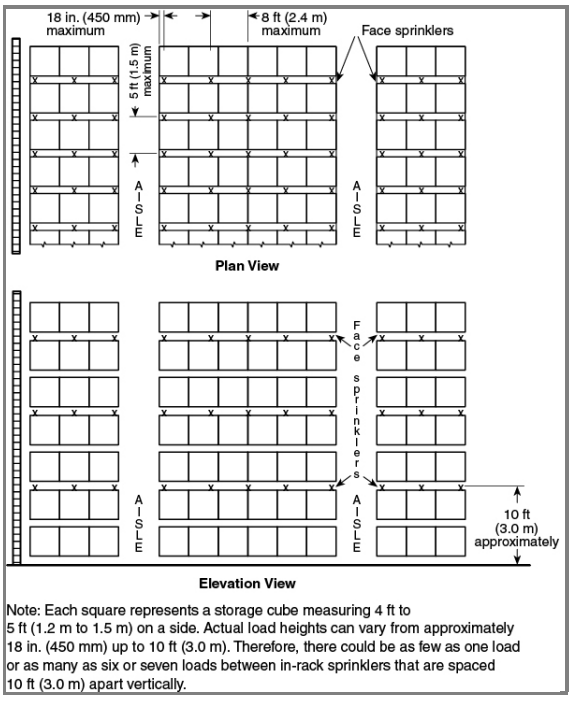


Figure 25.9.4.3.1(e) In-Rack Sprinkler Arrangement, Cartoned Group A Plastic and Exposed Nonexpanded Group A Plastic Commodities, Multiple-Row Racks, Storage Height Over 25 ft (7.6 m) — Option 3 [5 ft (1.5 m) Maximum Spacing].

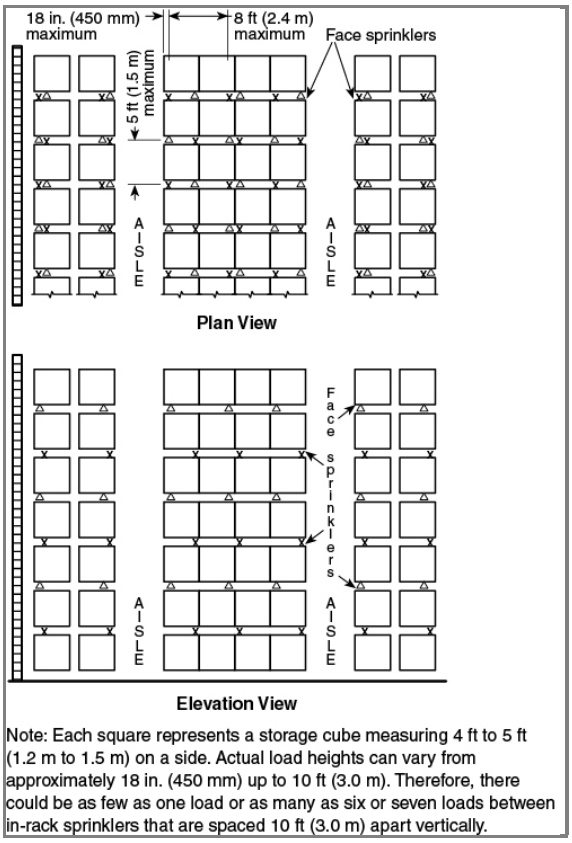
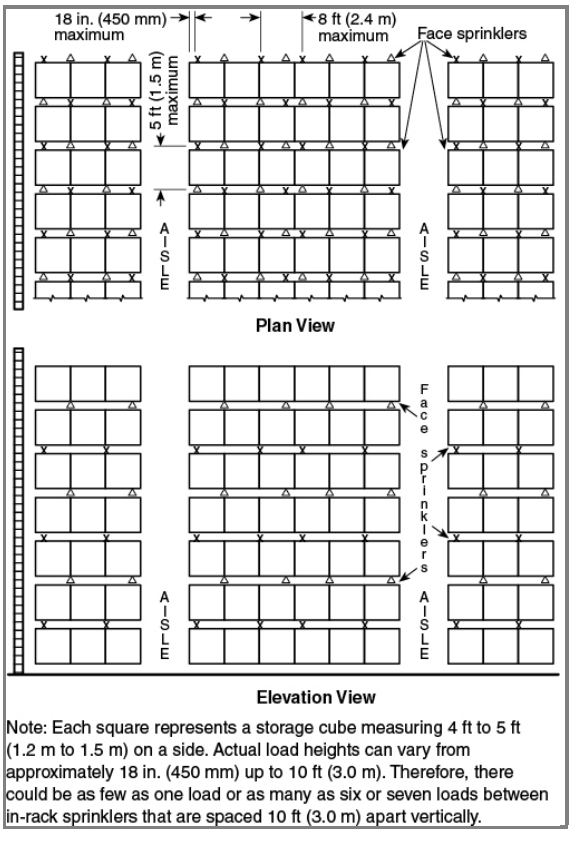


Figure 25.9.4.3.1(f) In-Rack Sprinkler Arrangement, Cartoned Group A Plastic and Exposed Nonexpanded Group A Plastic Commodities, Multiple-Row Racks, Storage Height Over 25 ft (7.6 m) — Option 4 [5 ft (1.5 m) Maximum Spacing].



A.25.9.4.3.1

All arrangements of exposed nonexpanded Group A plastic commodities cannot be protected with all types of sprinklers. Only certain combinations of ceiling sprinklers and in-rack sprinklers have been found to provide acceptable protection.

25.9.5 In-Rack Sprinkler Arrangements Due to Excessive Clearance.

25.9.5.1

Where the clearance to ceiling for rack storage of Class 1 through Class IV commodities up to and including 25 ft (7.6 m) in height protected by CMDA ceiling-level sprinklers exceeds 20 ft (6.1 m) and the ceiling-level protection is not capable of providing the protection needed for the storage height that would result in a clearance to ceiling of 20 ft (6.1 m), one level of supplemental, quick-response in-rack sprinklers located directly below the top tier of storage and at every flue space intersection shall be installed.

25.9.5.2

Where the clearance to ceiling for rack storage of Group A plastic commodities up to and including 25 ft (7.6 m) in height protected by CMDA ceiling-level sprinklers exceeds 10 ft (3.0 m), and the ceiling-level protection is not capable of providing the protection needed for the storage height that would result in a clearance to ceiling of 10 ft (3.0 m), one level of supplemental, quick-response in-rack sprinklers located directly below the top tier of storage and at every flue space intersection shall be installed.

25.9.5.3

Where the clearance to ceiling exceeds 10 ft (3.0 m) for rack storage over 25 ft (7.6 m) in height, and the ceiling-level protection is not capable of providing the protection needed for the storage height that would result in a clearance to ceiling of 10 ft (3.0 m), one level of supplemental, quick-response in-rack sprinklers located directly below the top tier of storage and at every flue space intersection shall be installed.

25.9.5.4

Where the supplemental in-rack sprinkler protection has been installed in accordance with this section, the ceiling-level sprinkler system design shall be based on the storage height that results in an acceptable clearance to ceiling.

25.9.5.5

Where in-rack sprinklers are required for the actual storage height based on a theoretical acceptable clearance to ceiling, in-rack sprinklers shall be installed as indicated by that criteria and supplemented as outlined in this section.

25.9.6 Rack Storage of Rubber Tires Up to and Including 20 ft (6.1 m) in Height.

The in-rack arrangements for rack storage of rubber tires, either on-side or on-tread, up to and including 20 ft (6.1 m) in height shall be in accordance with the guidelines outlined in Sections 25.4 through 25.7 as applicable.

25.10 In-Rack Sprinkler Arrangements in Combination with CMSA Sprinklers at Ceiling Level.

25.10.1* Rack Storage of Class I Through Class IV and Group A Plastic Commodities.

The in-rack arrangements for rack storage of Class I through Class IV and Group A plastic commodities protected by CMSA sprinklers at ceiling level shall be in accordance with the guidelines outlined in Sections 25.4 through 25.7 as applicable.

A.25.10.1

There are currently no situations where in-rack sprinklers are required to be used to protect Group A plastic commodities stored over 25 ft (7.6 m) in height where CMSA sprinklers are used at the ceiling.

25.11 In-Rack Sprinkler Arrangements in Combination with ESFR Sprinklers at Ceiling Level.

25.11.1 Rack Storage of Class I Through Class IV and Group A Plastic Commodities.

The in-rack arrangements for rack storage of Class I through Class IV and Group A plastic commodities protected by ESFR sprinklers at ceiling level shall be in accordance with the guidelines outlined in Sections 25.4 through 25.7 as applicable.

25.12 Design Criteria for In-Rack Sprinklers in Combination with Ceiling-Level Sprinklers.

25.12.1 General.

25.12.1.1

In-rack sprinkler design criteria for Group A plastic commodities shall be permitted for the protection of the same storage height and configuration of Class I, II, III, and IV commodities.

25.12.1.2

Pipe sizing of an in-rack sprinkler system shall be permitted to be based on hydraulic calculations and not restricted by any pipe schedule.

25.12.1.3

Where in-rack sprinklers are being installed to protect a storage rack and, due to the length of the rack, fewer in-rack sprinklers will be installed than the number of in-rack sprinklers specified in the in-rack design, the in-rack sprinkler design shall be based on only those in-rack sprinklers installed within the protected rack.

25.12.1.4

Where in-rack sprinkler arrangements have been installed in accordance with this chapter, except for Section 25.8 , the flow and pressure requirements of both the ceiling and in-rack sprinkler systems over the same protected area shall be hydraulically balanced together to the higher sprinkler system pressure requirement at their point of connection.

25.12.1.5

The minimum water supply requirements for a hydraulically designed occupancy hazard automatic in-rack sprinkler system shall be determined by adding the hose stream allowance from Table 20.12.2.6 to the water supply for ceiling-level sprinklers determined in Section 25.2 , unless indicated otherwise.

25.12.2 Number of Operating In-Rack Sprinklers.

25.12.2.1

The number of in-rack sprinklers in the design of the in-rack sprinkler system shall be in accordance with Table 25.12.2.1 .

Table 25.12.2.1 In-Rack Sprinkler System Design: Number of In-Rack Sprinklers

Type of Storage	Commodity Class	Rack Type	Ceiling Sprinkler Type	No. of Required In-Rack Sprinkler Levels	No. of In-Rack Sprinklers in the Design
Miscellaneous	Class I through IV, Group A plastics, and rubber tires	Any	Any	Any	4
Storage not meeting the definition of miscellaneous	Class I through III	Solid shelf	Any	One	6
			Any	More than one	10 (5 on each of the top two levels)
		Open	CMDA	One	6
			CMDA	More than one	10 (5 on each of the top two levels)
	Class I through IV	Open	CMSA	One	8
	Class I through IV and Group A plastics	Open	ESFR	One	8
	Class IV	Open	CMDA	More than one	10 (5 on each of the top two levels)
	Class IV and Group A plastics	Solid shelf	Any	One	8
				More than one	14 (7 on each of the top two levels)
		Open	CMDA	One	8
				More than one	14 (7 on each of the top two levels)
	Group A plastics	Open	CMSA	One	8
	Rubber tires	Open	CMDA	One	12

25.12.3 In-Rack Sprinkler Flow/Pressure.

25.12.3.1

The required flow or pressure required from the most remote in-rack sprinkler in the design of the in-rack sprinkler system shall be in accordance with Table 25.12.3.1 .

Table 25.12.3.1 In-Rack Sprinkler System Design: Minimum Required Flow/Pressure from In-Rack Sprinklers

Type of Storage	Commodity Class	Rack Type	Ceiling Sprinkler Type	Storage Height		Minimum Design Flow/Pressure for In-Rack Sprinklers
				ft	m	
Miscellaneous	Class I through IV, Group A plastics, and rubber tires	Any	Any	Any	Any	15 psi (1.0 bar)
Storage not meeting the definition of miscellaneous	Class I through IV	Open	CMDA	Up to 25	Up to 7.6	15 psi (1.0 bar)
			CMSA	Any	Any	15 psi (1.0 bar)
	Class I through IV and Group A plastics	Open	CMDA	Over 25	Over 7.6	30 gpm (115 L/min)
			ESFR	Any	Any	60 gpm (230 L/min)
		Solid shelves	Any	Any	Any	30 gpm (115 L/min)
	Group A plastics	Open	CMDA	Up to 25	Up to 7.6	15 psi (1.0 bar)
			CMSA	Up to 25	Up to 7.6	15 psi (1.0 bar)
	Rubber tires	Open	CMDA	Any	Any	30 psi (2.1 bar)

~~**25.1** General Requirements of In-Rack Sprinklers.~~

~~**25.1.1** Scope.~~

~~This section shall apply where rack storage of Class I through Class IV commodities, Group A plastic commodities, or rubber tires will be protected with in-rack sprinklers.~~

~~**25.1.2** Open-Frame Storage Racks.~~

~~**25.1.2.1**~~

~~The in-rack sprinkler arrangements as well as the ceiling and in-rack sprinkler design criteria for rack storage in this chapter shall be based on open-frame rack configurations as defined in 3.3.141 unless indicated otherwise.~~

~~**25.1.2.2**~~

~~Where Group A commodities are being stored in racks with aisles less than 3.5 ft (1.1 m) wide, in-rack sprinkler protection shall be in accordance with the guidelines for multiple-row racks.~~

~~**25.1.2.3**~~

~~Where open-frame double-row racks with storage up 25 ft (7.6 m) in height have no longitudinal flue, but have transverse flues at maximum 5 ft (1.5 m) intervals, the double-row rack storage arrangement shall be considered open-frame.~~

~~**25.1.2.4**~~

~~Where multiple-row racks of any height have no longitudinal flue, but have transverse flues at maximum 5 ft (1.5 m) intervals, the multiple-row rack storage arrangement shall be considered open-frame.~~

~~**25.1.3** In-Rack Sprinkler System.~~

~~**25.1.3.1** In-Rack Sprinkler System Size.~~

25.1.3.1.1

The area protected by a single in-rack sprinkler system shall not exceed 40,000 ft^2 (3720 m^2) of floor area occupied by the racks, including aisles, regardless of the number of in-rack sprinkler levels.

25.1.3.1.2

An in-rack sprinkler system shall be permitted to be supplied from the overhead ceiling sprinkler system where the area of the racks protected by the in-rack sprinklers, including the adjacent aisles, do not exceed 8,000 ft^2 (740 m^2).

25.1.3.2* In-Rack Sprinkler System Control Valves.

25.1.3.2.1

Unless the requirements of 25.1.3.2.2 or 25.1.3.2.3 are met, separate indicating control valves and drains shall be provided and arranged so that ceiling and in-rack sprinkler systems can be controlled independently.

25.1.3.2.2

Installation of 20 or fewer in-rack sprinklers supplied by any one ceiling sprinkler system shall not require a separate indicating control valve.

25.1.3.2.3

The separate indicating valves shall be permitted to be arranged as sectional control valves supplied from the ceiling sprinkler system where in-rack sprinklers are required and the racks including the adjacent aisles occupy 8000 ft^2 (740 m^2) or less of the area protected by the ceiling sprinklers.

25.1.3.3* Sprinkler Waterflow Alarm for In-Rack Sprinklers.

See Section C.4 .

25.1.4 Flue Space Requirements for Racks Protected by In-Rack Sprinklers.

25.1.4.1

Where in-rack sprinklers are protecting rack storage, nominal 6 in. (150 mm) transverse flue spaces between loads and at rack uprights shall be maintained.

25.1.4.2

Where in-rack sprinklers are protecting rack storage, random variations in the width of flue spaces or in their vertical alignment shall be permitted.

25.1.4.3

Where in-rack sprinklers are protecting double- and multiple-row rack storage up to and including 25 ft (7.6 m) in height, a longitudinal (back-to-back clearance between loads) flue space shall not be required.

25.1.4.4

Where in-rack sprinklers are protecting double-row racks over 25 ft (7.6 m) in height, nominal 6 in. (150 mm) longitudinal flue spaces shall be provided.

25.1.5 Building Steel Protection.

Where in-rack sprinklers are installed in accordance with this chapter, building steel shall not require special protection.

25.1.6 Movable Racks.

Rack storage in movable racks shall be protected in the same manner as multiple-row racks.

25.2 Ceiling-Level Sprinkler Design Criteria in Combination with In-Rack Sprinklers.

25.2.1 General.

25.2.1.1*

This section shall apply to storage of materials, such as Class I through Class IV and Group A plastic commodity as well as rubber tires, representing the broad range of combustibles stored in racks that are being protected by in-rack sprinklers. The requirements of Chapter 20 shall apply unless modified by this chapter. *(See Section C.9 .)*

25.2.1.2*

Ceiling-level sprinkler design criteria for single-, double-, and multiple-row racks in 25.2 shall be based on open rack configurations as defined in 3.3.141 .

25.2.1.3*

Ceiling-level sprinkler design criteria for Group A plastic commodities in this chapter shall be permitted for the protection of the same storage height and configuration of Class I, II, III, and IV commodities.

25.2.1.4

Ceiling-level sprinkler design criteria for single- and double-row rack storage of Group A plastic commodities shall be applicable where aisles are 3.5 ft (1.1 m) or greater in width.

25.2.1.5

Ceiling-level sprinkler design criteria for rack storage of Group A plastic commodities shall be protected as multiple-row racks where aisles are less than 3.5 ft (1.1 m) in width.

25.2.1.6

The minimum water supply requirements for a hydraulically designed occupancy hazard automatic ceiling-level sprinkler system shall be determined by adding the hose stream allowance from Table 20.12.2.6 to the water supply for in-rack sprinklers determined in Section 25.12 , unless indicated otherwise.

25.2.2 Miscellaneous and Low-Piled Storage.

25.2.2.1 Miscellaneous Storage.

25.2.2.1.1

This section shall apply to any of the following situations:

Miscellaneous storage of Class I through Class IV commodities up to and including 12 ft (3.7 m) in height

Miscellaneous storage of Group A plastic commodities up to and including 12 ft (3.7 m) in height

Miscellaneous storage of rubber tires up to and including 12 ft (3.7 m) in height

25.2.2.1.2

Where in-rack sprinklers are installed in accordance with Section 25.4 through Section 25.7 to protect miscellaneous rack storage of Class I through Class IV and Group A plastic commodities, as well as miscellaneous rack storage of rubber tires, up to and including 12 ft (3.7 m) in height under a maximum 32 ft (10.0 m) high ceiling, the ceiling-level sprinkler design criteria shall be in accordance with Figure 25.2.2.1.2 .

Figure 25.2.2.1.2 CMDA Ceiling-Level Sprinkler Design Criteria for Miscellaneous Storage Protected with One Level of In-Rack Sprinklers

25.2.2.1.3

Installation criteria as permitted by NFPA 13 and design criteria and modifiers as permitted by the density/area method of Section 19.2 for ordinary hazard Group 2 occupancies shall be applicable.

25.2.2.1.4 Hose Connections.

Hose connections shall not be required for the protection of miscellaneous storage.

25.2.2.2 Low-Piled Storage.

25.2.2.2.1

This section shall apply to any of the following situations:

Storage of Class I through Class IV commodities up to 12 ft and including (3.7 m) in height.

* Storage of Group A plastic commodities up to and including 5 ft (1.5 m) in height.

25.2.2.2.2

For low-piled rack storage with solid shelves of Class I through Class IV commodities up to and including 12 ft (3.7 m) in height, in-rack sprinklers shall be provided in accordance with Section 25.6 , and the ceiling-level sprinkler design shall be in accordance with Figure 25.2.2.1.2 .

25.2.2.2.3

For low-piled rack storage with solid shelves of Group A plastic commodities up to and including 5 ft (1.5 m) in height, in-rack sprinklers shall be provided in accordance with Section 25.6 , and the ceiling-level sprinkler design shall be in accordance with Figure 25.2.2.1.2 .

25.2.3 CMDA Ceiling Level Sprinkler Design Criteria in Combination with In-Rack Sprinklers.

25.2.3.1 General.

25.2.3.1.1

Ceiling-level sprinkler design criteria for the rack storage of Class I through Class IV commodities shall be in accordance with Section 25.2.3.2 for storage over 12 ft (3.7 m) and up to and including 25 ft (7.6 m) in height and Section 25.2.3.3 for storage over 25 ft (7.6 m) in height.

25.2.3.1.2

Ceiling-level sprinkler design criteria for the rack storage of Group A plastic commodities shall be in accordance with Section 25.2.3.4 for storage over 5 ft (1.5 m) and up to and including 25 ft (7.6 m) in height and Section 25.2.3.5 for storage over 25 ft (7.6 m) in height.

25.2.3.1.3

This chapter also shall be used to determine protection for commodities that are not entirely Group A plastic commodities but contain such quantities and arrangements of Group A plastic commodities that they are deemed more hazardous than Class IV commodities.

25.2.3.2 Rack Storage of Class I Through Class IV Commodities Stored Over 12 ft (3.7 m) and Up to and Including 25 ft (7.6 m) in Height.

~~**25.2.3.2.1***~~ ~~Single- and Double-Row Racks.~~

For single- or double-row rack storage of Class I through Class IV commodities, encapsulated or nonencapsulated, stored over 12 ft (3.7 m) and up to and including 25 ft (7.6 m) in height, Table 25.2.3.2.1 shall be used to determine the appropriate figure for determining ceiling-level sprinkler design criteria with the provision of one level of in-rack sprinklers.

Table 25.2.3.2.1 Single- or Double-Row Racks — Storage Height Over 12 ft (3.7 m) Up to and Including 25 ft (7.6 m)

Height	Commodity Class	Encapsulated	Aisles*		Sprinklers Mandatory In-Rack	Ceiling Sprinkler Water Dor			
						With In-Rack Sprinklers			Withou
			ft	m		Figure	Curves	Apply Figure 16.2.1.3.4.1	Figure
Over 12 ft (3.7 m) up to and including 20 ft (6.1 m)	I	No	4	1.2	No	16.2.1.3.2(a)	C and D	Yes	16.2.1.3.2(a
			8	2.4			A and B		
		Yes	4	1.2	No	16.2.1.3.2(e)	C and D		16.2.1.3.2(e
			8	2.4			A and B		
	II	No	4	1.2	No	16.2.1.3.2(b)	C and D		16.2.1.3.2(b
			8	2.4			A and B		
		Yes	4	1.2	No	16.2.1.3.2(e)	C and D		16.2.1.3.2(e
			8	2.4			A and B		
	III	No	4	1.2	No	16.2.1.3.2(c)	C and D		16.2.1.3.2(c
			8	2.4			A and B		
		Yes	4	1.2	1 level	16.2.1.3.2(f)	C and D		—
			8	2.4			A and B		
	IV	No	4	1.2	No	16.2.1.3.2(d)	C and D		16.2.1.3.2(c
			8	2.4			A and B		
		Yes	4	1.2	1 level	16.2.1.3.2(g)	C and D		—
			8	2.4			A and B		
Over 20 ft (6.1 m) up to and including 22 ft (6.7 m)	I	No	4	1.2	No	16.2.1.3.2(a)	C and D	No	16.2.1.3.2(a
			8	2.4			A and B		
		Yes	4	1.2	1 level	16.2.1.3.2(e)	C and D		—
			8	2.4			A and B		
	II	No	4	1.2	No	16.2.1.3.2(b)	C and D		16.2.1.3.2(b
			8	2.4			A and B		
		Yes	4	1.2	1 level	16.2.1.3.2(e)	C and D		—
			8	2.4			A and B		
	III	No	4	1.2	No	16.2.1.3.2(c)	C and D		16.2.1.3.2(c
			8	2.4			A and B		
		Yes	4	1.2	1 level	16.2.1.3.2(f)	C and D		—
			8	2.4			A and B		

Height	Commodity Class	Encapsulated	Aisles* ft	Aisles* m	Sprinklers Mandatory In-Rack	Ceiling Sprinkler Water Den With In-Rack Sprinklers Figure	Curves	Apply Figure 16.2.1.3.4.1	Without Figure
Over 22 ft (6.7 m) up to and including 25 ft (7.6 m)	I	No	4	1.2	No	16.2.1.3.2(a)	C and D	No	16.2.1.3.2(a
			8	2.4			A and B		
		Yes	4	1.2	1 level	16.2.1.3.2(e)	C and D		—
			8	2.4			A and B		
	II	No	4	1.2	No	16.2.1.3.2(b)	C and D		16.2.1.3.2(b
			8	2.4			A and B		
		Yes	4	1.2	1 level	16.2.1.3.2(e)	C and D		—
			8	2.4			A and B		
	III	No	4	1.2	No	16.2.1.3.2(c)	C and D		16.2.1.3.2(c
			8	2.4			A and B		
		Yes	4	1.2	1 level	16.2.1.3.2(f)	C and D		—
			8	2.4			A and B		
	IV	No	4	1.2	1 level	16.2.1.3.2(d)	C and D		—
			8	2.4			A and B		
		Yes	4	1.2		16.2.1.3.2(g)	C and D		—
			8	2.4			A and B		

*See 16.2.1.3.2.1 for interpolation of aisle widths.

25.2.3.2.2 Multiple-Row Racks.

25.2.3.2.2.1

For multiple-row racks, having a rack depth up to and including 16 ft (4.9 m) with aisles 8 ft (2.4 m) or wider, storing Class I through Class IV commodities, encapsulated or nonencapsulated, over 12 ft (3.7 m) and up to and including 25 ft (7.6 m) in height, Table 25.2.3.2.2.1 shall be used to determine the appropriate figure for determining ceiling-level sprinkler design criteria with the provision of one level of in-rack sprinklers.

Table 25.2.3.2.2.1 Multiple-Row Racks — Rack Depth Up to and Including 16 ft (4.9 m), Aisles 8 ft (2.4 m) or Wider and Storage Height Over 12 ft (3.7 m) Up to 25 ft (7.6 m)

Height	Commodity Class	Encapsulated	Sprinklers Mandatory In-Rack	Ceiling Sprinkler Water Demand					
				With In-Rack Sprinklers				Without	
				Figure	Curves	Apply Figure 16.2.1.3.4.1	1.25 × Density	Figure	Cu
Over 12 ft (3.7 m) up to and including 15 ft (4.6 m)	I	No	No	16.2.1.3.2(a)	C and D	Yes	No	16.2.1.3.2(a)	I an
		Yes		16.2.1.3.2(a)			Yes	16.2.1.3.2(a)	I an
	II	No		16.2.1.3.2(b)			No	16.2.1.3.2(b)	I an
		Yes		16.2.1.3.2(b)			Yes	16.2.1.3.2(b)	I an
	III	No	No	16.2.1.3.2(c)			No	16.2.1.3.2(c)	I an
		Yes	1 level	16.2.1.3.2(c)			Yes	-	NA
	IV	No	No	16.2.1.3.2(d)			No	16.2.1.3.2(d)	C a
		Yes	1 level	16.2.1.3.2(d)	A and B		1.50 × density	-	NA
Over 15 ft (4.6 m) up to and including 20 ft (6.1 m)	I	No	No	16.2.1.3.2(a)	C and D	Yes	No	16.2.1.3.2(a)	I an
		Yes		16.2.1.3.2(a)			Yes	16.2.1.3.2(a)	I an
	II	No		16.2.1.3.2(b)			No	16.2.1.3.2(b)	I an
		Yes		16.2.1.3.2(b)			Yes	16.2.1.3.2(b)	I an
	III	No	No	16.2.1.3.2(c)			No	16.2.1.3.2(c)	I an
		Yes	1 level	16.2.1.3.2(c)			Yes	NA	NA
	IV	No	1 level	16.2.1.3.2(d)			No		
		Yes		16.2.1.3.2(d)	A nd B		1.50 × density		
Over 20 ft (6.1 m) up to and including 25 ft (7.6 m)	I	No	No	16.2.1.3.2(a)	C and D	No	No	16.2.1.3.2(a)	I an
		Yes	1 level	16.2.1.3.2(a)			Yes	NA	NA
	II	No		16.2.1.3.2(b)			No		
		Yes		16.2.1.3.2(b)			Yes		
	III	No		16.2.1.3.2(c)			No		
		Yes		16.2.1.3.2(c)			Yes		
	IV	No	2 levels	16.2.1.3.2(d)			No		
		Yes		16.2.1.3.2(d)	A and B		1.50 × density		

NA: Not applicable.

25.2.3.2.2.2

For multiple-row racks, having a rack depth up to and including 16 ft (4.9 m) with aisles 8 ft (2.4 m) or wider, storing Class I through Class IV commodities, encapsulated or nonencapsulated, over 12 ft (3.7 m) and up to and including 25 ft (7.6 m) in height, Table 25.2.3.2.2.2 shall be used to determine the appropriate figure for determining ceiling-level sprinkler design criteria with the provision of one level of in-rack sprinklers.

Table 25.2.3.2.2.2 Determining Appropriate Ceiling-Level Protection Criteria Figure for Multiple-Row Racks of Class I through Class IV Commodities — Rack Depth Over 16 ft (4.9 m) or Aisles Narrower Than 8 ft (2.4 m), Storage Height Over 12 ft (3.7 m) Up to and Including 25 ft (7.6 m)

				Ceiling Sprinkler Water Demand					
				With In-Rack Sprinklers				Without	
Height	Commodity Class	Encapsulated	Sprinklers Mandatory In-Rack	Figure	Curves	Apply Figure 16.2.1.3.4.1	1.25 × Density	Figure	Cu
Over 12 ft (3.7 m) up to and including 15 ft (4.6 m)	I	No	No	16.2.1.3.2(a)	C and D	Yes	No	16.2.1.3.2(a)	I ar
		Yes		16.2.1.3.2(a)			Yes	16.2.1.3.2(a)	I ar
	II	No		16.2.1.3.2(b)			No	16.2.1.3.2(b)	I ar
		Yes		16.2.1.3.2(b)			Yes	16.2.1.3.2(b)	I ar
	III	No		16.2.1.3.2(c)			No	16.2.1.3.2(c)	I ar
		Yes	1 level	16.2.1.3.2(c)			Yes	-	
	IV	No	No	16.2.1.3.2(d)			No	16.2.1.3.2(d)	C a
		Yes	1 level	16.2.1.3.2(d)			1.50 × density	-	
Over 15 ft (4.6 m) up to and including 20 ft (6.1 m)	I	No	1 level	16.2.1.3.2(a)	C and D	Yes	No	NA	N
		Yes		16.2.1.3.2(a)			Yes		
	II	No		16.2.1.3.2(b)			No		
		Yes		16.2.1.3.2(b)			Yes		
	III	No		16.2.1.3.2(c)			No		
		Yes		16.2.1.3.2(c)			Yes		
	IV	No		16.2.1.3.2(d)			No		
		Yes		16.2.1.3.2(d)			1.50 × density		
Over 20 ft (6.1 m) up to and including 25 ft (7.6 m)	I	No	1 level	16.2.1.3.2(a)	C and D	No	No	NA	N
		Yes		16.2.1.3.2(a)			Yes		
	II	No		16.2.1.3.2(b)			No		
		Yes		16.2.1.3.2(b)			Yes		
	III	No		16.2.1.3.2(c)			No		
		Yes		16.2.1.3.2(c)			Yes		
	IV	No	2 levels	16.2.1.3.2(d)			No		
		Yes		16.2.1.3.2(d)			1.50 × density		

NA: Not applicable.

25.2.3.2.3 Ceiling-Level Protection Criteria Figures.

~~25.2.3.2.3.1*~~

~~The ceiling-level sprinkler design criteria in terms of density [gpm/ft^2 (mm/min)] and are a of sprinkler operation [ft^2 (m^2) of ceiling or roof] obtained from the appropriate density/area curves of Figure 25.2.3.2.3.1(a) through Figure 25.2.3.2.3.1(g) shall be modified as appropriate by 25.2.3.2.4 . These requirements shall apply to portable racks arranged in the same manner as single , double- or multiple-row racks. *(See Section C.14.)*~~

~~Figure 25.2.3.2.3.1(a) Sprinkler System Design Curves — 20 ft (6.1 m) High Rack Storage — Class I Nonencapsulated Commodities — Conventional Pallets.~~

~~Figure 25.2.3.2.3.1(b) Sprinkler System Design Curves — 20 ft (6.1 m) High Rack Storage — Class II Nonencapsulated Commodities — Conventional Pallets.~~

~~Figure 25.2.3.2.3.1(c) Sprinkler System Design Curves — 20 ft (6.1 m) High Rack Storage — Class III Nonencapsulated Commodities — Conventional Pallets.~~

~~Figure 25.2.3.2.3.1(d) Sprinkler System Design Curves — 20 ft (6.1 m) High Rack Storage — Class IV Nonencapsulated Commodities — Conventional Pallets.~~

Figure 25.2.3.2.3.1(e) Single- or Double-Row Racks — 20 ft (6.1 m) High Rack Storage — Sprinkler System Design Curves — Class I and Class II Encapsulated Commodities — Conventional Pallets.

Figure 25.2.3.2.3.1(f) Single- or Double-Row Racks — 20 ft (6.1 m) High Rack Storage — Sprinkler System Design Curves — Class III Encapsulated Commodities — Conventional Pallets.

Figure 25.2.3.2.3.1(g) Single- or Double-Row Racks — 20 ft (6.1 m) High Rack Storage — Sprinkler System Design Curves — Class IV Encapsulated Commodities — Conventional Pallets.

25.2.3.2.3.2*

Design densities obtained from Figure 25.2.3.2.3.1(a) through Figure 25.2.3.2.3.1(g) for single- and double-row racks shall be selected to correspond to aisle width. (See Section C.15.)

(A)

For aisle widths between 4 ft (1.2 m) and 8 ft (2.4 m), the rules for 4 ft (1.2 m) aisle width shall be used or direct linear interpolation between the densities shall be permitted.

(B)

The density given for 8 ft (2.4 m) wide aisles shall be applied to aisles wider than 8 ft (2.4 m).

(C)

The density given for 4 ft (1.2 m) wide aisles shall be applied to aisles more narrow than 4 ft (1.2 m) down to 3-½ ft (1.1 m).

(D)

Where aisles are more narrow than 3-½ ft (1.1 m), racks shall be considered to be multiple-row racks.

25.2.3.2.4* Ceiling Sprinkler Density Adjustments.

~~25.2.3.2.4.1~~

~~Where Class I, Class II, and Class III commodities are encapsulated in multiple-row racks over 12 ft (3.7 m) and up to and including 25 ft (7.6 m) in height, the ceiling sprinkler density obtained from the applicable figure in 25.2.3.2.3.1 shall be increased by 25 percent over that required for nonencapsulated commodities.~~

~~25.2.3.2.4.2~~

~~Where Class IV commodities are encapsulated in multiple-row racks over 12 ft (3.7 m) and up to and including 25 ft (7.6 m) in height, the ceiling sprinkler density obtained from the applicable figure in 25.2.3.2.3.1 shall be increased by 50 percent over that required for nonencapsulated.~~

~~25.2.3.2.4.3~~

~~Where in-rack sprinklers are being installed within racks of Class I through Class IV commodities stored over 12 ft (3.7 m) up to and including 20 ft (6.1 m) protected with CMDA sprinklers at ceiling level along with the minimum number of required in-rack sprinkler levels, densities obtained from design curves shall be adjusted in accordance with Figure 25.2.3.2.4.3 .~~

~~Figure 25.2.3.2.4.3 Adjustment to Ceiling-Level Sprinkler Density Due to Storage Height.~~

25.2.3.2.4.4

Where in-rack sprinklers are being installed within racks of Class I through Class IV commodities stored over 12 ft (3.7 m) and up to and including 20 ft (6.1 m) in height protected with CMDA sprinklers at ceiling level along with more than one level of in-rack sprinklers, but not in every tier, densities obtained from design curves and adjusted in accordance with Figure 25.2.3.2.4.3 shall be permitted to be reduced an additional 20 percent, as indicated in Table 25.2.3.2.4.4 .

Table 25.2.3.2.4.4 Adjustment to Ceiling Sprinkler Density for Storage Height and In-Rack Sprinklers

Storage Height	In-Rack Sprinklers	Apply Figure 16.2.1.3.4.1 for Storage Height Adjustment	Permitted Ceiling Sprinklers Density Adjustments Where In-Rack Sprinklers Are Installed
Over 12 ft (3.7 m) through 25 ft (7.6 m)	None	Yes	None
Over 12 ft (3.7 m) through 20 ft (6.1 m)	Minimum required	Yes	None
	More than minimum, but not in every tier	Yes	Reduce density 20% from that of minimum in-rack sprinklers
	In every tier except above the top tier	Yes	Reduce density 40% from that of minimum in-rack sprinklers
Over 20 ft (6.1 m) through 25 ft (7.3 m)	Minimum required	No	None
	More than minimum, but not in every tier	No	Reduce density 20% from that of minimum in-rack sprinklers
	In every tier except above the top tier	No	Reduce density 40% from that of minimum in-rack sprinklers

25.2.3.2.4.5*

Where in-rack sprinklers are being installed within racks of Class I through Class IV commodities stored over 12 ft (3.7 m) and up to and including 20 ft (6.1 m) in height protected with CMDA sprinklers at ceiling level along with in-rack sprinklers at each tier level, densities obtained from design curves and adjusted in accordance with Figure 25.2.3.2.4.3 shall be permitted to be reduced an additional 40 percent, as indicated in Table 25.2.3.2.4.4 .

25.2.3.2.4.6

Where in-rack sprinklers are being installed within racks of Class I through Class IV commodities stored over 20 ft (6.1 m) and up to and including 25 ft (7.6 m) in height protected with CMDA sprinklers at ceiling level along with the minimum number of required in-rack sprinkler levels, densities obtained from design curves shall be used. Densities shall not be adjusted in accordance with Figure 25.2.3.2.4.3 .

25.2.3.2.4.7

Where in-rack sprinklers are being installed within racks of Class I through Class IV commodities stored over 20 ft (6.1 m) and up to and including 25 ft (7.6 m) in height protected with CMDA sprinklers at ceiling level along with more than the minimum required level of in-rack sprinklers, but not in every tier, densities obtained from design curves shall be permitted to be reduced 20 percent, as indicated in Table 25.2.3.2.4.4 . Densities shall not be adjusted in accordance with Figure 25.2.3.2.4.3 for storage height.

25.2.3.2.4.8

Where in-rack sprinklers are being installed within racks of Class I through Class IV commodities stored over 20 ft (6.1 m) and up to and including 25 ft (7.6 m) in height protected with CMDA sprinklers at ceiling level along with in-rack sprinklers at each tier level, except above the top tier, densities obtained from design curves shall be permitted to be reduced 40 percent, as indicated in Table 25.2.3.2.4.4 . Densities shall not be adjusted in accordance with Figure 25.2.3.2.4.3 for storage height.

25.2.3.3 Rack Storage of Class I Through Class IV Commodities Over 25 ft (7.6 m) in Height.

25.2.3.3.1 Single- and Double-Row Racks.

25.2.3.3.1.1*

Where in-rack sprinklers are being installed within single- and double-row racks separated by aisles at least 4 ft (1.2 m) wide and with a clearance to ceiling up to and including 10 ft (3.0 m) of nonencapsulated Class I through Class IV commodities stored over 25 ft (7.6 m) in height protected by CMDA sprinklers at ceiling level, the ceiling sprinkler designs shall be in accordance with Table 25.2.3.3.1.1.

25.2.3.3.1.2

Where storage as described in 25.2.3.3.1.1 is encapsulated, the ceiling sprinkler density obtained from Table 25.2.3.3.1.1 shall be increased by 25 percent over that required for nonencapsulated commodities.

25.2.3.3.2 Multiple-Row Racks.

25.2.3.3.2.1

Where in-rack sprinkler are being installed within multiple-row racks separated by aisles at least 4 ft (1.2 m) wide and with a clearance to ceiling up to and including 10 ft (3.0 m) of nonencapsulated Class I through Class IV commodities stored over 25 ft (7.6 m) in height protected by CMDA sprinklers at ceiling level, the ceiling sprinkler designs shall be in accordance with Table 25.2.3.3.2.1.

25.2.3.3.2.2

Where storage as described in 25.2.3.3.2.1 is encapsulated, the ceiling sprinkler density obtained from Table 25.2.3.3.2.1 shall be increased by 25 percent over that required for nonencapsulated commodities.

25.2.3.4 Rack Storage of Group A Plastic Commodities Stored Over 5 ft (1.5 m) and Up to and Including 25 ft (7.6 m) in Height.

25.2.3.4.1 Cartoned Group A Plastic Commodities.

25.2.3.4.1.1

Where rack storage of cartoned Group A plastic commodities, encapsulated or nonencapsulated, having a clearance to ceiling up to and including 10 ft (3.0 m) is protected by in-rack sprinklers, ceiling-level sprinkler designs in terms of density [gpm/ft^2 (mm/min)] and area of operation [ft^2 (m^2)] shall be selected from Figure 25.9.3.1(a) through Figure 25.9.3.1(e) .

25.2.3.4.1.2

Linear interpolation of design densities and areas of application shall be permitted between storage heights with the same clearance to ceiling.

25.2.3.4.1.3

No interpolation between clearance to ceiling shall be permitted.

25.2.3.4.2 Exposed Nonexpanded Group A Plastic Commodities.

Where in-rack sprinkler protection is installed to protect rack storage of exposed nonexpanded Group A plastic commodities, encapsulated or nonencapsulated, stored over 5 ft (1.5 m) and up to and including 25 ft (7.6 m) in height protected by CMDA sprinklers at ceiling-level, the ceiling sprinkler design shall be in accordance with one of the following:

Where in-rack sprinklers are installed in accordance with Figure 25.9.3.3(a) , the ceiling-level sprinkler design shall be a minimum 0.45 gpm/ft^2 (18.3 mm/min) density over a 2000 ft^2 (186 m^2) demand area.

Where in-rack sprinklers are installed in accordance with Figure 25.9.3.3(b) , the ceiling-level sprinkler design shall be a minimum 0.30 gpm/ft^2 (12.2 mm/min) density over a 2000 ft^2 (186 m^2) demand area.

Where in-rack sprinklers are installed in accordance with Figure 25.9.3.3(c) , the ceiling-level sprinkler design shall be a minimum 0.45 gpm/ft^2 (18.3 mm/min) density over a 2000 ft^2 (186 m^2) demand area.

Where in-rack sprinklers are installed in accordance with Figure 25.9.3.3(d) , the ceiling-level sprinkler design shall be a minimum 0.30 gpm/ft^2 (12.2 mm/min) density over a 2000 ft^2 (186 m^2) demand area.

Where in-rack sprinklers are installed in accordance with Figure 25.9.3.3(e) , the ceiling-level sprinkler design shall be a minimum 0.6 gpm/ft^2 (24.4 mm/min) density over a 2000 ft^2 (186 m^2) demand area.

Where in-rack sprinklers are installed in accordance with Figure 25.9.3.3(f) , the ceiling-level sprinkler design shall be a minimum 0.45 gpm/ft^2 (18.3 mm/min) density over a 2000 ft^2 (186 m^2) demand area.

Where in-rack sprinklers are installed in accordance with Figure 25.9.3.3(g) , the ceiling-level sprinkler design shall be a minimum 0.8 gpm/ft^2 (32.6 mm/min) density over a 1500 ft^2 (139 m^2) demand area.

Where in-rack sprinklers are installed in accordance with Figure 25.9.3.3(h) , the ceiling-level sprinkler design shall be a minimum 0.6 gpm/ft^2 (24.4 mm/min) density over a 1500 ft^2 (139 m^2) demand area.

Where in-rack sprinklers are installed in accordance with Figure 25.9.3.3(i) , the ceiling-level sprinkler design shall be a minimum 0.30 gpm/ft^2 (12.2 mm/min) density over a 2000 ft^2 (186 m^2) demand area.

Where in-rack sprinklers are installed in accordance with Figure 25.9.3.3(j) , the ceiling-level sprinkler design shall be a minimum 0.8 gpm/ft^2 (32.6 mm/min) density over a 1500 ft^2 (139 m^2) demand area.

Where in-rack sprinklers are installed in accordance with Figure 25.9.3.3(k) , the ceiling-level sprinkler design shall be a minimum 0.30 gpm/ft^2 (12.2 mm/min) density over a 2000 ft^2 (186 m^2) demand area.

25.2.3.5* Rack Storage of Group A Plastic Commodities Stored Over 25 ft (7.6 m) in Height.

Where rack storage of Group A plastic commodities, encapsulated or nonencapsulated, over 25 ft (7.6 m) in height are protected by in-rack sprinklers in accordance with 25.9.4 25.9.4, ceiling-level sprinkler designs, in terms of density [gpm/ft^2 (mm/min)] and area of operation [ft^2 (m^2)], shall be selected from Table 25.2.3.5 Table 25.2.3.5 based on the storage height of commodity above the top level of in-rack sprinklers.

Table 25.2.3.5 Control Mode Density/Area Sprinkler Discharge Criteria for Single , Double , and Multiple-Row Racks of Group A Plastic Commodities with Storage Over 25 ft (7.6 m) in Height

Storage Height Above Top Level In-Rack Sprinklers		Ceiling Sprinklers Density	
ft	m	gpm/ft^2 over ft^2	mm/min over m^2
5 or less	1.5 or less	0.30/2000	12.2/186
Over 5 up to 10	Over 1.5 up to 3.0	0.45/2000	18.3/186

25.2.3.6 Rack Storage of Rubber Tires Stored Over 12 ft (3.7 m) in Height.

25.2.3.6.1 General.

The requirements of Chapter 20 shall apply unless modified in this section.

25.2.3.6.2* Ceiling Systems.

Where rack storage of rubber tires, either on-side or on-tread, over 5 ft (1.5 m) and up to and including 20 ft (6.1 m) in height protected by CMDA sprinklers at ceiling level with a maximum clearance to ceiling of 10 ft (3.0 m) along with one level of in-rack sprinklers, the ceiling-level sprinkler system design density and area of application shall be a minimum 0.40 gpm/ft^2 (16.3 mm/min) density over a 3000 ft^2 (279 m^2) demand area.

25.2.3.6.3 Reduced-Discharge Density.

Where high-expansion foam systems are installed in accordance with NFPA 11 to protect rack storage of rubber tires, either on-side or on-tread, over 5 ft (1.5 m) and up to and including 20 ft (6.1 m) in height protected by CMDA sprinklers at ceiling-level with a maximum clearance to ceiling of 10 ft (3.0 m) and one level of in-rack sprinklers, the ceiling-level sprinkler system design density shall be permitted to be reduced from 0.40 gpm/ft^2 (16.3 mm/min) 0.24 gpm/ft^2 (9.8 mm/min).

25.2.3.6.4 Water Supplies.

Total water supplies shall be capable of providing flow for automatic sprinklers, hose streams, and foam systems (if provided) for the duration required in Table 20.12.2.6.

25.2.4 CMSA Ceiling Level Sprinkler Design Criteria in Combination with In-Rack Sprinklers.

25.2.4.1 General.

25.2.4.1.1 Open Wood Joist Construction with CMSA Sprinklers at Ceiling-Level.

25.2.4.1.1.1

Where CMSA sprinklers are installed under open wood joist construction, fire-stopping in accordance with 25.2.4.1.1.3 shall be provided or the minimum operating pressure of the sprinklers shall be 50 psi (3.4 bar) for a K-11.2 (160) sprinkler or 22 psi (1.5 bar) for a K-16.8 (240) sprinkler.

25.2.4.1.1.2

Where each joist channel of open wood joist construction is fully fire-stopped to its full depth at intervals not exceeding 20 ft (6.1 m), the lower pressures specified in Table 25.2.4.2.1 shall be permitted to be used.

25.2.4.1.2 Preaction Systems for CMSA Sprinklers.

For the purpose of using Table 25.2.4.2.1, preaction systems shall be classified as dry pipe systems.

25.2.4.2 Rack Storage of Class I Through Class IV Commodities.

~~**25.2.4.2.1**~~

~~Where rack storage of Class I through Class IV commodities is protected by CMSA sprinklers at ceiling level along with one level of in-rack sprinklers, the ceiling-level sprinkler design criteria shall be in accordance with Table 25.2.4.2.1.~~

~~**25.2.4.2.2**~~

~~Protection shall be provided as specified in Table 25.2.4.2.1 or appropriate NFPA standards in terms of minimum operating pressure and the number of ceiling-level sprinklers to be included in the design area.~~

~~**25.2.4.3** Rack Storage of Group A Plastic Commodities.~~

~~25.2.4.3.1~~

Where rack storage of nonexpanded, cartoned and uncartoned, Group A plastic commodities is protected by CMSA sprinklers at ceiling level along with one level of in-rack sprinklers, the ceiling-level sprinkler system design criteria shall be in accordance with Table 25.2.4.3.1 .

Table 25.2.4.3.1 CMSA Ceiling-Level Sprinkler Design Criteria for Rack Storage of Group A Plastic Commodities Stored Up and Including 25 ft (7.6 m) in Height Supplemented with In-Rack Sprinklers

Storage Arrangement	Commodity Class	Maximum Storage Height		Maximum Ceiling/Roof Height		K-Factor/ Orientation	Type of System	Number of Design Sprinklers	Minimum Operating Pressure	
		ft	m	ft	m				psi	bar
Single-, double-, and multiple-row racks (no open-top containers)	Cartoned nonexpanded plastics	20	6.1	25	7.6	11.2 (160) Upright	Wet	15	50	3.4
						16.8 (240) Upright	Wet	15	22	1.5
						19.6 (280) Pendent	Wet	15	16	1.1
-						11.2 (160) Upright	Wet Wet	3020	50 75	3.4 5.2
-				30	9.1	16.8 (240) Upright	Wet	15*	22	1.5
-		-	-			19.6 (280) Pendent	Wet	15	16	1.1
-		25	7.6	30	9.1	11.2 (160) Upright	Wet	15 + 1 level of in-rack	50	3.4
-						16.8 (240) Upright	Wet	15*	22	1.5
-						19.6 (280) Pendent	Wet	15	16	1.1
-		25	7.6	35	11	11.2 (160) Upright	Wet	30 + 1 level of in-rack	50	3.4
-							Wet	20 + 1 level of in-rack	75	5.2
-						16.8 (240) Upright	Wet	30 + 1 level of in-rack	22	1.5
-							Wet	20 + 1 level of in-rack	35	2.4
-						19.6 (280) Pendent	Wet	15	25	1.7
-	-	20	6.1	25	7.6	11.2 (160) Upright	Wet	15	50	3.4
-						16.8 (240) Upright	Wet	15	22	1.5
-	Exposed nonexpanded plastics	20	6.1	30	9.1	11.2 (160) Upright	Wet	30	50	3.4
-							Wet	20	75	5.2
-						16.8 (240) Upright	Wet	15*	22	1.5
-		25	7.6	30	9.1	11.2 (160) Upright	Wet	15 + 1 level of in-rack	50	3.4
-						16.8 (240) Upright	Wet	15*	22	1.5
-		25	7.6	35	11	11.2 (160) Upright	Wet	30 + 1 level of in-rack	50	3.4

Storage Arrangement	Commodity Class	Maximum Storage Height		Maximum Ceiling/Roof Height		K-Factor/ Orientation	Type of System	Number of Design Sprinklers	Minimum Operating Pressure	
		ft	m	ft	m				psi	bar
-							Wet	20 + 1 level of in-rack	75	5.2
-						16.8 (240) Upright	Wet	30 + 1 level of in-rack	22	1.5
-							Wet	20 + 1 level of in-rack	35	2.4

*Minimum 8 ft (2.4 m) aisle.

25.2.4.3.2

Protection shall be provided as specified in Table 25.2.4.3.1 or appropriate NFPA standards in terms of minimum operating pressure and the number of ceiling-level sprinklers to be included in the design area.

25.2.5 ESFR Ceiling Level Sprinkler Design Criteria in Combination with In-Rack Sprinklers.

25.2.5.1 Rack Storage of Class I Through Class IV Commodities.

25.2.5.1.1

Where rack storage of Class I through Class IV commodities is protected by ESFR sprinklers at ceiling level along with one level of in-rack sprinklers, the ceiling-level sprinkler design criteria shall be in accordance with Table 25.2.5.1.1.

25.2.5.1.2

ESFR sprinkler systems, when supplemented with in-rack sprinklers, shall be designed such that the minimum operating pressure is not less than that indicated in Table 25.2.5.1.1 for type of storage, commodity, storage height, and building height involved.

25.2.5.1.3

The design area applicable to the ceiling-level design options listed in Table 25.xx shall consist of the most hydraulically demanding area of 12 sprinklers, consisting of four sprinklers on each of three branch lines.

25.2.5.2 Rack Storage of Group A Plastic Commodities.

~~25.2.5.2.1~~

Where rack storage of cartoned or exposed nonexpanded Group A plastic and cartoned expanded Group A plastic commodity is protected by ESFR sprinklers at ceiling level along with one level of in-rack sprinklers, the ceiling-level sprinkler design criteria shall be in accordance with Table 25.2.5.2.1.

Table 25.2.5.2.1 ESFR Ceiling-Level Sprinkler Design Criteria for Rack Storage of Group A Plastic Commodities Supplemented with In-Rack Sprinklers

Storage Arrangement	Commodity	Maximum Storage Height		Maximum Ceiling/Roof Height		Nominal K-Factor	Orientation	Minimum Operating Pressure		In-Rack Sprinkler Requiremer
		ft	m	ft	m			psi	bar	
Single-, double-, and multiple-row racks (no open-top containers)	Cartoned nonexpanded	20	6.1	25	7.6	14.0 (200)	Upright/ pendent	50	3.4	No
-	-	-	-			16.8 (240)	Upright/ pendent	35	2.4	No
-	-	-	-			22.4 (320)	Pendent	25	1.7	No
-	-	-	-			25.2 (360)	Pendent	15	1.0	No
-	-	-	-	30	9.1	14.0 (200)	Upright/ pendent	50	3.4	No
-	-	-	-			16.8 (240)	Upright/ pendent	35	2.4	No
-	-	-	-			22.4 (320)	Pendent	25	1.7	No
-	-	-	-			25.2 (360)	Pendent	15	1.0	No
-	-	-	-	35	11	14.0 (200)	Upright/ pendent	75	5.2	No
-	-	-	-			16.8 (240)	Upright/ pendent	52	3.6	No
-	-	-	-			22.4 (320)	Pendent	35	2.4	No
-	-	-	-			25.2 (360)	Pendent	20	1.4	No
-	-	-	-	40	12	16.8 (240)	Pendent	52	3.6	No
-	-	-	-			22.4 (320)	Pendent	40	2.7	No
-	-	-	-			25.2 (360)	Pendent	25	1.7	No
-	-	-	-	45	14	14.0 (200)	Pendent	90	6.2	Yes
-	-	-	-			16.8 (240)	Pendent	63	4.3	Yes
-	-	-	-			22.4 (320)	Pendent	40	2.7	No
-	-	-	-			25.2 (360)	Pendent	40	2.7	No
-	-	25	7.6	30	9.1	14.0 (200)	Upright/pendent	50	3.4	No

Storage Arrangement	Commodity	Maximum Storage Height ft	Maximum Storage Height m	Maximum Ceiling/Roof Height ft	Maximum Ceiling/Roof Height m	Nominal K-Factor	Orientation	Minimum Operating Pressure psi	Minimum Operating Pressure bar	In-Rack Sprinkler Requiremer
-	-	-	-			16.8 (240)	Upright/ pendent	35	2.4	No
-	-	-	-			22.4 (320)	Pendent	25	1.7	No
-	-	-	-			25.2 (360)	Pendent	15	1.0	No
-	-	-	-	32	10	14.0 (200)	Upright/ pendent	60	4.1	No
-	-	-	-			16.8 (240)	Upright/ pendent	42	2.9	No
-	-	-	-			14.0 (200)	Upright/ pendent	75	5.2	No
-	-	-	-			16.8 (240)	Upright/ pendent	52	3.6	No
-	-	-	-	35	11	22.4 (320)	Pendent	35	2.4	No
-	-	-	-			25.2 (360)	Pendent	20	1.4	No
-	-	-	-			16.8 (240)	Pendent	52	3.6	No
-	-	-	-	40	12	22.4 (320)	Pendent	40	2.7	No
-	-	-	-			25.2 (360)	Pendent	25	1.7	No
-	-	-	-			14.0 (200)	Pendent	90	6.2	Yes
-	-	-	-			16.8 (240)	Pendent	63	4.3	Yes
-	-	-	-	45	14	22.4 (320)	Pendent	40	2.7	No
-	-	-	-			25.2 (360)	Pendent	40	2.7	No
-	Exposed nonexpanded	20	6.1			14.0 (200)	Pendent	50	3.4	No
-	-	-	-	25	7.6	16.8 (240)	Pendent	35	2.4	No
-	-	-	-			14.0 (200)	Pendent	50	3.4	No
-	-	-	-	30	9.1	16.8 (240)	Pendent	35	2.4	No
-	-	-	-			14.0 (200)	Pendent	75	5.2	No
-	-	-	-	35	11	16.8 (240)	Pendent	52	3.6	No
-	-	-	-	40	12	16.8 (240)	Pendent	52	3.6	No

Storage Arrangement	Commodity	Maximum Storage Height ft	Maximum Storage Height m	Maximum Ceiling/Roof Height ft	Maximum Ceiling/Roof Height m	Nominal K-Factor	Orientation	Minimum Operating Pressure psi	Minimum Operating Pressure bar	In-Rack Sprinkler Requiremer
-	-	-	-	45	14	14.0 (200)	Pendent	90	6.2	Yes
-	-	-	-			16.8 (240)	Pendent	63	4.3	Yes
-	-	25	7.6	30	9.1	14.0 (200)	Pendent	50	3.4	No
-	-	-	-			16.8 (240)	Pendent	35	2.4	No
-	-	-	-	32	10	14.0 (200)	Pendent	60	4.1	No
-	-	-	-			16.8 (240)	Pendent	42	2.9	No
-	-	-	-	35	11	14.0 (200)	Pendent	75	5.2	No
-	-	-	-			16.8 (240)	Pendent	52	3.6	No
-	-	-	-	40	12	16.8 (240)	Pendent	52	3.6	No
-	-	-	-			22.4 (320)	Pendent	50	3.4	No
-	-	-	-			25.2 (360)	Pendent	50	3.4	No
-	-	-	-	45	14	14.0 (200)	Pendent	90	6.2	Yes
-	-	-	-			16.8 (240)	Pendent	63	4.3	Yes
-	Cartoned expanded	20	6.1	25	7.6	14.0 (200)	Upright/ pendent	50	3.4	No
-	-	-	-			16.8 (240)	Upright/ pendent	35	2.4	No
-	-	-	-	30	9.1	14.0 (200)	Upright/ pendent	50	3.4	No
-	-	-	-			16.8 (240)	Upright/ pendent	35	2.4	No
-	-	25	7.6	30	9.1	14.0 (200)	Upright/ pendent	50	3.4	No
-	-					16.8 (240)	Upright/ pendent	35	2.4	No
-	-			32	10	14.0 (200)	Pendent	60	4.1	No
-	-					16.8 (240)	Upright/ pendent	42	2.9	No

25.2.5.2.2

ESFR sprinkler systems, when supplemented with in-rack sprinklers, shall be designed such that the minimum operating pressure is not less than that indicated in Table 25.2.5.2.1 for type of storage, commodity, storage height, and building height involved.

25.2.5.2.3

The design area applicable to the ceiling-level design options listed in Table 25.2.5.2.1 shall consist of the most hydraulically demanding area of 12 sprinklers, consisting of four sprinklers on each of three branch lines.

25.3 In-Rack Sprinkler Characteristics.

25.3.1

In-rack sprinklers shall be pendent or upright, standard- or quick-response, ordinary-temperature rated and have a nominal K-factor of K-5.6 (80), K-8.0 (115), or K-11.2 (160).

25.3.2

In-rack sprinklers protecting open-frame rack storage where ESFR sprinklers are installed at ceiling level shall be quick-response, ordinary-temperature rated, and either K-8.0 (115) or K-11.2 (160).

25.3.3

In-rack sprinklers with intermediate- and high-temperature ratings shall be used near heat sources as required by 9.4.2.

25.3.4

In-rack sprinklers shall be permitted to have a different RTI rating than the ceiling sprinklers under which they are installed.

25.3.5 In-Rack Sprinkler Water Shields.

25.3.5.1 In-Rack Sprinkler Water Shields for Storage of Class I Through Class IV Commodities.

Water shields shall be provided directly above in-rack sprinklers, or listed intermediate level/rack storage sprinklers shall be used where there is more than one level, if not shielded by horizontal barriers. *(See Section C.3 .)*

25.3.5.2 In-Rack Sprinkler Water Shields for Plastic Storage.

Where in-rack sprinklers are not shielded by horizontal barriers, water shields shall be provided above the sprinklers, or listed intermediate level/rack storage sprinklers shall be used.

25.4 Vertical Spacing and Location of In-Rack Sprinklers.

25.4.1

In-rack sprinklers shall not be required to meet the obstruction criteria and clearance from storage requirements of Section 9.5.

25.4.2

A minimum 6 in. (150 mm) vertical clear space shall be maintained between in-rack sprinkler deflectors and the top of storage located below them.

25.4.3*

Where in-rack sprinklers are being installed within single- and double-row racks of Class I through Class IV commodities up to and including 20 ft (6.1 m) in height, the vertical clear space of in-rack sprinkler deflectors with respect to the top of storage located below them shall be permitted to be less than 6 in. (150 mm). (See Section C.16.)

25.4.4

In-rack sprinkler discharge shall not be obstructed by horizontal rack members.

25.4.5

Where one level of in-rack sprinklers are required by the guidelines of this chapter, in-rack sprinklers shall be installed at the first tier level at or above one-half of the highest expected storage height.

25.4.6

Where two levels of in-rack sprinklers are required by the guidelines of this chapter for rack storage of Class I through Class IV commodities up to and including 25 ft (7.6 m) in height, in-rack sprinklers shall be installed at the first tier level at or above one-third and two-thirds of the highest expected storage height.

25.4.7 Maximum Storage Height Above Top In-Rack Sprinkler Level.

25.4.7.1

Where in-rack sprinklers are required for single- and double-row rack storage of Class I through Class IV commodities over 25 ft (7.6 m) in height and protected by CMDA sprinklers at ceiling level, storage above the top level of in-rack sprinklers shall not exceed 10 ft (3.0 m)

25.4.7.2

Where in-rack sprinklers are required for multiple-row rack storage of Class I through Class IV commodities over 25 ft (7.6 m) in height and protected by CMDA sprinklers at ceiling level, storage above the top level of in-rack sprinklers shall not exceed 10 ft (3.0 m) for Class I, Class II, or Class III commodities or 5 ft (1.5 m) for Class IV commodities.

25.4.7.3

Where in-rack sprinklers are required for rack storage of plastic commodities over 25 ft (7.6 m) in height and protected by CMDA sprinklers at ceiling level, storage above the top level of in-rack sprinklers shall not exceed 10 ft (3.0 m).

25.4.8

Where single- and double-row rack storage of Class I through Class IV commodities is over 25 ft (7.6 m) in height and protected by CMDA sprinklers at ceiling level, in-rack sprinklers shall be staggered vertically where installed in accordance with Table 25.9.2.1.1, Figure 25.9.2.2(A)(a) through Figure 25.9.2.2(A)(j), and Figure 25.9.2.1.1(A)(a) through Figure 25.9.2.1.1(A)(e).

25.4.9

Where multiple-row rack storage of Class I through Class IV commodities is over 25 ft (7.6 m) in height and protected by CMDA sprinklers at ceiling level, in-rack sprinklers shall be staggered vertically where installed in accordance with Table 25.9.2.1.1, Figure 25.9.2.2(A)(a) through Figure 25.9.2.2(A)(j), and Figure 25.9.2.1.1(A)(a) through Figure 25.9.2.1.1(A)(e).

25.5 Horizontal Spacing and Location of In-Rack Sprinklers.

25.5.1 Horizontal Spacing of In-Rack Sprinklers.

25.5.1.1 General.

25.5.1.1.1

In-rack sprinklers shall be permitted to be installed horizontally less than 6 ft (1.8 m) apart.

25.5.1.1.2

For miscellaneous and low piled rack storage, the maximum allowable horizontal spacing of in-rack sprinklers shall be 8 ft (2.4 m).

25.5.1.1.3

For rack storage of rubber tires, the maximum allowable horizontal spacing of in-rack sprinklers shall be 8 ft (2.4 m).

25.5.1.2 CMDA Sprinklers Installed at Ceiling Level.

25.5.1.2.1*

Where single- and double-row rack storage of Class I through Class IV commodities is up to and including 25 ft (7.6 m) in height and protected by CMDA sprinklers at ceiling level, the maximum allowable horizontal spacing of in-rack sprinklers shall be in accordance with Table 25.5.1.2.1 .

Table 25.5.1.2.1 In-Rack Sprinkler Horizontal Spacing for Class I, II, III, and IV Commodities Stored in Single- or Double-Row Racks Up to 25 ft (7.6 m) in Height Protected by Control Mode Density/Area Sprinklers at Ceiling Level

		Commodity Class							
	Aisle Widths		I and II		III		IV		
Encapsulated	ft	m	ft	m	ft	m	ft	m	
No	8	2.4	12	3.7	12	3.7	10	3.0	
No	4	1.2	12	3.7	10	3.0	10	3.0	
Yes	—	—	8	2.4	8	2.4	8	2.4	

25.5.1.2.2

Where multiple-row rack storage of Class I through Class IV commodities is up to and including 25 ft (7.6 m) in height and protected by CMDA sprinklers at ceiling level, the maximum allowable horizontal spacing of in-rack sprinklers shall be in accordance with Table 25.5.1.2.2.

Table 25.5.1.2.2 In-Rack Sprinkler Horizontal Spacing for Class I, II, III, and IV Commodities Stored in Multiple-Row Racks Up to 25 ft (7.6 m) in Height Protected by Control Mode Density/Area Sprinklers at Ceiling Level

Commodity Class									
I, II, III					IV				
Spacing		Area			Spacing		Area		
ft	m	ft^2	m^2		ft	m	ft^2	m^2	
12	3.7	100	9.3		8	2.4	80	7.4	

(A)

The rack plan view shall be considered in determining the area covered by each sprinkler.

(B)

The aisles shall not be included in area calculations.

25.5.1.2.3

Where rack storage of plastic commodities is up to and including 25 ft (7.6 m) in height and protected by CMDA sprinklers at ceiling level, the maximum allowable horizontal spacing of in-rack sprinklers shall be in accordance with Figure 25.9.3.1(a) through Figure 25.9.3.1(e).

25.5.1.2.4

Where single- and double-row rack storage of Class I through Class IV commodities is over 25 ft (7.6 m) in height and protected by CMDA sprinklers at ceiling level, the maximum allowable horizontal spacing of in-rack sprinklers shall be in accordance with Table 25.9.2.1.1 and Figure 25.9.2.2(a) through Figure 25.9.2.2(j).

25.5.1.2.5

Where multiple-row rack storage of Class I through Class IV commodities is over 25 ft (7.6 m) in height and protected by CMDA sprinklers at ceiling level, the maximum allowable horizontal spacing of in-rack sprinklers shall be in accordance with Table 25.9.2.3.1 and Figure 25.9.2.3.1(a) through Figure 25.9.2.3.1(c).

25.5.1.2.6

Where single-row rack storage of cartoned Group A plastic commodities, expanded or nonexpanded, encapsulated or nonencapsulated, is over 25 ft (7.6 m) in height and protected by CMDA sprinklers at ceiling level, the maximum allowable horizontal spacing of in-rack sprinklers shall be in accordance with Figure 25.9.4.1.1(a) through Figure 25.9.4.1.1(d) or Figure 25.9.4.2.2.

25.5.1.2.7

Where double-row rack storage of cartoned Group A plastic commodities, expanded or nonexpanded, encapsulated or nonencapsulated, is over 25 ft (7.6 m) in height and protected by CMDA sprinklers at ceiling level, the maximum allowable horizontal spacing of in-rack sprinklers shall be in accordance with Figure 25.9.4.2.1(a) through Figure 25.9.4.2.1(c).

25.5.1.2.8

Where single- and double-row rack storage of exposed nonexpanded Group A plastic commodities, whether encapsulated or nonencapsulated, is over 25 ft (7.6 m) in height and protected by CMDA sprinklers at ceiling level, the maximum allowable horizontal spacing of in-rack sprinklers shall be in accordance with Figure 25.9.4.2.2.

~~**25.5.1.2.9***~~

~~Where multiple-row rack storage of exposed nonexpanded Group A plastic commodities, whether encapsulated or nonencapsulated, or cartoned Group A plastic commodities, expanded or nonexpanded, encapsulated or nonencapsulated, is over 25 ft (7.6 m) in height and protected by CMDA sprinklers at ceiling level, the maximum allowable horizontal spacing of in-rack sprinklers shall be in accordance with Figure 25.9.4.3.1(a) through Figure 25.9.4.3.1(f).~~

25.5.1.3 ~~CMSA Sprinklers Installed at Ceiling Level.~~

~~**25.5.1.3.1**~~

~~Where rack storage of Class I through Class IV commodities is up to and including 25 ft (7.6 m) in height and protected by CMSA sprinklers at ceiling level, the maximum allowable horizontal spacing of in-rack sprinklers shall be 8 ft (2.4 m).~~

~~**25.5.1.3.2**~~

~~Where rack storage of plastic commodities is up to and including 25 ft (7.6 m) in height and protected by CMSA sprinklers at ceiling level, the maximum allowable horizontal spacing of in-rack sprinklers shall be 5 ft (1.5 m).~~

~~**25.5.1.3.3**~~

~~Where rack storage of Class I through Class IV commodities is over 25 ft (7.6 m) in height and protected by CMSA sprinklers at ceiling level, the maximum allowable horizontal spacing of in-rack sprinklers shall be 5 ft (1.5 m).~~

25.5.1.4 ~~ESFR Sprinklers Installed at Ceiling Level.~~

~~Where rack storage is protected by ESFR sprinklers at ceiling level, the maximum allowable horizontal spacing of in-rack sprinklers shall be 5 ft (1.5 m).~~

25.5.2 ~~Horizontal Location of In-Rack Sprinklers.~~

~~**25.5.2.1**~~

~~In-rack sprinklers shall not be required to meet the obstruction criteria and clearance from storage requirements of Section 9.5.~~

~~**25.5.2.2***~~

~~Where in-rack sprinklers are installed in longitudinal flues, they shall be located at an intersection of transverse and longitudinal flues while not exceeding the maximum horizontal spacing rules.~~

~~**25.5.2.3**~~

~~Where horizontal distances between transverse flues exceed the maximum allowable horizontal linear spacing for in-rack sprinklers, in-rack sprinklers shall be installed at the intersection of the transverse and longitudinal flues, and additional in-rack sprinklers shall be installed between transverse flues to meet the maximum allowable horizontal linear spacing rules for in-rack sprinklers.~~

~~**25.5.2.4**~~

~~Where no transverse flues exist, horizontal spacing of in-rack sprinklers shall not exceed the maximum allowable spacing rules.~~

~~**25.5.2.5**~~

~~Where in-rack sprinklers are installed to protect a higher-hazard commodity that occupies only a portion of the length of a rack, in-rack sprinklers shall be extended a minimum of 8 ft (2.4 m) or one bay, whichever is greater, in each direction along the rack on either side of the higher hazard. The in-rack sprinklers protecting the higher hazard shall not be required to extend across the aisle.~~

~~**25.5.2.6**~~

~~The in-rack sprinkler arrangement protecting the higher hazard outlined in 25.5.2.5 shall not be required to be extended across the aisle.~~

~~**25.5.2.7***~~

~~Where rack storage is over 25 ft (7.6 m) in height, in-rack sprinklers shall be a minimum 3 in. (75 mm) radially from the side of rack uprights.~~

25.5.2.8

Where rack storage of Class I through Class IV commodities is up to and including 25 ft (7.6 m), in-rack sprinklers shall be permitted to be installed horizontally without regard to rack uprights. (See Section C.17.)

25.5.2.9

Where rack storage is over 25 ft (7.6 m) in height, face sprinklers shall be located within the rack a minimum 3 in. (75 mm) from rack uprights and no more than 18 in. (450 mm) from the aisle face of storage.

25.5.2.10

Where single- and double-row rack storage of Class I through Class IV commodities is over 25 ft (7.6 m) in height and protected by CMDA sprinklers at ceiling level, in-rack sprinklers shall be staggered horizontally where installed in accordance with Table 25.9.2.1.1, Figure 25.9.2.2(a) through Figure 25.9.2.2(j), and Figure 25.9.2.1.1(a) through Figure 25.9.2.1.1(e).

25.5.2.11

Where multiple-row rack storage of Class I through Class IV commodities is over 25 ft (7.6 m) in height and protected by CMDA sprinklers at ceiling level, in-rack sprinklers shall be staggered horizontally where installed in accordance with Table 25.9.2.3.1 and Figures 25.9.2.3.1(a) through Figure 25.9.2.3.1(c).

25.5.2.12

Where rack storage of plastic commodities is over 25 ft (7.6 m) in height, in-rack sprinklers in longitudinal flues shall be installed with the deflector located at or below the bottom of horizontal load beams or above or below other adjacent horizontal rack members.

25.5.2.13

Where miscellaneous and low piled single- and double-row rack storage does not have a longitudinal flue, in-rack sprinklers shall be located within 12 in. (300 mm) of the center of the rack while not exceeding the maximum allowable horizontal in-rack sprinkler spacing.

25.6 Protection of Racks with Solid Shelves.

25.6.1 General.

The requirements of Section 25.6 25.6 shall apply to racks with solid shelves except as modified in this section.

25.6.2

Ceiling-level sprinkler design criteria for CMDA, CMSA, and ESFR sprinklers shall be an applicable option for open racks combined with in-rack sprinklers installed in accordance with the criteria for solid shelving.

25.6.3 Vertical Spacing and Location of In-Rack Sprinklers in Racks with Solid Shelves.

25.6.3.1

Where CMDA sprinklers are at ceiling level protecting racks with solid shelving that exceeds 20 ft ^{2} (1.9 m ^{2}) in area but not 64 ft ^{2} (5.9 m ^{2}), in-rack sprinklers shall not be required below every shelf, but shall be installed below solid shelves at intermediate levels not more than 6 ft (1.8 m) apart vertically. (See Section C.11.)

25.6.3.2

Where CMDA sprinklers are at ceiling level protecting racks with solid shelving that exceeds 64 ft² (5.9 m²) in area or where the levels of storage exceed 6 ft (1.8 m), in-rack sprinklers shall be installed below each level of solid shelving.

25.6.3.3

Where CMSA sprinklers are at ceiling level and protect racks with solid shelving, in-rack sprinklers shall be installed beneath all tiers under the highest solid shelf.

25.6.3.4

Where ESFR sprinklers are at ceiling level and protect racks with solid shelving, in-rack sprinklers shall be installed beneath all tiers under the highest solid shelf.

25.6.3.5

Where racks with solid shelves obstruct only a portion of an open-frame rack, in-rack sprinklers shall be installed vertically as follows:

In accordance with Section 25.6.3.1 25.6.3.1 and 25.6.3.2 25.6.3.2 where CMDA sprinklers are installed at ceiling level

In accordance with 25.6.3.3 25.6.3.3 where CMSA sprinklers are installed at ceiling level

In accordance with 25.6.3.4 25.6.3.4 where ESFR sprinklers are installed at ceiling level

25.6.3.6

Where CMDA sprinklers are at ceiling level and protecting single- or double-row racks with solid shelves of Class I through Class IV commodities stored up to and including 25 ft (7.6 m) in height, a minimum 6 in. (150 mm) vertical clear space shall be maintained between in-rack sprinkler deflectors and the top of storage located below them.

25.6.4 Horizontal Spacing and Location of In-Rack Sprinklers in Racks with Solid Shelves.

25.6.4.1

Where racks with solid shelves contain storage of Class I through Class IV commodities, the maximum allowable horizontal spacing of in-rack sprinklers shall be 10 ft (3.0 m).

25.6.4.2

Where racks with solid shelves contain storage of plastic commodities, the maximum allowable horizontal spacing of in-rack sprinklers shall be 5 ft (1.5 m).

25.6.4.3

Where racks with solid shelves obstruct only a portion of an open-frame rack, in-rack sprinklers shall be extended beyond the end of the solid shelf a minimum of 4 ft (1.2 m) to the nearest flue space intersection.

25.7 Horizontal Barriers in Combination with In-Rack Sprinklers.

25.7.1*

Where required by sections of this chapter, horizontal barriers used in combination with in-rack sprinklers to impede vertical fire development shall be constructed of sheet metal, wood, or similar material and shall extend the full length and depth of the rack.

25.7.2

Barriers shall be fitted within 2 in. (50 mm) horizontally around rack uprights.

25.8 In-Rack Sprinkler Arrangements and Designs, Independent of Ceiling-Level Sprinklers.

25.8.1 Alternative In-Rack Sprinkler Protection Option 1.

25.8.1.1

Where Class I, II, III, IV and Group A plastic commodities are protected in accordance with the guidelines of this section, the in-rack sprinkler system shall not be required to be hydraulically balanced with the ceiling-level sprinkler system.

25.8.1.2

Where a storage rack will not be solely dedicated to the in-rack sprinkler system outlined in this section, either of the following shall apply:

Extend the protection outlined in this section horizontally one pallet load in all directions beyond the commodity storage area that is being protected by the alternative in-rack sprinkler arrangement.

Install a vertical barrier to segregate the commodities that are being protected by the alternative in-rack sprinkler arrangement.

~~**25.8.1.3**~~

~~Where a storage rack is partially protected by the in-rack sprinkler system outlined in this section, commodities that can be protected by the ceiling-level sprinkler system shall be permitted to be stored vertically above and horizontally adjacent to the portions of the storage rack protected in accordance with this section.~~

~~**25.8.1.4** Horizontal Barriers for Alternative In-Rack Sprinkler Protection Option 1.~~

~~**25.8.1.4.1**~~

~~The barrier shall be constructed of minimum 22 gauge (0.7 mm) sheet metal or of minimum ¾ in. (10 mm) plywood.~~

~~**25.8.1.4.2**~~

~~The barrier shall span horizontally to both aisle faces of the rack, covering up all flue spaces of the rack bays in which they are installed.~~

~~**25.8.1.4.3**~~

~~A maximum 3 in. (75 mm) wide horizontal gap shall be permitted at rack uprights or other equipment that would create an opening, such as vertical in-rack sprinkler pipe drops.~~

~~**25.8.1.4.4**~~

~~Where the dedicated storage is in open-frame racks, horizontal barriers shall be installed at vertical increments not exceeding 12 ft (3.6 m).~~

~~**25.8.1.4.5**~~

~~Where the dedicated storage is in racks with solid shelves, horizontal barriers shall be installed at every tier level of the dedicated storage rack.~~

~~**25.8.1.5**~~

~~In-rack sprinklers shall be quick-response, minimum K-8.0 (K-115) installed as close to the underside of the horizontal barrier as possible.~~

~~**25.8.1.6** Alternative In-Rack Sprinkler Protection Option 1 for Single-Row Racks.~~

25.8.1.6.1

For single-row racks, in-rack sprinklers shall be installed beneath horizontal barriers at each rack upright and within the rack bay as shown in Figure 25.8.1.6.1 Figure 25.8.1.6.1.

Figure 25.8.1.6.1 Alternative In-Rack Sprinkler Protection Option 1 for Single-Row Racks.

25.8.1.6.2

The maximum allowable horizontal spacing between in-rack sprinklers shall not exceed 5 ft (1.5 m).

25.8.1.7 Alternative In-Rack Sprinkler Protection Option 1 for Double-Row Racks.

25.8.1.7.1

For double-row racks, in-rack sprinklers shall be installed beneath horizontal barriers at each rack upright within the longitudinal flue space and at the face of the rack as well as at the face of each rack bay as shown in Figure 25.8.1.7.1 Figure 25.8.1.7.1.

Figure 25.8.1.7.1 Alternative In-Rack Sprinkler Protection Option 1 for Double-Row Racks.

25.8.1.7.2

The maximum allowable horizontal spacing between in-rack sprinklers shall not exceed 5 ft (1.5 m) at the rack face and 10 ft (3.0 m) within the longitudinal flue space.

25.8.1.8 Alternative In-Rack Sprinkler Protection Option 1 for Multiple-Row Racks.

25.8.1.8.1

For multiple-row racks, an alternating in-rack sprinkler arrangement shall be installed within adjacent transverse flue spaces and with sprinklers at the face of each flue space as shown in Figure 25.8.1.8.1 Figure 25.8.1.8.1.

Figure 25.8.1.8.1 Alternative In-Rack Sprinkler Protection Option 1 for Multiple-Row Racks.

25.8.1.8.2

The maximum allowable horizontal spacing between in-rack sprinklers at the face and at each alternating rack bay shall not exceed 5 ft (1.5 m) and shall not exceed 10 ft (3.0 m) between in-rack sprinklers at every other rack bay.

25.8.1.9 In-Rack Sprinkler System Design.

The in-rack sprinkler system design outlined in this section shall be based on a minimum flow of 60 gpm (230 L/min) from the most remote six in-rack sprinklers for single-row racks or the most remote eight in-rack sprinklers for both double-row and multiple-row racks.

25.8.1.10 Ceiling-Level Sprinkler System Design.

The ceiling-level sprinkler system shall be designed based on the highest commodity hazard not protected by the in-rack sprinkler system outlined in this section.

25.8.2 Alternative In-Rack Sprinkler Protection Option 2.

25.8.2.1

Where Class I, II, III, IV and Group A plastic commodities are protected in accordance with this section, the in-rack sprinkler system shall not be required to be hydraulically balanced with the ceiling-level sprinkler system.

25.8.2.2

For open-frame storage racks, install horizontal barriers as outlined in 25.7 as well as in-rack sprinklers a maximum of every 6 ft (1.8 m) vertically.

25.8.2.3

For storage racks having solid shelves with shelf areas that exceed 20 ft^2 (1.9 m^2) but not 64 ft^2 (5.9 m^2) and CMDA sprinklers are installed at ceiling level, in-rack sprinklers shall be installed below shelves at intermediate levels not more than 6 ft (1.8 m) apart vertically.

25.8.2.4

For storage racks having solid shelves with shelf areas that exceed 20 ft^2 (1.9 m^2) but not 64 ft^2 (5.9 m^2) and CMSA or ESFR sprinklers are installed at ceiling level, in-rack sprinklers shall be installed below each level of shelving.

25.8.2.5

For storage racks having solid shelves with shelf areas that exceed 64 ft^2 (5.9 m^2), in-rack sprinklers shall be installed below each level of shelving.

25.8.2.6

Where CMDA sprinklers are at ceiling level and protecting single- or double-row racks with solid shelves of Class I through Class IV commodities stored up to and including 25 ft (7.6 m) in height, a minimum 6 in. (150 mm) vertical clear space shall be maintained between in-rack sprinkler deflectors and the top of storage located below them.

25.8.2.7

Where racks contain storage of Class I through Class IV commodities, the maximum allowable horizontal spacing of in-rack sprinklers shall be 10 ft (3.0 m).

25.8.2.8

Where racks with solid shelves contain storage of plastic commodities, the maximum allowable horizontal spacing of in-rack sprinklers shall be 5 ft (1.5 m).

25.8.2.9

Face sprinklers shall be installed under each solid shelf or horizontal barrier at rack uprights.

25.8.2.10 In-Rack Sprinkler System Design.

The in-rack sprinkler design for the in-rack sprinkler arrangement outlined in this section shall be based on a minimum flow of 60 gpm (230 L/min) from the most remote eight in-rack sprinklers.

25.8.2.11

Where a storage rack will not be solely dedicated to the in-rack sprinkler system outlined in this section, either of the following shall apply:

25.8.2.11.1

Extend the protection outlined in this section horizontally one pallet load in all directions beyond the commodity storage area that is being protected by the alternative in-rack sprinkler arrangement.

25.8.2.11.2

Install a vertical barrier to segregate the commodities that are being protected by the alternative in-rack sprinkler arrangement.

~~**25.8.2.12**~~

~~Where a storage rack is partially protected by the in-rack sprinkler system outlined in this section, commodities that can be protected by the ceiling-level sprinkler system shall be permitted to be stored vertically above and horizontally adjacent to the portions of the storage rack protected in accordance with this section.~~

~~**25.9** In-Rack Sprinkler Arrangements in Combination with CMDA Sprinklers at Ceiling-Level.~~

~~**25.9.1** Rack Storage of Class I through Class IV Commodities Up to and Including 25 ft (7.6 m) in Height.~~

~~The in-rack arrangements for rack storage up to and including 25 ft (7.6 m) in height shall be in accordance with the guidelines outlined in Section 25.4 through 25.7 as applicable.~~

~~**25.9.2** Rack Storage of Class I through Class IV Commodities Over 25 ft (7.6 m) in Height.~~

~~**25.9.2.1** Single-Row Racks.~~

~~25.9.2.1.1*~~

~~In single-row racks with a maximum of 10 ft (3.0 m) between the top of storage and the ceiling, in-rack sprinklers shall be installed in accordance with Table 25.9.2.1.1 and Figure 25.9.2.1.1(a) through Figure 25.9.2.1.1(e).~~

~~Figure 25.9.2.1.1(a) In-Rack Sprinkler Arrangement, Class I, II, III, or IV Commodities, Single-Row Racks, Storage Height Over 25 ft (7.6 m) — Option 1.~~

~~Figure 25.9.2.1.1(b) In-Rack Sprinkler Arrangement, Class I, II, or III Commodities, Single-Row Racks, Storage Height Over 25 ft (7.6 m) — Option 1.~~

~~Figure 25.9.2.1.1(c) In-Rack Sprinkler Arrangement, Class I, II, or III Commodities, Single-Row Racks, Storage Height Over 25 ft (7.6 m) — Option 1.~~

~~Figure 25.9.2.1.1(d) In-Rack Sprinkler Arrangement, Class I, II, III, or IV Commodities, Single-Row Racks, Storage Height Over 25 ft (7.6 m) — Option 2.~~

~~**Figure 25.9.2.1.1(e) In-Rack Sprinkler Arrangement, Class I, II, III, or IV Commodities, Single-Row Racks, Storage Height Over 25 ft (7.6 m) — Option 3.**~~

Note: Each square represents a storage cube measuring 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. (450 mm) up to 10 ft (3.0 m). Therefore, there could be as few as one load or as many as six or seven loads between in-rack sprinklers that are spaced 10 ft (3.0 m) apart vertically.

~~25.9.2.1.2~~

~~Where a single-row rack is located against a wall, the in-rack sprinkler arrangement shall be permitted to be in accordance with Figure 25.9.2.2(a) through Figure 25.9.2.2(j).~~

~~25.9.2.1.3~~

~~Where in-rack sprinkler arrangement figures for single-row racks show in-rack sprinklers in transverse flue spaces centered between the rack faces, it shall be permitted to position these in-rack sprinklers in the transverse flue at any point between the load faces.~~

~~25.9.2.2~~ ~~Double-Row Racks.~~

~~25.9.2.2.1*~~

In double-row racks with a maximum of 10 ft (3.0 m) between the top of storage and the ceiling, in-rack sprinklers shall be installed in accordance with Table 25.9.2.2.1 and Figure 25.9.2.2.1(a) through Figure 25.9.2.2.1(j).

Table 25.9.2.2.1 Single- or Double-Row Racks of Class I Through Class IV Commodities Stored Over 25 ft (7.6 m) in Height with Aisles 4 ft (1.2 m) or More in Width

Commodity Class	In-Rack Sprinklers Approximate Vertical Spacing at Tier Nearest the Vertical Distance and Maximum Horizontal Spacing a,b,c		Figure	Maximum Storage Height	Stagger	Ceiling Sprinkler Operating Area		Ceiling Sprinkle Ceiling Up	
								Ordinary Temperature	
	Longitudinal Flue d	Face e,f				ft 2	m 2	gpm/ft 2	mm/m
I	Vertical 20 ft (6.1 m) Horizontal 10 ft (3.0 m) under horizontal barriers	None	16.3.1.3.1.1(A)(a)	30 ft (9.1 m)	No	2000	186	0.25	10.2
	Vertical 20 ft (6.1 m) Horizontal 10 ft (3.0 m)	Vertical 20 ft (6.1 m) Horizontal 10 ft (3.0 m)	16.3.1.3.1.1(A)(b)	Higher than 25 ft (7.6 m)	Yes			0.25	10.2
I, II, III	Vertical 10 ft (3.0 m) or at 15 ft (4.6 m) and 25 ft (7.6 m)	None	16.3.1.3.1.1(A)(c)	30 ft (9.1 m)	Yes	2000	186	0.3	12.2
	Vertical 10 ft (3.0 m m) Horizontal 10 ft (3.0 m m)	Vertical 30 ft (9.1 m) Horizontal 10 ft (3.0 m)	16.3.1.3.1.1(A)(d)	Higher than 25 ft (7.6 m)	Yes			0.3	12.2
	Vertical 20 ft (6.1 m) Horizontal 10 ft (3.0 m)	Vertical 20 ft (6.1 m) Horizontal 5 ft (1.5 m)	16.3.1.3.1.1(A)(e)		Yes			0.3	12.2
	Vertical 25 ft (7.6 m) Horizontal 5 ft (1.5 m)	Vertical 25 ft (7.6 m) Horizontal 5 ft (1.5 m)	16.3.1.3.1.1(A)(f)		No			0.3	12.2
	Horizontal barriers at 20 ft (6.1 m) Vertical intervals — two lines of	-	16.3.1.3.1.1(A)(g)		Yes			0.3	12.2

	~~sprinklers under barriers — maximum horizontal spacing 10 ft (3.0 m), staggered~~							
	~~Vertical 15 ft (4.6 m) Horizontal 10 ft (3.1 m)~~	~~Vertical 20 ft (6.1 m) Horizontal 10 ft (3.0 m)~~	~~16.3.1.3.1.1(A)(h)~~		~~Yes~~		~~0.35~~	~~14.3~~
	~~Vertical 20 ft (6.1 m) Horizontal 5 ft (1.5 m)~~	~~Vertical 20 ft (6.1 m) Horizontal 5 ft (1.5 m)~~	~~16.3.1.3.1.1(A)(i)~~		~~No~~		~~0.35~~	~~14.2~~
~~I, II, III, IV~~	~~Horizontal barriers at 15 ft (4.6 m) Vertical intervals — two lines of sprinklers under barriers — maximum horizontal spacing 10 ft (3.0 m), staggered~~	~~-~~	~~16.3.1.3.1.1(A)(j)~~	~~Higher than 25 ft (7.6 m)~~	~~Yes~~	~~2000~~	~~0.35~~	~~14.2~~

~~a~~ ~~Minimum in-rack sprinkler discharge, 30 gpm (114 L/min).~~

~~b~~ ~~Water shields required.~~

~~c~~ ~~All in-rack sprinkler spacing dimensions start from the floor.~~

~~d~~ ~~Install sprinklers at least 3 in. (75 mm)from uprights.~~

~~e~~ ~~Face sprinklers shall not be required for a Class I commodity consisting of noncombustible products on wood pallets (without combustible containers), except for arrays shown in Figure 16.3.1.3.1.1(A)(g) and Figure 16.3.1.3.1.1(A)(j).~~

~~f~~ ~~In Figure 16.3.1.3.1.1(A)(a) through Figure 16.3.1.3.1.1(A)(j), each square represents a storage cube that measures 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. to 10 ft (450 mm to 3.0 m). Therefore, there can be one load to six or seven loads between in-rack sprinklers that are spaced 10 ft (3.0 m) apart vertically.~~

~~g~~ ~~For encapsulated commodity, increase density 25 percent.~~

~~Figure 25.9.2.2.1(a) In-Rack Sprinkler Arrangement, Class I, II, or III Commodities, Storage Height Over 25 ft (7.6 m) — Option 1.~~

~~Figure 25.9.2.2.1(b) In-Rack Sprinkler Arrangement, Class I, II, or III Commodities, Storage Height Over 25 ft (7.6 m) — Option 2.~~

~~Figure 25.9.2.2.1(c) In-Rack Sprinkler Arrangement, Class I, II, or III Commodities, Storage Height Over 25 ft (7.6 m) — Option 3.~~

~~Figure 25.9.2.2.1(d) In-Rack Sprinkler Arrangement, Class I, II, or III Commodities, Storage Height Over 25 ft (7.6 m) — Option 4.~~

~~**Figure 25.9.2.2.1(c) In-Rack Sprinkler Arrangement, Class I, II, III, or IV Commodities, Storage Height Over 25 ft (7.6 m) — Option 1.**~~

~~Figure 25.9.2.2.1(f) In-Rack Sprinkler Arrangement, Class I, II, III, or IV Commodities, Storage Height Over 25 ft (7.6 m) — Option 2.~~

~~Figure 25.9.2.2.1(g) In-Rack Sprinkler Arrangement, Class I, II, III, or IV Commodities, Storage Height Over 25 ft (7.6 m) — Option 3.~~

~~25.9.2.3~~ ~~Multiple-Row Racks.~~

~~25.9.2.3.1*~~

In multiple-row racks with a maximum of 10 ft (3.0 m) between the top of storage and the ceiling, in-rack sprinklers shall be in accordance with Table 25.9.2.3.1 and Figure 25.9.1.3.1(a) through Figure 25.9.2.3.1(c).

Table 25.9.2.3.1 Multiple-Row Racks of Class I Through Class IV Commodities Stored Over 25 ft (7.6 m) in Height

Commodity Class	Encapsulated	In-Rack Sprinklers [a,b,c]						Height Limit (ft)	Stagger	Figure	Maxi Spa from e Stor to Hig In-R Sprin	
		Maximum Vertical Spacing		Maximum Horizontal Spacing in A Flue		Maximum Horizontal Spacing across Flue						
		ft	m	ft	m	ft	m				ft	
I	No	20	6.1	12	3.7	10	3.0	None	Between adjacent flues	16.3.1.3.1.3(A)(a)	10	
	Yes											
I, II, and III	No	15	4.6	10	3.0	10	3.0			16.3.1.3.1.3(A)(b)	10	
	Yes											
I, II, III, and IV	No	10	3.1	10	3.0	10	3.0			16.3.1.3.1.3(A)(c)	5	
	Yes											

For SI units, °C = 5/9 (°F-32); 1 gpm/ft^2 = 40.746 mm/min.

[a] All four rack faces shall be protected by sprinklers located within the racks and no more than 18 in. (450 mm) from the faces, as indicated in Figure 16.3.1.3.1.3(A)(a) through Figure 16.3.1.3.1.3(A)(c). It shall not be required for each sprinkler level to protect all faces.

[b] All in-rack sprinkler spacing dimensions start from the floor.

[c] In Figure 16.3.1.3.1.3(A)(a) through Figure 16.3.1.3.1.3(A)(c), each square represents a storage cube measuring 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. to 10 ft (450 mm to 3.0 m). Therefore, there could be as few as one load or as many as six or seven loads between in-rack sprinklers that are spaced 10 ft (3.1 m) apart vertically.

Figure 25.9.2.3.1(a) In-Rack Sprinkler Arrangement, Class I Commodities, Storage Height 25 ft to Maximum 30 ft (7.6 m to Maximum 9.1 m).

Figure 25.9.2.3.1(b) In-Rack Sprinkler Arrangement, Class I Commodities, Storage Height Over 25 ft (7.6 m).

~~Figure 25.9.2.3.1(c) In-Rack Sprinkler Arrangement, Class I, II, or III Commodities, Storage Height 25 ft to Maximum 30 ft (7.6 m to Maximum 9.1 m).~~

~~25.9.3~~ ~~Rack Storage of Group A Plastic Commodities Up to and Including 25 ft (7.6 m) in Height.~~

~~25.9.3.1~~

~~Where rack storage of cartoned Group A plastic commodities, encapsulated or nonencapsulated, having a clearance to ceiling up to and including 10 ft (3.1 m) require in-rack sprinklers, in-rack sprinkler arrangements shall be selected from Figure 25.9.3.1(a) through Figure 25.9.3.1(e) .~~

~~Figure 25.9.3.1(a) In-Rack Sprinkler Arrangement, Cartoned Group A Plastic Storage Up to 15 ft (4.6 m) in Height with Up to 10 ft (3.0 m) Clearance to Ceiling.~~

~~Figure 25.9.3.1(b) In-Rack Sprinkler Arrangement, Cartoned Group A Plastic Storage Up to Storage 20 ft (6.1 m) in Height with <5 ft (1.5 m) Clearance to Ceiling.~~

~~Figure 25.9.3.1(c) In-Rack Sprinkler Arrangement, Cartoned Group A Plastic Storage Up to Storage 20 ft (6.1 m) in Height with 5 ft to 10 ft (1.5 m to 3.0 m) Clearance to Ceiling.~~

~~**Figure 25.9.3.1(d) In-Rack Sprinkler Arrangement, Cartoned Group A Plastic Storage Up to Storage 25 ft (7.6 m) in Height with <5 ft (1.5 m) Clearance to Ceiling.** *(See Note 2.)*~~

~~**Figure 25.9.3.1(c) In-Rack Sprinkler Arrangement, Cartoned Group A Plastic Storage Up to Storage 25 ft (7.6 m) in Height with 5 ft to 10 ft (1.5 m to 3.0 m) Clearance to Ceiling.** *(See Note 2.)*~~

~~**25.9.3.2***~~

~~Notes in each figure shall be permitted to clarify options or to present additional options not shown in the figures.~~

~~25.9.3.3*~~

~~Where rack storage of exposed nonexpanded Group A plastic commodities, encapsulated or nonencapsulated, require in-rack sprinklers, in-rack sprinkler arrangements shall be selected from Figure 25.9.3.3(a) through Figure 25.9.3.3(k) .~~

~~Figure 25.9.3.3(a) In-Rack Sprinkler Arrangement, Exposed Nonexpanded Group A Plastic Commodities Up to 10 ft (3.0 m) in Height in Up to a 20 ft (6.1 m) High Building — Option 1.~~

~~Figure 25.9.3.3(b) In-Rack Sprinkler Arrangement, Exposed Nonexpanded Group A Plastic Commodities Up to 10 ft (3.0 m) in Height in Up to a 20 ft (6.1 m) High Building — Option 2.~~

~~Figure 25.9.3.3(c) In-Rack Sprinkler Arrangement, Exposed Nonexpanded Group A Plastic Commodities Up to 15 ft (4.6 m) in Height in Up to a 25 ft (7.6 m) High Building - Option 1.~~

~~Figure 25.9.3.3(d) In-Rack Sprinkler Arrangement, Exposed Nonexpanded Group A Plastic Commodities Up to 15 ft (4.6 m) in Height in Up to a 25 ft (7.6 m) High Building — Option 2.~~

~~Figure 25.9.3.3(e) In-Rack Sprinkler Arrangement, Exposed Nonexpanded Group A Plastic Commodities Up to 20 ft (6.1 m) in Height in Up to a 25 ft (7.6 m) High Building - Option 1.~~

~~Figure 25.9.3.3(f) In-Rack Sprinkler Arrangement, Exposed Nonexpanded Group A Plastic Commodities Up to 20 ft (6.1 m) in Height in Up to a 25 ft (7.6 m) High Building — Option 2.~~

~~Figure 25.9.3.3(g) In-Rack Sprinkler Arrangement, Exposed Nonexpanded Group A Plastic Commodities Up to 20 ft (6.1 m) in Height in Up to a 30 ft (9.1 m) High Building — Option 1.~~

~~Figure 25.9.3.3(h) In-Rack Sprinkler Arrangement, Exposed Nonexpanded Group A Plastic Commodities Up to 20 ft (6.1 m) in Height in Up to a 30 ft (9.1 m) High Building — Option 2.~~

~~Figure 25.9.3.3(i) In-Rack Sprinkler Arrangement, Exposed Nonexpanded Group A Plastic Commodities Up to 20 ft (6.1 m) in Height in Up to a 30 ft (9.1 m) High Building — Option 3.~~

~~Figure 25.9.3.3(j) In-Rack Sprinkler Arrangement, Exposed Nonexpanded Group A Plastic Commodities Up to 25 ft (7.6 m) in Height in Up to a 35 ft (10.7 m) High Building — Option 1.~~

~~Figure 25.9.3.3(k) In-Rack Sprinkler Arrangement, Exposed Nonexpanded Group A Plastic Commodities Up to 25 ft (7.6 m) in Height in Up to a 35 ft (10.7 m) High Building — Option 2.~~

~~**25.9.4** Rack Storage of Group A Commodities Over 25 ft (7.6 m) in Height.~~

~~**25.9.4.1** Single-Row Racks.~~

~~25.9.4.1.1~~

~~Where single-row rack storage of cartoned Group A plastic commodities, expanded or nonexpanded, encapsulated or nonencapsulated, is over 25 ft (7.6 m) in height, in-rack sprinklers shall be arranged in accordance with one of the options in Figure 25.9.4.1.1(a) through Figure 25.9.4.1.1(d).~~

~~Figure 25.9.4.1.1(a) In-Rack Sprinkler Arrangement, Cartoned Group A Plastic Commodities, Single-Row Racks, Storage Height Over 25 ft (7.6 m) — Option 1.~~

~~Figure 25.9.4.1.1(b) In-Rack Sprinkler Arrangement, Cartoned Group A Plastic Commodities, Single-Row Racks, Storage Height Over 25 ft (7.6 m) — Option 2.~~

~~Figure 25.9.4.1.1(c) In-Rack Sprinkler Arrangement, Cartoned Group A Plastic Commodities, Single-Row Racks, Storage Height Over 25 ft (7.6 m) — Option 3.~~

~~Figure 25.9.4.1.1(d) In-Rack Sprinkler Arrangement, Cartoned Group A Plastic Commodities, Single-Row Racks, Storage Height Over 25 ft (7.6 m) — Option 4.~~

~~**25.9.4.1.2**~~

~~Where a single-row rack of cartoned Group A plastic commodities is located against a wall, the in-rack sprinkler arrangement shall be permitted to be in accordance with Figure 25.9.4.2(a) or Figure 25.9.4.2(b).~~

~~25.9.4.2~~ ~~Double-Row Racks.~~

~~25.9.4.2.1~~

~~Where double-row rack storage of cartoned Group A plastic commodities, expanded or nonexpanded, encapsulated or nonencapsulated, is over 25 ft (7.6 m) in height, in-rack sprinklers shall be arranged in accordance with one of the options in Figure 25.3.5.2.1(a) through Figure 25.3.5.2.1(c).~~

~~Figure 25.9.4.2.1(a) In-Rack Sprinkler Arrangement, Cartoned Group A Plastic Commodities, Double-Row Racks, Storage Height Over 25 ft (7.6 m) — Option 1.~~

~~Figure 25.9.4.2.1(b) In-Rack Sprinkler Arrangement, Cartoned Group A Plastic Commodities, Double-Row Racks, Storage Height Over 25 ft (7.6 m) — Option 2.~~

Notes:
1. Sprinklers labeled 1 shall be required where loads labeled *A* or *B* represent top of storage.
2. Sprinklers labeled 1 and 2 shall be required where loads labeled *C* represent top of storage.
3. Sprinklers labeled 1 and 3 shall be required where loads labeled *D* or *E* represent top of storage.
4. For storage higher than loads labeled *F*, the cycle defined by Notes 2 and 3 is repeated.
5. Symbol x indicates face and in-rack sprinklers.
6. Each square represents a storage cube measuring 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. (450 mm) up to 10 ft (3.0 m). Therefore, there could be as few as one load or as many as six or seven loads between in-rack sprinklers that are spaced 10 ft (3.0 m) apart vertically.

~~**Figure 25.9.4.2.1(c) In-Rack Sprinkler Arrangement, Cartoned Group A Plastic Commodities, Double-Row Racks, Storage Height Over 25 ft (7.6 m) — Option 3.**~~

25.9.4.2.2*

Where double-row rack storage of exposed nonexpanded Group A plastic commodities, whether encapsulated or nonencapsulated, is over 25 ft (7.6 m) in height and has minimum 4 ft (1.2 m) wide aisles, in-rack sprinklers shall be arranged in accordance with Figure 25.9.4.2.2.

Figure 25.9.4.2.2 In-Rack Sprinkler Arrangement, Exposed Nonexpanded Group A Plastic Commodities, Double-Row Racks, Storage Height Over 25 ft (7.6 m).

25.9.4.2.3

Protection of Group A plastic commodities that are exposed and nonexpanded, whether encapsulated or nonencapsulated racks and with a clearance to ceiling up to and including 10 ft (3.1 m), shall be permitted only using in-rack sprinkler arrangements that are specifically permitted to be used with exposed nonexpanded plastic commodities.

25.9.4.3 Multiple-Row Racks.

~~25.9.4.3.1~~

~~Where multiple-row rack storage of exposed nonexpanded Group A plastic commodities, encapsulated or nonencapsulated, or cartoned Group A plastic commodities, expanded or nonexpanded, encapsulated or nonencapsulated, is over 25 ft (7.6 m) in height, in-rack sprinklers shall be arranged in accordance with one of the options in Figure 25.9.4.3.1(a) through Figure 25.9.4.3.1(f).~~

~~Figure 25.9.4.3.1(a) In-Rack Sprinkler Arrangement, Cartoned Group A Plastic and Exposed Nonexpanded Group A Plastic Commodities, Multiple-Row Racks, Storage Height Over 25 ft (7.6 m) — Option 1 [10 ft (3.0 m) Maximum Spacing].~~

~~Figure 25.9.4.3.1(b) In-Rack Sprinkler Arrangement, Cartoned Group A Plastic and Exposed Nonexpanded Group A Plastic Commodities, Multiple-Row Racks, Storage Height Over 25 ft (7.6 m) — Option 2 [10 ft (3.0 m) Maximum Spacing].~~

~~Figure 25.9.4.3.1(c) In-Rack Sprinkler Arrangement, Cartoned Group A Plastic and Exposed Nonexpanded Group A Plastic Commodities, Multiple-Row Racks, Storage Height Over 25 ft (7.6 m) — Option 1 [5 ft (1.5 m) Maximum Spacing].~~

~~Figure 25.9.4.3.1(d) In-Rack Sprinkler Arrangement, Cartoned Group A Plastic and Exposed Nonexpanded Group A Plastic Commodities, Multiple-Row Racks, Storage Height Over 25 ft (7.6 m) — Option 2 [5 ft (1.5 m) Maximum Spacing].~~

~~Figure 25.9.4.3.1(e) In-Rack Sprinkler Arrangement, Cartoned Group A Plastic and Exposed Nonexpanded Group A Plastic Commodities, Multiple-Row Racks, Storage Height Over 25 ft (7.6 m) — Option 3 [5 ft (1.5 m) Maximum Spacing].~~

~~**Figure 25.9.4.3.1(f) In-Rack Sprinkler Arrangement, Cartoned Group A Plastic and Exposed Nonexpanded Group A Plastic Commodities, Multiple-Row Racks, Storage Height Over 25 ft (7.6 m) — Option 4 [5 ft (1.5 m) Maximum Spacing].~~

~~**25.9.5** In-Rack Sprinkler Arrangements Due to Excessive Clearance.~~

25.9.5.1

Where the clearance to ceiling for rack storage of Class 1 through Class IV commodities up to and including 25 ft (7.6 m) in height protected by CMDA ceiling-level sprinklers exceeds 20 ft (6.1 m) and the ceiling-level protection is not capable of providing the protection needed for the storage height that would result in a clearance to ceiling of 20 ft (6.1 m), one level of supplemental, quick-response in-rack sprinklers located directly below the top tier of storage and at every flue space intersection shall be installed.

25.9.5.2

Where the clearance to ceiling for rack storage of plastic commodities up to and including 25 ft (7.6 m) in height protected by CMDA ceiling-level sprinklers exceeds 10 ft (3.0 m), and the ceiling-level protection is not capable of providing the protection needed for the storage height that would result in a clearance to ceiling of 10 ft (3.0 m) one level of supplemental, quick-response in-rack sprinklers located directly below the top tier of storage and at every flue space intersection shall be installed.

25.9.5.3

Where the clearance to ceiling exceeds 10 ft (3.0 m) for rack storage over 25 ft (7.6 m) in height, and the ceiling-level protection is not capable of providing the protection needed for the storage height that would result in a clearance to ceiling of 10 ft (3.0 m) one level of supplemental, quick-response in-rack sprinklers located directly below the top tier of storage and at every flue space intersection shall be installed.

25.9.5.4

Where the supplemental in-rack sprinkler protection has been installed in accordance with this section, the ceiling-level sprinkler system design shall be based upon the storage height that results in an acceptable clearance to ceiling.

25.9.5.5

Where in-rack sprinklers are required for the actual storage height based on a theoretical acceptable clearance to ceiling, in-rack sprinklers shall be installed as indicated by that criteria and supplemented as outlined in this section.

25.9.6 Rack Storage of Rubber Tires Up to and Including 20 ft (6.1 m) in Height.

The in-rack arrangements for rack storage of rubber tires, either on-side or on-tread, up to and including 20 ft (6.1 m) in height shall be in accordance with the guidelines outlined in 25.4 through 25.7 as applicable.

25.10 In-Rack Sprinkler Arrangements in Combination with CMSA Sprinklers at Ceiling-Level.

25.10.1* Rack Storage of Class I Through Class IV and Group A Plastic Commodities.

The in-rack arrangements for rack storage of Class I through Class IV and Group A plastic commodities protected by CMSA sprinklers at ceiling level shall be in accordance with the guidelines outlined in Section 25.4 through 25.7 as applicable.

25.11 In-Rack Sprinkler Arrangements in Combination with ESFR Sprinklers at Ceiling-Level.

25.11.1 Rack Storage of Class I Through Class IV and Group A Plastic Commodities.

The in-rack arrangements for rack storage of Class I through Class IV and Group A plastic commodities protected by ESFR sprinklers at ceiling level shall be in accordance with the guidelines outlined in Section 25.4 through 25.7 as applicable.

25.12 Design Criteria for In-Rack Sprinklers in Combination with Ceiling-Level Sprinklers.

25.12.1 General.

25.12.1.1

In-rack sprinkler design criteria for Group A plastic commodities shall be permitted for the protection of the same storage height and configuration of Class I, II, III, and IV commodities.

25.12.1.2

Pipe sizing of an in-rack sprinkler system shall be permitted to be based on hydraulic calculations and not restricted by any pipe schedule.

25.12.1.3

Where in-rack sprinklers are being installed to protect a storage rack and, due to the length of the rack, fewer in-rack sprinklers will be installed than the number of in-rack sprinklers specified in the in-rack design, the in-rack sprinkler design shall be based on only those in-rack sprinklers installed within the protected rack.

25.12.1.4

Where in-rack sprinkler arrangements have been installed in accordance with Section 25.10, Section 25.11 or Section 25.12, the flow and pressure requirements of both the ceiling and in-rack sprinkler systems over the same protected area shall be hydraulically balanced together to the higher sprinkler system pressure requirement at their point of connection.

25.12.1.5

The minimum water supply requirements for a hydraulically designed occupancy hazard automatic in-rack sprinkler system shall be determined by adding the hose stream allowance from Table 20.12.2.6 to the water supply for ceiling-level sprinklers determined in Section 25.2, unless indicated otherwise.

25.12.2 Number of Operating In-Rack Sprinklers.

25.12.2.1 In-Rack Design Based on 4 In-Rack Sprinklers.

Where in-rack sprinklers have been installed to protect miscellaneous storage, the number of in-rack sprinklers to account for in the design shall be based on the simultaneous operation of the most hydraulically remote four in-rack sprinklers.

25.12.2.2 In-Rack Design Based on 6 In-Rack Sprinklers.

25.12.2.2.1

Where in-rack sprinklers have been installed on one level to protect the following commodities and storage arrangements, the number of in-rack sprinklers to account for in the design shall be based on the simultaneous operation of the most hydraulically remote six in-rack sprinklers:

Class I through Class III commodities stored in racks with solid shelves.

Class I through Class III commodities stored in racks protected by CMDA sprinklers at ceiling level.

25.12.2.3 In-Rack Design Based on 8 In-Rack Sprinklers.

25.12.2.3.1

Where in-rack sprinklers have been installed on one level to protect the following commodities and storage arrangements, the number of in-rack sprinklers to account for in the design shall be based on the simultaneous operation of the most hydraulically remote eight in-rack sprinklers:

Class IV and Group A plastic commodities stored in racks with solid shelves.

Class IV and Group A plastic commodities stored in racks protected by CMDA sprinklers at ceiling level.

Class I through Class IV commodities stored in racks protected by CMSA sprinklers at ceiling level.

Group A plastic commodities stored in racks up to and including 25 ft (7.6 m) in height protected by CMSA sprinklers at ceiling level.

Class I through Class IV commodities stored in racks protected by ESFR sprinklers at ceiling level.

25.12.2.4 In-Rack Design Based on 10 In-Rack Sprinklers.

25.12.2.4.1

Where in-rack sprinklers have been installed on more than one level to protect the following commodities and storage arrangements, the number of in-rack sprinklers to account for in the design shall be based on the simultaneous operation of the most hydraulically remote ten in-rack sprinklers (five on each of the top two levels):

Class I through Class III commodities stored in racks with solid shelves.

Class I through Class III commodities stored in racks over 25 ft (7.6 m) in height protected by CMDA sprinklers at ceiling level.

Class IV commodities stored in racks up to and including 25 ft (7.6 m) in height protected by CMDA sprinklers at ceiling level.

25.12.2.5 In-Rack Design Based on 12 In-Rack Sprinklers.

Where in-rack sprinklers have been installed on one level to protect rack storage of rubber tires, the number of in-rack sprinklers to account for in the design shall be based on the simultaneous operation of the most hydraulically remote twelve in-rack sprinklers.

25.12.2.6 In-Rack Design Based on 14 In-Rack Sprinklers.

25.12.2.6.1

Where in-rack sprinklers have been installed on more than one level to protect the following commodities and storage arrangements, the number of in-rack sprinklers to account for in the design shall be based on the simultaneous operation of the most hydraulically remote fourteen in-rack sprinklers (seven on each of the top two levels):

Class IV and Group A plastic commodities stored in racks with solid shelves.

Class IV and Group A plastic commodities stored in racks protected by CMDA sprinklers at ceiling level.

25.12.3 In-Rack Sprinkler Flow/Pressure.

25.12.3.1 In-Rack Design Based on 15 psi (1.0 bar).

25.12.3.1.1

Where in-rack sprinklers have been installed to protect the following commodities and storage arrangements, the minimum allowable design pressure at the hydraulically most remote in-rack sprinkler shall be 15 psi (1.0 bar). (See Section C.19.)

Miscellaneous storage.

Class I through Class IV commodities stored in racks up to and including 25 ft (7.6 m) in height protected by CMDA sprinklers at ceiling level.

Class I through Class IV commodities stored in racks protected by CMSA sprinklers at ceiling level.

Group A plastic commodities stored in racks up to and including 25 ft (7.6 m) in height protected by CMDA sprinklers at ceiling level.

Group A plastic commodities stored in racks up to and including 25 ft (7.6 m) in height protected by CMSA sprinklers at ceiling level.

25.12.3.2 In-Rack Design Based on 30 psi (2.1 bar).

Where in-rack sprinklers have been installed to protect rack storage of rubber tires, the minimum allowable design pressure at the hydraulically most remote in-rack sprinkler shall 30 psi (2.1 bar).

25.12.3.3 In-Rack Design Based on 30 gpm (115 L/min).

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Chapter 26 Special Occupancy Requirements

26.1 General.

26.1.1 Application.

26.1.1.1

In addition to the requirements of Chapter 8, Chapters 11 through 22, and Chapter 23, the following special occupancy requirements shall apply.

26.1.1.1.1

All provisions of design criteria in this standard, including design area increases and reductions, shall also apply to these special occupancy requirements.

26.1.1.2

Where the requirements of the reference standard differ from the requirements of this standard, the reference standard shall take precedence.

26.1.2 Definitions.

For terms not defined in Chapter 3, the definitions of the reference standard shall apply.

26.2 Flammable and Combustible Liquids.

26.2.1 Design Requirements.

Sprinkler system discharge criteria for the protection of flammable and combustible liquids shall comply with NFPA 30.

26.2.2 Installation Requirements. (Reserved)

26.3 Aerosol Products.

26.3.1 Design Requirements.

Sprinkler system discharge criteria for the protection of aerosol products shall comply with NFPA 30B.

26.3.2 Installation Requirements. (Reserved)

26.4 Spray Application Using Flammable or Combustible Materials.

26.4.1 Design Requirements.

26.4.1.1*

The automatic sprinkler system shall be a wet pipe system, a dry pipe system, a preaction system, or an open-head deluge system, whichever is most appropriate for the portion of the spray operation being protected. [**33:**~~9.4.1~~ 9.6.1]

A.26.4.1.1

~~Spray application operations should be located only in buildings that are completely protected by an approved system of automatic sprinklers. If the operations are located in unsprinklered buildings, sprinklers should be installed to protect spray application processes where practical. Because of the rapidity and intensity of fires that involve spray operations, the available water should be ample to simultaneously supply all sprinkler heads likely to open in one fire without depleting the available water for use by hose streams. Noncombustible draft curtains can be used to limit the number of sprinklers that will open.~~ Subsection 9.6.1 of NFPA 33 lists four types of automatic sprinkler systems and requires that the one "most appropriate for the portion of the spray area being protected" be used. Generally, an open-head deluge system provides the highest level of protection, given that all sprinklers in the protected area flow simultaneously. This type of system is most appropriate for large, downdraft, water-wash spray booths when protecting automatic electrostatic spray application zones. [**33:** A.9.6.1]

~~Even when areas adjacent to coating operations are considered under reasonably positive fire control by adequate automatic sprinkler protection, damage is possible if operations are conducted on floors above those containing contents that are highly susceptible to water damage. Waterproofing and drainage of spray room floors can assist in reducing water damage on floors below. Proper drainage of the large volume of water frequently necessary to extinguish spray finishing room fires often presents considerable difficulty. [**33:** A.9.4]~~ Wet pipe automatic sprinkler systems are appropriate for protecting spray booths that utilize nonelectrostatic application processes or operations using listed electrostatic application processes. Wet pipe systems are also generally used to protect exhaust plenums (eliminator or scrubber sections), exhaust ducts, and air recirculation filter houses. [**33:** A.9.6.1]

~~Automatic sprinklers in spray areas, including the interior of spray booths and exhaust ducts, should be wet pipe, preaction, or deluge system so that water can be placed on the fire in the shortest possible time. Automatic sprinklers in spray booths and exhaust ducts should be of the lowest practical temperature rating. The delay in application of water with ordinary dry pipe sprinklers can permit a fire to spread so rapidly that final extinguishment is difficult without extensive resulting damage.~~ Dry pipe systems have been included because some exhaust duct designs include sections that are subject to freezing. [**33:** A.9.6.1]

~~The location of the sprinkler heads inside spray booths should be selected with care in order to avoid heads being placed in the direct path of spray and yet afford protection for the entire booth interior. When sprinkler heads are in the direct path of spray, even one day's operation can result in deposits on the sprinkler heads that insulate the fusible link or choke open head orifices to the extent that sprinklers cannot operate efficiently.~~ Preaction systems have been included because some spray application processes and equipment can be damaged by unwanted water discharge. This damage can be disruptive and costly. Powder spray booths and solvent concentrator (air pollution abatement) systems are examples of systems where it is appropriate to use a preaction system. [**33:** A.9.6.1]

~~Automatic sprinklers should also be located so that areas subject to substantial accumulations of overspray residue are protected. Generally, sprinklers are located no more than 4 ft (1.2 m) from side walls of booths and rooms and from dry overspray collectors (where applicable). Sprinklers in booths or rooms should be on Extra Hazard Occupancy spacing of 90 ft^2 (8.4 m^2).~~

~~All sprinklers in spray areas should be controlled by an accessible control valve, preferably an outside stem and yoke (OS&Y) valve. [**33:** A.9.4]~~

26.4.1.2

The automatic sprinkler system shall be designed ~~for Extra Hazard (Group 2) occupancies as defined in NFPA 13.~~ as follows:

(1) For spray application of styrene cross-link thermoset ~~resins, Section 17.3 of NFPA 33 shall apply.~~ resin application areas, sprinklers shall be designed for Ordinary Hazard (Group 2) as defined in this standard.

(2) ~~Automatic sprinkler systems for~~ For powder coating operations, sprinklers shall be designed for Ordinary Hazard (Group 2), as defined in ~~NFPA 13~~ this standard .

(3) For all other spray areas, sprinklers shall be designed for Extra Hazard (Group 2) as defined in this standard.

[**33:**~~9.4.2~~ 9.6.2]

~~*Exception No. 1: For spray application of styrene cross-link thermoset resins, Section 17.3 of NFPA 33 shall apply.*~~

~~*Exception No. 2: Automatic sprinkler systems for powder coating operations shall be designed for Ordinary Hazard (Group 2), as defined in NFPA 13. [**33:** 9.4.2]*~~

26.4.1.3

The sprinkler design area shall not be required to exceed the area of the booth or room in which spraying or resin application is conducted. [**33:** 9.6.2.1]

26.4.1.4

The water supply shall be sufficient to supply all sprinklers likely to open in any one fire incident without depleting the available water for use in hose streams. [**33:**~~9.4.3~~ 9.6.3]

26.4.1.5

Where sprinklers are installed to protect spray areas and mixing rooms only, water shall be permitted to be supplied from domestic water systems, provided the domestic supply can meet the design criteria of 26.4.1.2. [**33:**~~9.4.4~~ 9.6.4]

26.4.1.6

The sprinkler system shall be controlled by a separate, listed indicating valve(s), operable from floor level. [**33:**~~9.4.5~~ 9.6.5]

26.4.1.7

Automated liquid electrostatic spray application equipment that is unlisted shall be protected further by the following:

(1) In addition to meeting the requirements in ~~9.8.1~~ 9.9.1 of NFPA 33, the optical flame detection system shall also activate one of the following over each zone in which fire has been detected:

   (a) An open head deluge system designed to discharge a minimum density of 24.4 mm/min (0.6 gpm/ft^2)

   (b) A carbon dioxide extinguishing system

   (c) A dry chemical extinguishing system

   (d) A gaseous agent extinguishing system

   (e) A water mist fire protection system

   [**33:**~~9.8.2(1)~~ 9.9.2(1)]

(2) A wet pipe sprinkler system shall also be provided throughout the spray booth. This system shall meet all the applicable requirements of this standard for Extra Hazard (Group 2) occupancies.

[**33:**~~9.8.2(3)~~ 9.9.2(3)]

26.4.2 Installation Requirements.

26.4.2.1*

Sprinkler systems protecting stacks or ducts with widths or diameters equal to or greater than 10 in. (0.25 m) but less than 12 ft (3.7 m) shall meet all of the following requirements:

~~Sprinklers shall be spaced no more than 3.7 m (12 ft) apart.~~

(1) One sprinkler shall be located at the top of each vertical riser and at the midpoint of each offset. Additional sprinklers shall be spaced on 24 ft (7.3 m) centers if the rise is greater than 24 ft (7.3 m).

(2) Horizontal exhaust ducts shall have sprinklers located on 12 ft (3.7 m) centers beginning no more than 6 ft (1.7 m) from the duct entrance.

(3) If exhaust ducts are manifolded, a sprinkler shall be located in the manifold at the junction of each exhaust duct with the manifold.

(4) Sprinklers shall provide a minimum flow of 30 gpm (114 L/min) per head at a minimum of 15 psi (1 bar) pressure.

(5) Sprinklers shall be ordinary temperature rated, unless required to be higher due to operating temperatures measured in the ducts, in which case the operating temperature shall be at least 50°F (28°C) above the inside temperature of the duct.

(6)* The system demand shall include the discharge from the hydraulically most remote adjacent sprinklers in a common 100 linear ft (30.5 m) area of duct (horizontal and/or vertical).

(7)* The supply line to the duct sprinklers, if taken from the ceiling sprinkler system, shall be equipped with an accessible listed control valve.

[**33:**~~9.4.6~~ 9.6.6]

A.26.4.2.1

~~Subsection 26.4.1.1 lists four types of automatic sprinkler systems and requires that the one "most appropriate for the portion of the spray area being protected" be used. Generally, an open-head deluge system provides the highest level of protection, given that all sprinklers in the protected area flow simultaneously. This type of system is most appropriate for large, downdraft, water-wash spray booths when protecting automatic electrostatic spray application zones.~~ Water supply requirements for most industrial paint spray operations should be adequate to supply all automatic sprinklers in the spray area. Loss experience has shown that fires starting in the exhaust duct can spread to the spray booth and that fires starting in the booth can spread to the exhaust duct. [**33:** A.9.6.6]

~~Wet pipe automatic sprinkler systems are appropriate for protecting spray booths that utilize nonelectrostatic application processes or operations using listed electrostatic application processes. Wet pipe systems are also generally used to protect exhaust plenums (eliminator or scrubber sections), exhaust ducts, and air recirculation filter houses.~~ Sprinklers or sprinkler systems protecting stacks or ducts should be of a type not subject to freezing. Automatic systems are preferred, but manual systems are also acceptable. Nonfreeze or dry-type sprinkler systems can be used in ducts subject to freezing. For some industries, such as the automotive industry, manually operated open-head systems have proved to be effective protection for ducts and stacks. [**33:** A.9.6.6]

~~Dry pipe systems have been included because some exhaust duct designs include sections that are subject to freezing.~~ Ductwork in powder coating applications does not require fire protection. Based on design duct velocity, there is no accumulation of residual powder. [**33:** A.9.6.6]

~~Preaction systems have been included because some spray application processes and equipment can be damaged by unwanted water discharge. This damage can be disruptive and costly. Powder spray booths and solvent concentrator (air pollution abatement) systems are examples of systems where it is appropriate to use a preaction system. [**33:** A.9.4.1]~~

~~Water supply requirements for most industrial paint spray operations should be adequate to supply all automatic sprinklers in the spray area. Loss experience has shown that fires starting in the exhaust duct can spread to the spray booth and that fires starting in the booth can spread to the exhaust duct.~~

~~Sprinklers or sprinkler systems protecting stacks or ducts should be of a type not subject to freezing. Automatic systems are preferred, but manual systems are also acceptable. For some industries, such as the automotive industry, manually operated open-head systems have proved to be effective protection for ducts and stacks. [**33:** A.9.4.6]~~

26.4.2.1.1

Stacks and exhaust ducts shall be provided with access openings for inspection and cleaning of sprinklers. [**33:**~~9.4.6.1~~ 9.6.6.1]

26.4.2.1.2

Sprinkler systems protecting stacks and ducts that are subject to freezing shall be of a nonfreezing type or be a manually controlled open-head system. [**33:**~~9.4.6.2~~ 9.6.6.2]

26.4.2.2

Sprinklers shall be protected against overspray residue, either by location or covering, so that they will operate quickly in event of fire. [**33:**~~9.4.7~~ 9.6.7]

26.4.2.2.1

Sprinklers shall be permitted to be covered only by cellophane bags having a thickness of 0.003 in. (0.08 mm) or less or by thin paper bags. These coverings shall be replaced frequently so that heavy deposits of residue do not accumulate. [**33:**~~9.4.7.1~~ 9.6.7.1]

26.4.2.2.2

Sprinklers that have been painted or coated by overspray or residues shall be replaced with new sprinklers. [**33:**~~9.4.7.2~~ 9.6.7.2]

26.5 Solvent Extraction Plants. [NFPA 36]

26.5.1* Design Requirements.

A.26.5.1

Water spray or deluge systems that are used to protect solvent extraction process equipment or structures should be designed to provide a density of not less than 0.25 gpm/ft^2 (10.3 mm/min) of protected surface area. ~~(See NFPA 13 and NFPA 15 , for additional information.)~~ See this standard and NFPA 15 for additional information. Foam-water sprinkler or deluge systems that are used for the same purposes should be designed to provide a density of not less than 0.16 gpm/ft^2 (6.5 mm/min) of protected surface area. ~~(See NFPA 13 and NFPA 16 for additional information.)~~ See this standard and NFPA 16 for additional information. Preparation buildings should be protected with automatic sprinkler systems designed for ~~ordinary hazard (Group 2), in accordance with NFPA 13.~~ Ordinary Hazard (Group 2), in accordance with this standard. [**36:**~~A.4.8~~ A.4.9]

26.5.2 Installation Requirements. (Reserved)

26.6 Installation and Use of Stationary Combustion Engines and Gas Turbines.

26.6.1* Design Requirements.

Automatic sprinkler systems shall be designed to provide for a density of 0.3 gpm/ft^2 (12.2 mm/min) over the most remote 2500 ft^2 (230 m^2). [**37:**11.4.5.1]

26.6.2 Installation Requirements.

26.6.2.1

Sprinklers and spray nozzles shall be spaced at a 100 ft^2 (9 m^2) maximum area of coverage per sprinkler or spray nozzle. [**37:**11.4.5.1.1]

26.6.2.2

Sprinkler and water spray system coverage shall be provided to all areas within the enclosure located within 20 ft (6 m) of the following:

(1) The engine

(2) The lubricating oil system

(3) The fuel system

[**37:**11.4.5.1.2]

26.6.2.3

Sprinklers and water spray nozzles shall not be directed at engine components that are susceptible to thermal shock or deformation. [**37:**11.4.5.2]

26.7 Nitrate Film.

26.7.1 Design Requirements.

26.7.1.1

Every room, except projection booths and rewinding rooms, where nitrate film is stored or handled in quantities greater than 51 lb (23 kg), or ~~10 standard rolls~~ 10,000 ft (3050 m) , shall be protected by an automatic sprinkler system that is installed in accordance with the requirements for Group II extra hazard occupancies. [**40:**5.1.2]

26.7.1.2

Water supplies for automatic sprinklers shall be based on 20 gpm (1.26 L/sec) per sprinkler for 20 minutes for the total number of sprinklers in one vault plus 25 percent of the sprinklers in the communicating fire area. [**40:**5.2.2]

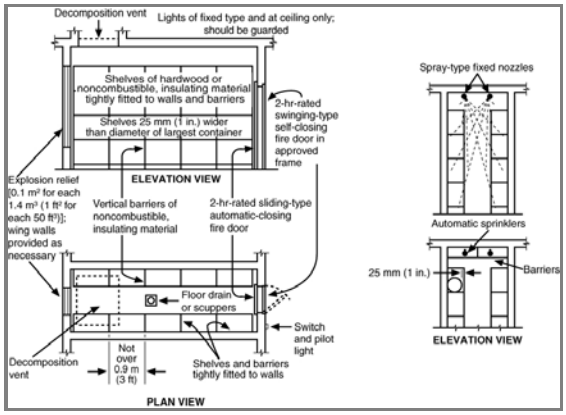
26.7.1.3* Vaults Other Than Extended Term Storage Vaults.

[**40:**6.3] *(See Figure A.26.7.1.3.)* Fire protection in vaults shall be provided by a deluge system with directional nozzles meeting the criteria in 26.7.1.4. [**40:**6.3.7]

A.26.7.1.3

See Figure A.26.7.1.3. The illustration shows the location of ~~sprinkler heads~~ sprinklers and the decomposition vent. [**40:**A.6.3]

Figure A.26.7.1.3 Standard Film Vault (for Other Than Extended Term Storage Film). [40:Figure A.6.3]



26.7.1.4

For extended term storage vaults in accordance with ~~Section~~ 6.5.5 of NFPA 40, fire protection shall be provided by a deluge system with directional nozzles installed in accordance with NFPA 15 and meeting the criteria in 26.7.1.4.1 through 26.7.1.4.9. [**40:**6.5.6]

26.7.1.4.1

Sprinkler systems in existing extended term storage vaults that were in compliance with the provisions of this standard at the time of installation shall be permitted to be continued in use. [**40:**6.5.6.1]

26.7.1.4.2

High-velocity open ~~head~~ water spray nozzles each capable of providing a discharge rate of 20 gpm (1.26 L/sec) at a gauge pressure of 50 psi (345 kPa) shall be installed. [**40:**6.5.6.2]

26.7.1.4.3

The design shall be based on a discharge density of ~~28 mm/min (0.68 gpm/ft^2)~~ 0.68 gpm/ft^2 (28 mm/min) over each face of storage racks. [**40:**6.5.6.3]

26.7.1.4.4*

The nozzles shall have a combined spray pattern capable of covering the face of the film storage racks. [**40:**6.5.6.4]

26.7.1.4.5

The nozzles shall be installed at the top of the storage shelf array, aimed at the opposite shelf array. [**40:**6.5.6.5]

26.7.1.4.6*

Nozzles shall be installed on opposite faces of the storage shelf array in a staggered pattern such that no nozzles are directly opposite one another. [**40:**6.5.6.6]

26.7.1.4.7

The water supply duration shall be a minimum of 20 minutes. [**40:**6.5.6.7]

26.7.1.4.8

The deluge system shall be activated by a signal from one of the following:

(1) An air sampling–type smoke detection system

(2) A fixed temperature heat sensitive cable

[**40:**6.5.6.8]

26.7.1.4.9

Full water flow shall be discharged from the water spray nozzles within 10 seconds of reaching the set point actuation of the detection system [**40:**6.5.6.9.6]

26.7.2 Installation Requirements.

26.7.2.1

In areas or rooms where nitrate film is handled, the area that is protected per sprinkler ~~head~~ shall not exceed 64 ft^2 (6 m^2) with sprinklers not being more than 8 ft (2.4 m) apart. [**40:**5.1.4]

26.7.2.2 Cabinet Protection.

[**40:**6.2.5]

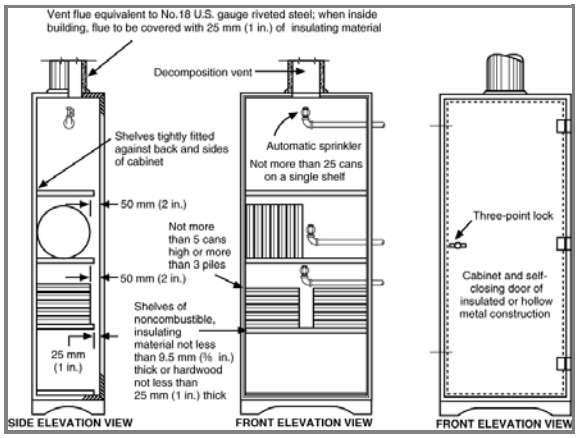
26.7.2.2.1

Cabinets having a capacity of more than ~~34 kg (75 lb), or 15 standard rolls,~~ 75 lb (34 kg), or 15,000 ft (4575 m) , of film shall be provided with at least one automatic sprinkler ~~head~~ . [**40:**6.2.5.1]

26.7.2.2.2

Where cans are stored on more than one shelf, as shown in Figure 26.7.2.2.2 and as described in 6.2.6.2 or 6.2.6.3 of NFPA 40, one sprinkler shall be provided for each shelf. [**40:**6.2.5.2]

Figure 26.7.2.2.2 Standard Film Cabinet for Other Than Extended Term Storage Film. [40:Figure 6.2.1]



26.7.2.3 Motion Picture Film Laboratories.

In all cases, sprinklers shall be arranged so that not more than two machines are protected by any one sprinkler ~~head~~ . [**40:**9.2.5.2]

26.8 Laboratories Using Chemicals.

26.8.1 Design Requirements.

Automatic sprinkler system protection shall be required for all new laboratories in accordance with the following:

(1) Automatic sprinkler system protection for Class A and Class B laboratories shall be in accordance with ~~NFPA 13~~ this standard for ordinary hazard (Group 2) occupancies.

(2) Automatic sprinkler system protection for Class C and Class D laboratories shall be in accordance with ~~NFPA 13~~ this standard for ordinary hazard (Group 1) occupancies.

[**45:**6.1.1.1]

26.8.2 Installation Requirements.

Fire sprinklers in laboratory units shall be the quick response (QR) sprinkler type installed in accordance with ~~NFPA 13~~ this standard . [**45:**6.1.1.2]

26.9 Oxygen-Fuel Gas Systems for Welding, Cutting, and Allied Processes.

26.9.1 Design Requirements.

26.9.1.1

Oxygen cylinders connected to one manifold shall be limited to a total gas capacity of 6500 ft^3 (184 m^3). [**51:**5.2.5]

26.9.1.1.1

Two such manifolds with connected cylinders shall be permitted to be located in the same room, provided the building is protected throughout with an approved automatic sprinkler system designed in accordance with this standard, furnishing a sprinkler discharge density of at least 0.25 gpm/ft^2 (10.2 mm/min) over a minimum operating area of at least 3000 ft^2 (279 m^2) with sprinklers located not more than 20 ft (6.1 m) above the floor where the manifolds are located. [**51:**5.2.5.1]

26.9.1.2

~~For mobile acetylene trailer systems, a~~ An automatic deluge sprinkler system shall be provided for MATS fire areas used as indoor and outdoor discharging stations. [**51:**10.5.8.1.1]

26.9.1.3

~~Deluge~~ Automatic deluge sprinkler systems shall ~~provide~~ be designed in accordance with the requirements of this standard using Extra Hazard Group 1 with a minimum ~~density of 0.3 gpm/ft 2 (12.2 mm/min) over~~ design area of 2500 ft^2 (232 m^2)for the entire MATS fire area ~~being protected~~ . [**51:**10.5.8.1.2]

26.9.1.4

The automatic deluge system shall be ~~identified and marked with a sign and shall~~ able to be activated automatically by a fast-acting fire detection system and also by ~~a~~ at least one manual ~~actuator.~~ pull station in an accessible location at a minimum of 25 ft (7.6 m) from the MATS fire area. [**51:**10.5.8.1.3]

26.9.1.5

The requirements of 26.9.1.2, 26.9.1.3 , and 26.9.1.4 shall not apply to existing indoor or outdoor facilities, equipment, structures, or installations where MATS are charged or discharged that existed or were approved for construction or installation prior to the effective date of this standard, ~~provided~~ providing the MATS ~~are~~ fire area is protected with an automatic sprinkler or deluge system with a minimum design density of not less than 0.25 gm/ft^2 (~~10.2~~ 10.1 mm/min). [**51:**10.5.8.1.4.1]

26.9.2 Installation Requirements.

26.9.2.1

In buildings protected by an automatic sprinkler system and water supply designed in accordance with this standard for an Ordinary Hazard Group 2 or more hazardous occupancy, where the occupancy other than the cylinder storage is not more hazardous than ordinary hazard as defined in this standard, the distance between designated storage areas shall be permitted to be reduced to ~~15.2 m (50 ft)~~ 50 ft (15.2 m). [**51:**4.3.4.1].

26.9.2.2

If the occupancy in such protected buildings between the designated storage areas is free of combustible material, the distance shall be permitted to be reduced to 25 ft (7.6 m). [**51:**4.3.4.2].

26.10 Acetylene Cylinder Charging Plants.

26.10.1 Design Requirements.

26.10.1.1

~~When sprinkler protection is provided, the area in which flammable compressed gases are stored or used shall be protected with a sprinkler system designed to be not less than that required by NFPA 13 for Extra Hazard Group 1 with a minimum design area of 2500 ft ^{2} (232.26 m ^{2}). [**51A:** 11.2.1.2]~~ An automatic deluge sprinkler system shall be provided for MATS fire areas used as indoor and outdoor charging and discharging stations. [**55:** 15.3.9.1.1]

26.10.1.2

~~At mobile acetylene trailer systems (MATS) at mobile acetylene charging plants, a fire sprinkler system in accordance with this standard, Extra Hazard Group I shall be installed in the areas occupied by trailers in charging or discharging stations. [**51A:** 11.2.1.3]~~ Automatic deluge sprinkler systems shall be designed in accordance with the requirements of this standard using Extra Hazard Group 1 with a minimum design area of 2500 ft ^{2} for the entire MATS fire area. [**55:** 15.3.9.1.2]

26.10.1.3

The automatic deluge system shall be able to be activated automatically by a fast-acting fire detection system and also by at least one manual pull station in an accessible location at a minimum of 25 ft (7.6 m) from the MATS fire area. [**55:** 15.3.9.1.3]

26.10.2 Installation Requirements. (Reserved)

26.11 Compressed Gases and Cryogenic Fluids Code.

26.11.1 Design Criteria.

26.11.1.1

When sprinkler protection is required, the area in which compressed gases or cryogenic fluids are stored or used shall be protected with a sprinkler system designed to be not less than that required by ~~NFPA 13~~ 19.3.3.1.1 for Ordinary Hazard Group 2~~.~~ density/area curve. [**55:**~~6.10.2.1~~ 6.11.2.1]

26.11.1.2

~~When~~ Where sprinkler protection is required, the area in which the flammable or pyrophoric compressed gases or cryogenic fluids are stored or used shall be protected with a sprinkler system designed to be not less than that required by ~~NFPA 13~~ 19.3.3.1.1 for Extra Hazard Group 1 density/area curve . [**55:**~~6.10.2.2~~ 6.11.2.2]

26.11.2 Installation Requirements. (Reserved)

26.12 Utility LP-Gas Plants.

26.12.1 Design Requirements.

26.12.1.1

The design of fire water supply and distribution systems, where used, shall provide for the simultaneous supply of those fixed fire protection systems involved in the maximum single incident expected in the plant, including monitor nozzles, at their design flow and pressure. [**59:**13.4.2]

26.12.1.2

An additional supply of 1000 gal/min (63 L/sec) shall be available for hand hose streams for a period of not less than 2 hours. [**59:**13.4.2.1]

26.12.1.3

Manually actuated monitors shall be permitted to be used to augment hand hose streams. [**59:**13.4.2.2]

26.12.2 Installation Requirements. (Reserved)

26.13 Production, Storage, and Handling of Liquefied Natural Gas (LNG).

26.13.1 Design Requirements.

The fire water supply and distribution systems, if provided, shall simultaneously supply water to fixed fire protection systems, including monitor nozzles, at their design flow and pressure, involved in the maximum single incident expected in the plant plus an allowance of 1000 gpm (63 L/sec) for hand hose streams for not less than 2 hours. [**59A:**12.5.2]

26.13.2 Installation Requirements. (Reserved)

26.14 Protection of Information Technology Equipment.

26.14.1 Design Requirements. (Reserved)

26.14.2 Installation Requirements.

26.14.2.1

~~Information technology equipment~~ ITE rooms and ~~information technology equipment~~ ITE areas located in a sprinklered building shall be provided with an automatic sprinkler system. [**75:**9.1.1]

26.14.2.1.1

ITE rooms and ITE areas located in a nonsprinklered building shall be provided with one or more automatic fire suppression systems as permitted by Chapter 9 of NFPA 75 .

26.14.2.2

Sprinkler systems protecting ~~information technology equipment~~ ITE areas shall be valved separately from other sprinkler systems. [**75:**9.1.3]

26.14.2.3

The requirement of 9.1.1.1 of NFPA 75 shall be permitted to be evaluated as part of the fire risk assessment as outlined in Chapter 4 of NFPA 75 . [**75:** 9.1.1.2]

26.14.2.4*

An automatic ~~sprinkler~~ fire suppression system~~or a gaseous fire extinguishing system~~ , as permitted by Chapter 9 of NFPA 75 , shall be provided for the protection of the area below a raised floor in an ~~information technology equipment room or information technology equipment~~ ITE room or ITE area where the area below the raised floor contains combustible material other than what is permitted in 26.14.2.5 . [**75:** 9.1.1.3] ~~when one or more of the following exist:~~

~~There is a critical need to protect data in the process, reduce equipment damage, and facilitate return to service.~~

~~The area below the raised floor contains combustible material.~~

~~[**75:** 9.1.1.2]~~

A.26.14.2.4

The use of carbon dioxide systems for the protection of spaces beneath raised floors is discussed in Section B.5 of NFPA 12 wherein it is pointed out that the design of such systems requires compensation for leakage and provision for a soft discharge to minimize turbulence and agent loss through perforated tiles. These same concerns exist for other inert gas clean agent systems installed in accordance with NFPA 2001. Since these spaces are usually of a very limited height, this type of fire suppression system may be easier to design and install than sprinklers. [**75:**~~A.8.1.1.2~~ A.9.1.1.3]

The use of halocarbon agents for protection of the spaces under a raised floor where the room is not simultaneously protected is not recommended. However, where a room is protected by a halocarbon system, the space beneath its raised floor needs to be included in the system coverage. [**75:** A.9.1.1.3]

26.14.2.5

An automatic fire suppression system shall not be required for the protection of the area below a raised floor in an ITE room or ITE area where combustible material under the floor is limited to the following:

(1) Cables listed for plenum use

(2) Listed plenum communications raceways

(3) Listed equipment power cords up to 15 ft (4.6 m) each

(4) Cables installed in metallic raceways

(5) Installations in compliance with Section 300.22(C) of *NFPA 70*

(6) Listed cooling hoses

[**75:** 9.1.1.4]

26.15 Standard on Incinerators, and Waste and Linen Handling Systems and Equipment.

26.15.1 Design Requirements. (Reserved)

26.15.2 Installation Requirements.

26.15.2.1

Automatic sprinklers shall be provided in incinerator rooms in accordance with this standard. [**82:**5.2.7.3]

26.15.2.2* Waste and Linen Chutes and Transport Systems.

[**82:**Chapter 6]

26.15.2.2.1 Gravity Waste or Linen Chutes.

[**82:**6.2]

26.15.2.2.1.1

Lined metal chutes ~~shall be protected internally by automatic sprinklers unless they are lined in accordance~~ that comply with 6.2.2.6.1 ~~in~~ of NFPA 82~~.~~ shall not require automatic sprinkler protection. [**82:**6.2.2.6.2]

26.15.2.2.1.2

~~This protection requires that a~~ A sprinkler shall be installed at or above the top ~~service opening~~ chute intake of the chute. [**82:**6.2.6.1.2]

26.15.2.2.1.3 Chute Sprinkler Protection.

Automatic sprinklers installed in gravity chute ~~service openings~~ intakes shall be recessed out of the chute area through which the material travels. [**82:**6.2.6.1.3]

26.15.2.2.1.4

~~In addition, a~~ A sprinkler shall be installed within the chute at alternate floor levels in ~~buildings over~~ chutes connecting more than two stories ~~in height~~ , with a mandatory sprinkler located at the lowest service level. [**82:**6.2.6.1.4]

26.15.2.2.1.5

Gravity chutes shall be protected internally by automatic sprinklers unless ~~they are lined~~ the chute is in accordance with ~~6.2.2.6.1 in~~ 6.2.2.5 or 6.2.2.6 of NFPA 82. [**82:**6.2.6.1.1]

26.15.2.2.1.6 Chute Room Automatic Sprinklers.

Automatic sprinklers shall be installed in chute ~~terminal~~ discharge rooms. [**82:**6.2.6.2.1]

26.15.2.2.2 Full Pneumatic Waste and Linen Conveying Systems.

[**82:**6.3]

26.15.2.2.2.1

Full pneumatic-type risers shall be protected internally by automatic sprinklers. [**82:**6.3.4.1]

26.15.2.2.2.2

A sprinkler shall be required at or above the top ~~loading station~~ chute intake door and at alternate floor levels in buildings over two stories ~~in height~~ , with a mandatory sprinkler located at the lowest ~~loading station~~ chute intake door . [**82:**6.3.4.2]

26.15.2.2.2.3

Sprinklers shall be recessed out of the station area through which the material travels. [**82:**6.3.4.3]

26.15.2.2.3 Gravity Pneumatic Trash or Linen Conveying Systems.

[**82:**6.4]

26.15.2.2.3.1 Chute Automatic Sprinklers.

Where material is to be stored at the bottom of the chute and above the riser discharge damper (above the transport tee), automatic sprinklers shall be installed below the last service door on the chute. [**82:**6.4.2.3]

26.15.2.2.3.2

Automatic sprinklers shall be installed in chute discharge rooms. [**82:**6.4.2.4.3]

26.15.2.3 ~~Other Waste Handling Systems.~~ Automatic Sprinklers. [82:7.4]

26.15.2.3.1

Automatic sprinklers shall be installed in rooms where waste handling systems and equipment are used to transport waste from interim storage areas to waste processing equipment, such as incinerators. [**82:**7.4.1]

26.15.2.3.2

In locations or rooms where waste handling systems and equipment are used for interim storage of waste only, the rooms shall be sprinklered in accordance with requirements specified in 26.15.2.4. [**82:**7.4.2]

26.15.2.4 Waste Compactors. [82:Chapter 8]

26.15.2.4.1

All chute-fed compactors shall have an automatic sprinkler with a minimum ½ in. (13 mm) orifice installed in the hopper of the compactor. [**82:**8.2.1]

26.15.2.4.2

Sprinklers shall be ordinary temperature-rated sprinklers. [**82:**8.2.1.1]

26.15.2.4.3

Sprinklers shall be supplied by a minimum of 1 in. (25.4 mm) ferrous piping or ¾ in. (19 mm) copper tubing line from the domestic cold water supply or by the building fire sprinkler system. [**82:**8.2.1.2]

26.15.2.4.4

Sprinkler water pipe shall be protected from freezing in outdoor installations. [**82:**8.2.1.3]

26.15.2.4.5

Hand-fed compactors located within a building and not operated in conjunction with a chute shall not require installation of an automatic sprinkler in the hopper. [**82:**8.2.2]

26.15.2.5

Waste and recyclables storage rooms shall be provided with automatic sprinklers in accordance with this standard. [**82:**9.3]

26.15.2.6

Rooms in which waste processing equipment is located shall be installed with automatic sprinklers. [**82:**10.4.1]

26.16 Standard for Ovens and Furnaces.

26.16.1 Design Requirements. (Reserved)

26.16.2 Installation Requirements.

26.16.2.1*

Where automatic sprinklers are provided, they shall be installed in accordance with ~~NFPA 13,~~ this standard unless otherwise permitted by 26.16.2.2. [**86:**9.2.1]

26.16.2.2

Where sprinklers that protect only ovens are installed and connection to a reliable fire protection water supply is not feasible, a domestic water supply connection shall be permitted to supply these sprinklers subject to the approval of the authority having jurisdiction. [**86:**9.2.2]

26.16.2.3

Where sprinklers are selected for the protection of ovens, furnaces, or related equipment, ~~the use of closed-head sprinkler~~ systems with only open sprinklers shall be ~~prohibited and only deluge sprinkler systems shall be used~~ installed where the following conditions exist:

(1) In equipment where temperatures can exceed 625°F (329°C)

(2) Where flash fire conditions can occur

[**86:**9.3.3]

26.16.2.4

Furnaces shall be located so as to minimize exposure to power equipment, process equipment, and sprinkler risers. [**86:**5.1.3.1]

26.16.2.5

Where water from a fixed protection system could come in contact with molten materials, such as molten salt or molten metal, shielding shall be provided to prevent water from contacting the molten material. [**86:**9.3.1]

26.16.2.6*

Galvanized pipe shall not be used in sprinkler or water spray systems in ovens, furnaces, or related equipment. [**86:**9.3.2]

26.17 Health Care Facilities Code, Class A Hyperbaric Chambers.

26.17.1 Design Requirements.

26.17.1.1

A fixed water deluge extinguishing system shall be installed in all chamber compartments that are designed for manned operations. [**99:**~~14.2.5.2~~ 14.2.6.2]

26.17.1.2

In chambers that consist of more than one chamber compartment (lock), the design of the deluge system shall meet the requirements of 26.17.1.1 when the chamber compartments are at different depths (pressures). [**99:**~~14.2.5.2.1~~ 14.2.6.2.1]

26.17.1.3

The deluge system in different compartments (locks) shall operate independently or simultaneously. [**99:**~~14.2.5.2.2~~ 14.2.6.2.2]

26.17.1.4

Fixed deluge systems shall not be required in chamber compartments that are used strictly as personnel transfer compartments (locks) and for no other purposes. [**99:**~~14.2.5.2.3~~ 14.2.6.2.3]

26.17.1.5*

Manual activation and deactivation deluge controls shall be located at the operator's console and in each chamber compartment (lock) containing a deluge system. [**99:**~~14.2.5.2.4~~ 14.2.6.2.4]

26.17.1.6

Controls shall be designed to prevent unintended activation. [**99:**~~14.2.5.2.4.1~~ 14.2.6.2.4.1]

26.17.1.7

Water shall be delivered from the fixed discharge nozzles as specified in 26.17.1.9 within 3 seconds of activation of any affiliated deluge control. [**99:**~~14.2.5.2.5~~ 14.2.6.2.5]

26.17.1.8*

Average spray density at floor level shall be not less than 2 gpm/ft^2 (81.5 L/min/m^2), with no floor area larger than 10.76 ft^2 (1 m^2) receiving less than 1 gpm/ft^2 (40.75 L/min/m^2). [**99:**~~14.2.5.2.6~~ 14.2.6.2.6]

26.17.1.9

Water shall be available in the deluge system to maintain the flow specified in 26.17.1.8 simultaneously in each chamber compartment (lock) containing the deluge system for 1 minute. [**99:**~~14.2.5.2.7~~ 14.2.6.2.7]

26.17.1.10

The limit on maximum extinguishment duration shall be governed by the chamber capacity (bilge capacity also, if so equipped) or its drainage system, or both. [**99:**~~14.2.5.2.7.1~~ 14.2.6.2.7.1]

26.17.1.11

The deluge system shall have stored pressure to operate for at least 15 seconds without electrical branch power. [**99:**~~14.2.5.2.8~~ 14.2.6.2.8]

26.17.2 Installation Requirements. (Reserved)

26.18 Fixed Guideway Transit and Passenger Rail Systems.

26.18.1 Design Requirements.

26.18.1.1

Other fire suppression systems, if approved, shall be permitted to be substituted for automatic sprinkler systems in the areas listed in 26.18.2.1. [**130:**~~5.7.3.4~~ 5.4.4.5]

26.18.2 Installation Requirements.

26.18.2.1

An automatic sprinkler protection system shall be provided in areas of stations used for concessions, in storage areas, in trash rooms, and ~~in the steel truss area of all escalators and~~ other similar areas with combustible loadings, except trainways. [**130:**~~5.7.3.1~~ 5.4.4.1]

26.18.2.2

Sprinkler protection shall be permitted to be omitted in areas of open stations remotely located from public spaces. [**130:**~~5.7.3.1.1~~ 5.4.4.2]

26.18.2.3

Installation of sprinkler systems shall comply with ~~NFPA 13~~ this standard or applicable local codes as required. [**130:**~~5.7.3.2~~ 5.4.4.3]

26.18.2.4

A sprinkler system waterflow alarm and supervisory signal service shall be installed. [**130:**~~5.7.3.3~~ 5.4.4.4]

26.19 Motion Picture and Television Production Studio Soundstages, Approved Production Facilities, and Production Locations.

26.19.1 Design Requirements. (Reserved)

26.19.2 Installation Requirements.

26.19.2.1

The requirements of ~~NFPA 13~~ this standard prohibiting obstructions to sprinkler discharge shall not be applicable if approved mitigation is employed. [**140:**4.11.1.3.1]

26.19.2.2

The requirements of ~~NFPA 13~~ this standard prohibiting obstructions to sprinkler discharge shall not be applicable if the building sprinkler system meets the design criteria for Extra Hazard, Group 2. [**140:**4.11.1.3.2]

26.19.2.3

In any production location building protected by an existing automatic sprinkler system, where solid- or hard-ceiling sets or platforms are introduced and create an obstruction to sprinkler discharge, the provisions of 26.19.2.4 or 26.19.2.5 shall be met. [**140:**5.11.3]

26.19.2.4*

The requirements of ~~NFPA 13~~ this standard prohibiting obstructions to sprinkler discharge shall not be applicable if approved mitigation is employed. [**140:**5.11.4]

A.26.19.2.4

Paragraphs 4.11.1.3.1 and 4.11.1.3.2 of NFPA 140 recognize motion picture and television industry practices that require sets to change constantly and that sets are "temporary" construction not subject to building codes or standards. Solid ceilings that obstruct the stage sprinklers are "flown" (moved) in or out to permit special shooting angles or lighting requirements, often on a scene-by-scene basis. With temporary walls and ceilings, it would be impractical to install a sprinkler system in a constantly changing structure. Therefore, one or more of the following mitigation techniques should be used to compensate for the areas shielded from sprinkler spray by solid or hard ceilings or platforms:

(1) Approved and listed heat detectors or smoke detectors can be installed beneath such solid or hard ceilings in excess of 600 ft^2 (55.7 m^2) in area and platforms in excess of 600 ft^2 (55.7 m^2) in area and 3 ft ~~(900 mm)~~ (0.9 m) in height. Detectors should be connected to an approved and listed central, proprietary, or remote station service or to a local alarm that will provide an audible signal (i.e., a bell or horn) at a constantly attended location. The detector system, including the alarm panel, is defined as a portable system because it is intended to be reinstalled when platforms or sets are changed. The detectors that are secured to standard outlet boxes and the listed fire alarm panels can be temporarily supported by sets, platforms, or pedestals. Spacing of detectors should be per manufacturers' requirements.

(2) The ceiling can be positioned to allow for the operation of the building's automatic fire sprinkler system after videotaping, filming, or broadcasting of programs has been completed for the day.

(3) A fire watch should be provided when the set is not in use.

(4) No combustible materials should be stored under any platforms. Consideration should be given to secure such covered areas with screen wire or other materials that will permit visual inspection and emergency access.

(5) Approved/listed fire retardants can be applied beneath combustible platforms.

(6) Approved/listed fire retardants can be applied to scenery, props, framework and deck of combustible platforms, and the hard ceilings of combustible sets.

[**140:** A.4.11.1.3.1]

26.19.2.5*

The requirements of ~~NFPA 13~~ this standard prohibiting obstructions to sprinkler discharge shall not be applicable if the building sprinkler system meets the design criteria for Extra Hazard, Group 2. [**140:**5.11.5]

26.20 Animal Housing Facilities.

26.20.1 Design Requirements. (Reserved)

26.20.1.1 (Reserved)

26.20.2 Installation Requirements. (Reserved)

26.20.2.1

Quick-response sprinklers shall be utilized in animal housing facilities. [**150:**9.2.3]

26.21 Water Cooling Towers.

26.21.1 Design Requirements.

26.21.1.1 Types of Systems.

26.21.1.1.1*

~~Because the counterflow tower design lends itself to either closed- or open-head systems, the~~ The following fire protection systems shall be permitted to be used in counterflow cooling towers :

(1) Wet pipe sprinkler system

(2) Dry pipe sprinkler system

(3) Preaction sprinkler system

(4) Deluge sprinkler system

[**214:**5.2.2.1]

A.26.21.1.1.1

Counterflow design configurations lend themselves to use of open- or closed-orifice fire protection systems. A deluge system provides a higher degree of protection where water supplies are adequate. In climates that are subject to freezing temperatures, ~~a~~ a dry pipe, preaction, or deluge system minimizes the possibility of failure due to pipes freezing. [**214:** A.5.2.2.1]

26.21.1.1.2*

~~The open-head~~ A deluge sprinkler system shall be used in crossflow towers ~~to maximize the water distribution and heat detection activation~~ . [**214:**5.2.2.2]

A.26.21.1.1.2

The crossflow design is such that it is difficult to locate sprinklers in the most desirable spots for both water distribution and heat detection. This situation ~~can be solved by separating these two functions and using separate water discharge and detection systems~~ is best addressed by using a deluge system . [**214:** A.5.2.2.2]

26.21.1.2 Minimum Rate of Application.

[**214:**5.2.3]

26.21.1.2.1

Under the fan decks of counterflow towers, the rate of application of water shall be 0.5 gpm/ft^2 (20.4 mm/min), including fan opening. [**214:**5.2.3.1]

26.21.1.2.2

Under the fan decks of crossflow towers, the rate of application of water shall be 0.33 gpm/ft^2 (13.45 mm/min), including fan opening. [**214:**5.2.3.2]

26.21.1.2.3

Over the fill areas of crossflow towers, the rate of application of water shall be 0.5 gpm/ft^2 (20.4 mm/min). [**214:**5.2.3.3]

26.21.1.3 Extended Fan Decks.

On towers having extended fan decks that completely enclose the distribution basin, the discharge outlets protecting the fill area shall be located over the basin, under the extension of the fan deck. [**214:**5.2.4.3]

26.21.1.3.1

These discharge outlets shall be open directional spray nozzles or other approved spray devices arranged to discharge 0.35 gpm/ft^2 (14.26 mm/min) directly on the distribution basin and 0.15 gpm/ft^2 (6.11 mm/min) on the underside of the fan deck extension. [**214:**5.2.4.3.1]

26.21.1.3.2

On towers having extended fan decks that do not completely enclose the hot-water basin, outlets protecting the fill shall be located under the distribution basin in accordance with 5.2.4.2.2 of NFPA 214. [**214:**5.2.4.3.2]

26.21.1.4 Combustible Fan Decks.

For deluge systems using directional spray nozzles in the pendant position, provisions shall be made to protect the underside of a combustible fan deck at a minimum of 0.15 gpm/ft^2 (6.11 mm/min), which shall be included as part of the application rate specified in 5.2.3 of NFPA 214. [**214:**5.2.4.4]

26.21.1.5* Water Basin Covers.

On film-filled towers that have solid, hot-water basin covers over the complete basin, the discharge outlets protecting the fill area shall be permitted to be located under the basin covers. [**214:**5.2.4.5]

26.21.1.5.1

These discharge outlets shall be open directional spray nozzles or other approved devices arranged to discharge 0.50 gpm/ft^2 (20.4 mm/min) into the distribution basin horizontally, with some of the spray splashing up and on the underside of the water basin covers. [**214:**5.2.4.5.1]

26.21.1.6 ~~Exterior~~ Exposure Protection.

[**214:**5.2.10]

26.21.1.6.1

Where any combustible exterior surfaces of a tower, including the fan deck and distribution basins, are less than 100 ft (30.5 m) from significant concentrations of combustibles such as structures or piled material, the combustible exposed surfaces of the tower shall be protected by an automatic water spray system. [**214:**5.2.10.1]

26.21.1.6.2

Systems for exterior protection shall be designed with the same attention and care as interior systems. [**214:**5.2.10.2]

26.21.1.6.2.1

Pipe sizing shall be based on hydraulic calculations. [**214:**5.2.10.2.1]

26.21.1.6.2.2

Water supply and discharge rate shall be based on a minimum 0.15 gpm/ft^2 (6.11 mm/min) for all protected surfaces. [**214:**5.2.10.2.2]

26.21.1.7 Sprinkler System Water Supply.

26.21.1.7.1 Deluge Systems.

26.21.1.7.1.1*

Where all cells of a cooling tower are protected by a single deluge system, the water supply shall be adequate to supply all discharge outlets on that system. [**214:**5.6.1.1]

26.21.1.7.1.2

Where two or more deluge systems are used to protect a cooling tower and fire-resistant partitions are not provided between the deluge systems, the water supply shall be adequate to supply all discharge outlets in the two most hydraulically demanding adjacent systems. [**214:**5.6.1.2]

26.21.1.7.1.3*

Where two or more deluge systems are separated by fire-resistant partitions, the water supply shall be adequate to supply all discharge outlets in the single most hydraulically demanding system. [**214:**5.6.1.3]

26.21.1.7.2 Wet, Dry, and Preaction Systems.

26.21.1.7.2.1*

Where each cell of the cooling tower is separated by a fire-resistant partition, the water supply shall be adequate to supply all discharge outlets in the hydraulically most demanding single cell. [**214:**5.6.2.1]

26.21.1.7.2.2*

Where fire-resistant partitions are not provided between each cell of a cooling tower, the water supply shall be adequate to supply all discharge outlets in the two most hydraulically demanding adjoining cells. [**214:**5.6.2.2]

26.21.1.7.3 Hose Streams.

Water supplies shall be sufficient to include a minimum of 500 gpm (1892.5 L/min) for hose streams in addition to the sprinkler requirements. [**214:**5.6.3]

26.21.1.7.4 Duration.

A water supply adequate for at least a 2-hour duration shall be provided for the combination of the water supply specified in 5.6.1 or 5.6.2 of NFPA 214, plus the hose stream demand specified in 26.21.1.7.3. [**214:**5.6.4]

26.21.2 Installation Requirements.

26.21.2.1* Counterflow Towers.

[**214:**5.2.4.1]

26.21.2.1.1

The discharge outlets shall be located under the fan deck and fan opening. [**214:**5.2.4.1.1]

26.21.2.1.2

Except under the fan opening, all discharge outlets shall have deflector distances installed in accordance with Section 9.5 of ~~NFPA 13~~ this standard . [**214:**5.2.4.1.2]

26.21.2.1.3

Closed-head discharge outlets for dry-pipe and preaction systems shall be installed in the upright position only. [**214:**5.2.4.1.3]

26.21.2.2* Crossflow Towers.

[**214:**5.2.4.2]

26.21.2.2.1

The discharge outlets protecting the plenum area shall be located under the fan deck and in the fan opening. [**214:**5.2.4.2.1]

26.21.2.2.2

Discharge outlets protecting the fill shall be located under the distribution basin on either the louver or drift eliminator side, discharging horizontally through the joist channels. [**214:**5.2.4.2.2]

26.21.2.2.3

Towers with an air travel dimension longer than the maximum allowable for the discharge device being used shall have discharge devices placed on both sides of the fill area in each joist channel. [**214:**5.2.4.2.3.1]

26.21.2.2.4

The pressure at each discharge device shall be adequate to provide protection for half of the length of the fill measured along the air travel. [**214:**5.2.4.2.3.2]

26.21.2.2.5

Where joist channels are wider than 2 ft (0.6 m), more than one discharge device shall be required per joist channel. [**214:**5.2.4.2.4.1]

26.21.2.2.6

If the discharge device being used is listed for the width of the joist channel being protected, one discharge device per joist channel shall be permitted to be used. [**214:**5.2.4.2.4.2]

26.21.2.3* Extended Fan Decks.

On towers having extended fan decks that completely enclose the distribution basin, the discharge outlets protecting the fill area shall be located over the basin, under the extension of the fan deck. [**214:**5.2.4.3]

26.21.2.4* Water Basin Covers.

On film-filled towers that have solid, hot-water basin covers over the complete basin, the discharge outlets protecting the fill area shall be permitted to be located under the basin covers. [**214:**5.2.4.5]

26.21.2.5 Valves.

[**214:**5.2.6]

26.21.2.5.1

Shutoff valves and automatically operated water control valves, if provided, shall be located as follows:

(1) Outside the fire-exposed area

(2) As close to the cooling tower as possible to minimize the amount of pipe to the discharge device

(3) Where they will be accessible during a fire emergency

[**214:**5.2.6.1.2]

26.21.2.5.2 Manual Release Valve.

[**214:**5.2.6.2]

26.21.2.5.2.1

Remote manual release valves, where required, shall be conspicuously located and accessible during a fire emergency. [**214:**5.2.6.2.1]

26.21.2.5.2.2

Where remote manual release valves are not required, an inspector's test valve shall be provided for each pilot-head-operated system. [**214:**5.2.6.2.2]

26.21.2.6 Strainers.

Strainers shall be required for systems utilizing discharge devices with waterways of less than ⅜ in. (9.5 mm) diameter. [**214:**5.2.7]

26.21.2.7 Heat Detectors.

Where deluge or preaction systems are used, heat detectors shall be installed and shall be selected from either of the types in 5.2.8.1 or 5.2.8.2 of NFPA 214. [**214:**5.2.8]

26.21.2.7.1

In mechanical-draft towers, pilot line detectors shall be located under the fan deck at the circumference of the fan opening and under the fan opening where necessary to comply with the spacing requirements in 26.21.2.7.1.1. *(For extended fan decks, see 5.2.8.2.3 in NFPA 214.)* [**214:**5.2.8.1.2.1(A)]

26.21.2.7.1.1

Pilot line detectors shall be spaced not more than 8 ft (2.4 m) apart in any direction including the fan opening. Temperature ratings shall be selected in accordance with operating conditions, but shall be no less than intermediate. [**214:**5.2.8.1.2.1(B)]

26.21.2.7.2

On towers having extended fan decks that completely enclose the distribution basin, electrical heat detectors shall be located under the fan deck extension in accordance with standard, indoor-spacing rules for the type detectors used in accordance with *NFPA 72*. [**214:**5.2.8.2.3]

26.21.2.7.2.1

Where the fan deck extension is 16 ft (4.9 m) or less and this dimension is the length of the joist channel, then only one row of detectors centered on and at right angles to the joist channels shall be required. Spacing between detectors shall be in accordance with *NFPA 72*. [**214:**5.2.8.2.3.1]

26.21.2.7.2.2

On towers having extended fan decks that do not completely enclose the hot-water basin, electrical heat detectors shall not be required under the fan deck extension. [**214:**5.2.8.2.3.2]

26.21.2.7.3

Where electrical heat detectors are inaccessible during tower operation, an accessible test detector shall be provided for each detection zone. [**214:**5.2.8.3]

26.21.2.7.4

Electrical heat detector components exposed to corrosive vapors or liquids shall be protected by materials of construction or by protective coatings applied by the equipment manufacturer. [**214:**5.2.8.4]

26.21.2.8 Protection for Fan Drive Motor.

[**214:**5.2.9]

26.21.2.8.1

A sprinkler or spray nozzle shall be provided over each fan drive motor where the motor is located so that it is not within the protected area of the tower. [**214:**5.2.9.1]

26.21.2.8.2

Where a preaction or deluge system is used, the detection system shall be extended to cover the motor. [**214:**5.2.9.2]

26.21.2.8.3

Provision shall be made to interlock the fan motors with the fire protection system so that the cooling tower fan motors are stopped in the cell(s) for which the system is actuated. [**214:**5.2.9.3]

26.21.2.8.4

Where the continued operation of the fans is vital to the process, a manual override switch shall be permitted to be provided to reactivate the fan when it is determined that there is no fire. [**214:**5.2.9.4]

26.21.2.9 Corrosion Protection.

[**214:**5.3]

26.21.2.9.1

Piping, fittings, hangers, braces, and attachment hardware including fasteners shall be hot-dipped galvanized steel in accordance with ASTM A153A/153M, *Standard Specification for Zinc Coating (Hot Dip) on Iron and Steel Hardware,* or other materials having a superior corrosion resistance. [**214:**5.3.1]

26.21.2.9.1.1

Exposed pipe threads and bolts on fittings shall be protected against corrosion. [**214:**5.3.1.1]

26.21.2.9.1.2

All other components shall be corrosion resistant or protected against corrosion by a coating. [**214:**5.3.1.2]

26.21.2.9.2*

Wax-type coatings shall not be used on devices without fusible elements. [**214:**5.3.2]

26.21.2.9.3*

Special care shall be taken in the handling and installation of wax-coated or similar sprinklers to avoid damaging the coating. [**214:**5.3.3]

26.21.2.9.3.1

Corrosion-resistant coatings shall not be applied to the sprinklers by anyone other than the manufacturer of the sprinklers. [**214:**5.3.3.1]

26.21.2.9.3.2

In all cases, any damage to the protective coating occurring at the time of installation shall be repaired at once using only the coating of the manufacturer of the sprinkler in an approved manner, so that no part of the sprinkler will be exposed after the installation has been completed. [**214:**5.3.3.2]

26.22 Standard for the Construction and Fire Protection of Marine Terminals, Piers, and Wharves.

26.22.1 Design Requirements.

26.22.1.1*

Unless the requirements of 26.22.1.2 apply, automatic sprinkler systems shall be designed based upon the design criteria for the protection of Group A plastics. [**307:**5.4.2.1]

26.22.1.2

With the approval of the authority having jurisdiction, the requirements of 26.22.1.1 shall not apply to buildings used exclusively for the handling or storage of specific cargoes and commodities that are defined as commodity classes less than Group A plastics by this standard. [**307:**5.4.2.2]

26.22.1.3

Buildings consistent with 26.22.1.2 shall be protected in accordance with the design criteria for the applicable commodity as required by this standard. [**307:**5.4.2.3]

26.22.1.4

Buildings used for the storage of hazardous materials shall be protected in accordance with this standard and the applicable codes and standards for the type of hazardous material being stored. [**307:**5.4.2.4]

26.22.2 Installation Requirements.

26.22.2.1 Piers and Wharves with Combustible Substructure.

26.22.2.1.1

Where there is danger of damage to sprinkler equipment by floating objects, physical barriers shall be provided to exclude such objects. [**307:**4.3.3.1.2.2]

26.22.2.1.2* Upward Projecting Sprinklers.

Where narrow horizontal channels or spaces are caused by caps, stringers, ties, and other structural members and where the standard upright sprinkler does not project sufficient water upward to extinguish or control fires on the underside of the pier or wharf deck, a sprinkler that projects water upward to wet the overhead shall be used. [**307:**4.3.3.1.3.1]

(A)

Location, spacing, and deflector position shall be governed by the discharge pattern of the sprinkler and the structure being protected. [**307:**4.3.3.1.3.1(A)]

(B)

The following design and installation guides shall apply where pendent sprinklers in the upright position or old-style sprinklers are to be utilized:

(1) The maximum coverage per sprinkler head shall be limited to 80 ft^2 (7.5 m^2).

(2) Where spacing or arrangement of stringers constitutes typical open-joist construction directly supporting the deck, sprinkler branch lines shall be installed between the bents at right angles to the stringers and shall meet the following requirements:

  (a) Spacing between branch lines shall not exceed 10 ft (3 m).

  (b) Sprinklers on branch lines shall be staggered and spaced not to exceed 8 ft (2.5 m) on center.

(3)* Where crisscross construction is involved, closer spacing of sprinklers shall be permitted as necessary to provide wetting of the entire structure.

(4) The deflectors of sprinklers on lines under stringers shall be located not less than 4 in. (100 mm) nor more than 10 in. (250 mm) below the bottom plane of the stringer, and not more than 18 in. (450 mm) below the underside of the pier or wharf deck.

(5)* The sprinkler system shall be hydraulically designed in accordance with the requirements of this standard and shall meet the following requirements:

  (a) Sprinkler orifice shall be ½ in. (12.7 mm) and shall discharge at a minimum pressure of 12.5 psi (85 kPa).

  (b) Design area shall be based upon the largest area between firestops plus an additional area embracing at least two branch lines on opposite sides of the firestop.

  (c) Minimum design area shall be not less than 5000 ft^2 (465 m^2).

(6) The temperature rating of the sprinkler shall not exceed 165°F (74°C).

(7) The maximum area to be protected by any one system shall be limited to 25,000 ft^2 (2325 m^2).

[**307:**4.3.3.1.3.1(B)]

~~**26.22.2.1.2**~~

~~The installation requirements in 26.22.2.1.2.1 , 26.22.2.1.2.1(A) , and 26.22.2.1.2.1(B) are also required.~~

26.23 Semiconductor Fabrication Facilities.

26.23.1 Design Requirements.

26.23.1.1*

Automatic sprinklers for cleanrooms or clean zones shall be installed in accordance with this standard and shall be hydraulically designed for a density of 0.20 gpm/ft^2 (8.15 L/min·m^2) over a design area of 3000 ft^2 (278.8 m^2). [**318:**~~4.1.2.1~~ 11.1.4.2]

26.23.1.2

Automatic sprinkler protection shall be designed and installed in the plenum and interstitial space above cleanrooms in accordance with this standard, for a density of 0.20 gpm/ft^2 (8.15 L/min·m^2) over a design area of 3000 ft^2 (278.8 m^2). [**318:**~~4.1.2.5~~ 11.1.4.3]

~~**26.23.1.2.1***~~

~~Automatic sprinklers shall be permitted to be omitted if the construction and occupancy of these spaces are noncombustible. [**318:** 4.1.2.5.1]~~

~~**A.26.23.1.2.1**~~

~~Examples of combustible materials that might be found in these spaces are as follows:~~

- ~~Roof, floor, wall construction materials~~
- ~~Unapproved HEPA or ULPA filter modules~~
- ~~Supply air or exhaust ducts~~
- ~~Air handler unit enclosures or air plenum boxes~~
- ~~Exposed electrical cable or pipe insulation~~
- ~~Plastic piping~~
- ~~Flammable or combustible liquid piping~~

~~[**318:** A.4.1.2.5.1]~~

26.23.1.3*

Sprinklers installed in duct systems shall be hydraulically designed to provide 0.5 gpm (1.9 L/min) over an area derived by multiplying the distance between the sprinklers in a horizontal duct by the width of the duct. [**318:**~~4.1.2.6.2~~ 11.2.1.2]

26.23.1.3.1*

Minimum discharge shall be 20 gpm (76 L/min) per sprinkler from the five hydraulically most remote sprinklers. [**318:**~~4.1.2.6.2.1~~ 11.2.1.2.1]

26.23.2 Installation Requirements.

26.23.2.1*

Wet pipe automatic sprinkler protection shall be provided throughout facilities containing cleanrooms and clean zones. [**318:**~~4.1.1~~ 11.1.4.1]

26.23.2.2*

Approved quick-response sprinklers shall be utilized for sprinkler installations within down-flow airstreams in cleanrooms and clean zones. [**318:**~~4.1.2.2~~ 11.1.4.4]

26.23.2.3*

Sprinklers shall be spaced a maximum of 20 ft (6.1 m) apart horizontally and 12 ft (3.7 m) apart vertically. [**318:**~~4.1.2.6.2.2~~ 11.2.1.2.2]

26.23.2.4

A separate indicating control valve shall be provided for sprinklers installed in ductwork. [**318:**~~4.1.2.6.3~~ 11.2.1.3]

26.23.2.5

The sprinklers shall be accessible for periodic inspection and maintenance. [**318:**~~4.1.2.6.6~~ 11.2.1.6]

26.24 Aircraft Hangars.

26.24.1 Design Requirements.

Sprinkler systems installed in aircraft hangars shall comply with NFPA 409.

26.24.2 Installation Requirements.

Sprinkler systems installed in aircraft hangars shall comply with NFPA 409.

26.25 Airport Terminal Buildings, Fueling Ramp Drainage, and Loading Walkways.

26.25.1 Design Requirements.

26.25.1.1

Passenger-handling areas shall be classified as Ordinary Hazard Group 1 Occupancy, as defined in this standard, for the purpose of sprinkler system design. [**415:**4.5.1.3]

26.25.1.2*

Baggage, package, and mail-handling areas shall be classified as Ordinary Hazard Group 2 Occupancy, as defined in this standard, for the purpose of sprinkler system design. [**415:**4.5.1.4]

A.26.25.1.2

The exposure to the airport terminal building from the airport ramp is significant. The number of building sprinklers operating from the exposure fire ~~can~~ could be greater than the number of building sprinklers operating from an internal ignition source. [**415:** A.4.5.1.5]

26.25.1.3

Other areas of the airport terminal building shall be classified in accordance with Chapter ~~5~~ 4 of this standard based on the occupancy of the area . [**415:**4.5.1.5]

26.25.1.4 Water Supply.

Water supply from public and private sources shall be adequate to supply maximum calculated sprinkler demand plus a minimum of 500 gpm (1893 L/min) for hose streams. The supply shall be available at the rate specified for a period of at least 1 hour. [**415:**4.5.5]

26.25.1.4.1

Main sizes shall be hydraulically calculated based on the total domestic and fire protection requirements. Mains shall be not ~~be~~ less than 8 in. (203 mm) in diameter except that laterals shall be permitted to be 6 in. (152 mm) in diameter if not over 200 ft (61 m) long. [**415:**4.5.5.1]

26.25.2 Installation Requirements. (Reserved)

26.26 Aircraft Engine Test Facilities.

26.26.1 Design Requirements.

26.26.1.1*

In engine test cells, the minimum design discharge density shall be 0.50 gpm/ft^2 (0.34 L/sec/m^2) of protected area. [**423:**7.6.3]

26.26.1.2

In engine test cells, water supplies shall be capable of meeting the largest demand at the design rate plus hose stream demand for a period of 30 minutes. [**423:**7.6.4]

26.26.1.2.1

Hose stream demand shall be a minimum of 250 gpm (16 L/sec). [**423:**7.6.4.1]

26.26.1.2.2

The hydraulic calculation and the water supply shall be based on the assumption that all sprinklers in the test cell are operating simultaneously. [**423:**7.6.4.2]

26.26.2 Installation Requirements. (Reserved)

26.27 Advanced Light Water Reactor Electric Generating Plants.

26.27.1 Design Requirements.

26.27.1.1* Sprinkler System Water Supply.

The fire water supply shall be calculated on the basis of the largest expected flow rate for a period of 2 hours but shall not be less than 300,000 gal (1,135,500 L), and the following criteria also shall apply:

(1) The flow rate shall be based on 500 gpm (1892.5 L/min) for manual hose streams plus the largest design demand of any sprinkler or fixed water spray system as determined in accordance with this standard, with NFPA 15, or with NFPA 804.

(2) The fire water supply shall be capable of delivering the design demand specified in 26.27.1.1(1) with the hydraulically least demanding portion of fire main loop out of service.

[**804:**9.2.1]

26.27.1.2 Yard Mains.

The underground yard fire main loop shall be installed to furnish anticipated water requirements, and the following criteria also shall be met:

(1) The type of pipe and water treatment shall be design considerations, with tuberculation as one of the parameters.

(2) Means for inspecting and flushing the systems shall be provided.

[**804:**9.4.1]

26.27.1.3 Cable Spreading Room.

The cable spreading room shall have an automatic fixed water-based suppression system, and the following criteria also shall be met:

(1) The location of sprinklers or spray nozzles shall protect cable tray arrangements to ensure water coverage for areas that could present exposure fire hazards to the cable raceways.

(2) Automatic sprinkler systems shall be designed for a density of 0.30 gpm/ft^2 (12.2 L/min•m^2) over the most remote 2500 ft^2 (232.2 m^2).

[**804:**10.4.1.1]

26.27.1.4 Cable Tunnels.

[**804:**10.4.2]

26.27.1.4.1

Automatic sprinkler systems shall be designed for a density of 0.30 gpm/ft^2 (12.2 L/min·m^2) for the most remote 100 linear ft (30.5 m) of cable tunnel up to the most remote 2500 ft^2 (232.2 m^2). [**804:**10.4.2.2.2]

26.27.1.4.2

Deluge sprinkler systems or deluge spray systems shall meet the following criteria:

(1) They shall be zoned to limit the area of protection to that which the drainage system can handle with any two adjacent systems actuated.

(2) They shall be hydraulically designed with each zone calculated with the largest adjacent zone flowing.

[**804:**10.4.2.2.4]

26.27.1.5* Beneath Turbine Generator Operating Floor.

All areas beneath the turbine generator operating floor shall be protected by an automatic sprinkler or foam-water sprinkler system meeting the following criteria:

(1) The sprinkler system beneath the turbine generator shall be designed around obstructions from structural members and piping.

(2) The sprinkler system shall be designed to a minimum density of 0.30 gpm/ft^2 (12.2 L/min·m^2) over a minimum application of 5000 ft^2 (464.5 m^2).

[**804:**10.8.2.1]

26.27.1.6* Turbine Generator Bearings.

[**804:**10.8.3]

26.27.1.6.1

Lubricating oil lines above the turbine operating floor shall be protected with an automatic sprinkler system to a minimum density of 0.30 gpm/ft^2 (12.2 L/min·m^2) that covers those areas subject to oil accumulation, including the area within the turbine lagging (skirt). [**804:**10.8.4]

26.27.1.6.2

Where shaft-driven ventilation systems are used, an automatic preaction sprinkler system providing a density of 0.30 gpm/ft^2 (12.2 L/min·m^2) over the entire area shall be provided. [**804:**10.8.7(2)]

26.27.1.7 Standby Emergency Diesel Generators and Combustion Turbines.

The sprinkler and water spray protection systems shall be designed for a 0.25 gpm/ft^2 (10.19 L/min·m^2) density over the entire area. [**804:**10.9.3(2)]

26.27.1.8 Fire Pump Room/House.

If sprinkler and water spray systems are provided for fire pump houses, they shall be designed for a minimum density of 0.25 gpm/ft^2 (10.19 L/min·m^2) over the entire fire area. [**804:**10.22.2]

26.27.1.9 Auxiliary Boilers.

Sprinkler and water spray systems shall be designed for a minimum density of 0.25 gpm/ft^2 (10.19 L/min·m^2) over the entire area. [**804:**10.24.3]

26.27.2 Installation Requirements.

26.27.2.1 Yard Mains, Hydrants, and Building Standpipes.

[**804:**9.4]

26.27.2.1.1

Approved visually indicating sectional control valves such as postindicator valves shall be provided to isolate portions of the main for maintenance or repair without simultaneously shutting off the supply to both primary and backup fire suppression systems. [**804:**9.4.2]

26.27.2.1.2*

Sectional control valves shall allow maintaining independence of the individual loop around each unit, and the following also shall apply:

(1) For such installations, common water supplies shall also be permitted to be utilized.

(2) For multiple-reactor sites with widely separated plants [approaching 1 mi (1.6 km) or more], separate yard fire main loops shall be used.

[**804:**9.4.4]

26.27.2.1.3

Sprinkler systems and manual hose station standpipes shall have connections to the plant underground water main so that a single active failure or a crack in a moderate-energy line can be isolated so as not to impair both the primary and the backup fire suppression systems unless otherwise permitted by the following:

(1) Alternatively, headers fed from each end shall be permitted inside buildings to supply both sprinkler and standpipe systems, provided steel piping and fittings meeting the requirements of ASME B31.1, *Code for Power Piping*, are used for the headers (up to and including the first valve) supplying the sprinkler systems where such headers are part of the seismically analyzed hose standpipe system.

(2) Where provided, such headers shall be considered an extension of the yard main system.

(3) Each sprinkler and standpipe system shall be equipped with an outside screw and yoke (OS&Y) gate valve or other approved shutoff valve.

[**804:**9.4.7]

26.27.2.2 Cable Tunnels.

The location of sprinklers or spray nozzles shall protect cable tray arrangements and possible transient combustibles to ensure water coverage for areas that could present exposure fire hazards to the cable raceways. [**804:**10.4.2.2.3]

26.27.2.3 Deluge.

Deluge sprinkler systems or deluge spray systems shall meet the following criteria:

(1) They shall be zoned to limit the area of protection to that which the drainage system can handle with any two adjacent systems actuated.

(2) They shall be hydraulically designed with each zone calculated with the largest adjacent zone flowing.

[**804:**10.4.2.2.4]

26.27.2.4

Cable tunnels over 50 ft (15.2 m) long shall be provided with hose stations and portable fire extinguishers installed outside the tunnel. [**804:**10.4.2.4(3)]

26.28 Light Water Nuclear Power Plants.

26.28.1 Design Requirements.

A fire protection water supply of reliability, quantity, and duration shall be provided by one of the two following methods:

(1) A fire protection water supply of not less than two separate 300,000 gal (1,135,500 L) supplies shall be provided.

(2) The 2-hour fire flow rate for 2 hours shall be calculated, and the following criteria shall be met:

  (a) The flow rate shall be based on 500 gpm (1892.5 L/min) for manual hose streams plus the largest design demand of any sprinkler or fixed water spray system(s) in the power block as determined in accordance with NFPA 13 or NFPA 15.

  (b) The fire water supply shall be capable of delivering this design demand with the hydraulically least demanding portion of fire main loop out of service.

[**805:**5.5.1]

26.28.2 Installation Requirements.

26.28.2.1

Sprinkler systems and manual hose station standpipes shall be connected to the plant fire protection water main so that a single active failure or a crack to the water supply piping to these systems can be isolated so as not to impair both the primary and backup fire suppression systems. [**805:**5.5.12]

26.28.2.2

Each sprinkler and standpipe system shall be equipped with an outside screw and yoke (OS&Y) gate valve or other approved shutoff valve. [**805:**5.5.17]

26.29 Hydroelectric Generating Plants. [NFPA 851]

26.29.1 Design Requirements.

26.29.1.1 Hydraulic Control Systems.

Fixed fire protection for this equipment, where provided, should be as follows:

Automatic wet pipe sprinkler systems utilizing a design density of 0.25 gpm/ft^2 (10.2 mm/min) for the entire hazard area.

Automatic foam-water sprinkler systems providing a density of 0.16 gpm/ft^2 (6.5 mm/min).

[**851:** 7.2.4]

26.29.1.2 Cable Concentrations.

Sprinkler or water spray systems should be designed for a density of 0.30 gpm/ft^2 (12.2 mm/min) over 2500 ft^2 (232 m^2). This coverage is for area protection. Individual cable tray tier coverage could be required based on the fire risk evaluation. [**851:** 7.5.3]

26.29.1.3 Cable Tunnels.

Where protection is required by the fire risk evaluation, cable tunnels should be protected by automatic water spray, automatic wet pipe sprinkler, or foam-water spray systems. Automatic sprinkler systems should be designed for a density of 0.30 gpm/ft^2 (12.2 mm/min) over 2500 ft^2 (232 m^2) or the most remote 100 linear ft (30.5 m) of cable tunnel up to 2500 ft^2 (232 m^2). [**851:** 7.6.1]

26.29.1.4 Emergency Generators.

Emergency generators located within main plant structures should be protected by automatic sprinkler, water spray, foam-water sprinkler, compressed air foam, or gaseous-type extinguishing systems. Sprinkler and water spray protection systems should be designed for a 0.25 gpm/ft^2 (10.2 mm/ min) density over the fire area. [**851:** 7.11.2]

26.29.1.5 Air Compressors.

Automatic sprinkler protection designed for a density of 0.25 gpm/ft^2 (10.2 mm/min) over the postulated oil spill or compressed air foam should be considered for air compressors containing a large quantity of oil. [**851:** 7.12]

26.29.1.6 Hydraulic Systems for Gate and Valve Operators.

Hydraulic control systems should use a listed fire-resistant fluid. Automatic sprinkler protection designed for a density of 0.25 gpm/ft^2 (10.2 mm/min) over the fire area or compressed air foam systems should be considered for hydraulic systems not using a listed fire-resistant fluid. [**851:** 7.13]

26.29.1.7 Fire Pumps.

Rooms housing diesel-driven fire pumps should be protected by automatic sprinkler, water spray, foam-water sprinkler, or compressed air foam systems. If sprinkler and water spray protection systems are provided, they should be designed for a density of 0.25 gpm/ft^2 (10.2 mm/min) over the fire area. For automatic foam-water sprinkler systems, a density of 0.16 gpm/ft^2 (6.5 mm/min) should be provided. [**851:** 7.14]

26.29.2 Installation Requirements.

26.29.2.1 Hydraulic Control Systems.

Fire extinguishing systems, where installed for lube oil systems employing combustible type oil, should include protection for the reservoirs, pumps, and all oil lines, especially where unions exist on piping and beneath any shielded area where flowing oil can collect. Facilities not provided with curbs or drains should extend coverage for a distance of 20 ft (6 m) from the oil lines, when measured from the outermost oil line. [**851:** 7.2.7]

26.29 Code for the Protection of Cultural Resource Properties — Museums, Libraries, and Places of Worship. [NFPA 909]

26.29.1 Design Requirements.

26.29.1.1*

Standard-response sprinklers shall be permitted for use in light-hazard areas. [**909:**~~9.12.13.1~~ 9.12.13.2]

26.29.1.2*

Preaction and dry pipe systems shall be designed to minimize the risk of corrosion in accordance with the requirements ~~of 26.30.2.1 through 22.30.2.5. [**909:** 9.12.13.5]~~ 9.12.13.3.1 through 9.12.13.3.6.5 of NFPA 909 . [**909:** 9.12.13.3]

26.29.1.3 System Design for Museums, Libraries, and Their Collections in Compact Storage.

26.29.1.3.1*

The design shall recognize the nature of the potential threat of a fire that originates in a compact mobile storage unit, where fuel loads are invariably large and fire growth is significantly different from that in other kinds of storage. [**909:**~~9.12.23.4.1.3~~ 9.12.24.4.1.3]

26.29.1.3.2*

The automatic fire suppression system, the compact storage system, and the storage compartmentalization features shall be designed to limit fire damage in accordance with the facility's fire safety objectives. [**909:**~~9.12.23.4.1.4(A)~~ 9.12.24.4.1.4(A)]

26.29.1.3.3

Design calculations shall include the number and size of the storage modules, the separation provided between the modules end-to-end and back-to-back, and the type of material being stored. [**909:**~~9.12.23.4.1.4(B)~~ 9.12.24.4.1.4(B)]

26.29.1.3.4

Where the automatic fire suppression is provided by automatic fire sprinkler systems, the systems shall be wet pipe, single interlock preaction, or single non-interlock preaction systems. [**909:**~~9.12.23.4.1.4(C)~~ 9.12.24.4.1.4(C)]

26.29.1.3.5

Dry pipe or double-interlock preaction systems shall not be installed in compact storage areas. [**909:**~~9.12.23.4.1.4(D)~~ 9.12.24.4.1.4(D)]

26.29.1.3.6

Where compact storage is installed in an existing storage area, the existing automatic fire detection and fire suppression systems shall be modified as required to accommodate the increased fire loading. [**909:**~~9.12.23.4.1.4(E)~~ 9.12.24.4.1.4(E)]

26.29.2 Installation Requirements.

26.29.2.1*

Branch lines shall be pitched at least ½ in. per 10 ft (4 mm/m), and mains shall be pitched at least ¼ in. per 10 ft (2 mm/m). [**909:**9.12.13.3.1]

A.26.29.2.1

~~Although prior to the 2007 edition NFPA 13 permitted the pipe for systems not subject to freezing to be installed without a back pitch, similar to the design of wet pipe systems, this arrangement allows water to accumulate in low points, increasing the rate of corrosion.~~ Proper pitching is an important element in reducing the risk of corrosion. The pitch requirements included in ~~NFPA 13~~ this standard should be considered the minimum acceptable pitch. Where adequate clearance is provided to permit the system to be installed without causing interferences with structural elements or causing low points, pitches exceeding this minimum requirement such as ~~4 mm/m (½ in./10 ft)~~ ½ in./10 ft (4 mm/m) should be considered. [**909:**~~A.9.12.12.3.1~~ A.9.12.13.3.1]

26.29.2.2*

Auxiliary drains shall be provided at all preaction system low points in accordance with ~~NFPA 13~~ the requirements of this standard for dry pipe systems ~~and~~ whether the preaction ~~systems~~ system piping subject to freezing or not . [**909:**9.12.13.3.2.1]

A.26.29.2.2

~~Additional auxiliary drainage should be provided, in accordance with NFPA 13~~ Due to heightened concerns regarding the issues associated with corrosion, additional auxiliary drainage is needed for all preaction systems , regardless of whether or not the protected area is subject to freezing.
[**909:**~~A.9.12.12.3.2.1~~ A.9.12.13.3.2.1]

26.29.2.3*

Where steel pipe is used in dry pipe and preaction systems, ~~the provisions of this standard~~ it shall be ~~applied assuming~~ assumed that the water supplies and environmental conditions ~~that~~ contribute to unusual corrosive properties~~, and a plan shall be developed to address piping corrosion~~ .
[**909:**9.12.13.3.3]

A.26.29.2.3

~~The wording is based on NFPA 13, 5.1.5.2 . The special sensitivity of cultural resource properties to water damage that could result from piping corrosion warrants the assumption of water supplies and environmental conditions that contribute to unusual corrosive properties. [**909:** A.9.12.12.3.3]~~ A plan to address piping corrosion should include one or more of the following:

(1) Installation of sprinkler piping that is corrosion resistant – Galvanized steel piping is not considered corrosion resistant for the purposes of this recommendation. Galvanized coatings can corrode where water and oxygen are present inside system piping. When galvanized coatings fail, the remaining uncoated steel corrodes at an accelerated rate.

(2) Installation of a special listed pre-primed preaction system, filled with water under normal conditions.

(3) Use of a continuous source of dry inert gas for pressure maintenance.

(4) Testing of the water supply for corrosivity prior to connection to the sprinkler system.

(5) Equipping any source of compressed air used for pressure maintenance with an air dryer or nitrogen separator

(6) Implementation of an approved plan for maintaining and monitoring the interior conditions of the pipe at established intervals and locations, including all of the following:

(a) Testing water flow devices between the semiannual tests using a means that does not introduce fresh water into the system

(b) Drying system piping before returning systems to service after trip tests or other incidents that introduce water into system piping beyond the riser

(c) Inspecting for obstructions when any of the following conditions are observed:

i. Pinhole leaks

ii. Frequent operation of system air compressor(s)

iii. Corrosion on the outside of pipe joints, fittings, or sprinklers

iv. Pitting, nodules, tubercles, or carbuncles inside piping or valves

v. Foreign material in water during drain tests or plugging of inspector's test connection(s)

vi. Plugged sprinklers

vii. Plugged piping in sprinkler systems dismantled during building alterations 2

Frequent false tripping of a dry pipe valve(s) with indications of corrosion inside the valve(s)

viii. A 50 percent increase in the time required for water to travel to the inspector's test connection after the valve trips during a full flow trip test of a dry pipe sprinkler system when compared to the original system acceptance test

[**909:** A.9.12.1.3.3.3]

These options are based on those specified by this standard for applications where water supplies are known to be corrosive. They are recommended in this code for steel dry pipe and preaction systems because the levels of corrosion found in these systems are unacceptable for cultural resource facilities. Although this standard also allows the option of treating all water that enters the system with an approved corrosion inhibitor, experience using this option has not been satisfactory in cultural resource facilities due to potential formation of external crystals on piping and potential reduction in the service life of gaskets in mechanical couplings. This standard includes the additional option of using a special listed pre-primed preaction system, in which the piping is normally filled with water.

[**909:** A.9.12.13.3.3]

26.30 National Electrical Code.

26.30.1 Design Requirements. (Reserved)

26.30.2 Installation Requirements.

26.30.2.1 Dedicated Electrical Space.

The space equal to the width and depth of the equipment and extending from the floor to a height of 6 ft (1.8 m) above the equipment or to the structural ceiling, whichever is lower, shall be dedicated to the electrical installation. No piping, ducts, leak protection apparatus, or other equipment foreign to the electrical installation shall be located in this zone.

Exception: Suspended ceilings with removable panels shall be permitted within the 1.8-m (6-ft) zone.

[

70:

110.26(E)(1)(a)]

26.30.2.2

The area above the dedicated space required by 26.30.2.1 shall be permitted to contain foreign systems, provided protection is installed to avoid damage to the electrical equipment from condensation, leaks, or breaks in such foreign systems. [**70:**110.26(E)(1)(b)]

26.30.2.3

Sprinkler protection shall be permitted for the dedicated space where the piping complies with this section. [**70:**110.26(E)(1)(c)]

26.31 Fire Protection of Telecommunication Facilities.

26.31.1 Design Requirements. (Reserved)

26.31.2 Installation Requirements.

26.31.2.1

All piping for dry pipe and preaction sprinkler systems shall be installed with a pitch in accordance with ~~NFPA 13~~ this standard whether or not the piping is subjected to freezing conditions. [**76:**8.6.2.2.2]

26.32 Exhaust Systems for Air Conveying of Vapors, Gases, Mists, and Noncombustible Particulate Solids.

26.32.1 Design Requirements.

26.32.1.1

Any portion of an exhaust system utilizing combustible components or having the potential for combustible residue buildup on the inside, where the duct cross-sectional area is greater than or equal to 75 in.^{2} (480 cm^2), shall be provided with an automatic extinguishing system within the duct and at the duct intake, hood, enclosure, or canopy~~, or shall be constructed of material listed for use without sprinkler protection~~ . [**91:**9.1]

26.32.1.2

When a sprinkler system is installed, means shall be provided to prevent water accumulation in the duct or flow of water back to a process subject that could be damaged by water. [**91:**9.2]

26.32.2 Installation Requirements. (Reserved)

26.33 Hypobaric Facilities.

26.33.1 Design Requirements.

26.33.1.1

A fire suppression system consisting of independently supplied and operating handline and fixed deluge-type water spray systems shall be installed. [**99B:**4.5.1.5]

26.33.1.2

Design of the fire suppression system shall be such that failure of components in either the handline or deluge system will not render the other system inoperative. [**99B:**4.5.1.6]

26.33.1.3

System design shall be such that activation of either the handline or the deluge system shall automatically cause the following:

(1) Visual and audio alarm indicators shall be activated at the chamber operator's console.

(2) All ungrounded electrical leads for power and lighting circuits contained inside the chamber shall be disconnected.

(3) Emergency lighting and communication, where used, shall be activated.

[**99B:**4.5.1.7]

26.33.1.4

Intrinsically safe circuits, including sound-powered communications, shall be permitted to remain connected when either the handline or deluge system is activated. [**99B:**4.5.1.8]

26.33.1.5

Control circuitry and other electrical equipment involved in the fire detection and suppression system shall be powered from the critical branch of the emergency electrical system and connected to the uninterruptible power supply (UPS). [**99B:**4.5.1.11]

26.33.1.6

In chambers that consist of more than one compartment, the deluge system shall operate independently or simultaneously even if the compartments are at different pressures (altitudes). [**99B:**4.5.2.2]

26.33.1.7

Fixed deluge systems shall not be required in chamber compartments that are used strictly as personnel transfer compartments and for no other purpose. [**99B:**4.5.2.3]

26.33.1.8

Manual activation and deactivation deluge controls shall be located at the operator's console and in each chamber compartment containing a deluge system. [**99B:**4.5.2.4]

26.33.1.9

Controls shall be designed to prevent unintended activation. [**99B:**4.5.2.4.1]

26.33.1.10

Water shall be delivered from the fixed discharge nozzles of the deluge system within 3 seconds of activation of any affiliated deluge control. [**99B:**4.5.2.5]

26.33.1.11*

Total water demand shall be determined by multiplying the total chamber floor area by 7.5 gpm/ft^2 (305.6 L/min/m^2). [**99B:**4.5.2.5.1]

26.33.1.12

The minimum operating pressure at the nozzle shall be 30 psi (206 kPa). [**99B:**4.5.2.5.2]

26.33.1.13

The water supply shall be constantly and fully charged. [**99B:**4.5.2.6]

26.33.1.14

The water supply pressure shall be constantly monitored and an interlock shall prevent chamber operation if water supply pressure has fallen 10 percent below normal operating charge pressure. [**99B:**4.5.2.7]

26.33.1.15

There shall be water in the deluge system to maintain the flow specified in 26.33.1.11 simultaneously in each chamber containing the deluge system for 1 minute. [**99B:**4.5.2.8]

26.33.1.16

The limit on maximum extinguishment duration shall be governed by the chamber capacity (bilge capacity also, if so equipped) and/or its drainage system. [**99B:**4.5.2.9]

26.33.1.17

The deluge system shall have stored pressure to operate for at least 15 seconds without electrical branch power. [**99B:**4.5.2.10]

26.33.2 Installation Requirements. (Reserved)

26.34 Coal Mines.

26.34.1 Design Requirements.

26.34.1.1 Underground Mining Operations.

26.34.1.1.1*

Fire sprinkler systems for underground mining operations shall be designed and installed in accordance with NFPA 120.

26.34.1.2 Coal Preparation Plants and Crusher Buildings.

26.34.1.2.1

When automatic sprinkler systems are to be supplied through the standpipe system, hydraulic calculations shall be used to ensure that the piping and the water supply meet the hose and automatic sprinkler demands simultaneously. [**120:**6.3.2.3.2]

26.34.1.3 Underground Conveyors.

26.34.1.3.1

The water supply shall be free of excessive sediment and corrosives. An approved strainer with a flush-out connection and manual shutoff valve shall be provided. [**120:** 9.4.6.3.1.1]

26.34.1.3.2

The water supply shall provide the required water flow for not less than 60 minutes. [**120:** 9.4.6.3.1.2]

26.34.1.3.3

Sprinkler systems shall meet the following requirements:

(1) The sprinklers shall be installed in accordance with this standard as far as practical, and shall have components that have been listed.

(2) The sprinkler head activation temperature shall not be less than 150°F (65.6°C) or greater than 300°F (148.9°C).

(3) Sprinklers shall be kept free of excessive rock dust, muck, conveyor string, or any other material that can block the discharge or insulate the fusible link.

(4) The application rate shall not be less than ~~10.2 L/min/m^2 (0.25 gpm/ft^2)~~ 0.25 gpm/ft^2 (10.2 L/min/m^2) of the top surface of the top belt~~. [120: 9.4.6.4]~~ , bottom surface of the top belt, and the top surface of the lower belt.

(5) With a water flow and pressure than is present under normal mine operating conditions, the residual pressure measured downstream of the opened sprinklers or the 8-head inspector's test connection of 10 psi (70 kPa) or greater for belt drive systems shall be maintained at all times.

(6) Maximum distance between nozzles on a branch line shall not exceed 8 ft (2.4 m).

(7) Piping for the deluge, foam, or closed-head sprinkler system shall be metal and listed for sprinkler applications.

(8)* Sprinkler piping shall be supported by UL-listed pipe hangers or other substantial metal supports such as angle iron, U bolts, or heavy chain.

A.26.34.1.3.3(8)

Pipe hangers should be designed to support five times the weight of the water-filled pipe plus 250 lb (114 kg) at each point of piping support. Hanger rods should be at least 3/8 in. (9.5 mm) thick for pipe up to 4 in. (102 mm). U hooks should be at least 5/16 in. (8 mm) thick for pipes up to 2 in. (50.8 mm) Eye rods should be at least 3/8 in. (9.5 mm) thick for pipe up to 4 in. (102 mm). This information is taken from Chapter 17 of this standard. [**120:** A.9.4.6.3.2(8)]

(9) The system shall be interlocked to shut down the conveyor and provide an audible and a visual alarm. ~~[120: 9.4.6.8]~~

(10) The components of the system shall be located so as to minimize the possibility of damage by roof fall or by the moving belt and its load.

[**120:** 9.4.6.3.2]

~~**26.34.1.3.4**~~

~~The application rate shall not be less than 10.2 L/min/m^2 (0.25 gpm/ft^2) of the top surface of the top belt. [120: 9.4.6.4]~~

~~**26.34.1.3.5**~~

~~The water supply shall be free of excessive sediment and corrosives and provide the required flow for not less than 10 minutes. A strainer with a flush-out connection and manual shutoff valve shall be provided. [120: 9.4.6.6]~~

~~**26.34.1.3.6**~~

~~The system shall be interlocked to shut down the conveyor and provide an audible and a visual alarm. [120: 9.4.6.8]~~

~~**26.34.1.3.7**~~

~~Fire suppression systems shall also comply with 26.35.1.1.1 . [120: 9.4.6.10]~~

~~**26.34.1.3.8**~~

~~Sprinkler systems shall meet the following requirements:~~

~~The sprinklers shall be installed in accordance with NFPA 13 as far as practical, and shall have components that have been listed.~~

~~The water supply shall be capable of supplying a constant flow of water with all heads functioning for a period of 10 minutes.~~

~~The sprinkler head activation temperature shall not be less than 65.6°C (150°F) or greater than 148.9°C (300°F).~~

~~[**120:** 9.4.6.13]~~

26.34.2 Installation Requirements.

26.34.2.1 Underground Conveyors.

26.34.2.1.1

Deluge water spray systems, foam systems, closed-head sprinkler systems, or dry-chemical systems automatically actuated by rise in temperature shall be installed at main and secondary belt conveyor drives. [**120:**9.4.6.1]

26.34.2.1.2

Fire suppression systems shall extend to the drive areas of belt conveyors, including drive motor(s), reducer, head pulley, and belt storage unit (takeup), including any hydraulic power unit; its electrical controls; and the top and bottom of the first ~~15.2 m (50 ft)~~ 50 ft (15.2 m) of belt from the drive on the downwind side. [**120:**9.4.6.2]

~~**26.34.2.1.3**~~

~~Piping for the deluge, foam, or closed-head sprinkler system shall be metal and listed for sprinkler applications. [**120:** 9.4.6.3]~~

~~**26.34.2.1.4**~~

~~The discharge shall be directed at both the upper and the bottom surface of the top belt and the upper surface of the bottom belt. [**120:** 9.4.6.5]~~

~~**26.34.2.1.5**~~

~~Maximum distance between nozzles on a branch line shall not exceed 2.4 m (8 ft). [**120:** 9.4.6.7]~~

~~**26.34.2.1.6**~~

~~The components of the system shall be located so as to minimize the possibility of damage by roof fall or by the moving belt and its load. [**120:** 9.4.6.9]~~

26.34.2.1.3

Deluge water spray systems shall meet the requirements of 26.34.2.1.3.1 through 26.34.2.1.3.5. [**120:**~~9.4.6.11~~ 9.4.6.3.3]

26.34.2.1.3.1

The system shall be activated by heat detectors or no less effective means . [**120:**~~9.4.6.11.1~~ 9.4.6.3.3.1]

26.34.2.1.3.2

~~Heat detectors~~ Detectors shall be located at the belt drive, hydraulic takeup unit (unless fire-resistive fluid is used), discharge roller, and the roof above the conveyor. [**120:**~~9.4.6.11.1.1~~ 9.4.6.3.3.1(A)]

26.34.2.1.3.3

~~Heat detectors~~ Detectors at the roof line should be spaced ~~2.4 m to 3.0 m (8 ft to 10 ft)~~ 8 ft to 10 ft (2.4 m to 3.0 m) apart along the entire length of the protected area of the belt. [**120:**~~9.4.6.11.1.2~~ 9.4.6.3.3.1(B)]

26.34.2.1.3.4

The water spray nozzles shall be full cone, corrosion resistant~~,~~ [if less than ⅜ in. (0.95 cm) inside diameter or K-factor 4.2 or lower], and provided with blow-off dust covers. [**120:**~~9.4.6.11.2~~ 9.4.6.3.3.2]

26.34.2.1.3.5

A closed sprinkler head shall be used over the electrical controls. [**120:**~~9.4.6.11.3~~ 9.4.6.3.3.4]

26.34.2.2 Mine Surface Buildings.

26.34.2.2.1

In addition, If sprinklers are installed, water flow, valve tamper, and low building temperature alarms shall be provided. [**120:**8.6.1.2]

26.35 Metal/Nonmetal Mining and Metal Mineral Processing Facilities.

26.35.1 Design Requirements.

26.35.1.1 Water Supplies.

26.35.1.1.1

When automatic sprinkler systems are supplied through the hand hose line standpipe system, hydraulic calculations shall be used to ensure that the piping and water supply will supply the hose and automatic sprinkler demands simultaneously. [**122:**6.2.3]

26.35.1.1.2

Where a fire water supply ~~[for a surface mineral processing plant]~~ is required by the risk assessment, capacity and availability shall provide the water demand for fire-fighting purposes, including hose and sprinkler systems, for a minimum duration of 2 hours. [**122:**13.7.2]

26.35.1.2*

Where provided, automatic sprinkler systems installed for the protection of flammable liquid or diesel fuel storage areas shall be of the foam-water type. [**122:**11.3.1]

26.35.1.3 New Solvent Extraction (SX) Facilities.

26.35.1.3.1

Fixed fire suppression shall be provided for the following SX facility areas and equipment:

(1) Buildings housing SX processes

(2) Interior of all mixer-settler vessels/cells

(3) Crud tanks that include treatment filters and centrifuges

(4) Coalescers

(5) Along launders and weirs outside of mixer-settler vessels

(6) Inside pipe trenches carrying solvents

(7) Inside organic solvent and diluent tanks

(8) Inside dikes enclosing organic solvent storage tanks

(9) Over organic solvent pumps

(10) Over elevated pipe racks carrying organic solvents in plastic pipes

(11) Other areas handling, processing, or exposed to flammable or combustible liquids

[**122:**13.19.1]

26.35.1.3.2*

Fire suppression for applications in 26.35.1.3.1 shall be water, foam, dry chemical, or water mist. [**122:**13.19.1.1]

26.35.1.3.3*

Design of fire suppression systems in 26.35.1.3.1 shall be based on criteria set forth in NFPA 11,NFPA 15, NFPA 16, and NFPA 17. [**122:**13.19.1.2]

26.35.1.3.4*

Actuation of fire suppression systems in 26.35.1.3.1 shall be automatic. [**122:**13.19.1.3]

26.35.1.3.5

As exposure protection, automatic water-only deluge (open-head) sprinkler systems shall be provided between mixer-settler trains if spaced closer than ~~15.24 m (50 ft)~~ 50 ft (15.24 m) from each other. [**122:**13.19.2]

26.35.1.3.6

As exposure protection, automatic water-only deluge sprinkler systems shall be provided around the exterior perimeter of organic solvent tanks if spaced closer than ~~15.24 m (50 ft)~~ 50 ft (15.24 m) from each other. [**122:**13.19.3]

26.35.1.3.7

As exposure protection, automatic fire suppression shall be provided over other critical equipment (i.e., transformers) or outside along important building walls [i.e., motor control center (MCC) rooms] that are within ~~15.24 m (50 ft)~~ 50 ft (15.24 m) of a solvent fire area. [**122:**13.19.4]

26.35.1.3.8

Hydraulic design of automatic fire suppression systems in 26.35.1.3.1 shall include the simultaneous operation of all fire protection systems associated with a single (multi-cell) train. [**122:**13.19.5]

26.35.1.3.9

The total flow rate of foam application and water associated with the discharge of automatic fire extinguishing systems, fixed monitors, and hydrants shall determine the total volume of fire water required. [**122:**13.19.6]

26.35.2 Installation Requirements. (Reserved)

26.36 Hazardous Materials Code.

26.36.1 Design Requirements.

Sprinkler system discharge criteria for the protection of hazardous materials shall comply with NFPA 400.

26.36.1.1 Requirements for Occupancies Storing Quantities of Hazardous Materials Exceeding the Maximum Allowable Quantities per Control Area for High Hazard Contents.

The design of the sprinkler system shall be not less than ordinary hazard Group 2 in accordance with ~~NFPA 13,~~ this standard except as follows:

(1) Where different requirements are specified in Chapters 11 through 21 of NFPA 400

(2) Where the materials or storage arrangement requires a higher level of sprinkler system protection in accordance with nationally recognized standards

(3) Where approved alternative automatic fire extinguishing systems are permitted

[**400:**6.2.1.1.1]

~~**26.36.1.2** General Requirements for Storage of Ammonium Nitrate Solids and Liquids.~~

~~Sprinkler systems shall be of the approved type and designed and installed in accordance with NFPA 13, and the following:~~

~~Ammonium nitrate in noncombustible or combustible containers (paper bags or noncombustible containers with removable combustible liners) shall be designated as a Class I commodity.~~

~~Where contained in plastic containers, ammonium nitrate shall be designated as a Class II commodity.~~

~~Where contained in fiber packs or noncombustible containers in combustible packaging, ammonium nitrate shall be designated as a Class III commodity.~~

~~[**400:** 11.2.6.1.3]~~

26.36.1.2 General Requirements for Storage of Organic Peroxide Formulations.

26.36.1.2.1

Where required by other provisions of this code, automatic sprinklers and water spray systems shall be designed and installed according to the requirements of ~~NFPA 13~~ this standard and NFPA 15 and shall provide the following discharge densities:

(1) Class I — 0.50 gpm/ft^2 (20.4 L/min/m^2)

(2) Class II — 0.40 gpm/ft^2 (16.3 L/min/m^2)

(3) Class III — 0.30 gpm/ft^2 (12.2 L/min/m^2)

(4) Class IV — 0.25 gpm/ft^2 (10.2 L/min/m^2)

[**400:**~~14.2.6.1~~ 14.2.5.1]

26.36.1.2.2

The system shall be designed as follows:

(1) It shall provide the required density over a 3000 ft^2 (280 m^2) area for areas protected by a wet pipe sprinkler system or ~~3900 ft^2 (360 m^2) for areas protected by a dry pipe~~ single-interlock preaction sprinkler system.

(2) Buildings using a dry pipe sprinkler system shall be provided with a required density over the hydraulically most remote 3900 ft^2 (360 m^2) design area, and, if used, sprinklers shall be within 6 ft (1.8 m) of the top of any stored organic peroxide formulation.

(3) The entire area of any building of less than 3000 ft^2 (280 m^2) shall be used as the area of application.

[**400:**~~14.2.6.2~~ 14.2.5.2]

26.36.1.2.3

Where required for detached storage buildings containing Class I organic peroxide formulations in quantities exceeding 2000 lb (907 kg), automatic sprinkler protection shall be open-head deluge-type, designed and installed in accordance with ~~NFPA 13~~ this standard . [**400:**~~14.2.6.3~~ 14.2.5.3]

26.36.1.3 Indoor Storage of Oxidizer Solids and Liquids.

26.36.1.3.1

Sprinkler protection for Class 2 oxidizers shall be designed in accordance with Table 26.36.1.3.1. [**400:**15.3.2.3.4.1]

Table 26.36.1.3.1 Ceiling Sprinkler Protection for Class 2 Oxidizers in Palletized or Bulk and Rack Storage Areas

Type of Storage	Ceiling Sprinklers						
	Storage Height		Density		Area of Application		
	ft	m	gpm/ft^2	L/min/m^2	ft^2	m^2	In-Rack Sprinklers
Palletized or bulk	8	2.4	0.20	8	3750	348	—
Palletized or bulk	12	3.7	0.35	14	3750	348	—
Rack	12	3.7	0.20	8	3750	348	One line above each level of storage, except the top level
Rack	16	4.9	0.30	12	2000	186	One line above each level of storage, except the top level

[**400:** Table 15.3.2.3.2.10(B)]

26.36.1.3.2

Ceiling sprinklers shall be high-temperature sprinklers. [**400:**15.3.2.3.4.2]

26.36.1.3.3 Storage Protection for Class 2 Oxidizers with In-Rack Sprinklers.

(A)

In-rack sprinklers shall be quick-response sprinklers with an ordinary-temperature rating and have a K-factor of not less than K = 8.0. [**400:**15.3.2.3.4.3(A)]

(B)

In-rack sprinklers shall be designed to provide 25 psi (172 kPa) for the six most hydraulically remote sprinklers on each level. [**400:**15.3.2.3.4.3(B)]

(C)

The in-rack sprinklers shall be 8 ft to 10 ft (2.4 m to 3.0 m) spacings in the longitudinal flue space at the intersection of the transverse flue spaces. [**400:**15.3.2.3.4.3(C)]

26.36.1.3.4 Sprinkler Criteria for Class 3 Oxidizers.

26.36.1.3.4.1 Class 3 Oxidizers Less than ~~2300 lb (1043~~ 2700 lb (1225 kg).

(A)

Sprinkler design criteria for buildings that require sprinkler protection and contain total quantities of Class 3 oxidizers less than ~~2300 lb (1043~~ 2700 lb (1225 kg) shall be in accordance with the requirements of 26.36.1.3.4.1(B). [**400:**15.3.2.4.13.1(A)]

(B)

Facilities that require sprinkler protection and contain total quantities of Class 3 oxidizers greater than 200 lb (91 kg), but less than ~~2300 lb (1043~~ 2700 lb (1225 kg), shall follow the sprinkler design criteria in Table 26.36.1.3.4.1(B). [**400:**15.3.2.4.13.1(B)]

Table 26.36.1.3.4.1(B) Sprinkler Protection of Class 3 Oxidizers Stored in Total Quantities Greater than 200 lb (91 kg) but Less than ~~2300 lb (1043~~ 2700 lb (1225 kg)

Storage Parameters	Shelf	Bulk or Pile	Bulk or Pile	Rack
Maximum storage height	6 ft (1.8 m)	5 ft (1.5 m)	10 ft (3 m)	10 ft (3 m)
Maximum ceiling height	25 ft (7.6 m)	25 ft (7.6 m)	25 ft (7.6 m)	NA
Aisles — pile separation	4 ft (1.2 m) min. clear aisles	4 ft (1.2 m) min. clear aisles	8 ft (2.4 m) min. clear aisles	8 ft (2.4 m) min. clear aisles
Ceiling design criteria	0.45 gpm/ft^2/2000 ft^2	0.35 gpm/ft^2/or 5000 ft^2 or 0.6 gpm/2000 ft^2	0.65 gpm/ft^2/5000 ft^2	0.35 gpm/ft^2/or 5000 ft^2 or 0.6 gpm/ft^2/2000 ft^2
In-rack sprinklers	NP	NP	NA	See ~~15.3.2.4.12.2.~~ 26.36.1.3.4.2
Hose stream demand	500 gpm	500 gpm	500 gpm	500 gpm
Duration	120 minutes	120 minutes	120 minutes	120 minutes

For SI units, 1 gal = 3.79 L. NA: Not applicable. NP: Not permitted.

[**400:** Table ~~15.3.2.4.12.1(B)~~ 15.3.2.4.13.1(B)]

26.36.1.3.4.2 Storage Protection for Class 3 Oxidizers In-Rack Sprinkler Criteria.

(A)

Where required by Table 26.36.1.3.4.1(B), in-rack sprinkler protection shall be as follows:

(1) In-rack sprinklers shall be installed above every level of oxidizer storage.

(2) In-rack sprinklers shall be spaced at maximum 4 ft (1.2 m) intervals to provide one sprinkler in each flue space.

(3) In-rack sprinklers shall be quick-response sprinklers with an ordinary-temperature rating and have a K-factor of not less than K = 8.0.

(4) In-rack sprinklers shall be designed to provide 25 psi (172 kPa) for the six most hydraulically remote sprinklers on each level.

[**400:**15.3.2.4.13.3(A)]

26.36.1.3.4.3 Class 3 Oxidizers Greater than or Equal to ~~2300 lb (1043~~ 2700 lb (1225 kg).

The sprinkler protection required by 26.36.1.3.4.3 shall be in accordance with Table 26.36.1.3.4.3.
[**400:**15.3.2.4.13.4(B)]

Table 26.36.1.3.4.3 Sprinkler Protection of Class 3 Oxidizers Stored in Total Quantities of Greater than or Equal to ~~2300 lb (1043~~ 2700 lb (1225 kg)

Storage Parameters	Bulk or Pile	Rack
Maximum storage height	5 ft (1.5 m)	10 ft (3 m)
Maximum ceiling height	25 ft (7.6 m)	NP
Aisles — pile separation	8 ft (2.4 m) min. clear aisles	8 ft (2.4 m) min. clear aisles
Ceiling design criteria	0.35 gpm/ft^2/5000 ft^2 (1.32 L/min/m^2/464.5 m^2)	Predominant for other commodities but not less than ordinary hazard Group II
In-rack sprinklers	NP	See ~~15.3.2.4.12.4~~ 26.36.1.3.4.4(B)
Hose stream demand	500 gpm (1893 L/min)	500 gpm (1893 L/min)
Duration	120 minutes	120 minutes

NP: Not permitted.

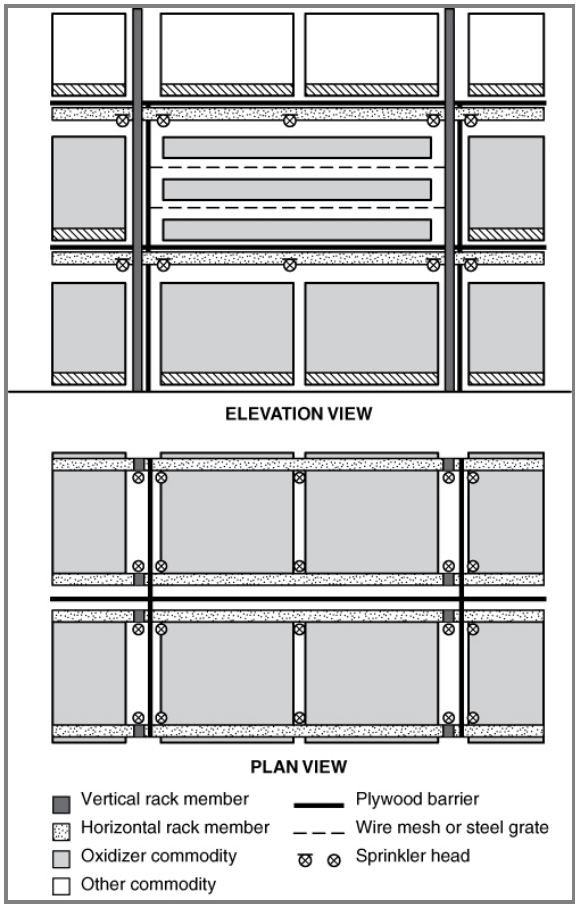
[**400:** Table ~~15.3.2.4.12.3(B)~~ 15.3.2.4.13.4(B)]

26.36.1.3.4.4 Special In-Rack Sprinkler Protection for Class 3 Oxidizers.

(A)

Where required by Table 26.36.1.3.4.3, special in-rack sprinkler protection, which is required by 26.36.1.3.4.4(C) , shall be as shown in Figure 26.36.1.3.4.4(A). [**400:**15.3.2.4.13.5(A)]

Figure 26.36.1.3.4.4(A) Arrangement of Barriers and In-Rack Sprinklers for Special Fire Protection Provisions. [400: **Figure 15.3.2.4.13.5(A)]**



(B)

In-rack automatic sprinklers shall be provided under each horizontal barrier and arranged in accordance with 26.36.1.3.4.4(C) through 26.36.1.3.4.4(J). [**400:**~~15.3.2.4.13.5(K)~~ 15.3.2.4.13.5(L)]

(C)

For double-row racks, two lines of in-rack sprinklers shall be provided between the face of the rack and the longitudinal vertical barrier located in the center of the rack. [**400:**~~15.3.2.4.13.5(L)~~ 15.3.2.4.13.5(M)]

(D)

For single-row racks, two lines of in-rack sprinklers shall be provided between each rack face. [**400:**~~15.3.2.4.13.5(M)~~ 15.3.2.4.13.5(N)]

(E)

Three in-rack sprinklers shall be provided on each in-rack sprinkler line as follows:

(1) Two sprinklers on each line shall be spaced approximately 1½ in. (38.1 mm) from each transverse vertical barrier.

(2) One in-rack sprinkler on each in-rack sprinkler line shall be located approximately equidistant between the transverse vertical barriers.

[**400:**~~15.3.2.4.13.5(N)~~ 15.3.2.4.13.5(O)]

(F)

In-rack sprinklers shall be of the upright or pendent type, with the fusible element located no more than 6 in. (152.4 mm) from the horizontal barrier. [**400:**~~15.3.2.4.13.5(O)~~ 15.3.2.4.13.5(P)]

(G)

The stock shall be maintained at least 6 in. (152.4 mm) below the sprinkler deflector. [**400:** 15.3.2.4.13.5(Q)]

(H)

In-rack sprinklers shall be K = 8.0, quick-response, ordinary-temperature-rated sprinklers. [**400:**~~15.3.2.4.13.5(Q)~~ 15.3.2.4.13.5(R)]

(I)

The in-rack sprinkler system shall be designed to supply 6 sprinklers on each line, with a total of 12 sprinklers operating at gauge pressure of 25 psi (172 kPa). [**400:**~~15.3.2.4.13.5(R)~~ 15.3.2.4.13.5(S)]

(J)

The design of the in-rack sprinkler system shall be independent of, and shall not be required to be balanced with, ceiling sprinkler systems. [**400:**~~15.3.2.4.13.5(S)~~ 15.3.2.4.13.5(T)]

26.36.1.3.4.5 Sprinkler Criteria for Class 4 Oxidizers.

(A)

Sprinkler protection for Class 4 oxidizers shall be installed on a deluge sprinkler system to provide water density of 0.35 gpm/ft^2 (14.4 L/min/m^2) over the entire storage area. [**400:**15.3.2.5.4.6(A)]

(B)

Sprinkler protection shall be installed in accordance with ~~NFPA 13~~ this standard . [**400:**15.3.2.5.4.6(B)]

26.36.2 Installation Requirements. (Reserved)

Supplemental Information

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Street Address:
City:
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Zip:
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~~**25.12.3.3.1**~~

~~Where in-rack sprinklers have been installed to protect rack storage of the following commodities and storage arrangements, the minimum allowable design pressure at the hydraulically most remote in-rack sprinkler shall be 30 gpm (115 L/min).~~

~~Class I through Class IV and Group A plastic commodities stored in racks with solid shelves.~~

~~Class I through Class IV and Group A plastic commodities stored in racks over 25 ft (7.6 m) in height protected by CMDA sprinklers at ceiling level.~~

~~**25.12.3.4** In-Rack Design Based on 60 gpm (230 L/min).~~

~~Where in-rack sprinklers have been installed to protect rack storage protected by ESFR sprinklers at ceiling level, the minimum allowable design pressure at the hydraulically most remote in-rack sprinkler shall be 60 gpm (230 L/min).~~

Supplemental Information

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TG_25_Draft_Chapter_25_Clean_Second_Draft_18-Jul-2017_.docx	Complete revision of Chapter 25. For staff use.	
Copy_of_Draft_Tables_for_Chapter_25_for_NFPA_Staff.xlsx	This is a copy of all the Tables that are in Chapter 25 for use by NFPA staff.	

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A.20.3

Commodity classification is governed by the types and amounts of materials (e.g., metal, paper, wood, plastics) that are a part of a product and its primary packaging. Consideration of all characteristics of the individual storage units, not just the product, is critical to identify the appropriate commodity classification. Refer to Table A.20.3 for general guidance for classifying commodities. For situations where it is difficult to determine the appropriate classification, testing should be considered to appropriately characterize the commodity.

Table A.20.3 General Guide to Identifying the Commodity Class for Solid Combustibles

Characteristics of Unit Load			Commodity Class
Material Used to Construct Product	Packaging Material	Pallet Material	
Noncombustible Product			
Entirely noncombustible	None or single-layer corrugated cartons	None, metal, or wood	Class I
Entirely noncombustible	None or single-layer corrugated cartons	Plastic	Class I, II, or III; see ~~5.6.2~~ 20.3.2
Entirely noncombustible	Multiple-layered corrugated cartons, wooden crates, or wood boxes	None, metal, or wood	Class II
Entirely noncombustible	Multiple-layered corrugated cartons, wooden crates, or wood boxes	Plastic	Class II, III, or IV; see ~~5.6.2~~ 20.3.2
Entirely noncombustible	Corrugated cartons, wooden crates, or wood boxes, with internal plastic packaging	None, metal, or wood	See Figure ~~5.6.3.3.3.1~~ 20.4.3.3(a)
Entirely noncombustible	Corrugated cartons, wooden crates, or wooden boxes, with internal plastic packaging	Plastic	See ~~5.6.2~~ 20.3.2 and Figure ~~5.6.3.3.3.1~~ 20.4.3.3(a)
Wood, Paper, Natural Fibers, or Group C Plastics			
Entirely wood, paper, natural fibers, or Group C plastics, or a mix of these with noncombustible materials	None, corrugated cartons, wooden crates, or wood boxes	None, metal, or wood	Class III
Entirely wood, paper, natural fibers, or Group C plastics, or a mix of these with noncombustible materials	Corrugated cartons, wooden crates, or wood boxes, with internal plastic packaging	None, metal, or wood	See Figure ~~5.6.3.3.3.1~~ 20.4.3.3(a)
Entirely wood, paper, natural fibers, or Group C plastics, or a mix of these with noncombustible materials	None, corrugated cartons, wooden crates, or wood boxes	Plastic	Class III or IV or cartoned nonexpanded Group A plastic; see ~~5.6.2~~ 20.3.2
Entirely wood, paper, natural fibers, or Group C plastics, or a mix of these with noncombustible materials	Corrugated cartons, wooden crates, or wood boxes, with internal plastic packaging	Plastic	See ~~5.6.2~~ 20.3.2 and Figure ~~5.6.3.3.3.1~~ 20.4.3.3(a)

Characteristics of Unit Load			Commodity Class
Material Used to Construct Product	Packaging Material	Pallet Material	
Group B Plastics			
Entirely Group B plastics, or a mix of these with noncombustible, wood, paper, natural fibers, or Group C plastics materials	None, corrugated cartons, wooden crates, or wood boxes	None, metal, or wood	Class IV
Entirely Group B plastics, or a mix of these with noncombustible, wood, paper, natural fibers, or Group C plastics materials	Corrugated cartons, wooden crates, or wood boxes	Plastic	Class IV or cartoned nonexpanded Group A plastic; see ~~5.6.2~~ 20.3.2
Entirely Group B plastics, or a mix of these with noncombustible, wood, paper, natural fibers, or Group C plastics materials	None	Plastic	Class IV or cartoned nonexpanded Group A plastic; see ~~5.6.2~~ 20.3.2
Entirely Group B plastics, or a mix of these with noncombustible, wood, paper, natural fibers, or Group C plastics materials	Corrugated cartons, wooden crates, or wood boxes, with plastic internal packaging	None, metal, or wood	See Figure ~~5.6.3.3.3.1~~ 20.4.3.3(a)
Entirely Group B plastics, or a mix of these with noncombustible, wood, paper, natural fibers, or Group C plastics materials	Corrugated cartons, wooden crates, or wood boxes, with plastic internal packaging	Plastic	See ~~5.6.2~~ 20.3.2 and Figure ~~5.6.3.3.3.1~~ 20.4.3.3(a)
Group A Plastics			
Free-flowing Group A plastic materials	Corrugated cartons, wooden crates, wood boxes, or bagged	None, metal, wood	Class IV
Free-flowing Group A plastic materials	Corrugated cartons, wooden crates, wood boxes, or bagged	Plastic	Class IV or cartoned nonexpanded Group A plastic; see ~~5.6.2~~ 20.3.2
Entirely nonexpanded Group A plastic	Corrugated cartons, wooden crates, or wood boxes	None, metal, wood, or plastic	Cartoned nonexpanded Group A plastic
Entirely nonexpanded Group A plastic	None	None, metal, wood, or plastic	Exposed nonexpanded Group A plastic
Entirely nonexpanded Group A plastic	Corrugated cartons, wooden crates, or wood boxes, with internal plastic packaging	None, metal, wood, or plastic	See Figure ~~5.6.3.3.3.1~~ 20.4.3.3(a)
Entirely expanded Group A plastic	Corrugated cartons, wooden crates, or wood boxes, with or without internal plastic packaging	None, metal, wood, or plastic	Cartoned expanded Group A plastic
Entirely expanded Group A plastic	None	None, metal, wood, or plastic	Exposed expanded Group A plastic
Mix of Group A plastics, noncombustible, wood, paper, natural fibers, Group B or C	Corrugated cartons, wooden crates, or wood boxes, with or without	None, metal, or wood	See Figure ~~5.6.3.3.3.1~~ 20.4.3.3(a)

Characteristics of Unit Load			Commodity Class
Material Used to Construct Product	Packaging Material	Pallet Material	
plastics materials	internal plastic packaging		
Mix of Group A plastics, noncombustible, wood, paper, natural fibers, Group B or C plastics materials	Corrugated cartons, wooden crates, or wood boxes	Plastic	See ~~5.6.2~~ 20.3.2 and Figure ~~5.6.3.3.3.1~~ 20.4.3.3(a)
Mix of Group A plastics, noncombustible, wood, paper, natural fibers, Group B or C plastics materials	None	None, metal, or wood	See Figure ~~5.6.3.3.3.2~~ 20.4.3.3(b)
Mix of Group A plastics, noncombustible, wood, paper, natural fibers, Group B or C plastics materials	None	Plastic	See ~~5.6.2~~ 20.3.2 and Figure ~~5.6.3.3.3.2~~ 20.4.3.3(b)

Note: This table provides guidance for the general characteristics to be considered in classifying a commodity. The additional commodity classification information included in this standard as well as any relevant test data that is available should be considered in identifying the appropriate classification.

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Organization: [Not Specified]
Street Address:
City:
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Zip:
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Detail SR-1038

Global SR-531

A.20.4

~~See Table A.20.4.~~

Specification of the type, amount, and arrangement of combustibles for any commodity classification is essentially an attempt to define the potential fire severity, based on its burning characteristics, so the fire can be successfully controlled by the prescribed sprinkler protection for the commodity class. In actual storage situations, however, many storage arrays do not fit precisely into one of the fundamental classifications; therefore, the user needs to make judgments after comparing each classification to the existing storage conditions. Storage arrays consist of thousands of products, which makes it impossible to specify all the acceptable variations for any class. As an alternative, a variety of common products are classified in this annex based on judgment, loss experience, and fire test results.

Table A.20.4(a) provides examples of commodities not addressed by the classifications in Section 20.4. The commodities listed in Table A.20.4(a) are outside the scope of NFPA 13 protection.

Table A.20.4(a) includes lithium ion batteries. Lithium ion batteries have been a research project within the NFPA Research Foundation. As a result, the following reports have been published:

(1) *Lithium Ion Batteries Hazard and Use Assessment*, published July 2011 and available at the NFPA Research Foundation web site.

(2) *Flammability Characterization of Lithium-ion Batteries in Bulk Storage*, published March 2013 and available at www.fmglobal.com/researchreports.

(3) *Lithium Ion Batteries Hazard and Use Assessment Phase IIB, Flammability Characterization of Li-ion Batteries for Storage Protection*, published April 2013 and available at the NFPA Research Foundation web site.

(4) *Lithium Ion Batteries Hazard and Use Assessment — Phase III*, published November 2016 and available at the NFPA Research Foundation web site.

Table A.20.4(b) is an alphabetized list of commodities with corresponding classifications.

Table A.20.4.1, Table A.20.4.2, Table A.20.4.3, Table A.20.4.4, and Table A.20.4.5.1 provide examples of commodities within a specific class.

Table A.20.4(a) Examples of Commodities Not Addressed by Classifications in Section 20.4

Ammunition Components
- Bulk primers and powder
Batteries
- Lithium and other similar exotic metals
- Lithium-ion and other rechargeable batteries that contain combustible electrolyte
Boat Storage
- Stored on racks
Boxes, Crates
- Empty, wood slatted*
Carpet Rolls
Combustible Metals — unless specifically identified otherwise
Compressed or Liquefied Flammable Gases (i.e., filled propane cylinders) — unless specifically identified otherwise
Explosives
- Blasting primers and similar items
Fertilizers (nitrates)
Fireworks
- Consumer and display
Flammable and Combustible Liquids — unless specifically identified otherwise
- Liquids that contain greater than 20 percent alcohol
Hanging Garments, Bulk Storage
Lighters (butane)

- Loose in large containers (Level 3 aerosol)

Storage Container

- Large container storage of household goods

*Should be treated as idle pallets.

Table A.20.4(b) Alphabetical Listing of Commodity Classes

Product Heading	Product	NFPA 13
Batteries	Dry cells (excludes lithium, lithium-ion, and other similar exotic metals or combustible electrolyte); without blister packing (if blister packed refer to commodity classification definitions)	Class I
	Vehicle; any size (e.g., automobile or truck); empty plastic casing	Group A Nonexpanded
	Vehicle; large (e.g., truck or larger); dry or wet (excludes lithium-ion and other cells containing combustible electrolyte) cells	Group A Nonexpanded
	Vehicle; small (e.g., automobile); wet (excludes lithium-ion and other cells containing combustible electrolyte) cells	Class I
Empty Containers	Noncombustible	Class I
	PET, bottles or jars	Class IV
	Rigid plastic (not including PET), up to 32 oz. (1 L)	Group A Nonexpanded
	Rigid plastic (not including PET), greater than 32 oz. (1 L)	Group A Expanded
	Wood; solid sided (e.g., crates, boxes)	Class II
Film Rolls, Including Photographic	Film (polypropylene, ~~polyesther~~polyester, polyethylene); rolled on any reel type	Group A Nonexpanded
	Film; 35 mm metal film cartridges in polyethylene cans; cartoned	Class III
	Film; motion picture or bulk rolls in polycarbonate, polyethylene or in metal cans; polyethylene bagged; cartoned	Class II
	Film; rolls in polycarbonate plastic cassettes; cartoned	Class IV
	Photographic paper; sheets; bagged in polyethylene; cartoned	Class III
Flammable/Combustible Liquids	Aerosol; Level 1	Class III
	Lighters; butane; blister-packed; cartoned	Group A Nonexpanded
	Liquids; up to 20 percent alcohol (e.g. alcoholic beverages, flavoring extracts); greater than 5 gal~~lon~~ (20 L) plastic containers with wall thickness greater than ¼ in. (6 mm)	Group A Nonexpanded
	Liquids; up to 20 percent alcohol (e.g., alcoholic beverages, flavoring extracts); metal, glass or ceramic containers	Class I
	Liquids; up to 20 percent alcohol (e.g., alcoholic beverages, flavoring extracts); plastic containers greater than 5 gal~~lons~~ (20 L) and wall thickness up to ¼ in. (6 mm)	Class II

Product Heading	Product	NFPA 13
	Liquids; up to 20 percent alcohol (e.g., alcoholic beverages, flavoring extracts); up to 5 gal~~lons~~ (20 L) plastic bottles or jars	Class I
	Liquids; up to 20 percent alcohol (e.g., alcoholic beverages, flavoring extracts); wood containers	Class II
Food Products — Frozen	Frozen foods; nonwaxed or nonplastic packaging	Class I
	Frozen foods; plastic trays	Class III
	Frozen foods; waxed or plastic-coated paper packaging	Class II
Food Products — Non-Frozen	Butter (stick or whipped spread) or margarine (up to 50 percent oil)	Class III
	Dry foods (such as baked goods, candy, cereals, cheese, chocolate, cocoa, coffee, grains, granular sugar, nuts, etc.); bagged or cartoned	Class III
	Foods (e.g., coffee, fish products, fruit, meat products, nuts, poultry, etc.); metal cans	Class I
	Fruits and vegetables (noncombustible semi-liquids); crushed; plastic containers up to 5 gal~~lons~~ (20 L)	Class I
	Fruits and vegetables; fresh; wood spacers, non-plastic trays or containers	Class I
	Margarine; over 50 and up to 80 percent oil	Group A Nonexpanded
	Meat; fresh; no plastic packaging; ~~uncartoned~~exposed	Class I
	Meat; fresh; no plastic packaging; cartoned	Class II
	Meat; fresh; plastic trays	Class III
	Milk; any container; stored in solid plastic crates	Group A Nonexpanded
	Milk; paper containers, or plastic bottles or jars up to 5 gal~~lons~~ (20 L) plastic bottles or jars	Class I
	Salt; bagged	Class I
	Salt; cartoned	Class II
	Snack foods (e.g., potato chips); plasticized aluminum bags; cartoned	Group A Nonexpanded
	Syrup; wooden container	Class II
Furniture and Bedding	Furniture and bedding; with foam cushioning	Group A Expanded
	Furniture; metal (e.g., file cabinets or desks with plastic trim); cartoned	Class I
	Furniture; wood (e.g., doors, windows, cabinets, etc.); no plastic coverings or foam cushioning	Class III
	Furniture; wood; plastic coverings nonexpanded plastic trim	Class IV
	Box spring; standard (minimal plastic materials)	Class III
	Box spring; wrapped in plastic cover	Class IV
	Mattress; foam (in finished form)	Group A Expanded
Housing Materials/Appliances	Appliances; major (e.g., stoves, refrigerators); no appreciable plastic interior or exterior trim; cartoned	Class II

Product Heading	Product	NFPA 13
	Appliances; major (e.g., stoves, refrigerators); no appreciable plastic interior or exterior trim; ~~uncartoned~~exposed	Class I
	Appliances; no appreciable plastic exterior trim (interior of unit can have appreciable plastic)	Class III
	Carpet tiles; cartoned	Group A Nonexpanded
	Fiberglass insulation; paper-backed rolls; bagged or unbagged	Class IV
	Floor coverings; vinyl, stacked tiles	Class IV
	Floor coverings; vinyl; rolled	Group A Nonexpanded
	Gypsum board	Class I
	Housing materials (such as sinks, countertops, etc.); noncombustible, cartoned or crated	Class II
	Paint; oil-based; friction-top metal containers; cartoned	Class IV
	Paint; water-based (latex); friction-top metal containers; cartoned	Class I
	Roofing shingles; asphalt-coated fiberglass	Class III
	Roofing shingles; asphalt-impregnated felt	Class IV
Miscellaneous	Ammunition; small arms and shotgun; cartoned	Class IV
	Charcoal; mineral spirit impregnated; bagged	Group A Expanded
	Charcoal; standard (non-mineral spirit impregnated); bagged	Class III
	Leather hides; baled	Class II
	Leather; finished products (e.g., shoes, jackets, gloves, bags, luggage, belts)	Class III
	Motors; electric	Class I
	Shock absorbers; metal dust cover	Class II
	Shock absorbers; plastic dust cover	Class III
	Skis; composite materials (plastic, fiberglass, foam, etc.)	Class IV
	Tobacco products; cartoned	Class III
	Toys; stuffed; foam or synthetic	Group A Expanded
	Transformer; dry or empty (i.e., void of oil)-filled	Class I
Noncombustible Liquids	Liquids or semi-liquids; PET containers greater than 5 gal~~lon~~ (20 L) having a nominal wall thickness greater than 0.25 in (6 mm)	Class IV
	Liquids or semi-liquids; PET containers up to 5 gal~~lon~~ (20 L) or greater than 5 gal~~lon~~ (20 L) having a nominal wall thickness up to 0.25 in (6 mm)	Class I
	Liquids or semi-liquids (e.g., crushed fruits and vegetables); plastic containers up to 5 gal~~lon~~ (18.9 L) capacity	Class I
	Liquids or semi-liquids; plastic (except PET) containers greater than 5 gal~~lon~~ (20 L) capacity having a nominal wall thickness greater than 0.25 in. (6 mm)	Group A Nonexpanded

Product Heading	Product	NFPA 13
	Liquids or semi-liquids; plastic (except PET) containers greater than 5 gal~~lon~~ (20 L) capacity having a nominal wall thickness up to 0.25 in. (6 mm)	Class II
	Liquids; cardboard drink boxes, plastic-coated, wax-coated, and/or aluminum-lined; ~~uncartoned~~exposed or on corrugated carton trays with plastic sheeting.	Class I
	Liquids; cardboard drink boxes, plastic-coated, wax-coated, and/or aluminum-lined; stored in plastic containers	Group A Nonexpanded
	Liquids; glass bottles or jars; cartoned	Class I
	Liquids; pharmaceuticals (nonflammable); glass bottles or jars; cartoned	Class II
	Liquids; plastic bottles or jars; stored in open or solid plastic crates	Group A Nonexpanded
Paper Products	Book signatures (paper part of book without hard cover)	Class II
	Cartons (i.e., cardboard flats); corrugated; partially assembled	Class IV
	Cartons (i.e., cardboard flats); corrugated; unassembled in neat piles	Class III
	Cartons; wax-coated, single-walled corrugated	Group A Nonexpanded
	Cellulosic paper products; nonwax-coated (e.g., books, cardboard games, cartoned tissue products, magazines, newspapers, paper cups, paper plates, paper towels, plastic-coated paper food containers, stationery)	Class III
	Cellulosic paper products; wax-coated (e.g., paper plates, cups); loosely packed; cartoned	Group A Nonexpanded
	Cellulosic paper products; wax-coated (e.g., paper plates, cups.); nested; cartoned	Class IV
	Matches; paper-type; cartoned	Class IV
	Matches; wooden; cartoned	Group A Nonexpanded
	Rolled; lightweight; in storage racks	Class IV
	Rolled; medium or heavyweight; in storage racks or on-side	Class III
	Tissue products; plastic-wrapped; cartoned	Class III
	Tissue products; plastic-wrapped; ~~uncartoned~~exposed	Group A Nonexpanded
Plastic/Rubber	ABS (Acrylonitrile-butadiene-styrene copolymer)	Group A Nonexpanded
	Acetal (polyformaldehyde)	Group A Nonexpanded
	Acrylic (polymethyl methacrylate)	Group A Nonexpanded
	Automobile bumpers and dashboards	Group A Expanded
	Butyl rubber	Group A Nonexpanded
	Cellulose Acetate	Class IV
	Cellulose Acetate Butyrate	Group A Nonexpanded
	Chloroprene rubber	Class IV

Product Heading	Product	NFPA 13
	Containers; nonexpanded plastic gridded or solid; collapsed or nested with no air spaces	Group A Nonexpanded
	ECTFE (ethylene-chlorotrifluoro-ethylene copolymer)	Class IV
	EPDM (ethylene-propylene rubber)	Group A Nonexpanded
	ETFE (ethylene-tetrafluoroethylene copolymer)	Class IV
	Ethyl Cellulose	Group A Nonexpanded
	FEP (fluorinated ethylene-propylene copolymer)	Class IV
	FRP (fiberglass-reinforced polyester)	Group A Nonexpanded
	Melamine (melamine formaldehyde)	Class III
	Nitrile Rubber (acrylonitrile-butadiene rubber)	Group A Nonexpanded
	Nylon (nylon 6, nylon 6/6)	Group A Nonexpanded
	PCTFE (polychlorotrifluoroethylene)	Class III
	PET (Polyethylene Terephthalate — thermoplastic polyester)	Group A Nonexpanded
	Phenolic	Class III
	Plastics; stored in fully closed and solid (no openings), metal containers	Class I
	Polybutadiene	Group A Nonexpanded
	Polycarbonate	Group A Nonexpanded
	Polyester elastomer	Group A Nonexpanded
	Polyethylene	Group A Nonexpanded
	Polypropylene	Group A Nonexpanded
	Polystyrene; foam products (plates, cups, etc.)	Group A Expanded
	Polystyrene; rigid products	Group A Nonexpanded
	Polyurethane	Group A Expanded
	PTFE (polytetrafluoroethylene)	Class III
	PVC (polyvinyl chloride) products, up to 20% percent plasticizer	Class III
	PVC (polyvinyl chloride) products, greater than 20% percent plasticizer	Group A Nonexpanded
	PVC resins; bagged	Class III
	PVDC (polyvinylidene chloride)	Class III
	PVDF (polyvinylidene fluoride)	Class III
	PVF (polyvinyl fluoride)	Group A Nonexpanded
	Rubber; natural in blocks; cartoned	Group A Nonexpanded
	Rubber; natural; expanded	Group A Expanded
	Rubber; natural; nonexpanded	Group A Nonexpanded
	Rubber; synthetic (santoprene)	Group A Nonexpanded
	SAN (styrene acrylonitrile)	Group A Nonexpanded
	SBR (styrene-butadiene rubber)	Group A Nonexpanded
	Silicone rubber	Class IV
	Urea (urea formaldehyde)	Class III

Product Heading	Product	NFPA 13
Plastic Containers	Bottles or jars (except PET) greater than 1 gal~~lon~~ (4 L) containing noncombustible solids	Group A Nonexpanded
	Bottles or jars (except PET) up to 1 gal~~lon~~ (4 L) containing noncombustible solids	Group A, cartoned (treat as cartoned even if ~~uncartoned~~exposed) Nonexpanded
Powders/Pills	Pharmaceutical pills; glass bottles or jars; cartoned	Class II
	Pharmaceuticals pills; plastic bottles or jars; cartoned	Class IV
	Polyvinyl Alcohol (PVA) resins; bagged	Class IV
	Powders; combustible (ordinary such as sugar or flour); free-flowing; bagged	Class II
	Powders; noncombustible free-flowing powdered or granular materials (cement, calcium chloride, clay, iron oxide, sodium chloride, sodium silicate, etc.)	Class I
	Powders; noncombustible; glass bottles or jars; cartoned	Class I
	Powders; noncombustible; PET bottles or jars	Class II
	Powders; noncombustible; plastic (other than PET) bottles or jars; ~~uncartoned~~exposed	Group A Nonexpanded
	Powders; noncombustible; plastic bottles or jars greater than 1 gal~~lon~~ (4 L) capacity	Group A Nonexpanded
	Powders; noncombustible; plastic bottles or jars up to 1 gal~~lon~~ (4 L) capacity; cartoned	Class IV
Textile Materials/Products	Cloth; natural fibers; baled	Class III
	Cloth; synthetic cloth	Group A Nonexpanded
	Clothing; natural fibers (e.g., wool, cotton) and viscose	Class III
	Cotton; cartoned	Class III
	Diapers; cotton or linen	Class III
	Diapers; plastic or nonwoven fabric; cartoned	Class IV
	Diapers; plastic or nonwoven fabric; plastic-wrapped; ~~uncartoned~~exposed	Group A Nonexpanded
	Fabric; rayon and nylon	Group A Nonexpanded
	Fabric; synthetic (except rayon and nylon); greater than 50/50 blend	Group A Nonexpanded
	Fabric; synthetic (except rayon and nylon); up to 50/50 blend	Group A Nonexpanded
	Fabric; vinyl-coated (e.g., tablecloth); cartoned	Group A Nonexpanded
	Fibers; rayon and nylon; baled	Class IV
	Fibers; synthetic (except rayon and nylon); baled	Group A Nonexpanded
	Thread or yarn; rayon and nylon; wood or paper spools	Class IV
	Thread or yarn; rayon or nylon; plastic spools	Group A Nonexpanded
	Thread or yarn; synthetic (except rayon and nylon); greater than 50/50 blend; paper or wood spools	Group A Nonexpanded Plastic

Product Heading	Product	NFPA 13
	Thread or yarn; synthetic (except rayon and nylon); greater than 50/50 blend; plastic spools	Group A Nonexpanded
	Thread or yarn; synthetic (except rayon and nylon); up to 50/50 blend; plastic spools	Group A Nonexpanded
	Thread or yarn; synthetic (except rayon and nylon); up to 50/50 blend; wood or paper spools	Group A Nonexpanded Plastic
Wax Products	Candles	Group A Expanded
	Paraffin or petroleum wax; blocks	Group A Expanded
Wire/Cable/Spools	Spools; plastic; empty	Group A Nonexpanded
	Spools; wood; empty	Class III
	Wire or cable; PVC insulated; metal or wood spools	Class II
	Wire or cable; PVC insulated; plastic spools	Class IV
	Wire; bare; metal spools, ~~uncartoned~~exposed	Class I
	Wire; bare; metal spools; cartoned	Class II
	Wire; bare; plastic spools; cartoned	Class IV
	Wire; bare; plastic spools; ~~uncartoned~~exposed	Group A Nonexpanded
	Wire; bare; wood or cardboard spools	Class II
Wood Products	Wood patterns	Class IV
	Wood products (e.g., fiberboard, lumber, particle board, plywood, pressboard with smooth ends and edges); bundled solid blocks	Class II
	Wood products (e.g., fiberboard, lumber, particle board, plywood, pressboard with smooth ends and edges); unbundled or non-solid blocks	Class III
	Wood products (e.g., toothpicks, clothespins and hangers)	Class III

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Organization: [Not Specified]
Street Address:
City:
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A.20.5.3

Many factors affect the protection of rack storage. Section ~~20.5.7~~ 20.5.3 defined the variables that limit or change the available protection criteria found in Chapters 21 through ~~24~~ 25 . Paragraphs ~~20.5.7.1 through 20.5.7.2~~ 20.5.3.1 through 20.5.3.3 identify the general terms of rack storage that identify which type of rack and shelving criteria is to be used in Chapters 21 through ~~24~~ 25 .

Submitter Information Verification

Submitter Full Name: AUT-SSD
Organization: National Fire Protection Assoc
Street Address:
City:
State:
Zip:
Submittal Date: Mon Oct 16 14:19:57 EDT 2017

Committee Statement

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Second Revision No. 1038-NFPA 13-2017 [Detail]

~~A.25.4.9~~

[Move text and table to the beginning of existing A.20.4] **Specification of the type, amount, and arrangement of combustibles for any commodity classification is essentially an attempt to define the potential fire severity, based on its burning characteristics, so the fire can be successfully controlled by the prescribed sprinkler protection for the commodity class. In actual storage situations, however, many storage arrays do not fit precisely into one of the fundamental classifications; therefore, the user needs to make judgments after comparing each classification to the existing storage conditions. Storage arrays consist of thousands of products, which makes it impossible to specify all the acceptable variations for any class. As an alternative, a variety of common products are classified in this annex based on judgment, loss experience, and fire test results.**

Table ~~A.25.4.9~~ A.20.4(a) provides examples of commodities not addressed by the classifications in Section 20.5. The commodities listed in Table ~~A.25.4.9~~ A.20.4(a) are outside the scope of NFPA 13 protection.

Table ~~A.20.3~~ A.20.4(a) includes lithium ion batteries. Lithium ion batteries have been a research project within the NFPA Research Foundation. As a result, the following reports have been published:

(1) *Lithium Ion Batteries Hazard and Use Assessment*, published July 2011 and available at the NFPA Research Foundation web site.

(2) *Flammability Characterization of Lithium-ion Batteries in Bulk Storage*, published March 2013 and available at www.fmglobal.com/researchreports.

(3) *Lithium Ion Batteries Hazard and Use Assessment Phase IIB, Flammability Characterization of Li-ion Batteries for Storage Protection*, published April 2013 and available at the NFPA Research Foundation web site.

(4) ~~*Sprinkler Protection Criteria for* Lithium Ion Batteries *Stored in Cartons*~~ *Hazard and Use Assessment — Phase III*, published ~~July~~ November 2016 and available at the NFPA Research Foundation web site.

Table ~~A.20.5~~ A.20.4(b) is an alphabetized list of commodities with corresponding classifications.

Table A.20.4.1, Table A.20.4.2, Table A.20.4.3, Table A.20.4.4, and Table A.20.4.5.1 provide examples of commodities within a specific class.

Table ~~A.25.4.9~~ A.20.4(a) Examples of Commodities Not Addressed by Classifications in Section ~~5.6~~ 20.4

Ammunition Components
- Bulk primers and powder
Batteries
- Lithium and other similar exotic metals
- Lithium-ion and other rechargeable batteries that contain combustible electrolyte
Boat Storage
- Stored on racks
Boxes, Crates
- Empty, wood slatted*
Carpet Rolls
Combustible Metals — unless specifically identified otherwise

Compressed or Liquefied Flammable Gases (i.e., filled propane cylinders) — unless specifically identified otherwise

Explosives

- Blasting primers and similar items

Fertilizers (nitrates)

Fireworks

- Consumer and display

Flammable and Combustible Liquids — unless specifically identified otherwise

- Liquids that contain greater than 20% alcohol

Hanging Garments, Bulk Storage

Lighters (butane)

- Loose in large containers (Level 3 aerosol)

Storage Container

- Large container storage of household goods

***Should be treated as idle pallets.**

Submitter Information Verification

Submitter Full Name: AUT-SSD
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Wed Sep 27 11:52:16 EDT 2017

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Second Revision No. 1035-NFPA 13-2017 [Chapter C]

Annex C Explanation of Test Data and Procedures for Rack Storage

This annex is not a part of the requirements of this NFPA document but is included for informational purposes only.

C.1

Annex C provides an explanation of the test data and procedures that led to the development of sprinkler system discharge criteria for rack storage applications. Numbers in brackets refer to paragraphs in the text.

C.2 ~~[5.6]~~ [20.3]

A review of full-scale fire tests run on the standard commodity (double tri-wall carton with metal liner), of Hallmark products and 3M products (e.g., abrasives, pressure-sensitive tapes of plastic fiber, and paper), and of the considerable number of commodity tests conducted provides a guide for commodity classifications. Such guidance is not related to any other method of classification of materials; therefore, sound engineering judgment and analysis of the commodity and the packaging should be used when selecting a commodity classification.

C.3 ~~[8.13.3.1]~~ [25.3.5.1]

Tests 71, 73, 81, 83, 91, 92, 95, and 100 in the 20 ft (6.1 m) high array involving a single level of in-rack sprinklers were conducted without heat or water shields. Results were satisfactory.

Test 115 was conducted with two levels of sprinklers in racks with shields. Test 116, identical to Test 115 but without water shields, produced a lack of control. Visual observation of lower level in-rack sprinklers that did not operate although they were in the fire area indicated a need for water shields.

Tests 115 and 116 were conducted to investigate the necessity for water shields where multiple levels of in-rack sprinklers are installed. Where water shields were not installed in Test 116, the fire jumped the aisle, and approximately 76 boxes were damaged. In Test 115 with water shields, the fire did not jump the aisle, and only 32 boxes were damaged. Water shields are, therefore, suggested wherever multiple levels of in-rack sprinklers are installed, except for installations with horizontal barriers or shelves that serve as water shields.

C.4 ~~[8.17.1.7]~~ [25.1.3.3]

The time of operation of the first sprinkler varied from 52 seconds to 3 minutes and 55 seconds, with most tests under 3 minutes, except in Test 64 (Class III), where the first sprinkler operated in 7 minutes and 44 seconds. Fire detection more sensitive than waterflow is, therefore, considered necessary only in exceptional cases.

C.5 ~~[8.17.5.1]~~ [16.15.1 and 20.11.1]

In most tests conducted, it was necessary to use small hose for mop-up operations. Small hose was not used in the high-expansion foam test.

Test 97 was conducted to evaluate the effect of dry pipe sprinkler operation. Test results were approximately the same as the base test with a wet pipe system. A study of NFPA records, however, indicates an increase in area of operation of 30 percent to be in order for dry pipe systems as compared with wet pipe systems.

C.6 ~~[12.1.1]~~ [20.6.5]

Tests were conducted as a part of this program with eave line windows or louvers open to simulate smoke and heat venting. These tests opened 87.5 percent and 91 percent more sprinklers than did comparative tests without windows or louvers open. Venting tests that have been conducted in other programs were without the benefit of sprinkler protection and, as such, are not considered in this report, which covers only buildings protected by sprinklers. The design curves are based upon the absence of roof vents or draft curtains in the building. During mop-up operations, ventilating systems, where installed, should be capable of manual exhaust operations.

C.7 ~~[12.12.1.3]~~ [20.14.1.3]

No tests were conducted with idle pallets in racks using standard spray sprinklers. However, tests were conducted using ESFR and large drop sprinklers. Such storage conceivably would introduce fire severity in excess of that contemplated by protection criteria for an individual commodity classification.

C.8 ~~[12.8.6]~~ [20.12.2.6]

In all valid tests with double-row racks, sprinkler water supplies were shut off at approximately 60 minutes. In only one test did the last sprinkler operate in excess of 30 minutes after ignition; the last sprinkler operated in excess of 25 minutes in three tests, with the majority of tests involving the last sprinkler operating within 20 minutes.

C.9 ~~[16.1.1 and 17.1.1]~~ [25.2.1.1]

The discharge criteria of Section ~~12.3~~ 20.10 uses as a basis the large-scale fire test series conducted at the Factory Mutual Research Center, West Glocester, Rhode Island.

The test building is approximately 200 ft × 250 ft (61 m × 76 m) [50,000 ft^2 (4650 m^2) in area], of fire-resistive construction, and contains a volume of approximately 2.25 million ft^3 (63,713 m^3), the equivalent of a 100,000 ft^2 (9300 m^2) building that is 22.5 ft (6.9 m) high. The test building has two primary heights beneath a single large ceiling. The east section is 30 ft (9.1 m) high, and the west section is 60 ft (18 m) high.

The test series for storage height of 20 ft (6.1 m) was conducted in the 30 ft (9.1 m) section with clearances from the top of storage to the ceiling nominally 10 ft (3.0 m).

Doors at the lower and intermediate levels and ventilation louvers at the tops of walls were kept closed during the majority of the fire tests, which minimized the effect of exterior conditions.

The entire test series was fully instrumented with thermocouples attached to rack members, simulated building columns, bar joists, and the ceiling.

Racks were constructed of steel vertical and horizontal members designed for 4000 lb (1815 kg) loads. Vertical members were 8 ft (2.4 m) on center for conventional racks and 4 ft (1.2 m) on center for simulated automated racks. Racks were 3½ ft (1 m) wide with 6 in. (150 mm) longitudinal flue space for an overall width of 7½ ft (2.3 m). Simulated automated racks and slave pallets were used in the main central rack in the 4 ft (1.2 m) aisle tests. Conventional racks and conventional pallets were used in the main central rack in the 8 ft (2.4 m) aisle tests. The majority of the tests were conducted with 100 ft^2 (9.3 m^2) sprinkler spacing.

The test configuration for storage heights of 15 ft (4.6 m), 20 ft (6.1 m), and 25 ft (7.6 m) covered an 1800 ft^2 (167.2 m^2) floor area, including aisles between racks. Tests that were used in producing this standard limited fire damage to this area. The maximum water damage area anticipated in the standard is 6000 ft^2 (555 m^2), the upper limit of the design curves.

The test data show that, as density is increased, both the extent of fire damage and sprinkler operation are reduced. The data also indicate that, with sprinklers installed in the racks, a reduction is gained in the area of fire damage and sprinkler operations (e.g., water damage).

Table C.9 illustrates these points. The information shown in the table is taken from the test series for storage height of 20 ft (6.1 m) using the standard commodity.

The fact that there is a reduction in both fire damage and area of water application as sprinkler densities are increased or where sprinklers are installed in racks should be considered carefully by those responsible for applying this standard to the rack storage situation.

In the test for storage height of 25 ft (7.6 m), a density of 0.55 gpm/ft^2 (22.4 mm/min) produced 42 percent, or 756 ft^2 (70 m^2), fire damage in the test array and a sprinkler-wetted area of 1400 ft^2 (130 m^2). Lesser densities would not be expected to achieve the same limited degree of control. Therefore, if the goal of smaller areas of fire damage is to be achieved, sprinklers in racks should be considered.

The test series for storage height over 25 ft (7.6 m) was conducted in the 60 ft (18 m) section of the test building with nominal clearances from the top of storage to the ceiling of either 30 ft (9.1 m) or 10 ft (3.0 m).

Doors at the lower and intermediate levels and ventilation louvers at the top of walls were kept closed during the fire tests, which minimized the effect of exterior wind conditions.

The purpose of the tests for storage height over 25 ft (7.6 m) was to accomplish the following:

(1) Determine the arrangement of in-rack sprinklers that can be repeated as pile height increases and that provide control of the fire

(2) Determine other protective arrangements, such as high-expansion foam, that provide control of the fire

Control was considered to have been accomplished if the fire was unlikely to spread from the rack of origin to adjacent racks or spread beyond the length of the 25 ft (7.6 m) test rack. To aid in this judgment, control was considered to have been achieved if the fire failed to exhibit the following characteristics:

(1) Jump the 4 ft (1.2 m) aisles to adjoining racks

(2) Reach the end face of the end stacks (north or south ends) of the main rack

Control is defined as holding the fire in check through the extinguishing system until the commodities initially involved are consumed or until the fire is extinguished by the extinguishing system or manual aid.

The standard commodity as selected in the 20 ft (6.1 m) test series was used in the majority of tests for storage over 25 ft (7.6 m). Hallmark products and 3M products described in the 20 ft (6.1 m) test series report also were used as representative of Class III or Class IV commodities, or both, in several tests. The results of privately sponsored tests on Hallmark products and plastic encapsulated standard commodities also were made available to the committee.

A 25 ft (7.6 m) long test array was used for the majority of the tests for storage over 25 ft (7.6 m). The decision to use such an array was made because it was believed that a fire in racks over 25 ft (7.6 m) high that extended the full length of a 50 ft (15 m) long rack could not be considered controlled, particularly as storage heights increased.

One of the purposes of the tests was to determine arrangements of in-rack sprinklers that can be repeated as pile height increases and that provide control of the fire. The tests for storage height of 30 ft (9.1 m) explored the effect of such arrays. Many of these tests, however, produced appreciable fire spread in storage in tiers above the top level of protection within the racks. (In some cases, a total burnout of the top tiers of both the main rack and the target rack occurred.) In the case of the 30 ft (9.1 m) Hallmark Test 134 on the 60 ft (18 m) site, the material in the top tiers of storage burned vigorously, and the fire jumped the aisle above the fourth tier. The fire then burned downward into the south end of the fourth tier. In the test on the floor, a nominal 30 ft (9.1 m) clearance occurred between the top of storage and the ceiling sprinklers, whereas on the platform this clearance was reduced to nominal 10 ft (3.0 m). In most cases, the in-rack sprinklers were effective in controlling fire below the top level of protection within the racks. It has been assumed by the Test Planning Committee that, in an actual case with a clearance of 10 ft (3.0 m) or less above storage, ceiling sprinklers would be expected to control damage above the top level of protection within the racks. Tests have been planned to investigate lesser clearances.

Tests 114 and 128 explore the effect of changing the ignition point from the in-rack standard ignition point to a face ignition location. It should be noted, however, that both of these tests were conducted with 30 ft (9.1 m) clearance from the ceiling sprinklers to the top of storage and, as such, ceiling sprinklers had little effect on the fire in the top two tiers of storage. Firespread in the three lower tiers is essentially the same. A similar change in the firespread where the ignition point is changed was noted in Tests 126 and 127. Once again, 30 ft (9.1 m) clearance occurred between the top of storage and the ceiling sprinklers, and, as such, the ceiling sprinklers had little effect on the face fire. Comparisons of Tests 129, 130, and 131 in the test series for storage height of 50 ft (15 m) indicate little effect of point of ignition in the particular configuration tested.

Test 125, when compared with Test 133, indicates no significant difference in result between approved low-profile sprinklers and standard sprinklers in the racks.

Table C.9 Summary of Relationship Between Sprinkler Discharge Density and the Extent of Fire Damage and Sprinkler Operation

Density [gpm/ft^2 (Lpm/m^2)]	Fire Damage in Test Array		Sprinkler Operation [165°F (74°C)] Area [ft^2 (m^2)]
	%	ft^2(m^2)	
0.30 (12.2) (ceiling only)	22	395 (37)	4500–4800 (418–446)
0.375 (15.2) (ceiling only)	17	306 (24)	1800 (167)
0.45 (18.3) (ceiling only)	9	162 (15)	700 (65)
0.20 (8.1) (ceiling only)	28–36	504–648 (46–60)	13,100–14,000 (1217–1300)
0.20 (8.1) (sprinklers at ceiling and in racks)	8	144 (13)	4100 (380)
0.30 (12.2) (sprinklers at ceiling and in racks)	7	126 (12)	700 (65)

For SI units, 1 ft = 0.3048 m; °C = ⅝(°F- 32); 1 gpm/ft^2 = 40.746 mm/min.

C.10 ~~[16.1.4 and 17.1.4]~~ [20.15]

Temperatures in the test column were maintained below 1000°F (538°C) with densities, of roof ceiling sprinklers only, of 0.375 gpm/ft^2 (15.3 mm/min) with 8 ft (2.4 m) aisles and 0.45 gpm/ft^2 (18.3 mm/min) with 4 ft (1.2 m) aisles using the standard commodity.

C.11 ~~[16.1.6.1 and 17.1.5.1]~~ [25.6.3.1]

Test 98 with solid shelves 24 ft (7.3 m) long and 7½ ft (2.3 m) deep at each level produced total destruction of the commodity in the main rack and jumped the aisle. Density was 0.3 gpm/ft^2 (12.2 mm/min) from the ceiling sprinklers only. Test 108 with shelves 24 ft (7.3 m) long and 3½ ft (1.0 m) deep and with a 6 in. (150 mm) longitudinal flue space and one level of sprinklers in the rack resulted in damage to most of the commodity in the main rack but did not jump the aisle. Density from ceiling sprinklers was 0.375 gpm/ft^2 (15.3 mm/min), and rack sprinklers discharged at 15 psi (1.0 bar).

These tests did not yield sufficient information to develop a comprehensive protection standard for solid shelf racks. Items such as increased ceiling density, use of bulkheads, other configurations of sprinklers in racks, and limitation of shelf length and depth should be considered.

Where such rack installations exist or are contemplated, the damage potential should be considered, and sound engineering judgment should be used in designing the protection system.

Test 98, with solid shelving obstructing both the longitudinal and transverse flue space, produced unsatisfactory results and indicates a need for sprinklers at each level in such a rack structure.

Test 147 was conducted with ceiling sprinklers only. Density was 0.45 gpm/ft^2 (18.3 mm/min) with a sprinkler spacing of 100 ft^2 (9.3 m^2). A total of 47 sprinklers opened, and 83 percent of the commodity was consumed. The fire jumped both aisles and spread to both ends of the main and target racks. The test was considered unsuccessful.

Test 148 was conducted with ceiling sprinklers and in-rack sprinklers. In-rack sprinklers were provided at each level (top of first, second, and third tiers) and were located in the longitudinal flue. They were directly above each other and 24 ft (7.3 m) on center or 22 ft (6.7 m) on each side of the ignition flue. Ceiling sprinkler discharge density was 0.375 gpm/ft^2 (15.3 mm/min). In-rack sprinkler discharge pressure was 30 psi (2.1 bar). A total of 46 ceiling sprinklers and three in-rack sprinklers opened, and 34 percent of the commodity was consumed. The fire consumed most of the material between the in-rack sprinklers and jumped both aisles.

C.12 ~~[16.1.7 and 17.1.6]~~ [20.3.3]

Fire tests with open-top containers in the upper tier of storage and a portion of the third tier of storage produced an increase in sprinkler operation from 36 to 41 sprinklers and a more pronounced aisle jump and increase in firespread in the main array. The smooth underside of the containers closely approximates fire behavior of slave pallets.

C.13 ~~[16.1.10 and 17.1.9]~~ [20.5.8.4.1.1]

Test 80 was conducted to determine the effect of closing back-to-back longitudinal 6 in. (150 mm) flue spaces in conventional pallet racks. Test results indicated fewer sprinklers operating than with the flue space open, and, as such, no minimum back-to-back clearance is necessary if the transverse flue space is kept open.

Tests 145 and 146 were conducted to investigate the influence of longitudinal and transverse flue dimensions in double-row racks without solid shelves. Results were compared with Tests 65 and 66. Flue dimensions in Tests 65, 66, 145, and 146 were 6 in. (150 mm), 6 in. (150 mm), 3 in. (75 mm), and 12 in. (300 mm), respectively. All other conditions were the same.

In Tests 65 and 66, 45, and 48, sprinklers operated compared with 59 and 58 for Tests 145 and 146, respectively. Fire damage in Tests 145 and 146 was somewhat less than in Tests 65 and 66; 2100 ft^3 (59 m^3) and 1800 ft^3 (51 m^3) in Tests 145 and 146, respectively, versus 2300 ft^3 (65 m^3) and 2300 ft^3 (65 m^3) in Tests 65 and 66, respectively, of combustible material were consumed.

Test results indicate narrow flue spaces of about 3 in. (75 mm) allow reasonable passage of sprinkler water down through the racks.

Tests 96 and 107, on multiple-row racks, used 6 in. (150 mm) transverse flue spaces. The water demand recommended in the standard is limited to those cases with nominal 6 in. (150 mm) transverse flues in vertical alignment.

C.14 ~~[16.2.1.3.1]~~ [21.4.1.1 and 25.2.3.2.3.1]

Tests 65 and 66, compared with Test 69, and Test 93, compared with Test 94, indicated a reduction in areas of application of 44.5 percent and 45.5 percent, respectively, with high temperature–rated sprinklers as compared with ordinary temperature–rated sprinklers. Other extensive Factory Mutual tests produced an average reduction of 40 percent. Design curves are based on this area reduction. In constructing the design curves, the high-temperature curves above 3600 ft^2 (335 m^2) of application, therefore, represent 40 percent reductions in area of application of the ordinary temperature curves in the 6000 ft^2 to 10,000 ft^2 (555 m^2 to 930 m^2) range.

Test 84 indicated the number of intermediate temperature–rated sprinklers operating is essentially the same as ordinary temperature–rated sprinklers.

C.15 ~~[16.2.1.3.2.1]~~ [21.4.1.2.1]

Tests were not conducted with aisles wider than 8 ft (2.4 m) or narrower than 4 ft (1.2 m). It is, therefore, not possible to determine whether lower ceiling densities should be used for aisle widths greater than 8 ft (2.4 m) or if higher densities should be used for aisle widths less than 4 ft (1.2 m).

C.16 ~~[16.2.1.4.2.3]~~ [25.4.2.1]

In one 20 ft (6.1 m) high test, sprinklers were buried in the flue space 1 ft (300 mm) above the bottom of the pallet load, and results were satisfactory. Coverage of aisles by in-rack sprinklers is, therefore, not necessary, and distribution across the tops of pallet loads at any level is not necessary for the occupancy classes tested.

C.17 ~~[16.2.1.4.2.6]~~ [25.5.1.6.1]

In all tests with in-rack sprinklers, obstructions measuring 3 in. × 3 ft (75 mm × 900 mm) were introduced on each side of the sprinkler approximately 3 in. (75 mm) from the sprinkler to simulate rack structure member obstruction. This obstruction had no effect on sprinkler performance in the 20 ft (6.1 m) high tests.

Tests 103, 104, 105, and 109 in the 30 ft (9.1 m) high test with in-rack sprinklers obstructed by rack uprights produced unsatisfactory results. Tests 113, 114, 115, 117, 118, and 120 in the 30 ft (9.1 m) high test series with in-rack sprinklers located a minimum of 2 ft (600 mm) from rack uprights produced improved results.

C.18 ~~[16.2.1.4.3]~~ [25.8.2.6]

In all except one case, using the standard commodity with one line of sprinklers installed in racks, only two sprinklers opened. In the one exception, two sprinklers opened in the main rack, and two sprinklers opened in the target rack.

C.19 ~~[16.2.1.4.4, 16.3.2.7.10, 17.2.2.6.8]~~ [25.12.3]

Operating pressures were 15 psi (1.0 bar) on all tests of sprinklers in racks with storage 20 ft (6.1 m) high and 30 psi (2.1 bar) for storage 30 ft (9.1 m) and 50 ft (15 m) high.

Tests 112 and 124 were conducted to compare the effect of increasing sprinkler discharge pressure at in-rack sprinklers from 30 psi to 75 psi (2.1 bar to 5.2 bar). With the higher discharge pressure, the fire did not jump the aisle, and damage below the top level of protection within the racks was somewhat better controlled by the higher discharge pressure of the in-rack sprinklers. A pressure of 15 psi (1 bar) was maintained on in-rack sprinklers in the first 30 ft (9.1 m) high tests (Tests 103 and 104). Pressure on in-rack sprinklers in subsequent tests was 30 psi (2.1 bar), except in Test 124, where it was 75 psi (5.2 bar).

C.20 ~~[16.2.4.1.1, 17.2.4.1.1]~~ [21.8.1.1 and 23.13.1]

A full-scale test program was conducted with various double-row rack storage arrangements of a cartoned Group A nonexpanded plastic commodity at the Factory Mutual Research Corporation (FMRC) test facility. The series of nine tests included several variations, one of which involved the use of the following four distinct shelving arrangements: slatted wood, solid wood, wire mesh, and no shelving. The results of the testing program, specifically Tests 1, 2, 3, and 5, clearly demonstrate the acceptable performance of sprinkler systems protecting storage configurations that involve the use of slated shelving as described in ~~16.2.4.1.1~~ 21.8.1.1 and ~~17.2.4.1.1~~ 23.13.1 . As a result of the test program, Factory Mutual has amended FM Loss Prevention Data Sheet 8-9 to allow slatted shelving to be protected in the same manner as an open rack arrangement.

Complete details of the test program are documented in the FMRC technical report FMRC J. I. 0X1R0.RR, “Large-Scale Fire Tests of Rack Storage Group A Plastics in Retail Operation Scenarios Protected by Extra Large Orifice (ELO) Sprinklers.”

C.21 ~~[17.1.2.1]~~ [21.5.1]

In the RSP rack storage test series as well as the stored plastics program palletized test series, compartmented 16 oz (1.1 bar) polystyrene jars were found to produce significantly higher protection requirements than the same commodity in a nested configuration. Polystyrene glasses and expanded polystyrene plates were comparable to the nested jars.

Different storage configurations within cartons or different products of the same basic plastic might, therefore, require reduced protection requirements.

In Test RSP-7, with nominal 15 ft (4.6 m) high storage with compartmented jars, a 0.6 gpm/ft^2 (24.4 mm/min) density, 8 ft (2.4 m) aisles, and a 10 ft (3.0 m) clearance to ceiling, 29 sprinklers opened. In Tests RSP-4 with polystyrene glasses, RSP-5 with expanded polystyrene plates, and RSP-16 with nested polystyrene jars all stored at nominal 15 ft (4.6 m) height, 10 ft (3.1 m) clearance to ceiling, 8 ft (2.4 m) aisles, and 0.6 gpm/ft^2 (24.4 mm/min) density, only four sprinklers opened.

However, Test RSP-11, with expanded polystyrene plates and 6 ft (1.8 m) aisles, demonstrated an increase in the number of operating sprinklers to 29. Test RSP-10 with expanded polystyrene plates, nominally 15 ft (4.6 m) high with a 10 ft (3.1 m) clearance and 8 ft (2.4 m) aisles, but protected only by 0.45 gpm/ft^2 (18.3 mm/min) density, opened 46 sprinklers and burned 100 percent of the plastic commodity.

At a nominal 20 ft (6.1 m) storage height with 8 ft (2.4 m) aisles, a 3 ft (900 mm) clearance to ceiling, and a 0.6 gpm/ft^2 (24.4 mm/min) density opened four sprinklers with polystyrene glasses in Test RSP-2 and 11 sprinklers with expanded polystyrene plates in Test RSP-6. In Test RSP-8, however, with the clearance to ceiling increased to 10 ft (3.1 m) and other variables held constant, 51 sprinklers opened, and 100 percent of the plastic commodity burned.

Test RSP-3, with polystyrene glasses at a nominal height of 25 ft (7.6 m) with a 3 ft (900 mm) clearance to ceiling, 8 ft (2.4 m) aisles, and 0.6 gpm/ft^2 (24.4 mm/min) ceiling sprinkler density in combination with one level of in-rack sprinklers, resulted in four ceiling sprinklers and two in-rack sprinklers operating. Test RSP-9, with the same configuration but with polystyrene plates, opened 12 ceiling sprinklers and three in-rack sprinklers.

No tests were conducted with compartmented polystyrene jars at storage heights in excess of a nominal 15 ft (4.6 m) as a part of this program.

C.22 ~~[17.2.1.2]~~ [21.5]

The protection of Group A plastics by extra large orifice (ELO) sprinklers designed to provide 0.6 gpm/ft^2/2000 ft^2 (24.4 mm/min/186 m^2) or 0.45 gpm/ft^2/2000 ft^2 (18.3 mm/min/186 m^2) without the installation of in-rack sprinklers was developed from full-scale testing conducted with various double-row rack storage arrangements of a cartoned Group A nonexpanded plastic commodity at the Factory Mutual Research Corporation (FMRC) test facility. The results of this test program are documented in the FMRC technical report, FMRC J.I. 0X1R0.RR, "Large-Scale Fire Tests of Rack Stored Group A Plastics in Retail Operation Scenarios Protected by Extra Large Orifice (ELO) Sprinklers." The test program was initiated to address the fire protection issues presented by warehouse-type retail stores with regard to the display and storage of Group A plastic commodities including, but not limited to, acrylonitrile-butadiene-styrene copolymer (ABS) piping, polyvinyl chloride (PVC) hose and hose racks, tool boxes, polypropylene trash and storage containers, and patio furniture. Tests 1 and 2 of this series included protection of the Group A plastic commodity stored to 20 ft (6.1 m) under a 27 ft (8.2 m) ceiling by a design density of 0.6 gpm/ft^2 (24.4 mm/min) utilizing ELO sprinklers. The results of the testing program clearly demonstrate the acceptable performance of sprinkler systems that protect storage configurations involving Group A plastics up to 20 ft (6.1 m) in height under a 27 ft (8.2 m) ceiling where using ELO sprinklers to deliver a design density of 0.6 gpm/ft^2 (24.4 mm/min) and Group A plastics up to 14 ft (4.2 m) in height under a 22 ft (6.7 m) ceiling where using ELO sprinklers to deliver a design density of 0.45 gpm/ft^2 (18.3 mm/min). The tabulation of the pertinent tests shown in Table C.22 demonstrates acceptable performance.

Table C.22 Summary of Test Results for Plastic Commodities Using ⅝ in. (15.9 mm) Orifice Sprinklers

Test Parameters	Date of Test						
	8/20/93	8/25/93	9/2/93	10/7/93	2/17/94	2/25/94	4/27/94
Type of shelving	Slatted wood	Slatted wood	Slatted wood	Slatted wood	Slatted wood	Slatted wood	Wire mesh
Other conditions/ inclusions	—	—	—	—	Draft curtains	Draft curtains	—
Storage height (ft-in.)	19-11	19-11	15-4	15-4	19-11	19-11	13-11
Number of tiers	6[a]	6[a]	5[b]	5[b]	6[a]	6[b]	3
Clearance to ceiling/sprinklers (ft-in.)	6-10/6-3	6-10/6-3	11-5/10-10	11-5/10-10	6-10/6-3	6-10/6-3	8-4/7-9
Longitudinal/ transverse flues (in.)	6/6 to 7½	6/6 to 7½	6/6 to 7	6/6 to 7½	6/6 to 7½	6/6 to 7½	6/3[c]
Aisle width (ft)	7½	7½	7½	7½	7½	7½	7½
Ignition centered below (number of sprinklers)	2	2	1	1	2	2	1
Sprinkler orifice size (in.)	0.64	0.64	0.64	0.64	0.64	0.64	0.64
Sprinkler temperature rating (°F)	165	286	286	165	165	286	286
Sprinkler RTI (ft-sec)$^{1/2}$	300	300	300	300	300	300	300
Sprinkler spacing (ft× ft)	8 × 10	8 × 10	8 × 10	8 × 10	8 × 10	8 × 10	10 × 10
Sprinkler identification	ELO-231	ELO-231	ELO-231	ELO-231	ELO-231	ELO-231	ELO-231
Constant water pressure (psi)	19	19	19	19	19	19	15.5
Minimum density (gpm/ft^2)	0.6	0.6	0.6	0.6	0.6	0.6	0.45
Test Results							
First sprinkler operation (min:sec)	2:03	2:25	1:12	0:44	1:25	0:52	0:49
Last sprinkler operation (min:sec)	2:12	15:19	6:34	7:34	15:54	14:08	10:58
Total sprinklers opened	4	9	7	13	35	18	12

Test Parameters	Date of Test						
	8/20/93	8/25/93	9/2/93	10/7/93	2/17/94	2/25/94	4/27/94
Total sprinkler discharge (gpm)	205	450	363	613	1651	945	600
Average discharge per sprinkler (gpm)	51	50	52	47	47	52	50
Peak/maximum 1-min average gas temperature (°F)	1107/566	1412/868	965/308	662/184	1575/883	1162/767	1464/895
Peak/maximum 1-min average steel temperature (°F)	185/172	197/196	233/232	146/145	226/225	255/254	502/500
Peak/maximum 1-min average plume velocity (ft/sec)	27/15	25/18	18/15[d]	14/10[d]	26/23	20/18[d]	33/20
Peak/maximum 1-min heat flux (Btu/ft^2/sec)	0.6/0.5	2.0/1.9	2.8/2.5	1.1/0.8	1.0/0.9	4.8/3.0	1.6/1.4
Aisle jump, east/west target ignition (min:sec)	None	8:24/None	5:35/10:10	None	None	[e]/8:18	[e]/None
Equivalent number of pallet loads consumed	3	9	6	5	12	13	12
Test duration (min)	30	30	30	30	30	30	30
Results acceptable	Yes	Yes	Yes	Yes	No[f]	No[g]	Yes

For SI units, 1 ft = 0.305 m; 1 in. = 25.4 mm; °F = (1.8 ×°C) + 32; °C = (°F - 32)/1.8; 1 psi = 0.069 bar; 1 gpm = 3.8 L/min; 1 ft/sec = 0.31 m/sec; 1 gpm/ft^2 = 40.746 mm/min.

[a] Main (ignition) racks divided into five or six tiers; bottom tiers each approximately 2 ft (600 mm) high and upper tiers each about 5 ft (1.5 m) high; wood shelving below commodity at second through fifth tiers.

[b] Main (ignition) racks divided into five or six tiers; bottom tiers each approximately 2 ft (600 mm) high and upper tiers each about 5 ft (1.5 m) high; wood shelving below commodity at second through fifth tiers; wire mesh shelving below commodity at sixth tier or below fifth (top) tier commodity.

[c] Transverse flues spaced 8 ft (2.4 m) apart [versus 3½ ft (1.1 m) apart in all other tests].

[d] Instrumentation located 5 ft (1.5 m) north of ignition.

[e] Minor surface damage to cartons.

[f] High water demand.

[g] Excessive firespread; marginally high water demand.

C.23 ~~[16.3.1.1]~~ [25.9.2.1, 25.9.2.2, 25.9.2.3]

The recommended use of ordinary temperature–rated sprinklers at ceiling for storage higher than 25 ft (7.6 m) was determined by the results of fire test data. A test with high temperature–rated sprinklers and 0.45 gpm/ft^2 (18.3 mm/min) density resulted in fire damage in the two top tiers just within acceptable limits, with three ceiling sprinklers operating. A test with 0.45 gpm/ft^2 (18.3 mm/min) density and ordinary temperature–rated sprinklers produced a dramatic reduction in fire damage with four ceiling sprinklers operating.

The four ordinary temperature-rated ceiling sprinklers operated before the first of the three high temperature–rated ceiling sprinklers. In both tests, two in-rack sprinklers at two levels operated at approximately the same time. The high temperature–rated sprinklers were at all times fighting a larger fire with less water than the ordinary temperature–rated ceiling sprinklers.

Tests 115 and 119 compare ceiling sprinkler density of 0.3 gpm/ft^2 (12.2 mm/min) with 0.45 gpm/ft^2 (18.3 mm/min). Damage patterns coupled with the number of boxes damaged in the main rack suggest that the increase in density produces improved control, particularly in the area above the top tier of in-rack sprinklers.

Tests 119 and 122 compare ceiling sprinkler temperature ratings of 286°F (141°C) and 165°F (74°C). A review of the number of boxes damaged and the firespread patterns indicates that the use of ordinary temperature–rated ceiling sprinklers on a rack configuration that incorporates in-rack sprinklers dramatically reduces the amount of firespread. Considering that in-rack sprinklers in the tests for storage over 25 ft (7.6 m) operated prior to ceiling sprinklers, it would seem that the installation of in-rack sprinklers converts an otherwise rapidly developing fire, from the standpoint of ceiling sprinklers, to a slower developing fire with a lower rate of heat release.

In the 20 ft (6.1 m) high test series, ceiling sprinklers operated before in-rack sprinklers. In the 30 ft (9.1 m) high series, ceiling sprinklers operated after in-rack sprinklers. The 50 ft (15 m) high test did not operate ceiling sprinklers. Ceiling sprinklers would, however, be needed if fire occurred in upper levels.

The results of these tests indicate the effect of in-rack sprinklers on storage higher than 25 ft (7.6 m). From the ceiling sprinkler operation standpoint, a fire with an expected high heat release rate was converted to a fire with a much lower heat release rate.

Since the fires developed slowly and opened sprinklers at two levels in the racks, only a few ceiling sprinklers were needed to establish control. Thus, the sprinkler operating area does not vary with height for storage over 25 ft (7.6 m) or for changes in sprinkler temperature rating and density.

All tests with sprinklers in racks were conducted using nominal ½ in. (15 mm) orifice size sprinklers of ordinary temperature.

C.24 [21.12]

~~[20.6]~~ A series of fire tests were conducted by Spacesaver Corporation that indicated control was achieved with light hazard sprinkler spacing and design. The tests used quick-response, ordinary-temperature sprinklers on 15 ft × 15 ft (4.6 m × 4.6 m) spacing with an 8 ft (2.4 m) high compact storage unit located in the middle of the sprinkler array. Results indicated a classic definition of control, the fire was held in check within the compact storage module and the fire did not jump the aisle or ignite any of the target arrays.

C.25 [21.11.6]

~~[20.5]~~ In July and August of 2007, a series of three large-scale fire tests were conducted at Southwest Research Institute to investigate the effectiveness of a specific ceiling and in-rack sprinkler protection scheme dedicated for the protection of paper files in 12 in. (300 mm) wide, and 16 in. (400 mm) and 10 in. (250 mm) high corrugated cardboard boxes (containers) maintained in multiple-row racks to a nominal height of 37 ft (11 m).

The storage rack for the main array in all three tests consisted of two 50 in. (1.3 m) deep racks placed back-to-back and separated by a 2 in. (50 mm) gap. The storage rack for the target array in all three tests consisted of a single 50 in. (1.3 m) deep rack separated on both sides of the main array by a 30 in. (750 mm) wide aisle. Rack uprights were a nominal 3 in. (75 mm) wide. Rack bays were 120 in. (3.0 m) wide, 38 in. (950 mm) high, and equipped with perforated metal decking having a minimum of 50 percent openings. Each storage bay was provided with 9 containers between uprights that was 3 containers deep and 3 containers high for a total of 81 containers per rack bay. Nominal 6 in. (150 mm) wide transverse flue spaces were provided at each rack upright. Both the main array and the target array were 4 bays long for an overall length of 41 ft 3 in. (12.6 m).

Open-grated (expanded) catwalks were provided in both storage aisles at the top of the third [9 ft 8 in. (2.9 m)], sixth [19 ft 2 in. (5.8 m)], and ninth [28 ft 8 in. (8.7 m)] tier levels.

The ceiling sprinkler system consisted of K-8.0 (115), 165°F (74°C) nominally rated, standard-response pendent automatic sprinklers installed on 10 ft × 10 ft (3.0 m × 3.0 m) spacing arranged to provide a constant 0.30 gpm/ft^2 (12.2 mm/min) density. A nominal 3 ft (900 mm) clearance was provided between the top of storage and the ceiling sprinklers.

The in-rack sprinkler system consisted of K-8.0 (115), 165°F (74°C) nominally rated, quick-response upright automatic sprinklers that were equipped with water shields and arranged to provide a constant 30 gpm (115 L/min) flow from each operating in-rack sprinkler. In-rack sprinklers were provided within the transverse flue spaces of the main array, 2 ft (600 mm) horizontally from the face of the rack, at the top of the third and ninth tier levels on one side of the main array and at the top of the sixth tier level on the other side of the main array. A minimum 6 in. (150 mm) vertical clearance was provided between the in-rack sprinkler and the top of storage within the storage rack.

The same type of sprinklers installed within the storage racks were also installed under each catwalk and designed to provide a constant 30 gpm (115 L/min) flow from each operating sprinkler. These sprinklers were centered within the aisles and installed 10 ft 3 in. (3.1 m) on line. They were arranged to be aligned with the adjacent transverse flue space when the flue space was not equipped with an in-rack sprinkler; they were positioned halfway between transverse flue spaces when the adjacent flue spaces were equipped with in-rack sprinklers.

In Test No. 1, ignition was at grade level, at the face of the rack and centered between rack uprights. The in-rack sprinklers within the transverse flue spaces nearest to the ignition location were at the top of the sixth tier level; the sprinkler under the catwalk at the top of the sixth tier level was located a horizontal distance of 15 in. (375 mm) away from the ignition location. The sprinkler under the catwalk at the top of the sixth tier level was the first sprinkler to operate at a time 2 minutes and 49 seconds after ignition. A total of 3 in-rack sprinklers and 1 catwalk sprinkler operated during this test; no ceiling-level sprinklers operated. The results of the test were considered acceptable.

In Test No. 2, ignition was at grade level at a rack upright, 2 ft (600 mm) horizontally from the rack face. The in-rack sprinkler within the transverse flue space of fire origin was at the top of the sixth tier level. The in-rack sprinkler directly over the ignition location was the first sprinkler to operate at a time 2 minutes and 9 seconds after ignition. A total of 2 in-rack sprinklers operated during this test; no ceiling-level sprinklers operated. The results of the test were considered acceptable.

In Test No. 3, ignition was at grade level, centered between rack uprights within the 2 in. (50 mm) gap. To allow vertical fire growth directly above the point of ignition, the gap was maintained open throughout the height of the storage rack. A total of 4 in-rack sprinklers and 1 sprinkler under a catwalk operated during the test; no ceiling-level sprinklers operated. The first in-rack sprinkler to operate was located at the top of the sixth tier level at a time 3 minutes and 1 second after ignition. The second in-rack sprinkler to operate was also at the top of the sixth tier level. The last 2 in-rack sprinklers to operate were both located at the top of the third tier level. The fifth and final sprinkler to operate was a sprinkler located under a catwalk at the top of the third tier level. The results of the test were considered acceptable.

All three tests were considered successful and confirmed that the ceiling and in-rack sprinkler protection scheme outlined in this standard for the protection of cartoned records storage maintained in multiple-row racks with catwalk access is acceptable.

C.26 ~~[16.1.10.3, 16.1.11.1.2, 17.1.9.3, 17.1.10.1.2]~~ [20.5.8.4.2.2]

During full-scale fire tests, flue space width and alignment are typically set with care for test consistency and repeatability. Some full-scale fire tests and fire experience have shown sprinkler protection designed and installed in accordance with this standard are able to tolerate random variations in flue width and vertical flue alignment. For example, see Test 7 in the National Quick Response Sprinkler Research Project: Large-Scale Fire Evaluation of Early Suppression ~~Quick~~ Fast -Response (ESFR) Automatic Sprinklers (report available from the NFPA Research Foundation web site). For Test 7, transverse flue variations were substantial such that some flues at various tiers were completely closed (i.e., pallet loads placed immediately adjacent to each other), and the vertical alignment of one transverse flue was completely disrupted. The result was the operation of eight K14 (K200) ESFR sprinklers as well as minor aisle jump to both target racks. Reported damage was 2½ pallet loads in the main rack array and ¼ pallet load in the large racks. Findings such as Test 7 support the toleration of flue variations in the real world. However, ideally pallet loads should be positioned in racks with care to reduce the challenge faced by sprinklers should a fire occur.

Submitter Information Verification

Submitter Full Name: AUT-SSD
Organization: National Fire Protection Assoc
Street Address:
City:
State:
Zip:
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Committee Statement

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Response Message:

Second Revision No. 1024-NFPA 13-2017 [Chapter D]

Annex D Sprinkler System Information from the ~~2012~~ 2018 Edition of the *Life Safety Code*

This annex is not a part of the requirements of this NFPA document but is included for informational purposes only.

D.1 Introduction.

This annex is provided as an aid to the user of NFPA 13 by identifying those portions of the 2012 edition of NFPA *101* that pertain to sprinkler system design and installation. It is not intended that this annex provide complete information regarding all aspects of fire protection addressed by NFPA *101*. It is important to note that this information was copied from NFPA *101* but did not use NFPA's extract policy and is not intended to be a part of the requirements of NFPA 13.

D.1.1

The following sections cover situations where NFPA *101* provides different guidance on the design or installation of a fire sprinkler system from NFPA 13. In some cases, this different guidance is based on descriptions of unique situations handled by NFPA *101*. In other cases, this different guidance stems from the different objective for NFPA *101*, life safety of the occupant, rather than the property protection afforded by NFPA 13.

D.1.1.1 Features of Fire Protection.

D.1.1.1.1 Atriums.

Glass walls and inoperable windows shall be permitted in lieu of the fire barriers where all the following are met:

(1) Automatic sprinklers are spaced along both sides of the glass wall and the inoperable windows at intervals not to exceed 6 ft (1830 mm).

(2) The automatic sprinklers specified in 8.6.7(1)(c)(i) of NFPA *101* are located at a distance from the glass wall not to exceed 12 in. (305 mm) and arranged so that the entire surface of the glass is wet upon operation of the sprinklers.

(3) The glass wall is of tempered, wired, or laminated glass held in place by a gasket system that allows the glass framing system to deflect without breaking (loading) the glass before the sprinklers operate.

(4) The automatic sprinklers required by 8.6.7(1)(c)(i) of NFPA *101* are not required on the atrium side of the glass wall and the inoperable window where there is no walkway or other floor area on the atrium side above the main floor level. [***101*:**8.6.7(1)(c)]

D.1.1.2 Special Structures and High-Rise Buildings.

D.1.1.2.1

High-rise buildings shall be protected throughout by an approved, supervised automatic sprinkler system in accordance with NFPA *101*, Section 9.7. A sprinkler control valve and a waterflow device shall be provided for each floor. [***101*:**11.8.3.1]

D.1.1.3 Lodging or Rooming Houses.

D.1.1.3.1

In buildings sprinklered in accordance with NFPA 13, closets that contain equipment such as washers, dryers, furnaces, or water heaters shall be sprinklered regardless of size. [***101*:**~~26.3.6.3.5~~ 26.3.6.2.5]

D.1.1.3.2

In existing lodging or rooming houses, sprinkler installations shall not be required in closets not exceeding 24 ft^2 (2.2 m^2) and in bathrooms not exceeding 55 ft^2 (5.1 m^2). [***101*:**~~26.3.6.3.6~~ 26.3.6.2.6]

D.1.1.4 New Hotels and Dormitories.

D.1.1.4.1

The provisions for draft stops and closely spaced sprinklers in NFPA 13 shall not be required for openings complying with NFPA *101*, 8.6.9.1, where the opening is within the guest room or guest suite. [***101*:**28.3.5.4]

D.1.1.4.2

Listed quick-response or listed residential sprinklers shall be used throughout guest rooms and guest room suites. [***101*:**28.3.5.6]

D.1.1.5 Existing Hotels and Dormitories.

D.1.1.5.1

In guest rooms and in guest room suites, sprinkler installations shall not be required in closets not exceeding 24 ft^2 (2.2 m^2) and in bathrooms not exceeding 55 ft^2 (5.1 m^2). [***101*:**29.3.5.5]

D.1.1.6 New Apartment Buildings.

D.1.1.6.1

In buildings sprinklered in accordance with NFPA 13~~,~~ :

(1) ~~closets~~ Closets less than 12 ft^2 (1.1 m^2) ~~in area~~ in individual dwelling units shall not be required to be sprinklered.

(2) Closets that contain equipment such as washers, dryers, furnaces, or water heaters shall be sprinklered regardless of size.

[***101*:**30.3.5.3]

D.1.1.6.2

Listed quick-response or listed residential sprinklers shall be used throughout all dwelling units. [***101*:**~~30.3.5.5~~ 30.3.5.6]

D.1.1.6.3

The draft stop and closely spaced sprinkler requirements of NFPA 13 shall not be required for convenience openings complying with NFPA *101*, 8.6.9.1, where the convenience opening is within the dwelling unit. [***101*:**~~30.3.5.4~~ 30.3.5.5]

D.1.1.7 Existing Apartment Buildings.

D.1.1.7.1

In individual dwelling units, sprinkler installation shall not be required in closets not exceeding 24 ft^2 (2.2 m^2) and in bathrooms not exceeding 55 ft^2 (5.1 m^2). Closets that contain equipment such as washers, dryers, furnaces, or water heaters shall be sprinklered regardless of size. [***101*:**31.3.5.3]

D.1.1.7.2

In buildings sprinklered in accordance with NFPA 13, bathrooms not greater than 55 ft^2 (5.1 m^2) in individual dwelling units shall not be required to be sprinklered. [***101*** **:** 31.3.5.4]

D.1.1.7.3

The draft stop and closely spaced sprinkler requirements of NFPA 13 shall not be required for convenience openings complying with NFPA *101*, 8.6.9.1, where the convenience opening is within the dwelling unit. [***101*:**~~31.3.5.4~~ 31.3.5.5]

D.1.1.8 Existing Residential Board and Care Occupancies.

D.1.1.8.1

Standard-response sprinklers shall be permitted for use in hazardous areas in accordance with NFPA *101*, 33.2.3.2. [***101*:**33.2.2.2.4]

D.1.1.8.2

Where an automatic sprinkler system is installed, for either total or partial building coverage, all of the following requirements shall be met:

(1) The system shall be in accordance with NFPA *101*, Section 9.7, and shall initiate the fire alarm system in accordance with 33.2.3.4.1, as modified by 33.2.3.5.3.1 through 33.2.3.5.3.6 of NFPA *101*.

(2) The adequacy of the water supply shall be documented to the authority having jurisdiction.

[***101*:**33.2.3.5.3]

D.1.1.8.2.1

In prompt evacuation capability facilities, all of the following shall apply:

(1) An automatic sprinkler system in accordance with NFPA 13D shall be permitted.

(2) Automatic sprinklers shall not be required in closets not exceeding 24 ft^2 (2.2 m^2) and in bathrooms not exceeding 55 ft^2 (5.1 m^2), provided that such spaces are finished with lath and plaster or materials providing a 15-minute thermal barrier.

[***101*:**33.2.3.5.3.1]

D.1.1.8.2.2

In slow and impractical evacuation capability facilities, all of the following shall apply:

(1) An automatic sprinkler system in accordance with NFPA 13D with a 30-minute water supply, shall be permitted.

(2) All habitable areas and closets shall be sprinklered.

(3) Automatic sprinklers shall not be required in bathrooms not exceeding 55 ft^2 (5.1 m^2), provided that such spaces ~~ster~~ are finished with lath and plaster or materials providing a 15-minute thermal barrier.

[***101*:**33.2.3.5.3.2]

D.1.1.8.2.3

In prompt and slow evacuation capability facilities, where an automatic sprinkler system is in accordance with NFPA 13, sprinklers shall not be required in closets not exceeding 24 ft^2 (2.2 m^2) and in bathrooms not exceeding 55 ft^2 (5.1 m^2), provided that such spaces are finished with lath and plaster or materials providing a 15-minute thermal barrier. [***101*:**33.2.3.5.3.3]

D.1.1.8.2.4

In prompt and slow evacuation capability facilities in buildings four or fewer stories above grade plane, systems in accordance with NFPA 13R shall be permitted. [***101*:**33.2.3.5.3.4]

D.1.1.8.2.5

In impractical evacuation capability facilities in buildings four or fewer stories above grade plane, systems in accordance with NFPA 13R shall be permitted. All habitable areas and closets shall be sprinklered. Automatic sprinklers shall not be required in bathrooms not exceeding 55 ft^2 (5.1 m^2), provided that such spaces are finished with lath and plaster or materials providing a 15-minute thermal barrier. [***101*:**33.2.3.5.3.5]

D.1.1.8.2.6

Initiation of the fire alarm system shall not be required for existing installations in accordance with NFPA *101*, 33.2.3.5.6. [***101*:**33.2.3.5.3.6]

D.1.1.8.2.7

All impractical evacuation capability facilities shall be protected throughout by an approved, supervised automatic sprinkler system in accordance with NFPA *101*, 33.2.3.5.3. [***101*:**33.2.3.5.3.7]

D.1.1.9 New Mercantile Occupancies.

D.1.1.9.1 Protection of Vertical Openings.

Any vertical opening shall be protected in accordance with NFPA *101*, Section 8.6, except under the following conditions:

(1) In Class A or Class B mercantile occupancies protected throughout by an approved, supervised automatic sprinkler system in accordance with NFPA *101*, 9.7.1.1(1), unprotected vertical openings shall be permitted at one of the following locations:

(a) Between any two floors

(b) Among the street floor, the first adjacent floor below, and adjacent floor (or mezzanine) above

(2) In Class C mercantile occupancies, unprotected openings shall be permitted between the street floor and the mezzanine.

(3) The draft stop and closely spaced sprinkler requirements of NFPA 13 shall not be required for unenclosed vertical openings permitted in NFPA *101*, 36.3.1(1) and (2).

[***101*:**36.3.1]

D.1.1.9.2

Rooms housing building service equipment, janitor closets, and service elevators shall be permitted to open directly onto exit passageways, provided that all of the following criteria are met:

(1) The required fire resistance rating between such rooms or areas and the exit passageway shall be maintained in accordance with NFPA *101*, 7.1.3.2.

(2) Such rooms or areas shall be protected by an approved, supervised automatic sprinkler system in accordance with NFPA *101*, 9.7.1.1(1), but the exceptions in NFPA 13 allowing the omission of sprinklers from such rooms shall not be permitted.

[***101*:**~~36.4.4.6.2~~ 36.4.4.9.2]

D.1.1.10 Existing Mercantile Occupancies.

D.1.1.10.1 Protection of Vertical Openings.

Any vertical opening shall be protected in accordance with NFPA *101*, Section 8.6, except under any of the following conditions:

(1) In Class A or Class B mercantile occupancies protected throughout by an approved, supervised automatic sprinkler system in accordance with NFPA *101*, 9.7.1.1(1), unprotected vertical openings shall be permitted at one of the following locations:

(a) Between any two floors

(b) Among the street floor, the first adjacent floor below, and the adjacent floor (or mezzanine) above

(2) In Class C mercantile occupancies, unprotected openings shall be permitted between the street floor and the mezzanine.

(3) The draft stop and closely spaced sprinkler requirements of NFPA 13 shall not be required for unenclosed vertical openings permitted in NFPA *101*, ~~37.3.1(1)~~ 36.3.1(1) and (2).

[***101*:**37.3.1]

D.1.1.10.2

Rooms housing building service equipment, janitor closets, and service elevators shall be permitted to open directly onto exit passageways, provided that all of the following criteria are met:

(1) The required fire resistance rating between such rooms or areas and the exit passageway shall be maintained in accordance with NFPA *101*, 7.1.3.2.

(2) Such rooms or areas shall be protected by an approved automatic sprinkler system in accordance with NFPA *101*, 9.7.1.1(1) but the exceptions in NFPA 13 allowing the omission of sprinklers from such rooms shall not be permitted.

[***101*:**~~37.4.4.6.2~~ 37.4.4.9.2]

D.1.1.11 Industrial Occupancies.

D.1.1.11.1 Special Provisions — High-Rise Buildings.

The provisions of NFPA *101*, ~~11.8.5.2.4(2)~~ 11.8.5.3.4(2) for jockey pumps and NFPA *101*, ~~11.8.5.2.4(3)~~ 11.8.5.3.4(3) for air compressors serving dry-pipe and preaction systems shall not apply to special-purpose industrial occupancies. [***101*:**~~40.4.1~~ 40.4.2.2]

D.2 Life Safety Code.

D.2.1 Features of Fire Protection.

D.2.1.1 Design Requirements. (Reserved)

D.2.1.2 Installation Requirements.

D.2.1.2.1 Atriums.

Glass walls and inoperable windows shall be permitted in lieu of the fire barriers where all the following are met:

(1) Automatic sprinklers are spaced along both sides of the glass wall and the inoperable windows at intervals not to exceed 6 ft (1830 mm).

(2) The automatic sprinklers specified in NFPA *101*, 8.6.7(1)(c)(i) are located at a distance from the glass wall not to exceed 12 in. (305 mm) and arranged so that the entire surface of the glass is wet upon operation of the sprinklers.

(3) The glass wall is of tempered, wired, or laminated glass held in place by a gasket system that allows the glass framing system to deflect without breaking (loading) the glass before the sprinklers operate.

(4) The automatic sprinklers required by NFPA *101*, 8.6.7(1)(c)(i) are not required on the atrium side of the glass wall and the inoperable window where there is no walkway or other floor area on the atrium side above the main floor level. [***101*:**8.6.7(1)(c)]

D.2.2 Special Structures and High-Rise Buildings.

D.2.2.1 Design Criteria.

D.2.2.1.1

High-rise buildings shall be protected throughout by an approved, supervised automatic sprinkler system in accordance with NFPA *101*, Section 9.7. A sprinkler control valve and a waterflow device shall be provided for each floor. [***101*:**11.8.3.1]

D.2.3 New Assembly Occupancies.

D.2.3.1 Design Criteria.

D.2.3.1.1 Protection of Vertical Openings.

Any vertical opening shall be enclosed or protected in accordance with Section 8.6 of NFPA *101*, unless otherwise permitted by one of the following:

(1) Stairs or ramps shall be permitted to be unenclosed between balconies or mezzanines and main assembly areas located below, provided that the balcony or mezzanine is open to the main assembly area.

(2) Exit access stairs from lighting and access catwalks, galleries, and gridirons shall not be required to be enclosed.

(3) Assembly occupancies protected by an approved, supervised automatic sprinkler system in accordance with Section 9.7 of NFPA *101* shall be permitted to have unprotected vertical openings between any two adjacent floors, provided that such openings are separated from unprotected vertical openings serving other floors by a barrier complying with 8.6.5 of NFPA 101.

(4) Assembly occupancies protected by an approved, supervised automatic sprinkler system in accordance with Section 9.7 of NFPA *101* shall be permitted to have convenience stair openings in accordance with 8.6.9.2 of NFPA *101*.

[***101*:**12.3.1]

D.2.3.2 Installation Requirements. (Reserved)

D.2.4 Existing Assembly Occupancies.

D.2.4.1 Design Criteria.

D.2.4.1.1 Protection of Vertical Openings.

Any vertical opening shall be enclosed or protected in accordance with NFPA *101*, Section 8.6, unless otherwise permitted by one of the following:

(1) Stairs or ramps shall be permitted to be unenclosed between balconies or mezzanines and main assembly areas located below, provided that the balcony or mezzanine is open to the main assembly area.

(2) Exit access stairs from lighting and access catwalks, galleries, and gridirons shall not be required to be enclosed.

(3) Assembly occupancies protected by an approved, supervised automatic sprinkler system in accordance with NFPA *101*, Section 9.7, shall be permitted to have unprotected vertical openings between any two adjacent floors, provided that such openings are separated from unprotected vertical openings serving other floors by a barrier complying with NFPA *101*, 8.6.5.

(4) Assembly occupancies protected by an approved, supervised automatic sprinkler system in accordance with NFPA *101*, Section 9.7, shall be permitted to have convenience stair openings in accordance with NFPA *101*, 8.6.9.2.

[***101:***13.3.1]

D.2.4.2 Installation Requirements. (Reserved)

D.2.5 New Educational Occupancies. (Reserved)

D.2.6 Existing Educational Occupancies. (Reserved)

D.2.7 New Day-Care Occupancies. (Reserved)

D.2.8 Existing Day-Care Occupancies. (Reserved)

D.2.9 New Health Care Occupancies. (Reserved)

D.2.10 Existing Health Care Occupancies. (Reserved)

D.2.11 New Ambulatory Health Care Occupancies. (Reserved)

D.2.12 Existing Ambulatory Health Care Occupancies. (Reserved)

D.2.13 New Detention and Correctional Occupancies. (Reserved)

D.2.14 Existing Detention and Correctional Occupancies. (Reserved)

D.2.15 One- and Two-Family Dwellings. (Reserved)

D.2.16 Lodging or Rooming Houses.

D.2.16.1 Design Requirements. (Reserved)

D.2.16.2 Installation Requirements.

D.2.16.2.1

In buildings sprinklered in accordance with NFPA 13 closets that contain equipment such as washers, dryers, furnaces, or water heaters shall be sprinklered, regardless of size. [***101*:~~26.3.6.3.5~~ 26.3.6.2.5]

D.2.16.2.2

In existing lodging or rooming houses, sprinkler installations shall not be required in closets not exceeding 24 ft^2 (2.2 m^2) and in bathrooms not exceeding 55 ft^2 (5.1 m^2). [***101*:~~26.3.6.3.6~~ 26.3.6.2.6]

D.2.17 New Hotels and Dormitories.

D.2.17.1 Design Requirements. (Reserved)

D.2.17.2 Installation Requirements.

D.2.17.2.1

The provisions for draft stops and closely spaced sprinklers in NFPA 13 shall not be required for openings complying with NFPA *101*, 8.6.9.1, where the opening is within the guest room or guest suite. [***101*:**28.3.5.4]

D.2.17.2.2

Listed quick-response or listed residential sprinklers shall be used throughout guest rooms and guest room suites. [***101*:**28.3.5.6]

D.2.18 Existing Hotels and Dormitories.

D.2.18.1 Design Requirements. (Reserved)

D.2.18.2 Installation Requirements.

D.2.18.2.1

In guest rooms and in guest room suites, sprinkler installations shall not be required in closets not exceeding 24 ft^2 (2.2 m^2) and in bathrooms not exceeding 55 ft^2 (5.1 m^2). [***101*:**29.3.5.5]

D.2.19 New Apartment Buildings.

D.2.19.1 Design Requirements. (Reserved)

D.2.19.2 Installation Requirements.

D.2.19.2.1

In buildings sprinklered in accordance with NFPA 13~~,~~ :

(1) ~~closets~~ Closets less than 12 ft^2 (1.1 m^2) ~~in area~~ in individual dwelling units shall not be required to be sprinklered.

(2) Closets that contain equipment such as washers, dryers, furnaces, or water heaters shall be sprinklered regardless of size.

[***101*:**30.3.5.3]

D.2.19.2.2

Listed quick-response or listed residential sprinklers shall be used throughout all dwelling units. [***101*:**~~30.3.5.5~~ 30.3.5.6]

D.2.19.2.3

The draft stop and closely spaced sprinkler requirements of NFPA 13 shall not be required for convenience openings complying with NFPA *101*, 8.6.9.1, where the convenience opening is within the dwelling unit. [***101*:**~~30.3.5.4~~ 30.3.5.5]

D.2.20 Existing Apartment Buildings.

D.2.20.1 Design Requirements. (Reserved)

D.2.20.2 Installation Requirements.

D.2.20.2.1

In individual dwelling units, sprinkler installation shall not be required in closets not exceeding 24 ft^2 (2.2 m^2) and in bathrooms not exceeding 55 ft^2 (5.1 m^2). Closets that contain equipment such as washers, dryers, furnaces, or water heaters shall be sprinklered, regardless of size. [***101*:**31.3.5.3]

D.2.20.2.2

The draft stop and closely spaced sprinkler requirements of NFPA 13 shall not be required for convenience openings complying with NFPA *101*, 8.6.9.1, where the convenience opening is within the dwelling unit. [***101*:**~~31.3.5.4~~ 31.3.5.5]

D.2.21 New Residential Board and Care Occupancies. (Reserved)

D.2.22 Existing Residential Board and Care Occupancies.

D.2.22.1 Design Requirements. (Reserved)

D.2.22.2 Installation Requirements.

D.2.22.2.1

Standard-response sprinklers shall be permitted for use in hazardous areas in accordance with NFPA *101*, 33.2.3.2. [***101*:**33.2.2.2.4]

D.2.22.2.2

In prompt and slow evacuation facilities, where an automatic sprinkler system is in accordance with NFPA 13 sprinklers shall not be required in closets not exceeding 24 ft^2 (2.2 m^2) and in bathrooms not exceeding 55 ft^2 (5.1 m^2), provided that such spaces are finished with lath and plaster or materials providing a 15-minute thermal barrier. [***101*:**33.2.3.5.3.3]

D.2.23 New Mercantile Occupancies.

D.2.23.1 Design Requirements. (Reserved)

D.2.23.2 Installation Requirements.

D.2.23.2.1 Protection of Vertical Openings.

Any vertical opening shall be protected in accordance with NFPA *101*, Section 8.6, except under any of the following conditions:

(1) In Class A or Class B mercantile occupancies protected throughout by an approved, supervised automatic sprinkler system in accordance with NFPA *101*, 9.7.1.1(1), unprotected vertical openings shall be permitted at one of the following locations:

  (a) Between any two floors

  (b) Among the street floor, the first adjacent floor below, and adjacent floor (or mezzanine) above

(2) In Class C mercantile occupancies, unprotected openings shall be permitted between the street floor and the mezzanine.

(3) The draft stop and closely spaced sprinkler requirements of NFPA 13 shall not be required for unenclosed vertical openings permitted in NFPA *101*, 36.3.1(1) and (2).

[***101*:**36.3.1]

D.2.23.2.2

Rooms housing building service equipment, janitor closets, and service elevators shall be permitted to open directly onto exit passageways, provided that all of the following criteria are met:

(1) The required fire resistance rating between such rooms or areas and the exit passageway shall be maintained in accordance with NFPA *101*, 7.1.3.2.

(2) Such rooms or areas shall be protected by an approved, supervised automatic sprinkler system in accordance with NFPA *101*, 9.7.1.1(1) but the exceptions in NFPA 13 allowing the omission of sprinklers from such rooms shall not be permitted.

[***101*:**~~36.4.4.6.2~~ 36.4.4.9.2]

D.2.24 Existing Mercantile Occupancies.

D.2.24.1 Design Requirements. (Reserved)

D.2.24.2 Installation Requirements.

D.2.24.2.1 Protection of Vertical Openings.

Any vertical opening shall be protected in accordance with NFPA *101*, Section 8.6, except under any of the following conditions:

(1) In Class A or Class B mercantile occupancies protected throughout by an approved, supervised automatic sprinkler system in accordance with NFPA *101*, 9.7.1.1(1), unprotected vertical openings shall be permitted at one of the following locations:

  (a) Between any two floors

  (b) Among the street floor, the first adjacent floor below, and the adjacent floor (or mezzanine) above

(2) In Class C mercantile occupancies, unprotected openings shall be permitted between the street floor and the mezzanine.

(3) The draft stop and closely spaced sprinkler requirements of NFPA 13 shall not be required for unenclosed vertical openings permitted in NFPA *101*, ~~37.3.1(1)~~ 36.3.1(1) and (2). [***101*:**37.3.1]

D.2.24.2.2

Rooms housing building service equipment, janitor closets, and service elevators shall be permitted to open directly onto exit passageways, provided that all of the following criteria are met:

(1) The required fire resistance rating between such rooms or areas and the exit passageway shall be maintained in accordance with NFPA *101*, 7.1.3.2.

(2) Such rooms or areas shall be protected by an approved, supervised automatic sprinkler system in accordance with NFPA *101*, 9.7.1.1(1), but the exceptions in NFPA 13 allowing the omission of sprinklers from such rooms shall not be permitted.

[***101***:~~37.4.4.6.2~~ 37.4.4.9.2]

D.2.25 New Business Occupancies.

D.2.25.1 Design Requirements. (Reserved)

D.2.25.2 Installation Requirements. (Reserved)

D.2.26 Existing Business Occupancies.

D.2.26.1 Design Requirements. (Reserved)

D.2.26.2 Installation Requirements. (Reserved)

D.2.27 Industrial Occupancies. (Reserved)

D.2.27.1 Design Criteria.

D.2.27.1.1 Special Provisions — High-Rise Buildings.

The provisions of NFPA *101*, ~~11.8.5.2.4(2)~~ 11.8.5.3.4(2) , for jockey pumps and NFPA *101*, ~~11.8.5.2.4(3)~~ 11.8.5.3.4(3) , for air compressors serving dry-pipe and pre-action systems shall not apply to special-purpose industrial occupancies. [***101***:~~40.4.1~~ 40.2.2]

D.2.28 Storage Occupancies. (Reserved)

Supplemental Information

File Name	Description	Approved
Annex_D_Sprinkler_System_Information_from_the.docx	For staff use.	

Submitter Information Verification

Submitter Full Name: AUT-SSD
Organization: National Fire Protection Assoc
Street Address:
City:
State:
Zip:
Submittal Date: Wed Aug 16 10:39:15 EDT 2017

Committee Statement

Committee Statement: Updates extract information from the 2015 edition of the life Safety Code.
Response Message:

Second Revision No. 1023-NFPA 13-2017 [Section No. F.3]

F.3 References for Extracts in Informational Sections.

NFPA 14, *Standard for the Installation of Standpipe and Hose Systems*, 2016 edition.

NFPA 24, *Standard for the Installation of Private Fire Service Mains and Their Appurtenances*, 2019 edition.

NFPA 33, *Standard for Spray Application Using Flammable or Combustible Materials*, 2018 edition.

NFPA 36, *Standard for Solvent Extraction Plants*, 2017 edition.

NFPA 37, *Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines*, 2018 edition.

NFPA 40, *Standard for the Storage and Handling of Cellulose Nitrate Film*, 2019 edition.

NFPA 75, *Standard for the Fire Protection of Information Technology Equipment*, 2017 edition.

NFPA 82, *Standard on Incinerators and Waste and Linen Handling Systems and Equipment*, 2014 edition.

NFPA 86, *Standard for Ovens and Furnaces*, 2019 edition.

NFPA 99, *Health Care Facilities Code*, 2018 edition.

NFPA 99B , *Standard for Hypobaric Facilities* , 2018 edition.

NFPA *101*®, *Life Safety Code*®, 2018 edition.

NFPA 120, *Standard for Fire Prevention and Control in Coal Mines*, 2015 edition.

NFPA 122, *Standard for Fire Prevention and Control in Metal/Nonmetal Mining and Metal Mineral Processing Facilities*, 2015 edition.

NFPA 140, *Standard on Motion Picture and Television Production Studio Soundstages, Approved Production Facilities, and Production Locations*, 2018 edition.

NFPA 214, *Standard on Water-Cooling Towers*, 2016 edition.

NFPA 307, *Standard for the Construction and Fire Protection of Marine Terminals, Piers, and Wharves*, 2016 edition.

NFPA 318, *Standard for the Protection of Semiconductor Fabrication Facilities*, 2018 edition.

NFPA 415, *Standard on Airport Terminal Buildings, Fueling Ramp Drainage, and Loading Walkways*, 2016 edition.

NFPA 423, *Standard for Construction and Protection of Aircraft Engine Test Facilities*, 2016 edition.

NFPA 804, *Standard for Fire Protection for Advanced Light Water Reactor Electric Generating Plants*, 2015 edition.

NFPA 909, *Code for the Protection of Cultural Resource Properties — Museums, Libraries, and Places of Worship*, 2017 edition.

Submitter Information Verification

Submitter Full Name: AUT-SSD
Organization: National Fire Protection Assoc
Street Address:
City:
State:
Zip:
Submittal Date: Sat Aug 12 17:50:10 EDT 2017

Committee Statement

Committee Statement: NFPA 120 is not referenced in the annex and therefore has been deleted per MOS.

Response Message:

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Second Revision No. 531-NFPA 13-2017 [Global Input]

Find and replace all instances of "unexpanded" referencing Group A plastics with "nonexpanded" for consistency throughout the reorganized document. Change "uncartoned" to "exposed" throughout the docuement as per FR#774.

Submitter Information Verification

Submitter Full Name: AUT-SSI
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Mon Jul 17 10:37:57 EDT 2017

Committee Statement

Committee Statement: The use of "nonexpanded" has become preferred over "unexpanded" when referencing Group A plastics that are not "expanded". Previously there has been some consistency within chapters as the usage has been updated piecemeal but not throughout the document. The reorganization is an ideal time to make this term consistent throughout the standard and its annexes.

At least one change, introduced in FR-791, has indicated the need to change "unexpanded" to the preferred "nonexpanded". This change should be implemented globally.

FR#774 required "uncartoned" to be changed to "exposed" throughout the document.

Response Message:

Public Comment No. 185-NFPA 13-2017 [Global Input]

Second Revision No. 532-NFPA 13-2017 [Global Input]

"Change 'Biocide' to 'Bacterial Inhibitor' throughout"

Submitter Information Verification

Submitter Full Name: AUT-SSI
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Mon Jul 17 10:41:17 EDT 2017

Committee Statement

Committee Statement: "Biocide" is a product that must be registered with the EPA and must be used in strict accordance with the label. Furthermore, Biocide applications are required to be applied by a DEC licensed pesticide applicator. Applications must be documented by the applicator and all application records filed with the DEC on an annual basis. "Biocide" should be changed to "Bacterial inhibitor" or "Biostatic inhibitor".

Response Message:

Public Comment No. 31-NFPA 13-2017 [Global Input]

Second Revision No. 1042-NFPA 13-2017 [Global Comment]

SSI-AAA

Update metric conversions in NFPA 13 to match that as shown on the attached list and pdf of NFPA 13.

Supplemental Information

File Name	Description	Approved
13-SSI_metrics.pdf	Metric conversions - SSI-AAA	
Metric_values_used_in_NFPA_13..docx		

Submitter Information Verification

Submitter Full Name: AUT-SSI
Organization: National Fire Protection Assoc
Street Address:
City:
State:
Zip:
Submittal Date: Fri Oct 06 13:37:08 EDT 2017

Committee Statement

Committee Statement: The metric conversions in the attached list are considered to be “soft” or approximate conversions and are intended to consider trade sizes for pipe and other materials and have been appropriately rounded with the number of significant digits taken into account. The intent of this list is to provide for consistent use of metric conversions throughout the standard with the understanding that it is acceptable for an engineer, authority having jurisdiction, designer or, installer to use an exact conversion rather than an approximate conversion as used in the standard when necessary.

The attached list has been reviewed by the NFPA 13 Metric Task Group.

Response Message:

Nominal Pipe Diameter	Testing Allowance
in.(mm)	in.(mm)
16 (400)	0.153 (1.90)
18 (450)	0.172 (2.14)
20 (500)	0.191 (2.37)
24 (600)	0.229 (2.84)

Notes:

(1) For other length, diameters, and pressures, utilize Equation 10.10.2.2.6a or 10.10.2.2.6b to determine the appropriate testing allowance.

(2) For test sections that contain various sizes and sections of pipe, the testing allowance is the sum of the testing allowances for each size and section.

[**24:** Table 10.10.2.2.6]

6.10.2.3 Other Means of Hydrostatic Tests.
Where required by the AHJ, hydrostatic tests shall be permitted to be completed in accordance with the requirements of AWWA C600, AWWA C602, AWWA C603, and AWWA C900. [**24:**10.10.2.3]

6.10.2.4 Operating Test.
[**24:**10.10.2.4]

6.10.2.4.1
Each hydrant shall be fully opened and closed under system water pressure. [**24:**10.10.2.4.1]

6.10.2.4.2
Dry barrel hydrants shall be checked for proper drainage. [**24:**10.10.2.4.2]

6.10.2.4.3
All control valves shall be fully closed and opened under system water pressure to ensure proper operation. [**24:**10.10.2.4.3]

6.10.2.4.4
Where fire pumps supply the private fire service main, the operating tests required by 6.10.2.4 shall be completed with the pumps running. [**24:**10.10.2.4.4]

6.10.2.5 Backflow Prevention Assemblies.
[**24:**10.10.2.5]

6.10.2.5.1
The backflow prevention assembly shall be forward flow tested to ensure proper operation. [**24:**10.10.2.5.1]

6.10.2.5.2
The minimum flow rate required by 6.10.2.5.1 shall be the system demand, including hose stream demand where applicable. [**24:**10.10.2.5.2]

Chapter 7 Requirements for System Components and Hardware

7.1 General.

This chapter shall provide requirements for correct use of sprinkler system components and hardware.

7.1.1* Listing.

7.1.1.1

Materials or devices not specifically designated by this standard shall be used in accordance with all conditions, requirements, and limitations of their special listing.

7.1.1.1.1
All special listing requirements shall be included and identified in the product submittal literature and installation instructions.

7.1.1.2
Unless the requirements of 7.1.1.3, 7.1.1.4, or 7.1.1.5 are met, all materials and devices essential to successful system operation shall be listed.

7.1.1.2.1
Valve components (including valve trim, internal parts, gaskets, and the like) shall not be required to be individually listed.

7.1.1.3
Equipment as permitted in Table 7.3.1.1 and Table 7.4.1 shall not be required to be listed.

7.1.1.3.1
Nonmetallic pipe and fittings included in Table 7.3.1.1 and Table 7.4.1 shall be listed.

7.1.1.4
Materials meeting the requirements of 17.1.2, 17.1.6.2, 17.1.6.3, and 17.1.7.3 shall not be required to be listed.

7.1.1.5*
Components that do not affect system performance shall not be required to be listed.

7.1.2 Rated Pressure.
System components shall be rated for the maximum system working pressure to which they are exposed but shall not be rated at less than 175 psi (12 bar) for components installed above ground and 150 psi (10 bar) for components installed underground.

7.2 Sprinklers.

7.2.1* Sprinkler Identification.
All sprinklers shall be permanently marked with one or two English uppercase alphabetic characters to identify the manufacturer, immediately followed by three or four numbers, to uniquely identify a sprinkler as to K-factor, deflector characteristic, pressure rating, and thermal sensitivity.

7.2.2 Sprinkler Discharge Characteristics.

7.2.2.1* General.
Unless the requirements of 7.2.2.2, 7.2.2.3, or 7.2.2.4 are met, the K-factor, relative discharge, and marking identification for sprinklers having different K-factors shall be in accordance with Table 7.2.2.1.

Table 7.2.2.1 Sprinkler Discharge Characteristics Identification

Nominal K-Factor [gpm/(psi)$^{1/2}$]	Nominal K-Factor [L/min/(bar)$^{1/2}$]	K-Factor Range [gpm/(psi)$^{1/2}$]	K-Factor Range [L/min/(bar)$^{1/2}$]	Percent of Nominal K-5.6 Discharge	Thread Type
1.4	20	1.3–1.5	19–22	25	½ in. (15 mm) NPT
1.9	27	1.8–2.0	26–29	33.3	½ in. (15 mm) NPT
2.8	40	2.6–2.9	38–42	50	½ in. (15 mm) NPT
4.2	60	4.0–4.4	57–63	75	½ in.(15 mm) NPT

Nominal K-Factor [gpm/(psi)$^{1/2}$]	Nominal K-Factor [L/min/(bar)$^{1/2}$]	K-Factor Range [gpm/(psi)$^{1/2}$]	K-Factor Range [L/min/(bar)$^{1/2}$]	Percent of Nominal K-5.6 Discharge	Thread Type
5.6	80	5.3–5.8	76–84	100	½ in. (15 mm) NPT
8.0	115	7.4–8.2	107–118	140	¾ in. (20 mm) NPT or ½ in. (15 mm) NPT
11.2	160	10.7–11.7	159–166	200	½ in. (15 mm) NPT or ¾ in. (20 mm) NPT
14.0	200	13.5–14.5	195–209	250	¾ in. (20 mm) NPT
16.8	240	16.0–17.6	231–254	300	¾ in. (20 mm) NPT
19.6	280	18.6–20.6	272–301	350	1 in.(25 mm) NPT
22.4	320	21.3–23.5	311–343	400	1 in. (25 mm) NPT
25.2	360	23.9–26.5	349–387	450	1 in. (25 mm) NPT
28.0	400	26.6–29.4	389–430	500	1 in. (25 mm) NPT

Note: The nominal K-factor for dry-type sprinklers are used for sprinkler selection. See 23.4.4.9.3 for use of adjusted dry-type sprinkler K-factors for hydraulic calculation purposes.

7.2.2.2 Pipe Threads.
Listed sprinklers having pipe threads different from those shown in Table 7.2.2.1 shall be permitted.

7.2.2.3 K-Factors Greater than K-28 (400).
Sprinklers listed with nominal K-factors greater than K-28 (400) shall increase the flow by 100 percent increments when compared with a nominal K-5.6 (80) sprinkler.

7.2.2.4 Residential Sprinklers.
Residential sprinklers shall be permitted with K-factors other than those specified in Table 7.2.2.1.

7.2.2.5 CMSA and ESFR K-Factors.
Control mode specific application (CMSA) and early suppression fast-response (ESFR) sprinklers shall have a minimum nominal K-factor of K-11.2 (160).

7.2.2.6 ESFR K-Factor.
ESFR sprinkler K-factor shall be selected as appropriate for the hazard. *(See Chapter 12.)*

7.2.3 Occupancy Limitations.
Unless the requirements of 7.2.3.1 or 7.2.3.2 are met, sprinklers shall not be listed for protection of a portion of an occupancy classification.

7.2.3.1 Residential Sprinklers.
Residential sprinklers shall be permitted to be listed for portions of residential occupancies as defined in 12.1.1.

7.2.3.2 Special Sprinklers.

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Special sprinklers shall be permitted to be listed for protection of a specific construction feature in a portion of an occupancy classification. *(See 15.2.)*

7.2.4* Temperature Characteristics.

7.2.4.1
Automatic sprinklers shall have their frame arms, deflector, coating material, or liquid bulb colored in accordance with the requirements of Table 7.2.4.1 or the requirements of 7.2.4.2, 7.2.4.3, 7.2.4.4, or 7.2.4.5.

Table 7.2.4.1 Temperature Ratings, Classifications, and Color Codings

Maximum Ceiling Temperature		Temperature Rating		Temperature Classification	Color Code	Glass Bulb Colors
°F	°C	°F	°C			
100	38	135–170	57–77	Ordinary	Uncolored or black	Orange or red
150	66	175–225	79–107	Intermediate	White	Yellow or green
225	107	250–300	121–149	High	Blue	Blue
300	149	325–375	163–191	Extra high	Red	Purple
375	191	400–475	204–246	Very extra high	Green	Black
475	246	500–575	260–302	Ultra high	Orange	Black
625	329	650	343	Ultra high	Orange	Black

7.2.4.2
A dot on the top of the deflector, the color of the coating material, or colored frame arms shall be permitted for color identification of corrosion-resistant sprinklers.

7.2.4.3
Color identification shall not be required for ornamental sprinklers such as factory-plated or factory-painted sprinklers or for recessed, flush, or concealed sprinklers.

7.2.4.4
The frame arms of bulb-type sprinklers shall not be required to be color coded.

7.2.4.5
The liquid in bulb-type sprinklers shall be color coded in accordance with Table 7.2.4.1.

7.2.5 Special Coatings.

7.2.5.1* Corrosion Resistant.

7.2.5.2* Painting.
Sprinklers shall only be painted by the sprinkler manufacturer.

7.2.5.3 Ornamental Finishes.

7.2.5.3.1
Ornamental finishes shall only be applied to sprinklers and, if applicable, their concealed cover plates, by the sprinkler manufacturer.

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7.2.5.3.2
Sprinklers with ornamental finishes where utilized shall be specifically listed.

7.2.6 Escutcheons and Cover Plates.

7.2.6.1
Plates, escutcheons, or other devices used to cover the annular space around a sprinkler shall be metallic or shall be listed for use around a sprinkler.

7.2.6.2*
Escutcheons used with recessed, flush-type, or concealed sprinklers shall be part of a listed sprinkler assembly.

7.2.6.3
Cover plates used with concealed sprinklers shall be part of the listed sprinkler assembly.

7.3 Aboveground Pipe and Tube.

7.3.1 General.

7.3.1.1
Pipe or tube shall meet or exceed one of the standards in Table 7.3.1.1 or be in accordance with 7.3.3.

Table 7.3.1.1 Pipe or Tube Materials and Dimensions

Materials and Dimensions	Standard
Ferrous Piping (Welded and Seamless)	
Specification for Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless Steel Pipe for Fire Protection Use	ASTM A795
Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless	ANSI/ASTM A53
Wrought Steel Pipe	ANSI/ASME B36.10M
Specification for Electric-Resistance-Welded Steel Pipe	ASTM A135
Copper Tube (Drawn, Seamless)	
Specification for Seamless Copper Tube	ASTM B75
Specification for Seamless Copper Water Tube	ASTM B88
Specification for General Requirements for Wrought Seamless Copper and Copper-Alloy Tube	ASTM B251
Specification for Liquid and Paste Fluxes for Soldering Applications of Copper and Copper-Alloy Tube	ASTM B813
Brazing Filler Metal (Classification BCuP-3 or BCuP-4)	AWS A5.8
Solder Metal, Section 1: Solder Alloys Containing Less Than 0.2% Lead and Having Solidus Temperatures Greater than 400°F	ASTM B32
Alloy Materials	ASTM B446
CPVC	
Nonmetallic Piping Specification for Special Listed Chlorinated Polyvinyl chloride (CPVC) Pipe	ASTM F442
Brass Pipe	

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Materials and Dimensions	Standard
Specification for Seamless Red Brass Pipe	ASTM B43
Stainless Steel	
Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes	ASTM A312/312M

7.3.2* Nonmetallic Pipe and Tubing.

7.3.2.1
Nonmetallic pipe in accordance with Table 7.3.1.1 shall be investigated for suitability in automatic sprinkler installations and listed for this service.

7.3.2.1.1
Other types of nonmetallic pipe or tube investigated for suitability in automatic sprinkler installations and listed for this service, including but not limited to CPVC, and differing from that provided in Table 7.3.1.1 shall be permitted where installed in accordance with their listing limitations.

7.3.2.1.2
Manufacturer’s installation instructions shall include its listing limitations.

7.3.2.2
Nonmetallic pipe shall not be listed for portions of an occupancy classification.

7.3.3* Listed Metallic Pipe and Tubing.

7.3.3.1
Other types of pipe or tube investigated for suitability in automatic sprinkler installations and listed for this service, including steel, and differing from that provided in Table 7.3.1.1 shall be permitted where installed in accordance with their listing limitations, including installation instructions.

7.3.3.2
Pipe or tube shall not be listed for portions of an occupancy classification.

7.3.4 Pipe and Tube Identification.

7.3.4.1*
All pipe shall be marked along its length by the manufacturer in such a way as to properly identify the type of pipe.

7.3.4.2
The marking shall be visible on every piece of pipe over 2 ft (600 mm) long.

7.3.4.3
Pipe identification shall include the manufacturer's name, model designation, or schedule.

7.4 Fittings.

7.4.1*
Fittings used in sprinkler systems shall meet or exceed the standards in Table 7.4.1 or be in accordance with 7.4.2 or 7.4.4.

Table 7.4.1 Fittings Materials and Dimensions

Materials and Dimensions	Standard
Cast Iron	
Cast Iron Threaded Fittings, Class 125 and 250	ASME B16.4

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Materials and Dimensions	Standard
Cast Iron Pipe Flanges and Flanged Fittings	ASME B16.1
Malleable Iron	
Malleable Iron Threaded Fittings, Class 150 and 300	ASME B16.3
Steel	
Factory-Made Wrought Steel Buttweld Fittings	ASME B16.9
Buttwelding Ends for Pipe, Valves, Flanges, and Fittings	ASME B16.25
Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures	ASTM A234
Steel Pipe Flanges and Flanged Fittings	ASME B16.5
Forged Steel Fittings, Socket Welded and Threaded	ASME B16.11
Copper	
Wrought Copper and Copper Alloy Solder Joint Pressure Fittings	ASME B16.22
Cast Copper Alloy Solder Joint Pressure Fittings	ASME B16.18
CPVC	
Chlorinated Polyvinyl Chloride (CPVC) Specification for Schedule 80 CPVC Threaded Fittings	ASTM F437
Specification for Schedule 40 CPVC Socket Type Fittings	ASTM F438
Specification for Schedule 80 CPVC Socket Type Fittings	ASTM F439
Bronze Fittings	
Cast Copper Alloy Threaded Fittings Classes 125 and 250	ASTM B16.15
Stainless Steel	
Specification for Wrought Austenitic Stainless Steel Pipe Fittings	ASTM A403/A403M
Ductile Iron Fittings	ASTM A536

7.4.2
In addition to the standards in Table 7.4.1, nonmetallic fittings shall also be in accordance with 7.4.4.

7.4.3 Nonmetallic Fittings.
Nonmetallic fittings in accordance with Table 7.4.1 shall be investigated for suitability in automatic sprinkler installations and listed for this service. Listed nonmetallic fittings shall be installed in accordance with their listing limitations, including installation instructions.

7.4.4*
Other types of fittings investigated for suitability in automatic sprinkler installations and listed for this service, including but not limited to CPVC and steel, and differing from that provided in Table 7.4.1 shall be permitted when installed in accordance with their listing limitations, including installation instructions.

7.5 Joining of Pipe and Fittings.

7.5.1 Threaded Pipe and Fittings.

7.5.1.1

All threaded pipe and fittings shall have threads cut to ASME B1.20.1, *Pipe Threads, General Purpose (Inch)*.

7.5.1.2*
Steel pipe with wall thicknesses less than Schedule 30 [in sizes 8 in. (200 mm) and larger] or Schedule 40 [in sizes less than 8 in. (200 mm)] shall only be permitted to be joined by threaded fittings where the threaded assembly is investigated for suitability in automatic sprinkler installations and listed for this service.

7.5.2 Welded Pipe and Fittings.

7.5.2.1 General.

7.5.2.1.1
Welding shall be permitted as a means of joining sprinkler piping in accordance with 7.5.2.2 through 7.5.2.6.

7.5.2.2* Fabrication.

7.5.2.2.1
When welding sprinkler pipe, the pipe shall be shop welded unless the requirements of 7.5.2.2 or 7.5.2.3 are met.

7.5.2.2.2
Where the design specifications require any part of the piping system to be welded in place, welding of sprinkler piping shall be permitted where the welding process is performed in accordance with NFPA 51B and the mechanical fittings required by 16.9.11.5 and 16.6 are provided.

7.5.2.2.3
Tabs for longitudinal earthquake bracing shall be permitted to be welded to in-place piping where the welding process is performed in accordance with NFPA 51B.

7.5.2.2.4
Welding shall not be performed where there is impingement of rain, snow, sleet, or high wind on the weld area of the pipe product.

7.5.2.2.5
Torch cutting and welding shall not be permitted as a means of modifying or repairing sprinkler systems.

7.5.2.3 Fittings.

7.5.2.3.1*
Welded fittings used to join pipe shall be listed fabricated fittings or manufactured in accordance with Table 7.4.1.

7.5.2.3.2
Fittings referenced in 7.5.2.3.1 shall be joined in conformance with a qualified welding procedure as set forth in this section and shall be an acceptable product under this standard, provided that materials and wall thickness are compatible with other sections of this standard.

7.5.2.3.3
Fittings shall not be required where pipe ends are buttwelded in accordance with the requirements of 7.5.2.4.3.

7.5.2.3.4
When the pipe size in a run of piping is reduced, a reducing fitting designed for that purpose shall be used in accordance with the requirements of 7.5.2.3.1.

7.5.2.4 Welding Requirements.

7.5.2.4.1*

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Welds between pipe and welding outlet fittings shall be permitted to be attached by full penetration welds, partial penetration groove welds, or fillet welds.

7.5.2.4.2*
The minimum throat thickness shall be not less than the thickness of the pipe, the thickness of the welding fitting, or 3⁄16 in. (5 mm), whichever is least.

7.5.2.4.3*
Circumferential butt joints shall be cut, beveled, and fit so that full penetration is achievable.

7.5.2.4.4
Full penetration welding shall not be required.

7.5.2.4.5
Where slip-on flanges are welded to pipe with a single fillet weld, the weld shall be on the hub side of the flange and the minimum throat weld thickness shall not be less than 1.25 times the pipe wall thickness or the hub thickness, whichever is less.

7.5.2.4.6
Face welds on the internal face of the flange shall be permitted as a water seal in addition to the hub weld required in 7.5.2.4.5.

7.5.2.4.7
Tabs for longitudinal earthquake bracing shall have minimum throat weld thickness not less than 1.25 times the pipe wall thickness and welded on both sides of the longest dimension.

7.5.2.4.8
When welding is performed, the following shall apply:
(1) Holes in piping for outlets shall be cut to the full inside diameter of fittings prior to welding in place of the fittings.

(2) Discs shall be retrieved.

(3) Openings cut into piping shall be smooth bore, and all internal slag and welding residue shall be removed.

(4) Fittings shall not penetrate the internal diameter of the piping.

(5) Steel plates shall not be welded to the ends of piping or fittings.

(6) Fittings shall not be modified.

(7) Nuts, clips, eye rods, angle brackets, or other fasteners shall not be welded to pipe or fittings, except as permitted in 7.5.2.2.3 and 7.5.2.4.7.

(8) Completed welds shall be free from cracks, incomplete fusion, surface porosity greater than 1⁄16 in. (1.6 mm) diameter, and undercut deeper than 25 percent of the wall thickness or 1⁄32 in. (0.8 mm), whichever is less.

(9) Completed circumferential butt weld reinforcement shall not exceed 3⁄32 in. (2.4 mm).

7.5.2.5 Qualifications.

7.5.2.5.1
A welding procedure shall be prepared and qualified by the contractor or fabricator before any welding is done.

7.5.2.5.2
Qualification of the welding procedure to be used and the performance of all welders and welding operators shall be required and shall meet or exceed the requirements of AWS B2.1, *Specification for Welding Procedure and Performance Qualification*; ASME *Boiler and Pressure Vessel Code*, Section IX, "Welding and Brazing Qualifications"; or other applicable qualification standard as required by the authority having jurisdiction, except as permitted by 7.5.2.5.3.

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7.5.2.5.3
Successful procedure qualification of complete joint penetration groove welds shall qualify partial joint penetration (groove/fillet) welds and fillet welds in accordance with the provisions of this standard.

7.5.2.5.4
Welding procedures qualified under standards recognized by previous editions of this standard shall be permitted to be continued in use.

7.5.2.5.5
Contractors or fabricators shall be responsible for all welding they produce.

7.5.2.5.6
Each contractor or fabricator shall have available to the authority having jurisdiction an established written quality assurance procedure ensuring compliance with the requirements of 7.5.2.4.

7.5.2.6 Records.

7.5.2.6.1
Welders or welding machine operators shall, upon completion of each welded pipe, place their identifiable mark or label onto each piece adjacent to a weld.

7.5.2.6.2
Contractors or fabricators shall maintain certified records, which shall be available to the authority having jurisdiction, of the procedures used and the welders or welding machine operators employed by them, along with their welding identification.

7.5.2.6.3
Records shall show the date and the results of procedure and performance qualifications.

7.5.3 Groove Joining Methods.

7.5.3.1*
Pipe, fittings, valves, and devices to be joined with grooved couplings shall contain cut, rolled, swaged, or cast grooves in accordance with standard grooved coupling manufacturer dimensions.

7.5.3.1.1*
Pipe, fittings, valves, devices, and couplings that conform with or are listed in compliance with standardized groove specifications shall be considered compatible.

7.5.3.1.2
Other groove dimensions and grooving methods shall be acceptable in accordance with 7.5.5.1.

7.5.3.2
Grooved couplings, including gaskets used on dry pipe, preaction, and deluge systems, shall be listed for dry service.

7.5.4* Brazed and Soldered Joints.

7.5.4.1
Solder joints, where permitted, shall be fabricated in accordance with the methods and procedures listed in ASTM B828, *Standard Practice for Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings.*

7.5.4.2
Unless the requirements of 7.5.4.3 or 7.5.4.4 are met, joints for the connection of copper tube shall be brazed.

7.5.4.3
Solder joints shall be permitted for exposed wet pipe systems in light hazard occupancies where the temperature classification of the installed sprinklers is of the ordinary- or intermediate-temperature classification.

7.5.4.4

Solder joints shall be permitted for wet pipe systems in light hazard and ordinary hazard (Group 1) occupancies where the piping is concealed, irrespective of sprinkler temperature ratings.

7.5.4.5*
Soldering fluxes shall be in accordance with Table 7.3.1.1.

7.5.4.6
Brazing fluxes, if used, shall not be of a highly corrosive type.

7.5.5 Other Joining Methods.

7.5.5.1
Other joining methods investigated for suitability in sprinkler installations and listed for this service shall be permitted where installed in accordance with their listing limitations, including installation instructions.

7.5.5.2 Outlet Fittings.
Rubber-gasketed outlet fittings that are used on sprinkler systems shall meet the following requirements:
(1) Be installed in accordance with the listing and manufacturer's installation instructions

(2) Have all disks retrieved

(3) Have smooth bores cut into the pipe, with all cutting residue removed

(4) Not be modified

7.5.6 End Treatment.

7.5.6.1
After cutting, pipe ends shall have burrs and fins removed.

7.5.6.2
Pipe used with listed fittings and its end treatment shall be in accordance with the fitting manufacturer's installation instructions and the fitting’s listing.

7.6 Valves.

7.6.1 Valve Closure Time.
Listed indicating valves shall not close in less than 5 seconds when operated at maximum possible speed from the fully open position.

7.7 Waterflow Alarm Devices.
Waterflow alarm devices shall be listed for the service and so constructed and installed that any flow of water from a sprinkler system equal to or greater than that from a single automatic sprinkler of the smallest K-factor installed on the system will result in an audible alarm on the premises within 5 minutes after such flow begins and until such flow stops.

7.8 Additives and Coatings.

7.8.1
Additives to the water supply intended for control of microbiological or other corrosion shall be listed for use within fire sprinkler systems.

7.8.2
Internal pipe coatings, excluding galvanizing, intended for control of microbiological or other corrosion shall be listed for use within fire sprinkler systems.

Chapter 8 System Types and Requirements

8.1 Wet Pipe Systems.

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8.1.1 Pressure Gauges.

8.1.1.1
An approved pressure gauge conforming to 16.13 shall be installed in each system riser.

8.1.1.2*
Pressure gauges shall be installed above and below each alarm check valve or system riser check valve where such devices are present.

8.1.1.2.1
A single pressure gauge shall be permitted to be installed on a manifold below multiple riser check valves or alarm check valves.

8.1.1.2.2
Pressure gauges below check valves required by 16.15.2.2(1) shall not be required.

8.1.2 Relief Valves.

8.1.2.1
Unless the requirements of 8.1.2.2 are met, a wet pipe system shall be provided with a listed relief valve not less than ½ in. (15 mm) in size and set to operate at 175 psi (12 bar) or 10 psi (0.7 bar) in excess of the maximum system pressure, whichever is greater.

8.1.2.2
Where auxiliary air reservoirs are installed to absorb pressure increases, a relief valve shall not be required.

8.1.2.3
A relief valve per 8.1.2.1 shall be required downstream of check valves required by 16.15.2.2(1).

8.1.3 Auxiliary Systems.
A wet pipe system shall be permitted to supply an auxiliary dry pipe, preaction, or deluge system, provided the water supply is adequate.

8.1.4
Heat tracing shall not be used in lieu of heated valve enclosures to protect the valve and supply pipe from freezing.

8.1.5 Air Venting.
A single air vent with a connection conforming to 16.7 shall be provided on each wet pipe system utilizing metallic pipe. *(See A.16.7.)*

8.1.5.1
Venting from multiple points on each system shall not be required.

8.2* Dry Pipe Systems.

8.2.1 Pressure Gauges.
Approved pressure gauges in accordance with 16.13 shall be connected as follows:
(1) On the water side and air side of the dry pipe valve

(2) At the air pump supplying the air receiver where one is provided

(3) At the air receiver where one is provided

(4) In each independent pipe from air supply to dry pipe system

(5) At quick-opening devices

8.2.2 Sprinklers.
The following sprinkler orientations and arrangements shall be permitted for dry pipe systems:
(1) Upright sprinklers

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(2) *Listed dry sprinklers

(3) Pendent sprinklers and sidewall sprinklers installed on return bends, where the sprinklers, return bend, and branch line piping are in an area maintained at or above 40°F (4°C)

(4) Horizontal sidewall sprinklers installed so that water is not trapped

(5) Pendent sprinklers and sidewall sprinklers, where the sprinklers and branch line piping are in an area maintained at or above 40°F (4°C), the water supply is potable, and the piping for the dry pipe system is copper or CPVC specifically listed for dry pipe applications

8.2.3* Size of Systems.

8.2.3.1*
The system capacity (volume) controlled by a dry pipe valve shall be determined by 8.2.3.2, 8.2.3.3, 8.2.3.4, 8.2.3.5, or 8.2.3.7.

8.2.3.1.1
For dry pipe systems protecting dwelling unit portions of any occupancy, system size shall be such that initial water is discharged from the system test connection in not more than 15 seconds, starting at the normal air pressure on the system and at the time of fully opened inspection test connection.

8.2.3.1.1.1
Dry pipe systems protecting dwelling unit portions of any occupancy shall not be permitted to use the options outlined in 8.2.3.2, 8.2.3.3, or 8.2.3.4.

8.2.3.2
System size shall be such that initial water is discharged from the system test connection in not more than 60 seconds, starting at the normal air pressure on the system and at the time of fully opened inspection test connection.

8.2.3.3
A system size of not more than 500 gal (1900 L) shall be permitted without a quick-opening device and shall not be required to meet any specific water delivery requirement to the inspection test connection.

8.2.3.4
A system size of not more than 750 gal (2850 L) shall be permitted with a quick-opening device and shall not be required to meet any specific water delivery requirement to the inspection test connection.

8.2.3.5
System size shall be based on dry pipe systems being calculated for water delivery in accordance with **8.2.3.6**.

8.2.3.6 Dry Pipe System Water Delivery.

8.2.3.6.1
Calculations for dry pipe system water delivery shall be based on the hazard shown in Table 8.2.3.6.1.

Table 8.2.3.6.1 Dry Pipe System Water Delivery

Hazard	Number of Most Remote Sprinklers Initially Open	Maximum Time of Water Delivery (seconds)
Light	1	60
Ordinary I	2	50
Ordinary II	2	50
Extra I	4	45
Extra II	4	45
High piled	4	40

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8.2.3.6.2
The calculation program and method shall be listed by a nationally recognized testing laboratory.

8.2.3.6.3
For dry pipe systems protecting dwelling unit portions of any occupancy, the sprinklers in the dwelling unit shall have a maximum water delivery time of 15 seconds to the single most remote sprinkler.

8.2.3.6.4
Residential sprinklers shall be listed for dry pipe applications.

8.2.3.7*
System size shall be such that initial water discharge from the system trip test connection or manifold outlets is not more than the maximum time of water delivery specified in Table 8.2.3.6.1, starting at normal air pressure on the system and at the time of fully opened test connection.

8.2.3.7.1
When flow is from four sprinklers, the test manifold shall be arranged to simulate two sprinklers on each of two sprinkler branch lines.

8.2.3.7.2
When flow is from three sprinklers, the test manifold shall be arranged to simulate two sprinklers on the most remote branch line and one sprinkler on the next adjacent branch line.

8.2.3.7.3
When flow is from two sprinklers, the test manifold shall be arranged to simulate two sprinklers on the most remote branch line.

8.2.3.7.4
When flow is from one sprinkler, the test manifold shall be installed as per the requirements for a trip test connection in accordance with 16.14.2.

8.2.3.7.5
A system meeting the requirements of this section shall not be required to also meet the requirements of 8.2.3.2 or 8.2.3.5.

8.2.3.8
Dry pipe systems with water delivery times other than 8.2.3.2, 8.2.3.5, and 8.2.3.7 shall be acceptable where listed by a nationally recognized testing laboratory.

8.2.3.9
Unless installed in a heated enclosure, check valves shall not be used to subdivide the dry pipe systems.

8.2.3.9.1
When check valves are used to subdivide dry pipe systems in accordance with 8.2.3.9, a hole 1/8 in. (3.2 mm) in diameter shall be drilled in the clapper of each check valve to permit equalization of air pressure among the various parts of the system.

8.2.3.9.2
Where auxiliary drains are not provided for each subdivided section, an approved indicating drain valve supervised in the closed position in accordance with 16.9.3.3, connected to a bypass around each check valve, shall be provided as a means for draining the system.

8.2.3.10
Gridded dry pipe systems shall not be installed.

8.2.4 Quick-Opening Devices.

8.2.4.1
A listed quick-opening device shall be permitted to help meet the requirements of 8.2.3.2, 8.2.3.5, 8.2.3.7, or 8.2.3.8.

8.2.4.2
The quick-opening device shall be located as close as practical to the dry pipe valve.

8.2.4.3
To protect the restriction orifice and other operating parts of the quick-opening device against submergence, the connection to the riser shall be above the point at which water (priming water and back drainage) is expected when the dry pipe valve and quick-opening device are set, except where design features of the particular quick-opening device make these requirements unnecessary.

8.2.4.4
Where a valve is installed in the connection between a dry pipe sprinkler riser and a quick-opening device, it shall be an indicating-type valve that is sealed, locked, or electrically supervised in the open position.

8.2.4.5
A check valve shall be installed between the quick-opening device and the intermediate chamber of the dry pipe valve, where the quick-opening device requires protection against submergence after system operation.

8.2.4.6
If the quick-opening device requires pressure feedback from the intermediate chamber, a valve type that will clearly indicate whether it is opened or closed shall be permitted in place of that check valve.

8.2.4.7
Where a valve is utilized in accordance with 8.2.4.6, the valve shall be constructed so that it can be locked or sealed in the open position.

8.2.4.8 Antiflooding Device.

8.2.4.8.1
Unless the requirements of 8.2.4.8.2 are met, a listed antiflooding device shall be installed in the connection between the dry pipe sprinkler riser and the quick-opening device.

8.2.4.8.2
A listed antiflooding device shall not be required where the quick-opening device has built-in antiflooding design features or the quick-opening device is listed or approved without the use of an antiflooding device.

8.2.5* Location and Protection of Dry Pipe Valve.

8.2.5.1* General.
The dry pipe valve and supply pipe shall be protected against freezing and mechanical injury.

8.2.5.2 Valve Rooms.

8.2.5.2.1
Valve rooms shall be lighted and heated.

8.2.5.2.2
The source of heat shall be of a permanently installed type.

8.2.5.2.3
Heat tape shall not be used in lieu of heated valve enclosures to protect the dry pipe valve and supply pipe against freezing.

8.2.5.3 Supply.
The supply for the sprinkler in the dry pipe valve enclosure shall be either from the dry side of the system or from a wet pipe sprinkler system that protects the area where the dry pipe valve is located.

8.2.5.4 High Water Level Protection.

8.2.5.4.1

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Where it is possible to reseat the dry valve after actuation without first draining the system, protection against occurrence of water above the clapper shall be permitted in accordance with 8.2.5.4.3.

8.2.5.4.2 Low Differential Dry Pipe Valve.
Protection against accumulation of water above the clapper shall be provided for low differential dry pipe valves in accordance with 8.2.5.4.3.

8.2.5.4.3 High Water Level Device.
An automatic high water level signaling device or an automatic drain shall be permitted.

8.2.6 Air Pressure and Supply.

8.2.6.1
Where the term *air* is used throughout this standard, it shall also include the use of nitrogen or other approved gas.

8.2.6.2 Maintenance of Air Pressure.
Air or nitrogen or other approved gas pressure shall be maintained on dry pipe systems throughout the year.

8.2.6.3* Air Supply.

8.2.6.3.1
The compressed air supply shall be from a source available at all times.

8.2.6.3.2*
The air supply shall have a capacity capable of restoring normal air pressure in the system within 30 minutes.

8.2.6.3.3
The requirements of 8.2.6.3.2 shall not apply in refrigerated spaces maintained below 5°F (–15°C), where normal system air pressure shall be permitted to be restored within 60 minutes.

8.2.6.4 Air Supply Connections.

8.2.6.4.1*
The connection from the air supply to the dry pipe valve shall not be less than ½ in. (1[illegible]mm) in diameter and shall enter the system above the priming water level of the dry pipe valve.

8.2.6.4.2
A check valve shall be installed in the air filling connection.

8.2.6.4.2.1
For systems that are filled manually, a listed or approved shutoff valve of either the renewable disc or ball valve type shall be installed on the supply side of this check valve and shall remain closed unless filling the system.

8.2.6.5 Relief Valve.
An approved relief valve shall be provided between the air supply and the shutoff valve and shall be set to relieve pressure no less than 10 psi (0.7 bar) in excess of system air pressure provided in 8.2.6.7.1 and shall not exceed the manufacturer's limitations.

8.2.6.6 Automatic Air Maintenance.

8.2.6.6.1*
Unless the requirements of 8.2.6.6.2 are met, where the air supply to a dry pipe system is maintained automatically, the air supply shall be from a dependable plant system or an air compressor with an air receiver, and shall utilize an air maintenance device specifically listed for such service and capable of controlling the required air pressure on, and maximum airflow to, the dry pipe system.

8.2.6.6.2

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Where the air compressor supplying the dry pipe system has a capacity less than 5.5 ft^3/min (160 L/min) at 10 psi (0.7 bar), an air receiver or air maintenance device shall not be required.

8.2.6.6.3
The automatic air supply to more than one dry pipe system shall be connected to enable individual maintenance of air pressure in each system.

8.2.6.6.3.1
Each dry pipe system shall have a dedicated air maintenance device.

8.2.6.6.4
A check valve or other positive backflow prevention device shall be installed in the air supply to each system to prevent airflow or waterflow from one system to another.

8.2.6.6.5
Where an air compressor is the dedicated air supply, it shall be installed in accordance with *NFPA 70*, Article 430.

8.2.6.6.5.1
The disconnecting means for an automatic air compressor shall not be a general-use light switch or a cord-and-plug connected motor.

8.2.6.7 System Air Pressure.

8.2.6.7.1
The system air pressure shall be maintained in accordance with the instruction sheet furnished with the dry pipe valve, or shall be 20 psi (1.4 bar) in excess of the calculated trip pressure of the dry pipe valve, based on the highest normal water pressure of the system supply.

8.2.6.7.2
The permitted rate of air leakage shall be as specified in 27.2.2.

8.2.6.8 Nitrogen or Other Approved Gas.

8.2.6.8.1*
Where nitrogen or other approved gas is used, the supply shall be from a reliable source.

8.2.6.8.2
Where stored nitrogen or other approved gas is used, the gas shall be introduced through a pressure regulator and shall be in accordance with 8.2.6.6.

8.2.6.8.3
A low pressure alarm shall be provided on gas storage containers to notify the need for refilling.

8.2.6.8.4*
When nitrogen or other approved gas is the only source of gas for pressurizing a system, it shall have a capacity capable of restoring normal gas pressure in the system within 30 minutes.

8.3 Preaction Systems and Deluge Systems.

8.3.1* General.

8.3.1.1*
All components of pneumatic, hydraulic, or electrical systems shall be compatible.

8.3.1.2
The automatic water control valve shall be provided with hydraulic, pneumatic, or mechanical manual means for operation that is independent of detection devices and of the sprinklers.

8.3.1.3 Pressure Gauges.
Approved pressure gauges conforming with 16.13 shall be installed as follows:
(1) Above and below preaction valve and below deluge valve

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(2) On air supply to preaction and deluge valves

8.3.1.4
A supply of spare fusible elements for heat-responsive devices, not less than two of each temperature rating, shall be maintained on the premises for replacement purposes.

8.3.1.5
Hydraulic release systems shall be designed and installed in accordance with manufacturer's requirements and listing for height limitations above deluge valves or deluge valve actuators to prevent water column.

8.3.1.6 Location and Spacing of Releasing Devices.

8.3.1.6.1
Spacing of releasing devices, including automatic sprinklers used as releasing devices, shall be in accordance with their listing and manufacturer' specifications.

8.3.1.6.2
The release system shall serve all areas that the preaction system protects.

8.3.1.6.3
Where thermal activation is utilized, the activation temperature of the release system shall be lower than the activation temperature of the sprinkler.

8.3.1.7 Devices for Test Purposes and Testing Apparatus.

8.3.1.7.1
Where detection devices installed in circuits are located where not accessible for testing, an additional detection device shall be provided on each circuit for test purposes at an accessible location and shall be connected to the circuit at a point that will ensure a proper test of the circuit.

8.3.1.7.2
Testing apparatus capable of producing the heat or impulse necessary to operate any normal detection device shall be furnished to the owner of the property with each installation.

8.3.1.7.3
Where explosive vapors or materials are present, hot water, steam, or other methods of testing not involving an ignition source shall be used.

8.3.1.7.4*
A separate additional indicating control valve, supervised in accordance with 16.9.3.3, shall be permitted to be installed in the riser assembly above a preaction or deluge valve to permit full function trip testing as required by NFPA 25, without flooding the system.

8.3.1.8 Location and Protection of System Water Control Valves.

8.3.1.8.1
System water control valves and supply pipes shall be protected against freezing and mechanical injury.

8.3.1.8.2 Valve Rooms.

8.3.1.8.2.1
Valve rooms shall be lighted and heated.

8.3.1.8.2.2
The source of heat shall be of a permanently installed type.

8.3.1.8.2.3
Heat tracing shall not be used in lieu of heated valve enclosure rooms to protect preaction and deluge valves and supply pipe against freezing.

8.3.2 Preaction Systems.

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8.3.2.1
Preaction systems shall be one of the following types:
(1) A single interlock system, which admits water to sprinkler piping upon operation of detection devices

(2) A non-interlock system, which admits water to sprinkler piping upon operation of detection devices or automatic sprinklers

(3) A double interlock system, which admits water to sprinkler piping upon operation of both detection devices and automatic sprinklers

8.3.2.2 Size of Systems — Single and Non-Interlock Preaction Systems.
Not more than 1000 automatic sprinklers shall be controlled by any one preaction valve.

8.3.2.3 Size of Systems — Double Interlock Preaction Systems.

8.3.2.3.1
The system size controlled by a double interlock preaction valve shall be determined by either 8.3.2.3.1.1, 8.3.2.3.1.2, 8.3.2.3.1.3, or8.3.2.3.1.4.

8.3.2.3.1.1
A system size for double interlock preaction systems of not more than 500 gal (1900 L) shall be permitted and shall not be required to meet any specific water delivery requirement to the trip test connection.

8.3.2.3.1.2
The system size for double interlock preaction systems shall be designed to deliver water to the system test connection in no more than 60 seconds, starting at the normal air pressure on the system, with the detection system activated and the inspection test connection fully opened simultaneously.

8.3.2.3.1.3
The system size for double interlock preaction systems shall be based on calculating water delivery in accordance with 8.2.3.6, anticipating that the detection system activation and sprinkler operation will be simultaneous.

8.3.2.3.1.4*
The system size for double interlock preaction systems shall be designed to deliver water to the system trip test connection or manifold outlets in not more than the maximum time of water delivery specified in **Table 8.2.3.6.1**, starting at the normal air pressure on the system, with the detection system activated and the inspection trip test connection or manifold opened simultaneously.

8.3.2.3.2
A listed quick-opening device shall be permitted to be used to help meet the requirements of 8.3.2.3.1.2, 8.3.2.3.1.3, and 8.3.2.3.1.4.

8.3.2.4* Supervision.

8.3.2.4.1
Sprinkler piping and fire detection devices shall be automatically supervised where more than 20 sprinklers are on the system.

8.3.2.4.2
Except as permitted by 8.3.2.4.3, air or nitrogen supervising pressure for preaction systems shall be installed in conformance with the dry pipe system air pressure and supply rules of 8.2.6.

8.3.2.4.3
The relief valves required by 8.2.6 shall be permitted to be omitted for the type of preaction system described in 8.3.2.1(1) when the air pressure is supplied from a source that is not capable of developing pressures in excess of 15 psi (1.0 bar).

8.3.2.4.4
All preaction system types described in 8.3.2.1(2) and 8.3.2.1(3) shall maintain a minimum supervising air or nitrogen pressure of 7 psi (0.5 bar).

8.3.2.5 Sprinklers.

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The following sprinkler orientations and arrangements shall be permitted for preaction systems:
(1) Upright sprinklers

(2) *Listed dry sprinklers

(3) Pendent sprinklers and sidewall sprinklers installed on return bends, where the sprinklers, return bend, and branch line piping are in an area maintained at or above 40°F (4°C)

(4) Horizontal sidewall sprinklers, installed so that water is not trapped

(5) Pendent sprinklers and sidewall sprinklers, where the sprinklers and branch line piping are in an area maintained at or above 40°F (4°C), the water supply is potable, and the piping for the preaction system is copper or CPVC specifically listed for dry pipe applications

8.3.2.6 System Configuration.
Preaction systems of the type described in 8.3.2.1(3) and all preaction systems protecting storage occupancies, excluding miscellaneous storage, shall not be gridded.

8.3.3* Deluge Systems.

8.3.3.1
The detection devices or systems shall be automatically supervised.

8.3.3.2
Deluge systems shall be hydraulically calculated.

8.4 Combined Dry Pipe and Preaction Systems for Piers, Terminals, and Wharves.

8.4.1
In addition to the requirements of Section 8.4, design and installation requirements for piers, terminals, and wharves shall be in accordance with Section 26.22.

8.4.2* General.

8.4.2.1*
Combined automatic dry pipe and preaction systems shall be so constructed that failure of the detection system shall not prevent the system from functioning as a conventional automatic dry pipe system.

8.4.2.2
Combined automatic dry pipe and preaction systems shall be so constructed that failure of the dry pipe system of automatic sprinklers shall not prevent the detection system from properly functioning as an automatic fire alarm system.

8.4.2.3
Provisions shall be made for the manual operation of the detection system at locations requiring not more than 200 ft (61 m) of travel.

8.4.2.4 Sprinklers.
The following types of sprinklers and arrangements shall be permitted for combined dry pipe and preaction systems:
(1) Upright sprinklers

(2) *Listed dry sprinklers

(3) Pendent sprinklers and sidewall sprinklers installed on return bends, where both the sprinklers and the return bends are located in a heated area

(4) Horizontal sidewall sprinklers, installed so that water is not trapped

8.4.3 Dry Pipe Valves in Combined Systems.

8.4.3.1

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Where the system consists of more than 600 sprinklers or has more than 275 sprinklers in any fire area, the entire system shall be controlled through two 6 in. (150 mm) dry pipe valves connected in parallel and shall feed into a common feed main.

8.4.3.2*
Where parallel dry pipe valves are required by 8.4.3.1, these valves shall be checked against each other.

8.4.3.3
Each dry pipe valve shall be provided with a listed tripping device actuated by the detection system.

8.4.3.4
Dry pipe valves shall be cross-connected through a 1 in. (25 mm) pipe connection to permit simultaneous tripping of both dry pipe valves.

8.4.3.5
The 1 in. (25 mm) cross-connection pipe shall be equipped with an indicating valve so that either dry pipe valve can be shut off and worked on while the other remains in service.

8.4.3.6
The check valves between the dry pipe valves and the common feed main shall be equipped with ½ in. (15 mm) bypasses so that a loss of air from leakage in the trimmings of a dry pipe valve will not cause the valve to trip until the pressure in the feed main is reduced to the tripping point.

8.4.3.7
An indicating valve shall be installed in each of these bypasses so that either dry pipe valve can be completely isolated from the main riser or feed main and from the other dry pipe valve.

8.4.3.8
Each combined dry pipe and preaction system shall be provided with listed quick-opening devices at the dry pipe valves.

8.4.4 Subdivision of System Using Check Valves.

8.4.4.1
Where more than 275 sprinklers are required in a single fire area, the system shall be divided into sections of 275 sprinklers or fewer by means of check valves.

8.4.4.2
Where the system is installed in more than one fire area or story, not more than 600 sprinklers shall be supplied through any one check valve.

8.4.4.3
Each section shall have a 1¼ in. (32 mm) drain on the system side of each check valve supplemented by a dry pipe system auxiliary drain.

8.4.4.4
Section drain lines and dry pipe system auxiliary drains shall be located in heated areas or inside heated cabinets to enclose drain valves and auxiliary drains for each section.

8.4.5 Time Limitation.

8.4.5.1
The sprinkler system shall be so constructed and the number of sprinklers controlled shall be so limited that water shall reach the farthest sprinkler within a period of time not exceeding 1 minute for each 400 ft (120 m) of common feed main from the time the heat-responsive system operates.

8.4.5.2
The maximum time permitted shall not exceed 3 minutes.

8.4.6 System Test Connection.
The end section shall have a system test connection as required for dry pipe systems.

8.5 Multi-Cycle Systems.

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8.5.1
All multi-cycle systems shall be specifically tested and listed as systems.

8.5.2
All multi-cycle systems shall be installed in compliance with the manufacturer's installation instructions.

8.6* Antifreeze Systems.

8.6.1* General.

8.6.1.1
The use of antifreeze solutions shall be in conformity with state and local health regulations.

8.6.1.2
Antifreeze shall not be used in ESFR systems unless the ESFR sprinkler is listed for use with the antifreeze solution.

8.6.1.3
Where pendent sprinklers are utilized, the water shall be drained from the entire system after hydrostatic testing with water.

8.6.1.3.1
The requirements of 8.6.1.3 shall not apply where the system is hydrostatically tested with properly mixed antifreeze solution.

8.6.1.4
Where antifreeze systems are remote from the system riser, a placard shall be mounted on the system riser that indicates the number and location of all remote antifreeze systems supplied by that riser.

8.6.1.5
A placard shall be placed on the antifreeze system main valve that indicates the manufacture type and brand of the antifreeze solution, the concentration by volume of the antifreeze solution used, and the volume of the antifreeze solution used in the system.

8.6.2* Antifreeze Solutions.

8.6.2.1*
Except as permitted in 8.6.2.2, antifreeze solutions shall be listed for use in sprinkler systems.

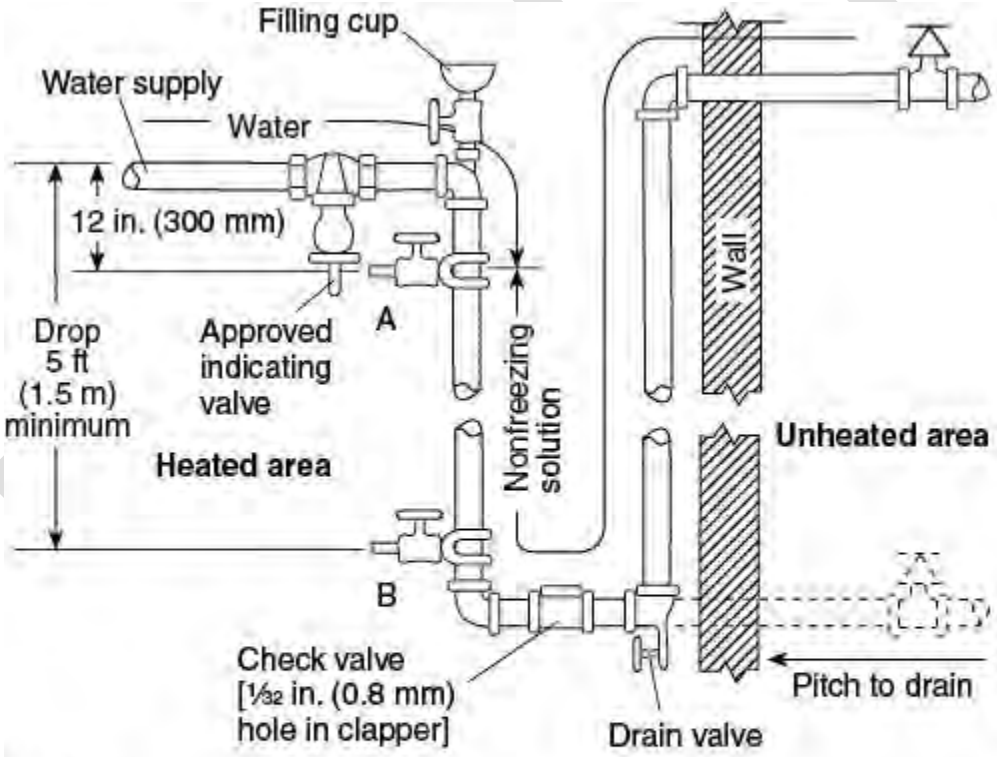
8.6.2.2
Premixed antifreeze solutions of propylene glycol shall be permitted to be used with ESFR sprinklers where the ESFR sprinklers are listed for such use in a specific application.

8.6.3 Arrangement of Supply Piping and Valves.

8.6.3.1
Where the connection between the antifreeze system and the wet pipe system does not incorporate a backflow prevention device, and the conditions of 8.6.3.5 are not met, piping and valves shall be installed as illustrated in Figure 8.6.3.1.

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Figure 8.6.3.1 Arrangement of Supply Piping and Valves.



Notes:

1. Check valves are permitted to be omitted where sprinklers are below the level of valve A.
2. The 1/32 in. (0.8 mm) hole in the check valve clapper is needed to allow for expansion of the solution during a temperature rise, thus preventing damage to sprinklers.

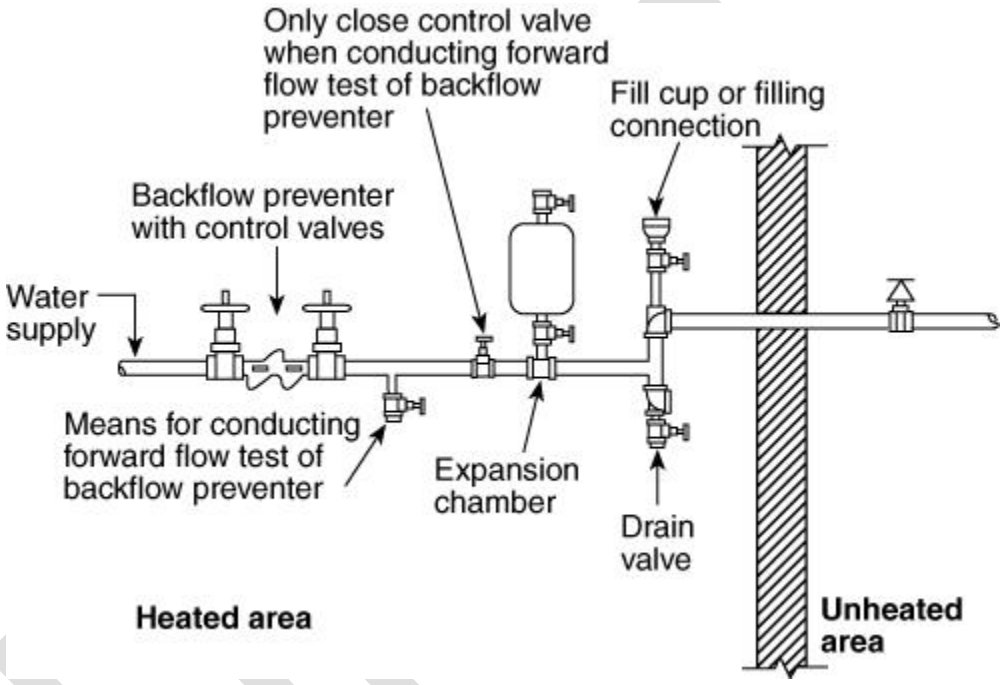
8.6.3.2*

Where the connection between the antifreeze system and the supply piping incorporates a backflow prevention device, and the conditions of 8.6.3.5 are not met, piping and valves shall be installed as illustrated in Figure 8.6.3.3 or Figure 8.6.3.4.

8.6.3.2.1
A means shall be provided to perform a full forward flow test in accordance with 16.14.5.

8.6.3.3*
Where the connection between the antifreeze system and the wet pipe system incorporates a backflow prevention device, and the conditions of 8.6.3.5 are not met, a listed expansion chamber shall be provided to compensate for thermal expansion of the antifreeze solution as illustrated in Figure 8.6.3.3.

Figure 8.6.3.3 Arrangement of Supply Piping with Backflow Device.

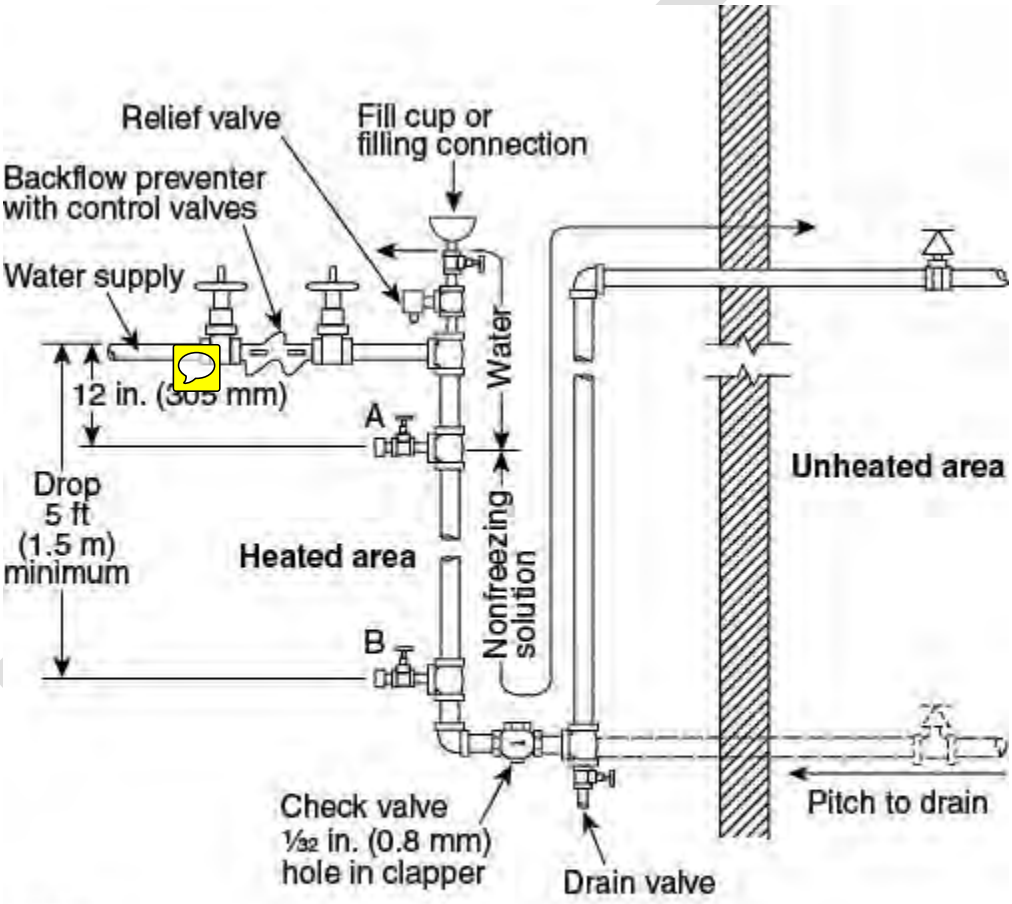


8.6.3.3.1
When determining the size of the expansion chamber, the precharge air temperature and precharge air pressure shall be included.

8.6.3.3.2
The size of the expansion chamber shall be such that the maximum system pressure does not exceed the rated pressure for any components of the antifreeze system.

8.6.3.4
A listed ½ in. (13 mm) relief valve shall be permitted in lieu of the expansion chamber required in **8.6.3.3**, and as illustrated in Figure 8.6.3.4, provided the antifreeze system volume does not exceed 40 gal (150 L).

Figure 8.6.3.4 Arrangement of Supply Piping with Relief Valve and Backflow Device.



Notes:
1. Check valve can be omitted where sprinklers are below the level of valve A.
2. The 1/32 in. (0.8 mm) hole in the check valve clapper is needed to allow for expansion of the solution during a temperature rise, thus preventing damage to sprinklers.

8.6.3.5
The requirements of paragraphs 8.6.3.1, 8.6.3.2, and 8.6.3.3 shall not apply where the following three conditions are met:

(1) The antifreeze system is provided with an automatic pressure pump or other device or apparatus to automatically maintain a higher pressure on the system side than on the supply side of the water supply check valve separating the antifreeze system from the water supply.

(2) Provision is made to automatically release solution to prevent overpressurization due to thermal expansion of the solution.

(3) Provision is made to automatically supply premixed solution as needed to restore system pressure due to thermal contraction.

8.6.3.6*
A drain/test connection shall be installed at the most remote portion of the system.

8.6.3.7
For systems with a capacity larger than 150 gal (570 L), an additional test connection shall be provided for every 100 gal (380 L).

8.7 Outside Sprinklers for Protection Against Exposure Fires (Exposure Protection Sprinkler Systems).

8.7.1 Applications.

8.7.1.1
Exposure protection sprinkler systems shall be permitted on buildings and structures regardless of whether the building's interior is protected by a sprinkler system.

8.7.1.2
Where exposure protection systems are required, they shall be installed to provide protection of windows and other openings within masonry walls, complete protection of walls, protection of roofs, or any combination thereof.

8.7.2 Water Supply and Control.

8.7.2.1
Unless the requirements of 8.7.2.2 are met, sprinklers installed for protection against exposure fires shall be supplied from a standard water supply as outlined in Chapter 24.

8.7.2.2
Where approved, other supplies, such as manual valves or pumps or fire department connections, shall be permitted to supply water to sprinklers for exposure protection.

8.7.2.3
Where fire department connections are used for water supply, they shall be so located that they will not be affected by the exposing fire.

8.7.3 Control.

8.7.3.1
Each system of outside sprinklers shall have an independent control valve.

8.7.3.2
Manually controlled open sprinklers shall be used only where constant supervision is present.

8.7.3.3
Sprinklers shall be of the open or automatic type.

8.7.3.4
Automatic sprinklers in areas subject to freezing shall be on dry pipe systems conforming to Section 8.2 or antifreeze systems conforming to Section 8.6, or be dry sprinklers of an adequate length connected to wet pipe systems located in heated areas.

8.7.3.5

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Automatic systems of open sprinklers shall be controlled by the operation of fire detection devices designed for the specific application.

8.7.4 System Components.

8.7.4.1 Drain Valves.
Each system of outside sprinklers shall have a separate drain valve installed on the system side of each control valve, except where an open sprinkler, top-fed system is arranged to facilitate drainage.

8.7.4.2 Check Valves.

8.7.4.2.1*
Where sprinklers are installed on two adjacent sides of a building, protecting against two separate and distinct exposures, with separate control valves for each side, the end lines shall be connected with check valves located so that one sprinkler around the corner will operate.

8.7.4.2.2
The intermediate pipe between the two check valves shall be arranged to drain.

8.7.4.2.3*
As an alternate solution, an additional sprinkler shall be installed on each system located around the corner from the system involved.

8.7.4.3 System Arrangement.
Where one exposure affects two sides of the protected structure, the system shall not be subdivided between the two sides but rather shall be arranged to operate as a single system.

8.7.5 Pipe and Fittings.
Pipe and fittings installed on the exterior of the building or structure shall be corrosion resistant.

8.7.6 Strainers.
A listed strainer shall be provided in the riser or feed main that supplies sprinklers having nominal K-factors smaller than K-2.8 (40).

8.7.7 Gauge Connections.
An approved pressure gauge conforming to16.13 shall be installed immediately below the control valve of each system.

8.7.8 Sprinklers.

8.7.8.1
A single line of sprinklers is permitted to protect a maximum of two stories of wall area or two levels of vertically aligned windows where architectural features are sufficiently flush to allow rundown.

8.7.8.2
Where window sills or similar features result in recesses or projections exceeding 1 in. (25 mm) in depth, separate sprinklers shall be provided for each window on each level, regardless of whether protection is being provided for windows or complete walls.

8.7.8.3
For wall protection systems, sprinklers shall be located 6 in. to 12 in. (150 mm to 300 mm) from the wall surface and within 6 in. (150 mm) of the top of the wall, with maximum spacing of 8 ft (2.4 m) or as indicated in the sprinkler listing for exposure protection use.

8.7.8.4
For protection of window and similar openings, listed window sprinklers shall be positioned within 2 in. (50 mm) of the top of the window sash in accordance with Table 8.7.8.4.

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Table 8.7.8.4 Position of Window Sprinklers

Width of Window (ft)	Nominal K-Factor		Nominal Distance from Window [in. (mm)]
	U.S.	Metric	
Up to 3	2.8	40	7 (180)
>3 to 4	2.8	40	8 (205)
>4 to 5	2.8	40	9 (230)
	5.6	80	12 (305)
>5 to 7	11.2	160	12 (305)
	Two 2.8	40	7 (180)
>7 to 9.5	14.0	200	12 (305)
	Two 2.8	40	9 (230)
>9.5 to 12	Two 5.6	80	12 (305)

For SI units, 1 ft = 0.3048 m.

8.7.8.5
Where exposure protection sprinkler systems are installed, listed cornice sprinklers shall be used to protect combustible cornices exceeding 12 in. (300 mm) in depth.

8.7.8.5.1
Cornice sprinklers shall be installed in each bay formed by cornice features and shall be spaced up to a maximum distance of 10 ft (3.0 m) apart, with deflectors 8 in. (200 mm) below the underside of the roof sheathing.

8.7.8.6
Open spray sprinklers (upright, pendent, or sidewall) shall be permitted for application in roof protection when installed in accordance with ordinary hazard Group 1 protection areas and discharge criteria, with deflectors aligned parallel to the slope and positioned a minimum 18 in. (450 mm) above the roof surface.

8.7.8.6.1
Upright sprinklers positioned as ridge pole sprinklers shall be permitted with their deflectors horizontal and minimum 6 in. (150 mm) above the ridge, with their maximum spacing and protection areas determined in the plan view rather than along the slope.

8.7.9* Exposure Protection Sprinkler Systems.

8.7.9.1
Exposure protection sprinkler systems shall be hydraulically calculated using Table 8.7.9.1 based on severity of exposure as indicated by a relative classification of guide number or other approved source.

Table 8.7.9.1 Exposure Protection

Section A — Wall and Window Sprinklers						
Exposure Severity	Guide Number	Level of Wall or Window Sprinklers	Minimum Nominal K-Factor	Discharge Coefficient (K-Factor)	Minimum Average Application Rate Over Protected Surface	
					gpm/ft^2	mm/min
Light	1.50 or less	Top 2 levels	2.8 (40)	2.8 (40)	0.20	8.1

Section A — Wall and Window Sprinklers						
Exposure Severity	Guide Number	Level of Wall or Window Sprinklers	Minimum Nominal K-Factor	Discharge Coefficient (K-Factor)	Minimum Average Application Rate Over Protected Surface	
					gpm/ft^2	mm/min
Moderate	1.5–2.20	Next lower 2 levels	1.9 (27)	1.9 (27)	0.15	6.1
		Next lower 2 levels	1.4 (20)	1.4 (20)	0.10	4.1
		Top 2 levels	5.6 (80)	5.6 (80)	0.30	12.2
		Next lower 2 levels	4.2 (60)	4.2 (60)	0.25	10.2
		Next lower 2 levels	2.8 (40)	2.8 (40)	0.20	8.1
Severe	>2.20	Top 2 levels	11.2 (161)	11.2 (161)	0.40	16.3
		Next lower 2 levels	8.0 (115)	8.0 (115)	0.35	14.3
		Next lower 2 levels	5.6 (80)	5.6 (80)	0.30	12.2

Section B — Cornice Sprinklers			
Guide Number	Cornice Sprinkler Minimal Nominal K-Factor	Application Rate per Lineal Foot (gpm)	Application Rate per Lineal Meter (L/min)
1.50 or less	2.8 (40)	0.75	9.3
>1.51–2.20	5.6 (80)	1.50	18.6
>2.20	11.2 (161)	3.00	37.3

8.7.9.2
In no case shall compliance with Table 8.7.9.1 result in a sprinkler discharge pressure below 7 psi (0.5 bar).

8.7.9.3
Only half of the flow from upright, pendent, and other nondirectional sprinklers shall be used in determining the minimum average application rate over the protected surface.

8.7.9.4
The water supply shall be capable of simultaneously supplying the total demand of sprinklers along an exposure to a maximum length of 300 ft (90 m). Where systems of open sprinklers are used, the water supply shall be capable of simultaneously flowing all sprinklers that would flow as part of all systems that could be actuated within any 300 ft (90 m) length.

8.7.9.5
The water supply duration for an exposure protection sprinkler system shall be a minimum of 60 minutes.

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8.7.9.6
A level of window sprinklers as described in Table 8.7.9.1 shall be defined as a floor level of the building being protected.

8.7.9.7
Window sprinklers shall be permitted to cover more than 25 ft^2 (2.3 m^2) of window area per level.

8.7.9.7.1
The starting pressure shall be calculated based on the application rate over 25 ft^2 (2.3 m^2) of window area as indicated in Table 8.7.9.1.

8.7.9.7.2
The maximum spacing between window sprinklers shall not exceed 8 ft (2.4 m) unless listed for a greater distance.

8.8* Refrigerated Spaces.

8.8.1 Spaces Maintained at Temperatures Above 32°F (0°C).
Where temperatures are maintained above 32°F (0°C) in refrigerated spaces, the requirements in this section shall not apply.

8.8.2* Spaces Maintained at Temperatures Below 32°F (0°C).

8.8.2.1 General.

8.8.2.1.1*
Where sprinkler pipe passes through a wall or floor into the refrigerated space, a section of pipe arranged for removal shall be provided immediately inside the space.

8.8.2.1.2
The removable length of pipe required in 8.8.2.1.1 shall be a minimum of 30 in. (750 mm).

8.8.2.2 Low Air Pressure Alarm.

8.8.2.2.1
Unless the requirements of 8.8.2.2.2 are met, a low air pressure alarm to a constantly attended location shall be installed.

8.8.2.2.2
Systems equipped with local low pressure alarms and an automatic air maintenance device shall not be required to alarm to a constantly attended location.

8.8.2.3 Piping Pitch.
Piping in refrigerated spaces shall be installed with pitch as outlined in 16.10.3.3.

8.8.2.4* Air or Nitrogen Supply.
Air or nitrogen supply for systems shall be one of the following:
(1) Air from the room of lowest temperature to reduce the moisture content

(2) Air compressor/dryer package listed for the application utilizing ambient air

(3) Compressed nitrogen gas from cylinders used in lieu of compressed air

8.8.2.5* Control Valve.
An indicating-type control valve for operational testing of the system shall be provided on each sprinkler riser outside of the refrigerated space.

8.8.2.6* Check Valve.

8.8.2.6.1
Unless the requirements of 8.8.2.6.2 are met, a check valve with a 3⁄32 in. (2.4 mm) diameter hole in the clapper shall be installed in the system riser below the test valve required in 8.8.2.5.

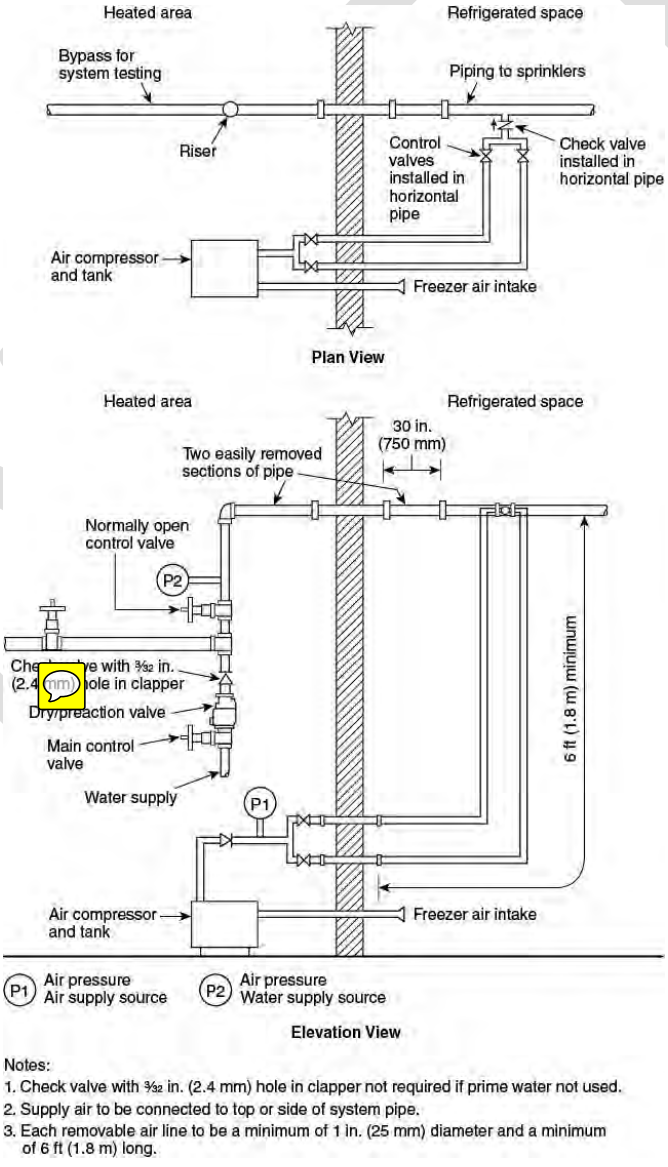
8.8.2.6.2
Check valves shall not be required where dry pipe or preaction valves are used and designed to completely drain all water above the seat and that are listed for installation without priming water remaining and where priming water is not used in the system riser.

8.8.2.7 Air or Nitrogen Supply Piping.

8.8.2.7.1*
The air or nitrogen supply piping entering the freezer area shall be as stated in 8.8.2.7.1.1 and 8.8.2.7.1.2.

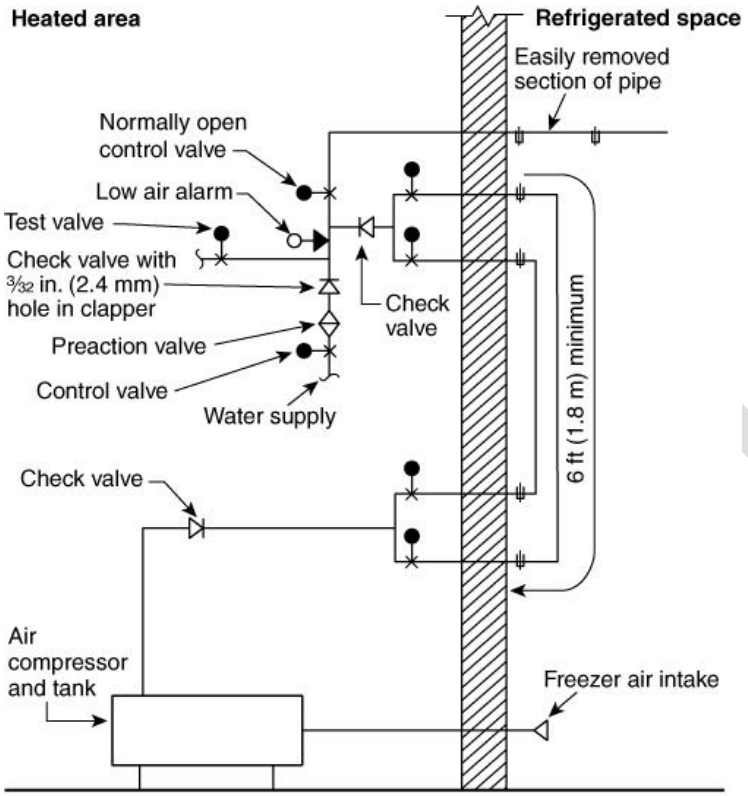
8.8.2.7.1.1 Air Supply.
The supply piping shall be equipped with two easily removable supply lines at least 6 ft (1.8 m) long and at least 1 in. (25 mm) in diameter as shown in Figure 8.8.2.7.1.1(a) or Figure 8.8.2.7.1.1(b).

Figure 8.8.2.7.1.1(a) Refrigerator Area Sprinkler System Used to Minimize the Chances of Developing Ice Plugs.



Notes:
1. Check valve with 3⁄32 in. (2.4 mm) hole in clapper not required if prime water not used.
2. Supply air to be connected to top or side of system pipe.
3. Each removable air line to be a minimum of 1 in. (25 mm) diameter and a minimum of 6 ft (1.8 m) long.

Figure 8.8.2.7.1.1(b) Preaction System Arrangement.



8.8.2.7.1.2 Nitrogen Supply.
The supply piping shall be equipped with a single easily removable supply line at least 6 ft (1.8 m) long and at least 1 in. (25 mm) in diameter.

8.8.2.7.2
Each supply line shall be equipped with control valves located in the warm area.

8.8.2.7.3
Only one air supply line shall be open to supply the system air at any one time.

8.8.2.8 Fire Detection for Preaction Release.

8.8.2.8.1 Detectors for Preaction Systems.

8.8.2.8.1.1*
The release system shall be designed to operate prior to sprinkler operation, unless detectors meet the requirements of 8.8.2.8.1.2.

(A)

Detectors shall be electric or pneumatic fixed temperature type with temperature ratings less than that of the sprinklers.

(B)
Detection devices shall not be rate-of-rise type.

8.8.2.8.1.2
Where the system is a double interlock preaction system or single interlock preaction antifreeze system, detection devices shall be permitted to be any type specifically approved for use in a refrigerated area if installed in accordance with their listing requirements and *NFPA 72*.

8.8.2.8.2 Detector Location at Ceiling.

8.8.2.8.2.1
Under smooth ceilings, detectors shall be spaced not exceeding their listed spacing.

8.8.2.8.2.2
For other than smooth ceilings, detectors shall not exceed one-half of the listed linear detector spacing or full allowable sprinkler spacing, whichever is greater.

8.8.2.8.3 Detector Location in Racks.

8.8.2.8.3.1
Unless conditions in 8.8.2.8.4 are met, one level of detectors shall be installed for each level of sprinklers.

8.8.2.8.3.2
Detectors shall be installed vertically within one storage level of the rack sprinklers and as follows:
(1) Detectors shall be located in the transverse flue in single-row racks and in the longitudinal flue in double-row racks.

(2) For multiple-row racks, detectors shall be located in either longitudinal or transverse flue space and shall be within 5 ft (1.5 m) horizontally of each sprinkler.

(3) Separate detection systems shall be installed for ceiling sprinkler systems and in-rack sprinkler systems.

(4) Where system is double interlock preaction type, ceiling detection system shall operate solenoid valves on both ceiling and in-rack preaction systems.

8.8.2.8.4 Single Detection System for Ceiling and In-Rack Sprinklers.
Ceiling detection only shall be permitted wher of the following conditions are met:
(1) Maximum storage height is 35 ft (10.5 m).

(2) Maximum ceiling height is 40 ft (12.0 m).

(3) Maximum hazard of storage is Class III.

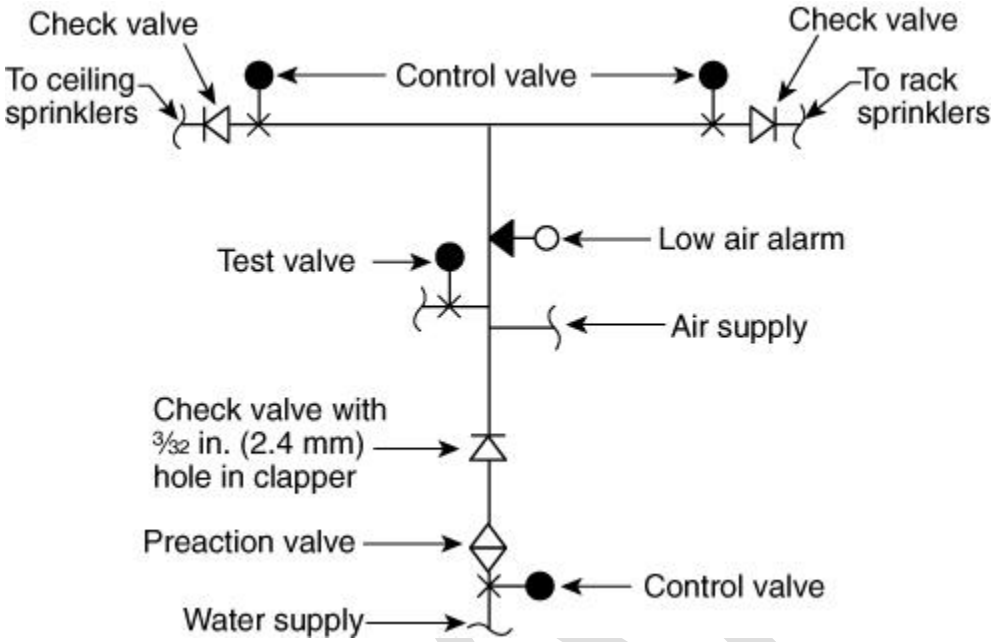
(4) No solid shelves are present.

(5) One preaction valve is used for both ceiling and in-rack sprinklers protecting the same area, with separate indicating control valves and check valves provided downstream as shown in Figure 8.8.2.8.4.

(6) Detectors at the ceiling are spaced at a maximum of one-half the listed detector spacing but not less than the sprinkler spacing.

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Figure 8.8.2.8.4 Valve Arrangement.



8.9 Commercial-Type Cooking Equipment and Ventilation.

8.9.1 General.
In cooking areas protected by automatic sprinklers, additional sprinklers or automatic spray nozzles shall be provided to protect commercial-type cooking equipment and ventilation systems that are designed to carry away grease-laden vapors unless otherwise protected.

8.9.2* Sprinklers and Automatic Spray Nozzles.

8.9.2.1
Unless the requirements of 8.9.2.2 are met, standard sprinklers or automatic spray nozzles shall be so located as to provide for the protection of exhaust ducts, hood exhaust duct collars, and hood exhaust plenum chambers.

8.9.2.2
Sprinklers or automatic spray nozzles in ducts, duct collars, and plenum chambers shall not be required where all cooking equipment is served by listed grease extractors.

8.9.2.3
Unless the requirements of 8.9.2.5 are met, standard sprinklers or automatic spray nozzles shall be so located as to provide for the protection of cooking equipment and cooking surfaces.

8.9.2.4
Hoods containing automatic fire-extinguishing systems are protected areas; therefore, these hoods are not considered obstructions to overhead sprinkler systems and shall not require floor coverage underneath.

8.9.2.5

Cooking equipment below hoods that contain automatic fire-extinguishing equipment is protected and shall not require protection from the overhead sprinkler system.

8.9.3 Sprinkler and Automatic Spray Nozzle Location — Ducts.

8.9.3.1
Unless the requirements of 8.9.3.2 or 8.9.3.4 are met, exhaust ducts shall have one sprinkler or automatic spray nozzle located at the top of each vertical riser and at the midpoint of each offset.

8.9.3.2
Sprinklers or automatic spray nozzles shall not be required in a vertical riser located outside of a building, provided the riser does not expose combustible material or provided the interior of the building and the horizontal distance between the hood outlet and the vertical riser is at least 25 ft (7.6 m).

8.9.3.3
Unless the requirements of 8.9.3.4 are met, horizontal exhaust ducts shall have sprinklers or automatic spray nozzle devices located on 10 ft (3.0 m) centers beginning no more than 5 ft (1.5 m) from the duct entrance.

8.9.3.4
Sprinklers or automatic spray nozzles shall be required in ducts.

8.9.3.4.1
Where ducts do not exceed 75 ft (23 m) in length and the entire exhaust duct is protected in accordance with NFPA 96, sprinkler(s) or automatic spray nozzle(s) shall not be required.

8.9.3.5
A sprinkler(s) or an automatic spray nozzle(s) in exhaust ducts subject to freezing shall be properly protected against freezing by approved means. *(See 16.4.1.)*

8.9.4 Sprinkler and Automatic Spray Nozzle Location — Duct Collar.

8.9.4.1
Each hood exhaust duct collar shall have one sprinkler or automatic spray nozzle located 1 in. minimum to 12 in. maximum (25 mm minimum to 300 mm maximum) above the point of duct collar connection in the hood plenum.

8.9.4.2
Hoods that have listed fire dampers located in the duct collar shall be protected with a sprinkler or automatic spray nozzle located on the discharge side of the damper and shall be so positioned as not to interfere with damper operation.

8.9.5 Sprinkler and Automatic Spray Nozzle Location — Exhaust Plenum Chambers.

8.9.5.1
Hood exhaust plenum chambers shall have one sprinkler or automatic spray nozzle centered in each chamber not exceeding 10 ft (3.0 m) in length.

8.9.5.2
Plenum chambers greater than 10 ft (3.0 m) in length shall have two sprinklers or automatic spray nozzles evenly spaced, with the maximum distance between the two sprinklers not to exceed 10 ft (3.0 m).

8.9.6 Sprinkler and Automatic Spray Nozzle Temperature Ratings and K-Factors.

8.9.6.1
Where the exposed temperature is expected to be 300°F (149°C) or less, sprinklers or automatic spray nozzles being used in duct, duct collar, and plenum areas shall be of the extra high–temperature classification [325°F to 375°F (163°C to 191°C)].

8.9.6.2
When use of a temperature-measuring device indicates temperatures above 300°F (149°C), a sprinkler or automatic spray nozzle of higher classification shall be used.

8.9.6.3
Sprinklers or automatic spray nozzles being used in duct, duct collar, and plenum areas shall have orifices with K-factors not less than K-1.4 (20) and not more than K-5.6 (80).

8.9.7 Sprinkler and Automatic Spray Nozzle.
Access shall be provided to all sprinklers or automatic spray nozzles for examination and replacement.

8.9.8 Cooking Equipment.

8.9.8.1 General.
Cooking equipment (such as deep fat fryers, ranges, griddles, and broilers) that is considered to be a source of ignition shall be protected in accordance with the provisions of 8.9.1.

8.9.8.2 Deep Fat Fryers.

8.9.8.2.1
A sprinkler or automatic spray nozzle used for protection of deep fat fryers shall be listed for that application.

8.9.8.2.2
The position, arrangement, location, and water supply for each sprinkler or automatic spray nozzle shall be in accordance with its listing.

8.9.8.3 Fuel and Heat Shutoff.

8.9.8.3.1
The operation of any cooking equipment sprinkler or automatic spray nozzle shall automatically shut off all sources of fuel and heat to all equipment requiring protection.

8.9.8.3.2
Any gas appliance not requiring protection but located under ventilating equipment shall also be shut off.

8.9.8.3.3
All shutdown devices shall be of the type that requires manual resetting prior to fuel or power being restored.

8.9.9 Indicating Valves.
A listed indicating valve shall be installed in the water supply line to the sprinklers and spray nozzles protecting the cooking and ventilating system.

8.9.10 Strainers.
A listed line strainer shall be installed in the main water supply preceding sprinklers or automatic spray nozzles having nominal K-factors smaller than K-2.8 (40).

8.9.11 Test Connection.
A system test connection shall be provided to verify proper operation of equipment specified in 8.9.8.3.

8.10 Pilot Line Detectors.

8.10.1
Pilot line detectors and related components including pipe and fittings shall be corrosion resistant when installed in areas exposed to weather or corrosive conditions.

8.10.2
Where subject to mechanical or physical damage, pilot line detectors and related detection system components shall be protected.

8.10.3
Where spray sprinklers are used as pilot line detectors, they shall be installed in accordance with Section **8.10** and the spacing and location rules of Section **10.2**, except that the obstruction to water distribution rules for automatic sprinklers shall not be required to be followed.

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Where located under a ceiling, pilot sprinklers shall be positioned in accordance with the requirements of Section 10.2.

8.10.4
The temperature rating of spray sprinklers utilized as pilot line detectors shall be selected in accordance with 9.4.2.

8.10.5
Maximum horizontal spacing for indoor locations shall not exceed 12 ft (3.7 m).

8.10.6
Pilot line detectors shall be permitted to be spaced more than 22 in. (550 mm) below a ceiling or deck where the maximum spacing between pilot line detectors is 10 ft (3.0 m) or less.

8.10.6.1
Other maximum horizontal spacing differing from those required in 8.10.5 shall be permitted where installed in accordance with their listing.

8.10.7
Pilot line detectors located outdoors, such as in open process structures, shall be spaced such that the elevation of a single level of pilot line detectors and between additional levels of pilot line detectors shall not exceed 17 ft (5.2 m).

8.10.8
The maximum distance between pilot line detectors installed outdoors shall not exceed 8 ft (2.4 m).

8.10.8.1
The horizontal distance between pilot line detectors installed outdoors on a given level shall be permitted to be increased to 10 ft (3.0 m) when all of the following conditions are met:
(1) The elevation of the first level does not exceed 15 ft (4.6 m).

(2) The distance between additional levels does not exceed 12 ft (3.7 m).

(3) The pilot line actuators are staggered vertically.

8.10.8.2
Alternate vertical spacing of pilot line detectors differing from those required in 8.10.8.1 shall be permitted where installed in accordance with their listing.

8.10.9
Pilot line detectors located in open-sided buildings shall follow the indoor spacing rules.

8.10.9.1
A row of pilot line detectors spaced in accordance with the outdoor pilot line detector spacing rules shall be located along the open sides of open-sided buildings.

8.10.9.2
Pilot line detectors located under open gratings shall be spaced in accordance with the outdoor rules.

8.10.9.3
Where two or more adjacent water spray systems in one fire area are controlled by separate pilot line detector systems, the detectors on each system shall be spaced independently as if the dividing line between the systems were a wall or draft curtain.

8.10.9.4
Where pilot line detectors are installed in water cooling tower applications, they shall be in accordance with Section 26.21.

8.10.10
Pipe supplying pilot line detectors shall be permitted to be supported from the same points of hanger attachment as the piping system it serves.

8.10.10.1
Pipe supplying pilot line detectors shall not be required to meet the requirements of 18.5.

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Chapter 9 Sprinkler Location Requirements

9.1* Basic Requirements.

9.1.1*
The requirements for spacing, location, and position of sprinklers shall be based on the following principles:
(1) Sprinklers shall be installed throughout the premises.

(2) Sprinklers shall be located so as not to exceed the maximum protection area per sprinkler.

(3) *Sprinklers shall be positioned and located so as to provide satisfactory performance with respect to activation time and distribution.

(4) Sprinklers shall be permitted to be omitted from areas specifically allowed by this standard.

(5) When sprinklers are specifically tested and test results demonstrate that deviations from clearance requirements to structural members do not impair the ability of the sprinkler to control or suppress a fire, their positioning and locating in accordance with the test results shall be permitted.

(6) Clearance between sprinklers and ceilings exceeding the maximums specified in this standard shall be permitted, provided that tests or calculations demonstrate comparable sensitivity and performance of the sprinklers to those installed in conformance with these sections.

9.2 Allowable Sprinkler Omission Locations.

9.2.1* Concealed Spaces Not Requiring Sprinkler Protection.

9.2.1.1*
Concealed spaces of noncombustible and limited-combustible construction with minimal combustible loading having no access shall not require sprinkler protection.

9.2.1.1.1
The space shall be considered a concealed space even with small openings such as those used as return air for a plenum.

9.2.1.1.2
Small openings with both of the following limits shall be permitted:
(1) A combined total area of not more than 20 percent of the ceiling, construction feature, or plane shall be used to determine the boundaries of the concealed space.

(2) Gaps greater than 4 ft (1.2 m) long shall not be more than 8 in. (200 mm) wide.

9.2.1.1.3
The space above cloud ceilings meeting the requirements in 9.2.7.1 and having openings with a combined total area of not more than 20 percent of the ceiling, construction feature, or plane used to determine the boundaries of the concealed space shall be permitted.

9.2.1.2
Concealed spaces of noncombustible and limited-combustible construction with limited access and not permitting occupancy or storage of combustibles shall not require sprinkler protection.

9.2.1.2.1
The space shall be considered a concealed space even with small openings such as those used as return air for a plenum.

9.2.1.3
Concealed spaces formed by studs or joists with less than 6 in. (150 mm) between the inside or near edges of the studs or joists shall not require sprinkler protection. *(See Figure 10.2.6.1.5.1.)*

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9.2.1.4
Concealed spaces formed by bar joists with less than 6 in. (150 mm) between the roof or floor deck and ceiling shall not require sprinkler protection.

9.2.1.5*
Concealed spaces formed by ceilings attached directly to or within 6 in. (150 mm) of wood joist or similar solid member construction shall not require sprinkler protection.

9.2.1.6*
Concealed spaces formed by ceilings attached to composite wood joist construction either directly or onto metal channels not exceeding 1 in. (25 mm) in depth, provided the joist channels as measured from the top of the batt insulation are separated into volumes each not exceeding 160 ft^3 (4.5 m^3) using materials equivalent to the web construction and at least 3½ in. (90 mm) of batt insulation is installed at the bottom of the joist channels when the ceiling is attached utilizing metal channels, shall not require sprinkler protection.

9.2.1.7
Concealed spaces filled with noncombustible insulation shall not require sprinkler protection.

9.2.1.7.1
A maximum 2 in. (50 mm) air gap at the top of the space shall be permitted.

9.2.1.8
Concealed spaces within wood joist construction having noncombustible insulation filling the space from the ceiling up to the bottom edge of the joist of the roof or floor deck shall not require sprinkler protection.

9.2.1.9
Concealed spaces within composite wood joist construction having noncombustible insulation filling the space from the ceiling up to the bottom edge of the composite wood joist of the roof or floor deck and with the joist channels separated into volumes each not exceeding 160 ft^3 (4.5 m^3) to the full depth of the composite wood joist, with material equivalent to the web construction, shall not require sprinkler protection.

9.2.1.10
Concealed spaces over isolated small compartments not exceeding 55 ft^2 (5.1 m^2) in area shall not require sprinkler protection.

9.2.1.11
Concealed spaces where rigid materials are used and the exposed surfaces, in the form in which they are installed, comply with one of the following shall not require sprinkler protection:
(1) The surface materials have a flame spread index of 25 or less, and the materials have been demonstrated not to propagate fire more than 10.5 ft (3.2 m) when tested in accordance with ASTM E84, *Standard Test Method of Surface Burning Characteristics of Building Materials*, or UL 723, *Standard for Test for Surface Burning Characteristics of Building Materials*, extended for an additional 20 minutes.

(2) The surface materials comply with the requirements of ASTM E2768, *Standard Test Method for Extended Duration Surface Burning Characteristics of Building Materials (30 min Tunnel Test)*.

9.2.1.12*
Concealed spaces in which the exposed materials are constructed entirely of fire retardant–treated wood as defined by NFPA 703 shall not require sprinkler protection.

9.2.1.13
Noncombustible concealed spaces having exposed combustible insulation where the heat content of the facing and substrate of the insulation material does not exceed 1000 Btu/ft^2 (11,400 kJ/m^2) shall not require sprinkler protection.

9.2.1.14
Concealed spaces below insulation that is laid directly on top of or within wood joists or composite wood joists used as ceiling joists in an otherwise sprinklered concealed space, with the ceiling attached directly to the bottom of the joists, shall not require sprinkler protection.

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9.2.1.15
Vertical pipe chases under 10 ft^2 (0.9 m^2) that are firestopped at each floor using materials equivalent to the floor construction, and where such pipe chases shall contain no sources of ignition, piping shall be water-filled , limited combustible or noncombustible, and pipe penetrations at each floor shall be properly sealed and shall not require sprinkler protection.

9.2.1.16
Exterior columns under 10 ft^2 (0.9 m^2) in area, formed by studs or wood joist supporting exterior canopies that are fully protected with a sprinkler system, shall not require sprinkler protection.

9.2.1.17*
Concealed spaces formed by noncombustible or limited-combustible ceilings suspended from the bottom of wood joists, composite wood joists, wood bar joists, or wood trusses that have insulation filling all of the gaps between the bottom of the trusses or joists, and where sprinklers are present in the space above the insulation within the trusses or joists, shall not require sprinkler protection.

9.2.1.17.1
The heat content of the facing, substrate, and support of the insulation material shall not exceed 1000 Btu/ft^2 (11,400 kJ/m^2).

9.2.1.18*
Concealed spaces formed by noncombustible or limited-combustible ceilings suspended from the bottom of wood joists and composite wood joists with a maximum nominal chord width of 2 in. (50 mm), where joist spaces are full of noncombustible batt insulation with a maximum 2 in. (50 mm) air space between the decking material and the top of the batt insulation shall not require sprinklers.

9.2.1.18.1
Facing that meets the requirements for noncombustible or limited-combustible material covering the surface of the bottom chord of each joist and secured in place per the manufacturer's recommendations shall not require sprinklers.

9.2.1.19 Exterior Soffits, Eaves, Overhangs, and Decorative Frame Elements.

9.2.1.19.1
Sprinklers shall be permitted to be omitted from within combustible soffits, eaves, overhangs, and decorative frame elements that are constructed in accordance with 9.2.1.19.2 through 9.2.1.19.5.

9.2.1.19.2
Combustible soffits, eaves, overhangs, and decorative frame elements shall not exceed 4 ft 0 in. (1.2 m) in width.

9.2.1.19.3
Combustible soffits, eaves, overhangs, and decorative frame elements shall be draftstopped, with a material equivalent to that of the soffit, into volumes not exceeding 160 ft^3 (4.5 m^3).

9.2.1.19.4
Combustible soffits, eaves, overhangs, and decorative frame elements shall be separated from the interior of the building by walls or roofs of noncombustible or limited-combustible construction.

9.2.1.19.5
Combustible soffits, eaves, overhangs, and decorative frame elements shall have no openings or unprotected penetrations directly into the building.

9.2.2 Spaces Under Ground Floors, Exterior Docks, and Platforms.
Sprinklers shall be permitted to be omitted from spaces under ground floors, exterior docks, and platforms where all of the following conditions exist:
(1) The space is not accessible for storage purposes and is protected against accumulation of wind-borne debris.

(2) The space contains no equipment such as conveyors or fuel-fired heating units.

(3) The floor over the space is of tight construction.

(4) No combustible or flammable liquids or materials that under fire conditions would convert into combustible or flammable liquids are processed, handled, or stored on the floor above the space.

9.2.3 Exterior Projections.

9.2.3.1
Sprinklers shall be permitted to be omitted where the exterior canopies, roofs, porte-cocheres, balconies, decks, and similar projections are constructed with materials that are noncombustible, limited-combustible, or fire retardant–treated wood as defined in NFPA 703, or where the projections are constructed utilizing a noncombustible frame, limited-combustibles, or fire retardant–treated wood with an inherently flame-resistant fabric overlay as demonstrated by Test Method 2 in accordance with NFPA 701.

9.2.3.2
Sprinklers shall be permitted to be omitted from below the exterior projections of combustible construction, provided the exposed finish material on the exterior projections are noncombustible, limited-combustible, or fire retardant–treated wood as defined in NFPA 703, and the exterior projections contain only sprinklered concealed spaces or any of the following unsprinklered combustible concealed spaces:
(1) Combustible concealed spaces filled entirely with noncombustible insulation

(2) Light or ordinary hazard occupancies where noncombustible or limited-combustible ceilings are directly attached to the bottom of solid wood joists so as to create enclosed joist spaces 160 ft^3 (4.5 m^3) or less in volume, including space below insulation that is laid directly on top or within the ceiling joists in an otherwise sprinklered attic *[see 19.3.3.1.4(4)(d)]*

(3) Concealed spaces over isolated small exterior projections not exceeding 55 ft^2 (5.1 m^2) in area

9.2.3.3
Sprinklers shall be permitted to be omitted from an exterior exit corridorwhere the exterior wall of the corridor is at least 50 percent open and where the corridor is entirely of noncombustible construction.

9.2.4 Dwelling Units.

9.2.4.1 Bathrooms.

9.2.4.1.1*
Unless sprinklers are required by 9.2.4.1.2 or 9.2.4.1.3, sprinklers shall not be required in bathrooms that are located within dwelling units, that do not exceed 55 ft^2 (5.1 m^2) in area, and that have walls and ceilings of noncombustible or limited-combustible materials with a 15-minute thermal barrier rating, including the walls and ceilings behind any shower enclosure or tub.

9.2.4.1.2
Sprinklers shall be required in bathrooms of limited care facilities and nursing homes, as defined in NFPA *101*.

9.2.4.1.3
Sprinklers shall be required in bathrooms opening directly onto public corridors or exitways.

9.2.4.2* Closets and Pantries.
Sprinklers are not required in clothes closets, linen closets, and pantries within dwelling units in hotels and motels where the area of the space does not exceed 24 ft^2 (2.2 m^2) and the walls and ceilings are surfaced with noncombustible or limited-combustible materials.

9.2.5* Hospital Clothes Closets.
Sprinklers shall not be required in clothes closets of patient sleeping rooms in hospitals where the area of the closet does not exceed 6 ft^2 (0.5 m^2), provided the distance from the sprinkler in the patient sleeping room to the back wall of the closet does not exceed the maximum distance permitted by 9.5.3.2.

9.2.6
Sprinklers shall not be required in electrical equipment rooms where all of the following conditions are met:

(1) The room is dedicated to electrical equipment only.

(2) Only dry-type electrical equipment is used.

(3) Equipment is installed in a 2-hour fire-rated enclosure including protection for penetrations.

(4) No storage is permitted to be stored in the room.

9.2.7 Cloud Ceilings.

9.2.7.1*
Sprinklers shall be permitted to be omitted above cloud ceilings where all of the following apply:
(1) *The combined total area of the openings around the cloud are less than or equal to 20 percent of the area of the ceiling, construction feature, or plane used to determine the boundaries of the compartment.

(2) The width of the gap and the maximum sprinkler protection area shall meet Table 9.2.7.1.

(3) The requirements of 9.2.7.2 are met.

Table 9.2.7.1 Maximum Sprinkler Protection Area Based on Ceiling Cloud Width and Opening Width

Ceiling Cloud — Minimum Width Dimension (ft)	Maximum Area (ft^2) — Opening Width ≤0.5 in./ ft of Ceiling Height	Maximum Area (ft^2) — Opening Width ≤0.75 in./ ft of Ceiling Height	Maximum Area (ft^2) — Opening Width ≤1 in./ ft of Ceiling Height
2–<2.5	175	70	NP
2.5–4	225	120	70
>4	225	150	150

9.2.7.2
When sprinklers are omitted from above a cloud ceiling in accordance with 9.2.7.1, the requirements of this section shall apply.

9.2.7.2.1
All sprinklers shall be quick response standard spray or extended coverage pendent or upright sprinklers.

9.2.7.2.2
Maximum cloud ceiling height shall not exceed 20 ft (6.1 m).

9.2.7.2.3
Maximum spacing and area of protection shall not exceed the maximum requirements of Table 10.2.4.2.1(a) for light hazard and Table 10.2.4.2.1(b) for ordinary hazard.

9.2.7.2.3.1
Where extended coverage sprinklers are used, the maximum distance between sprinklers shall not exceed 16 ft (4.9 m).

9.2.7.2.4
Cloud ceilings shall be of smooth ceiling construction.

9.2.7.2.5*
For irregular shaped ceiling clouds (not rectangular) the minimum width dimension shall be the smallest width dimension of the cloud and for the gap shall be the greatest dimension between clouds or adjacent walls as applicable.

9.2.8 Revolving Doors Enclosures.
Sprinkler protection shall not be required within revolving door enclosures.

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Sprinklers shall not be required to be installed in furniture such as portable wardrobe units, cabinets, trophy cases, and similar items not intended for occupancy. This type of feature shall be permitted to be attached to the finished structure.

9.2.10* Equipment Enclosures.
Sprinklers shall not be required to be installed within electrical equipment, mechanical equipment, or air handling units not intended for occupancy.

9.2.11 Noncombustible Vertical Shafts.
Sprinklers shall not be required at the top of noncombustible or limited-combustible, nonaccessible vertical duct, electric, and mechanical shafts as permitted by 9.3.3.1.1 and 9.3.3.1.2.

9.2.12 Noncombustible Stairways.

9.2.12.1
Sprinklers shall not be required at the bottom of stairwells complying with the provisions of 9.3.4.2.3.1.

9.2.12.2
Sprinklers shall not be required for exterior stair towers complying with the provisions of 9.3.4.2.4.

9.2.13 Elevator Hoistways and Machine Rooms.
Sprinklers shall not be required in locations complying with 9.3.6.2, 9.3.6.3, or 9.3.6.6.

9.2.14 Duct Protection.
Sprinklers shall not be required in vertical duct risers complying with 9.3.9.1.2.

9.2.15 Open-Grid Ceilings.
Sprinklers shall not be required below open grid ceiling installations complying with 9.3.10.

9.2.16 Drop-Out Ceilings.
Sprinklers shall not be required below drop-out ceilings complying with 9.3.11.

9.2.17 Skylights.
Sprinklers shall not be required in skylights complying with 9.3.16.

9.3 Special Situations.

9.3.1 Heat-Producing Devices with Composite Wood Joist Construction.
Where heat-producing devices such as furnaces or process equipment are located in the joist channels above a ceiling attached directly to the underside of composite wood joist construction that would not otherwise require sprinkler protection of the spaces, the joist channel containing the heat-producing devices shall be sprinklered by installing sprinklers in each joist channel, on each side, adjacent to the heat-producing device.

9.3.2
Unless the requirements of 9.2.1.18 are met, sprinklers used in horizontal combustible concealed spaces (with a slope not exceeding 2 in 12) with combustible wood truss, wood joist construction, or bar joist construction having a combustible upper surface and where the depth of the space is less than 36 in. (900 mm) from deck to deck, from deck to ceiling, or with double wood joist construction with a maximum of 36 in. (900 mm) between the top of the bottom joist and the bottom of the upper joist shall be listed for such use.

9.3.2.1
Sprinklers specifically listed to provide protection of combustible concealed spaces described in 9.3.2 shall be permitted to be used in accordance with 9.4.1.2 where the space is less than 12 in. (300 mm) from deck to deck or deck to ceiling.

9.3.2.2
Sprinklers specifically listed to provide protection of combustible concealed spaces described in 9.3.2 shall be permitted to be used in accordance with 9.4.1.2 throughout the area when a portion of the area exceeds a depth of 36 in. (900 mm).

9.3.2.3

Sprinklers specifically listed to provide protection of combustible concealed spaces described in 9.3.2 shall be permitted to be used in accordance with 9.4.1.2 to protect composite wood joist construction.

9.3.3 Vertical Shafts.

9.3.3.1 General.
Unless the requirements of 9.3.3.1.1 or 9.3.3.1.2 are met, one sprinkler shall be installed at the top of shafts.

9.3.3.1.1
Noncombustible or limited-combustible, nonaccessible vertical duct shafts shall not require sprinkler protection.

9.3.3.1.2
Noncombustible or limited-combustible, nonaccessible vertical electrical or mechanical shafts shall not require sprinkler protection.

9.3.3.2* Shafts with Combustible Surfaces.

9.3.3.2.1
Where vertical shafts have combustible surfaces, one sprinkler shall be installed at each alternate floor level.

9.3.3.2.2
Where a shaft having combustible surfaces is trapped, an additional sprinkler shall be installed at the top of each trapped section.

9.3.3.3 Accessible Shafts with Noncombustible Surfaces.
Where accessible vertical shafts have noncombustible surfaces, one sprinkler shall be installed near the bottom.

9.3.4 Stairways.

9.3.4.1 Combustible Construction.
Sprinklers shall be installed beneath all stairways of combustible construction.

9.3.4.1.1
Sprinklers shall be installed at the top of combustible stair shafts.

9.3.4.1.2*
Sprinklers shall be installed under the landings at each floor level.

9.3.4.1.3
Sprinklers shall be installed beneath the lowest intermediate landing.

9.3.4.2 Noncombustible Construction.

9.3.4.2.1
In noncombustible stair shafts having noncombustible stairs with noncombustible or limited-combustible finishes, sprinklers shall be installed at the top of the shaft and under the first accessible landing above the bottom of the shaft.

9.3.4.2.2
Where noncombustible stair shafts are divided by walls or doors, sprinklers shall be provided on each side of the separation.

9.3.4.2.3
Sprinklers shall be installed beneath landings or stairways where the area beneath is used for storage.

9.3.4.2.3.1
Sprinklers shall be permitted to be omitted from the bottom of the stairwell when the space under the stairs at the bottom is blocked off so that storage cannot occur.

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9.3.4.2.4
Sprinklers shall be permitted to be omitted from exterior stair towers when the exterior walls of the stair tower are at least 50 percent open and when the stair tower is entirely of noncombustible construction.

9.3.4.3* Stairs Serving Two or More Areas.
When stairs have openings to each side of a fire wall(s), sprinklers shall be installed in the stair shaft at each floor landing with multiple openings.

9.3.5* Vertical Openings.

9.3.5.1* General.
Unless the requirements of 9.3.5.4 are met, where moving stairways, staircases, or similar floor openings are unenclosed and where sprinkler protection is serving as the alternative to enclosure of the vertical opening, the floor openings involved shall be protected by closely spaced sprinklers in combination with draft stops in accordance with 9.3.5.2 and 9.3.5.3.

9.3.5.2 Draft Stops.
Draft stops shall meet all of the following criteria:
(1) The draft stops shall be located immediately adjacent to the opening.

(2) The draft stops shall be at least 18 in. (450 mm) deep.

(3) The draft stops shall be of noncombustible or limited-combustible material that will stay in place before and during sprinkler operation.

9.3.5.3 Sprinklers.

9.3.5.3.1
Sprinklers shall be spaced not more than 6 ft (1.8 m) apart and placed 6 in. to 12 in. (150 mm to 300 mm) from the draft stop on the side away from the opening.

9.3.5.3.2
Where sprinklers are closer than 6 ft (1.8 m), cross baffles shall be provided in accordance with 10.2.5.4.2.

9.3.5.4 Large Openings.
Closely spaced sprinklers and draft stops are not required around large openings such as those found in shopping malls, atrium buildings, and similar structures where all adjoining levels and spaces are protected by automatic sprinklers in accordance with this standard and where the openings have all horizontal dimensions between opposite edges of 20 ft (6.1 m) or greater and an area of 1000 ft^2 (95 m^2) or greater.

9.3.6 Elevator Hoistways and Machine Rooms.

9.3.6.1
Automatic fire sprinklers shall not be required in elevator machine rooms, elevator machinery spaces, control spaces, or hoistways of traction elevators installed in accordance with the applicable provisions in NFPA *101*, or the applicable building code, where all of the following conditions are met:
(1) The elevator machine room, machinery space, control room, control space, or hoistway of traction elevator is dedicated to elevator equipment only.

(2) The elevator machine room, machine room, machinery space, control room, or control space of traction elevators is protected by smoke detectors, or other automatic fire detection, installed in accordance with *NFPA 72*.

(3) The elevator machinery space, control room, control space, or hoistway of traction elevators is separated from the remainder of the building by walls and floor/ceiling or roof/ceiling assemblies having a fire resistance rating of not less than that specified by the applicable building code.

(4) No materials unrelated to elevator equipment are permitted to be stored in elevator machine rooms, machinery spaces, control rooms, control spaces, or hoistways of traction elevators.

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(5) The elevator machinery is not of the hydraulic type.

9.3.6.2*
Automatic sprinklers in elevator machine rooms, elevator machinery spaces, or at the tops of hoistways shall be of ordinary- or intermediate-temperature rating.

9.3.6.3*
Upright, pendent, or sidewall spray sprinklers shall be installed at the top of elevator hoistways.

9.3.6.4
The sprinkler required at the top of the elevator hoistway by 9.3.6.3 shall not be required where the hoistway for passenger elevators is noncombustible or limited-combustible and the car enclosure materials meet the requirements of ASME A17.1, *Safety Code for Elevators and Escalators*.

9.3.6.5 Combustible Suspension in Elevators.

9.3.6.5.1
Sprinklers shall be installed at the top and bottom of elevator hoistways where elevators utilize combustible suspension means such as noncircular elastomeric-coated or polyurethane-coated steel belts.

9.3.6.5.2
The sprinklers in the elevator hoistway shall not be required where the suspension means provide not less than an FT-1 rating when tested to the vertical burn test requirements of UL 2556, *Wire and Cable Test Methods* (Tri-national standard, with NMX-J-556-ANCE and CSA 22.2 No. 2556).

9.3.6.5.3
The suspension means shall not continue to burn for more than 60 seconds nor shall the indicator flag be burned more than 25 percent.

9.3.7* Library Stack Areas and Record Storage.
Where books or records are stored in fixed open book shelves, sprinklers shall be installed in accordance with one of the following:
(1) Sprinklers shall be permitted to be installed without regard to aisles where clearance between sprinkler deflectors and tops of stacks is 18 in. (450 mm) or more.

(2) Where the 18 in. (450 mm) clearance between sprinkler deflectors and tops of stacks cannot be maintained, sprinklers shall be installed in every aisle and at every tier of stacks with distance between sprinklers along aisles not to exceed 12 ft (3.7 m) in accordance with Figure 9.3.7(a).

(3) Where the 18 in. (450 mm) clearance between sprinkler deflectors and tops of stacks cannot be maintained and where vertical shelf dividers are incomplete and allow water distribution to adjacent aisles, sprinklers shall be permitted to be omitted in alternate aisles on each tier, and where ventilation openings are also provided in tier floors, sprinklers shall be staggered vertically in accordance with Figure 9.3.7(b).

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Figure 9.3.7(a) Sprinklers in Multitier Bookstacks with Complete Vertical Dividers.

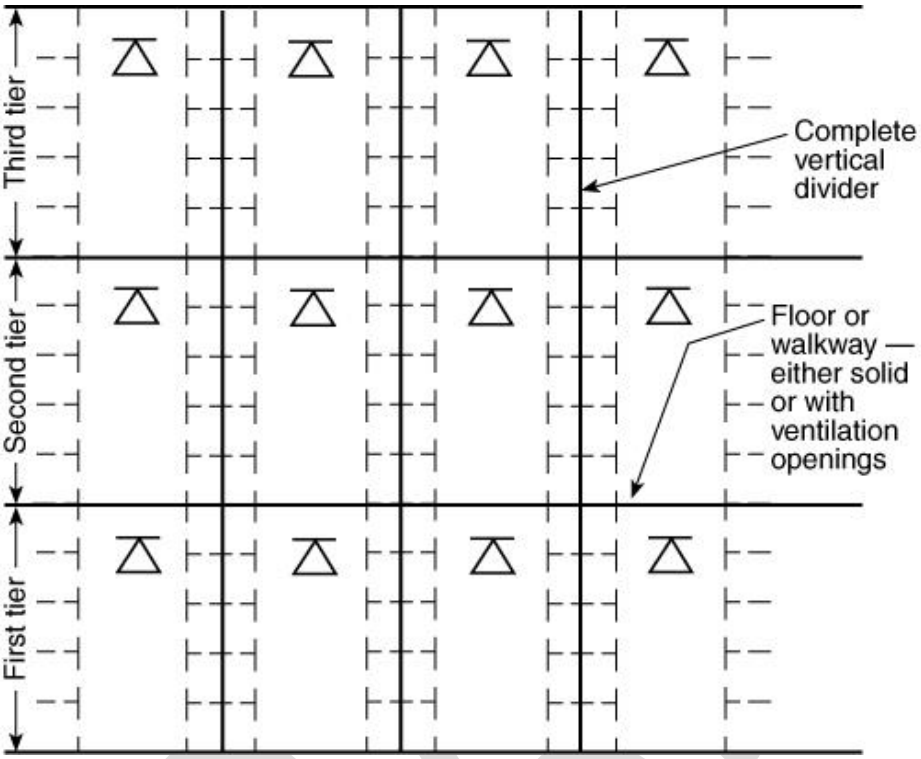
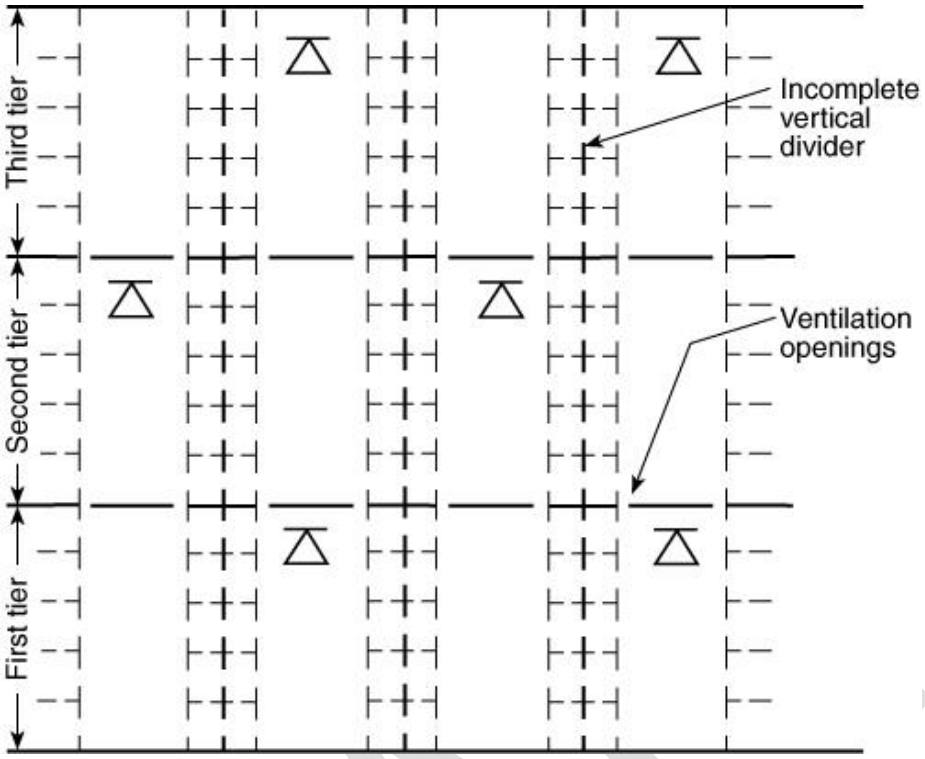


Figure 9.3.7(b) Sprinklers in Multitier Bookstacks with Incomplete Vertical Dividers.



9.3.8* Industrial Ovens and Furnaces.

9.3.9 Duct Protection.
Duct protection shall be required to meet the requirements of 9.3.8 where required by the authority having jurisdiction or the applicable referenced code or standard.

9.3.9.1 Sprinkler Location.

9.3.9.1.1
Unless the requirements of 9.3.9.1.2 or 9.3.9.1.3 are met, ducts shall have one sprinkler located at the top of each vertical riser and at the midpoint of each offset.

9.3.9.1.2
Sprinklers shall not be required in a vertical riser located outside of a building, provided the riser does not expose combustible material or provided the interior of the building and the horizontal distance between the hood outlet and the vertical riser is at least 25 ft (7.6 m).

9.3.9.1.3
Horizontal exhaust ducts shall have sprinklers located on 10 ft (3.0 m) centers beginning no more than 5 ft (1.5 m) from the duct entrance.

9.3.9.2 Protection Against Freezing.
Sprinklers in exhaust ducts subject to freezing shall be properly protected against freezing. *(See 16.4.1.)*

9.3.9.3 Sprinkler Access.
Access shall be provided to all sprinklers for inspection, testing, and maintenance.

9.3.9.4 Strainers.
A listed line strainer shall be installed in the main water supply preceding sprinklers having nominal K-factors smaller than K-2.8 (40).

9.3.10* Open-Grid Ceilings.
Open-grid ceilings shall only be installed beneath sprinklers where one of the following is met:

(1) Open-grid ceilings in which the openings are ¼ in. (6 mm) or larger in the least dimension, where the thickness or depth of the material does not exceed the least dimension of the opening, and where such openings constitute 70 percent of the area of the ceiling material. The spacing of the sprinklers over the open-grid ceiling shall then comply with the following:
(a) In light hazard occupancies where sprinkler spacing (either spray or old-style sprinklers) is less than 10 ft × 10 ft (3 m × 3 m), a minimum clearance of at least 18 in. (450 mm) shall be provided between the sprinkler deflectors and the upper surface of the open-grid ceiling. Where spacing is greater than 10 ft × 10 ft (3 m × 3 m) but less than 10 ft × 12 ft (3 m × 3.7 m), a clearance of at least 24 in. (600 mm) shall be provided from spray sprinklers and at least 36 in. (900 mm) from old-style sprinklers. Where spacing is greater than 10 ft × 12 ft (3 m × 3.7 m), a clearance of at least 48 in. (1.2 m) shall be provided.

(b) In ordinary hazard occupancies, open-grid ceilings shall be permitted to be installed beneath spray sprinklers only. Where sprinkler spacing is less than 10 ft × 10 ft (3 m × 3 m), a minimum clearance of at least 24 in. (600 mm) shall be provided between the sprinkler deflectors and the upper surface of the open-grid ceiling. Where spacing is greater than 10 ft × 10 ft (3 m × 3 m), a clearance of at least 36 in. (900 m) shall be provided.

(2) Other types of open-grid ceilings shall be permitted to be installed beneath sprinklers where they are listed for such service and are installed in accordance with instructions contained in each package of ceiling material.

9.3.11 Drop-Out Ceilings and Ceiling Materials.

9.3.11.1*
Drop-out ceilings and ceiling materials shall be permitted to be installed beneath sprinklers where the ceiling panels or ceiling materials are listed for that service and are installed in accordance with their listings.

9.3.11.2
Drop-out ceilings and ceiling materials meeting the criteria in 9.3.11.1 shall not be installed below quick-response or extended coverage sprinklers unless specifically listed for that application.

9.3.11.3
Drop-out ceilings and ceiling materials meeting the criteria in 9.3.11.1 shall not be considered ceilings within the context of this standard.

9.3.11.4*
Piping installed above drop-out ceilings and ceiling materials meeting the criteria in 9.3.11.1 shall not be considered concealed piping.

9.3.11.5*
Sprinklers shall not be installed beneath drop-out ceilings or ceiling materials meeting the criteria in **9.3.11.1**.

9.3.12*
Old-style sprinklers shall be installed in fur storage vaults.

9.3.13 Stages.

9.3.13.1
Sprinklers shall be installed under the roof at the ceiling, in spaces under the stage either containing combustible materials or constructed of combustible materials, and in all adjacent spaces and dressing rooms, storerooms, and workshops.

9.3.13.2
Where proscenium opening protection is required, a deluge system shall be provided with open sprinklers located not more than 3 ft (900 mm) away from the stage side of the proscenium arch and spaced up to a maximum of 6 ft (1.8 m) on center. *(See Chapter 11 for design criteria.)*

9.3.14 Spaces Above Ceilings.

9.3.14.1
Where spaces have ceilings that are lower than the rest of the area, the space above this lower ceiling shall be sprinklered unless it complies with the rules of 9.2.1 for allowable unsprinklered concealed spaces.

9.3.14.2
Where the space above a drop ceiling is sprinklered, the sprinkler system shall conform to the rules of **19.2.2** and Section 20.10.

9.3.14.3*
Where there is a noncombustible space above a noncombustible or limited-combustible drop ceiling that is sprinklered because it is open to an adjacent sprinklered space and where there is no possibility for storage above the drop ceiling, the sprinkler system shall be permitted to extend only as far into the space as 0.6 times the square root of the design area of the sprinkler system in the adjacent space.

9.3.14.3.1
The sprinkler system shall extend at least 24 ft (7.2 m) into the space above the ceiling.

9.3.15* Sprinkler-Protected Glazing.
Where sprinklers are used in combination with glazing as an alternative to a required fire-rated wall or window assembly, the sprinkler-protected assembly shall comply with the following:
(1) Sprinklers shall be listed as specific application window sprinklers unless the standard spray sprinklers are specifically permitted by the building code.

(2) Sprinklers shall be supplied by a wet-pipe system.

(3) Glazing shall be heat-strengthened, tempered, or glass ceramic and shall be fixed.

(4) Where the assembly is required to be protected from both sides, sprinklers shall be installed on both sides of the glazing.

(5) The use of sprinkler-protected glazing shall be limited to non-load-bearing walls.

(6) The glazed assembly shall not have any horizontal members that would interfere with uniform distribution of water over the surface of the glazing, and there shall be no obstructions between sprinklers and glazing that would obstruct water distribution.

(7) The water supply duration for the design area that includes the window sprinklers shall not be less than the required rating of the assembly

9.3.16 Vestibules.
Sprinkler protection shall not be required within entrance vestibules of noncombustible construction that do not contain combustibles and are 150 ft^2 (13.9 m^2) or less in area.

9.3.17 Skylights.

9.3.17.1
Sprinklers shall be permitted to be omitted from skylights not exceeding 32 ft^2 (3.0 m^2) in area, regardless of hazard classification, that are separated by at least 10 ft (3.0 m) horizontally from any other unprotected skylight or unprotected ceiling pocket.

9.3.17.1.1
When a sprinkler is installed directly beneath a skylight not exceeding 32 ft^2 (3.0 m^2), the distance to the ceiling shall be measured to the plane of the ceiling as if the skylight was not present.

9.3.17.2
Skylights not exceeding 32 ft^2 (3.0 m^2) shall be permitted to have a plastic cover.

9.3.18 Concealed Spaces.

9.3.18.1 Concealed Spaces Requiring Sprinkler Protection.
Concealed spaces of exposed combustible construction shall be protected by sprinklers except in concealed spaces where sprinklers are not required to be installed by 9.2.1.1 through 9.2.1.19 and 9.2.2.

9.3.18.1.1* Concealed Space Design Requirements.
Sprinklers in concealed spaces having no access for storage or other use shall be installed in accordance with the requirements for light hazard occupancy.

9.3.18.1.2 Localized Protection of Exposed Combustible Construction or Exposed Combustibles.
When otherwise noncombustible or limited-combustible concealed spaces that would not require sprinkler protection have localized exposed combustible construction, or contain localized areas of exposed combustibles, the combustibles shall be permitted to be protected as follows:
(1) If the exposed combustibles are in the vertical partitions or walls around all or a portion of the enclosure, a single row of sprinklers spaced not over 12 ft (3.7 m) apart nor more than 6 ft (1.8 m) from the inside of the partition shall be permitted to protect the surface. The first and last sprinklers in such a row shall not be over 5 ft (1.5 m) from the ends of the partitions.

(2) If the exposed combustibles are in the horizontal plane, the area of the combustibles shall be permitted to be protected with sprinklers on a light hazard spacing. Additional sprinklers shall be installed no more than 6 ft (1.8 m) outside the outline of the area and not more than 12 ft (3.7 m) on center along the outline. When the outline returns to a wall or other obstruction, the last sprinkler shall not be more than 6 ft (1.8 m) from the wall or obstruction.

9.3.19 Spaces Under Ground Floors, Exterior Docks, and Platforms.

9.3.19.1
Unless the requirements of 9.2.2 are met, sprinklers shall be installed in spaces under all combustible ground floors and combustible exterior docks and platforms.

9.3.20 Exterior Projections.

9.3.20.1*
Unless the requirements of 9.2.3.1, 9.2.3.2, or 9.2.3.3 are met, sprinklers shall be installed under exterior projections exceeding 4 ft (1.2 m) in width.

9.3.20.2*
Sprinklers shall be installed under all exterior projections greater than 4 ft (1.2 m) where combustibles are stored.

9.3.21 Electrical Equipment.

9.3.21.1*
Unless the requirements of 9.2.6 are met, sprinkler protection shall be required in electrical equipment rooms.

9.4 Use of Sprinklers.

9.4.1 General.

9.4.1.1*
Sprinklers shall be installed in accordance with their listing.

9.4.1.2
Where no sprinklers are specifically listed for construction features or other special situations that require unusual water distribution, the requirements of 9.4.1.1 shall not apply and listed sprinklers shall be permitted to be installed in positions other than anticipated by their listing to achieve specific results.

9.4.1.3*
Upright sprinklers shall be installed with the frame arms parallel to the branch line, unless specifically listed for other orientation.

9.4.1.4
Where solvent cement is used as the pipe and fittings bonding agent, sprinklers shall not be installed in the fittings prior to the fittings being cemented in place.

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9.4.1.5 Protective Caps and Straps.

9.4.1.5.1*
Protective caps and straps shall be removed using means that are in accordance with the manufacturer's installation instructions.

9.4.1.5.2*
Protective caps and straps shall be removed from all sprinklers prior to the time when the sprinkler system is placed in service.

9.4.1.5.3
Protective caps and straps on all upright sprinklers or on any sprinklers installed more than 10 ft (3.0 m) above the floor shall be permitted to be removed from sprinklers immediately following their installation.

9.4.2 Temperature Ratings.

9.4.2.1*
Unless the requirements of 9.4.2.2, 9.4.2.3, 9.4.2.4, or 9.4.2.5 are met, ordinary- and intermediate-temperature sprinklers shall be used throughout buildings.

9.4.2.2
Where maximum ceiling temperatures exceed 100°F (38°C), sprinklers with temperature ratings in accordance with the maximum ceiling temperatures of Table 7.2.4.1 shall be used.

9.4.2.3
High-temperature sprinklers shall be permitted to be used throughout ordinary and extra hazard occupancies, storage occupancies, and as allowed in this standard and other NFPA codes and standards.

9.4.2.4
Sprinklers of intermediate- and high-temperature classifications shall be installed in specific locations as required by 9.4.2.5.

9.4.2.5*
The following practices shall be observed to provide sprinklers of other than ordinary-temperature classification unless other temperatures are determined or unless high-temperature sprinklers are used throughout, and temperature selection shall be in accordance with Table 9.4.2.5(a), Table 9.4.2.5(b), Table 9.4.2.5(c), and Figure 9.4.2.5:
(1) *Sprinklers in the high-temperature zone shall be of the high-temperature classification, and sprinklers in the intermediate-temperature zone shall be of the intermediate-temperature classification.

(2) Sprinklers located within 12 in. (300 mm) to one side or 30 in. (750 mm) above an uncovered steam main, heating coil, or radiator shall be of the intermediate-temperature classification.

(3) Sprinklers within 7 ft (2.1 m) of a low-pressure blowoff valve that discharges free in a large room shall be of the high-temperature classification.

(4) Sprinklers under glass or plastic skylights exposed to the direct rays of the sun shall be of the intermediate-temperature classification.

(5) Sprinklers in an unventilated, concealed space, under an uninsulated roof, or in an unventilated attic shall be of the intermediate-temperature classification.

(6) Sprinklers in unventilated show windows having high-powered electric lights near the ceiling shall be of the intermediate-temperature classification.

(7) Sprinklers protecting commercial-type cooking equipment and ventilation systems shall be of the high- or extra high–temperature classification as determined by use of a temperature-measuring device. *(See 8.9.6.)*

(8) Sprinklers protecting residential areas installed near specific heat sources identified in Table 9.4.2.5(c) shall be installed in accordance with Table 9.4.2.5(c).

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(9) Ordinary-temperature sprinklers located adjacent to a heating duct that discharges air that is less than 100°F (38°C) are not required to be separated in accordance with Table 9.4.2.5(a) or Table 9.4.2.5(c).

(10) Sprinklers in walk-in type coolers and freezers with automatic defrosting shall be of the intermediate-temperature classification or higher.

(11) Sprinklers in closets containing ventless clothes dryers shall be of the intermediate-temperature classification or higher.

Table 9.4.2.5(a) Temperature Ratings of Sprinklers Based on Distance from Heat Sources

Type of Heat Condition	Ordinary-Temperature Rating	Intermediate-Temperature Rating	High-Temperature Rating
(1) Heating ducts			
(a) Above	More than 2 ft 6 in. (750 mm)	2 ft 6 in. or less (750 mm)	
(b) Side and below	More than 1 ft 0 in. (300 mm)	1 ft 0 in. or less (300 mm)	
(c) Diffuser	Any distance except as shown under Intermediate-Temperature Rating column	*Downward discharge:* Cylinder with 1 ft 0 in. (300 mm) radius from edge extending 1 ft 0 in. below and 2 ft 6 in. (750 mm) above *Horizontal discharge:* Semicylinder or cylinder with 2 ft 6 in. (750 mm) radius in direction of flow extending 1 ft 0 in. (300 mm) below and 2 ft 6 in. (750 mm) above	
(2) Unit heater and radiant heater			
(a) Horizontal discharge		*Discharge side:* 7 ft 0 in. (2.1 m) to 20 ft 0 in. (6.1 m) radius pie-shaped cylinder *(see Figure 8.3.2.5)* extending 7 ft 0 in. (2.1 m) above and 2 ft 0 (600 mm) in. below heater; also 7 ft 0 in. (2.1 m) radius cylinder more than 7 ft 0 in. (2.1 m) above unit heater	7 ft 0 in. (2.1 m) radius cylinder extending 7 ft 0 (2.1 m) in. above and 2 ft 0 (600 mm) in. below unit heater
(b) Vertical downward discharge *(for sprinklers below unit heater, see Figure 8.3.2.5)*		7 ft 0 in. (2.1 m) radius cylinder extending upward from an elevation 7 ft 0 in. (2.1 m) above unit heater	7 ft 0 in. (2.1 m) radius cylinder extending from the top of the unit heater to an elevation 7 ft 0 in. (2.1 m) above unit heater
(3) Steam mains (uncovered)			
(a) Above	More than 2 ft 6 in. (750 mm)	2 ft 6 in. or less (750 mm)	

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Type of Heat Condition	Ordinary-Temperature Rating	Intermediate-Temperature Rating	High-Temperature Rating
(b) Side and below	More than 1 ft 0 in. (300 mm)	1 ft 0 in. or less (300 mm)	
(c) Blowoff valve	More than 7 ft 0 in. (2.1 m)		7 ft 0 in. or less (2.1 m)

Table 9.4.2.5(b) Temperature Ratings of Sprinklers in Specified Locations

Location	Ordinary-Temperature Rating	Intermediate-Temperature Rating	High-Temperature Rating
Skylights		Glass or plastic	
Attics	Do not use	Ventilated or unventilated	
Peaked roof: metal or thin boards, concealed or not concealed, insulated or uninsulated	Ventilated	Unventilated	
Flat roof: metal, not concealed	Ventilated or unventilated	Note: For uninsulated roof, climate and insulated or uninsulated occupancy can necessitate intermediate sprinklers. Check on job.	
Flat roof: metal, concealed, insulated or uninsulated	Ventilated	Unventilated	
Show windows	Ventilated	Unventilated	

Note: A check of job condition by means of thermometers might be necessary.

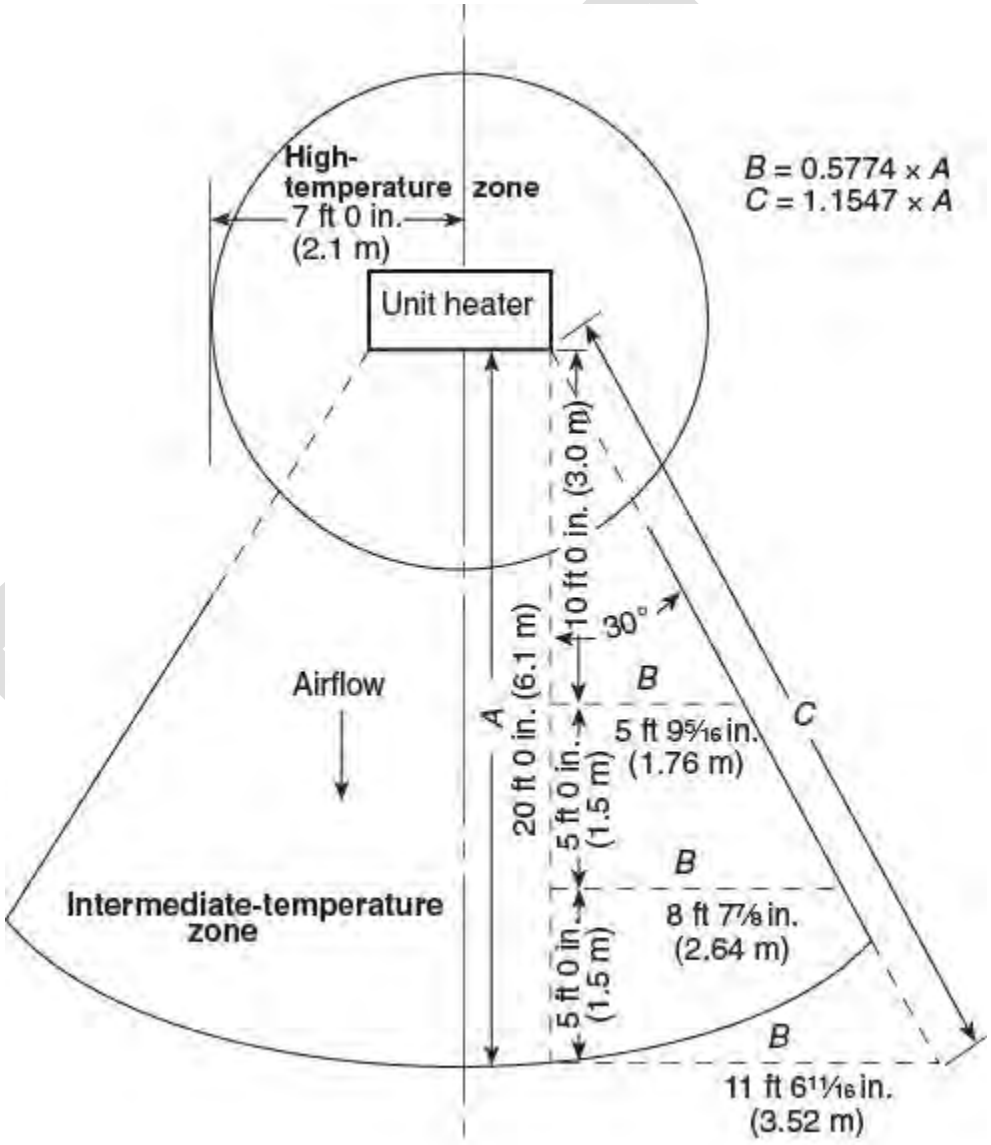
Table 9.4.2.5(c) Temperature Ratings of Sprinklers in Specified Residential Areas

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Heat Source	Minimum Distance from Edge of Source to Ordinary-Temperature Sprinkler		Minimum Distance from Edge of Source to Intermediate-Temperature Sprinkler	
	in.	mm	in.	mm
Side of open or recessed fireplace	36	915	12	300
Front of recessed fireplace	60	1525	36	915
Coal- or wood-burning stove	42	1070	12	305
Kitchen range	18	460	9	230
Wall oven	18	460	9	230
Hot air flues	18	460	9	230
Uninsulated heat ducts	18	460	9	230
Uninsulated hot water pipes	12	305	6	155
Side of ceiling- or wall-mounted hot air diffusers	24	610	12	305
Front of wall-mounted hot air diffusers	36	915	18	460
Hot water heater or furnace	6	155	3	75
Light fixture: 0 W–250 W	6	155	3	75
250 W–499 W	12	305	6	155

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Figure 9.4.2.5 High-Temperature and Intermediate-Temperature Zones at Unit Heaters and Radiant Heaters.



9.4.2.6
In case of occupancy change involving temperature change, the sprinklers shall be changed accordingly.

9.4.2.7*
The minimum temperature rating of ceiling sprinklers in general storage, rack storage, rubber tire storage, roll paper storage, and baled cotton storage applications shall be 150°F (66°C).

9.4.3 Thermal Sensitivity.

9.4.3.1*
Sprinklers in light hazard occupancies shall be one of the following:
(1) Quick-response type as defined in 3.3.206.5.14

(2) Residential sprinklers in accordance with the requirements of 8.4.5

(3) Quick response CMSA sprinklers

(4) ESFR sprinklers

(5) Standard-response sprinklers used for modifications or additions to existing light hazard systems equipped with standard-response sprinklers

(6) Standard-response sprinklers used where individual standard-response sprinklers are replaced in existing light hazard systems

9.4.3.2
Where quick-response sprinklers are installed, all sprinklers within a compartment shall be quick-response unless otherwise permitted in 9.4.3.3, 9.4.3.4, or 9.4.3.5.

9.4.3.3
Where there are no listed quick-response sprinklers in the temperature range required, standard-response sprinklers shall be permitted to be used.

9.4.3.4
The provisions of 9.4.3.2 shall not apply to in-rack sprinklers.

9.4.3.5
In other than light hazard occupancies, where a sprinkler carries a listing for both standard-response protection and quick-response protection at different coverage areas, that sprinkler shall be permitted to be installed within a compartment at the spacing for both the quick-response and standard-response listings without any separation between the areas so covered.

9.4.3.6
When existing light hazard systems are converted to use quick-response or residential sprinklers, all sprinklers in a compartment shall be changed.

9.4.4 Sprinklers with K-Factors Less than K-5.6 (80).

9.4.4.1
Sprinklers shall have a minimum nominal K-factor of 5.6 (80) unless otherwise permitted by 9.4.4.

9.4.4.2
For light hazard occupancies, sprinklers having a nominal K-factor smaller than K-5.6 (80) shall be permitted, subject to the following restrictions:
(1) The system shall be hydraulically calculated.

(2) Sprinklers with nominal K-factors of less than K-5.6 (80) shall be installed only in wet pipe sprinkler systems or in accordance with the limitations of 9.4.4.3 or 9.4.4.4.

(3) A listed strainer shall be provided on the supply side of sprinklers with nominal K-factors of less than K-2.8 (40).

9.4.4.3

Sprinklers with nominal K-factors of less than K-5.6 (80) shall be permitted to be installed in conformance with 19.4.2 for protection against exposure fires.

9.4.4.4
Sprinklers with nominal K-factors of K-4.2 (57) shall be permitted to be installed on dry pipe and preaction systems protecting light hazard occupancies where piping is corrosion resistant or internally galvanized.

9.4.5 Thread Size Limitations.
Sprinklers having a K-factor exceeding K-5.6 (80) and having ½ in. (15 mm) National Pipe Thread (NPT) shall not be installed in new sprinkler systems.

9.5 Position, Location, Spacing, and Use of Sprinklers.

9.5.1 General.

9.5.1.1
Sprinklers shall be located, spaced, and positioned in accordance with the requirements of Section 9.5.

9.5.1.2
Sprinklers shall be positioned to provide protection of the area consistent with the overall objectives of this standard by controlling the positioning and allowable area of coverage for each sprinkler.

9.5.1.3
The requirements of 9.5.2 through 9.3.17 shall apply to all sprinkler types unless modified by more restrictive rules in Section 10.2 through Section 14.2.

9.5.2 Protection Areas per Sprinkler.

9.5.2.1 Determination of Protection Area of Coverage.

9.5.2.1.1
The protection area of coverage per sprinkler (A_s) shall be determined as follows:
(1) Along branch lines as follows:
(a) Determine distance between sprinklers (or to wall or obstruction in the case of the end sprinkler on the branch line) upstream and downstream

(b) Choose the larger of either twice the distance to the wall or the distance to the next sprinkler

(c) Define dimension as *S*

(2) Between branch lines as follows:
(a) Determine perpendicular distance to the sprinkler on the adjacent branch line (or to a wall or obstruction in the case of the last branch line) on each side of the branch line on which the subject sprinkler is positioned

(b) Choose the larger of either twice the distance to the wall or obstruction or the distance to the next sprinkler

(c) Define dimension as *L*

9.5.2.1.2
The protection area of coverage of the sprinkler shall be established by multiplying the *S* dimension by the *L* dimension, as follows:

$$A_s = S \times L \qquad \textbf{[9.5.2.1.2]}$$

9.5.2.2 Maximum Protection Area of Coverage.

9.5.2.2.1
The maximum allowable protection area of coverage for a sprinkler (A_s) shall be in accordance with the value indicated in the section for each type or style of sprinkler.

9.5.2.2.2
The maximum area of coverage of any sprinkler shall not exceed 400 ft^2 (37 m^2).

9.5.3 Sprinkler Spacing.

9.5.3.1 Maximum Distance Between Sprinklers.

9.5.3.1.1
The maximum distance permitted between sprinklers shall be based on the centerline distance between adjacent sprinklers.

9.5.3.1.2
The maximum distance shall be measured along the slope of the ceiling.

9.5.3.1.3
The maximum distance permitted between sprinklers shall comply with the value indicated in the applicable section for each type or style of sprinkler.

9.5.3.2 Maximum Distance from Walls.

9.5.3.2.1
The distance from sprinklers to walls shall not exceed one-half of the allowable maximum distance between sprinklers.

9.5.3.2.2
The distance from the wall to the sprinkler shall be measured to the wall behind furniture, such as wardrobes, cabinets, and trophy cases.

9.5.3.2.3
The distance from the wall to the sprinkler shall be measured to the wall when sprinklers are spaced near windows and no additional floor space is created.

9.5.3.3 Minimum Distance from Walls.

9.5.3.3.1
The minimum distance permitted between a sprinkler and the wall shall comply with the value indicated in the applicable section for each type or style of sprinkler.

9.5.3.3.2
The distance from the wall to the sprinkler shall be measured perpendicular to the wall.

9.5.3.4 Minimum Distance Between Sprinklers.

9.5.3.4.1
A minimum distance shall be maintained between sprinklers to prevent operating sprinklers from wetting adjacent sprinklers and to prevent skipping of sprinklers.

9.5.3.4.2
The minimum distance permitted between sprinklers shall comply with the value indicated in the applicable section for each type or style of sprinkler.

9.5.4 Deflector Position.

9.5.4.1* Distance Below Ceilings.

9.5.4.1.1
The distances between the sprinkler deflector and the ceiling above shall be selected based on the type of sprinkler and the type of construction.

9.5.4.1.2 Corrugated Metal Deck Roofs.

9.5.4.1.2.1

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For corrugated metal deck roofs up to 3 in. (75 mm) in depth, the distance shall be measured to the sprinkler from the bottom of the deck.

9.5.4.1.2.2
For decks deeper than 3 in. (75 mm), the distance shall be measured to the highest point on the deck.

9.5.4.1.3
For ceilings that have insulation installed directly against underside of the ceiling or roof structure, the deflector distance shall be measured from the bottom of the insulation and shall be in accordance with 9.5.4.1.3.1 or 9.5.4.1.3.2.

9.5.4.1.3.1
For insulation that is installed directly against the ceiling or roof structure and is installed flat and parallel to the ceiling or roof structure, the deflector distance shall be measured to the underside of the insulation.

9.5.4.1.3.2
For insulation that is installed in a manner that causes it to deflect or sag down from the ceiling or roof structure, the deflector distance shall be measured as half of the distance of the deflection from the insulation high point to the insulation low point.

(A)
If the deflection or sag in the insulation exceeds 6 in. (150 mm), the deflector distance shall be measured to the high point of the insulation.

(B)
The deflector shall not be positioned above the low point of the insulation.

9.5.4.1.4*
Heat collectors shall not be used as a means to assist the activation of a sprinkler.

9.5.4.2 Deflector Orientation.
Deflectors of sprinklers shall be aligned parallel to ceilings, roofs, or the incline of stairs.

9.5.5 Obstructions to Sprinkler Discharge.

9.5.5.1* Performance Objective.
Sprinklers shall be located so as to minimize obstructions to discharge as defined in 9.5.5.2 and 9.5.5.3, or additional sprinklers shall be provided to ensure adequate coverage of the hazard. *(See Figure A.9.5.5.1.)*

9.5.5.2* Obstructions to Sprinkler Discharge Pattern Development.

9.5.5.2.1
Continuous or noncontinuous obstructions less than or equal to 18 in. (450 mm) below the sprinkler deflector that prevent the pattern from fully developing shall comply with 9.5.5.2.

9.5.5.2.2
Sprinklers shall be positioned in accordance with the minimum distances and special requirements of Section 10.2 through Section 14.2 so that they are located sufficiently away from obstructions such as truss webs and chords, pipes, columns, and fixtures.

9.5.5.3* Obstructions that Prevent Sprinkler Discharge from Reaching Hazard.
Continuous or noncontinuous obstructions that interrupt the water discharge in a horizontal plane more than 18 in. (450 mm) below the sprinkler deflector in a manner to limit the distribution from reaching the protected hazard shall comply with 9.5.5.3.

9.5.5.3.1*
Sprinklers shall be installed under fixed obstructions over 4 ft (1.2 m) in width.

9.5.5.3.1.1*
Open grate flooring over 4 ft (1.2 m) in width shall require sprinkler protection below the grating.

9.5.5.3.1.2

Sprinklers shall be located below the obstruction and not more than 3 in. (75 mm) from the outside edge of the obstruction.

9.5.5.3.1.3
Where sprinklers are located adjacent to the obstruction, they shall be of the intermediate level rack type.

9.5.5.3.1.4
The deflector of automatic sprinklers installed under fixed obstructions shall be positioned no more than 12 in. (300 mm) below the bottom of the obstruction.

9.5.5.3.1.5
Sprinklers shall not be required under noncombustible obstructions over 4 ft (1.2 m) wide where the bottom of the obstruction is 24 in. (600 mm) or less above the floor or deck.

9.5.5.3.2*
Sprinklers shall not be required under obstructions that are not fixed in place, such as conference tables.

9.5.5.3.3
Sprinklers installed under obstructions shall be of the same type (spray, CMSA, ESFR, residential) as installed at the ceiling except as permitted by 9.5.5.3.3.1.

9.5.5.3.3.1
Spray sprinklers shall be permitted to be utilized under overhead doors.

9.5.5.3.4*
Sprinklers installed under open gratings shall be of the intermediate level/rack storage type or otherwise shielded from the discharge of overhead sprinklers.

9.5.5.4 Closets.
In all closets and compartments, including those closets housing mechanical equipment, that are not larger than 400 ft^3 (11.3 m^3) in size, a single sprinkler at the highest ceiling level shall be sufficient without regard to obstructions or minimum distance to the wall.

9.5.6 Clearance from Deflector to Storage.

9.5.6.1*
Unless the requirements of 9.5.6.2, 9.5.6.3, 9.5.6.4, or 9.5.6.5 are met, the clearance between the deflector and the top of storage or contents of the room shall be 18 in. (450 mm) or greater.

9.5.6.2
Where other standards specify greater clearance to storage minimums, they shall be followed.

9.5.6.3
A minimum clearance to storage of 36 in. (900 mm) shall be permitted for special sprinklers.

9.5.6.4
A minimum clearance to storage of less than 18 in. (450 mm) between the top of storage and ceiling sprinkler deflectors shall be permitted where proven by successful large-scale fire tests for the particular hazard.

9.5.6.5
The clearance from the top of storage to sprinkler deflectors shall be not less than 36 in. (900 mm) where rubber tires are stored.

9.5.6.6
The 18 in. (450 mm) dimension shall not limit the height of shelving on a wall or shelving against a wall in accordance with 10.2.8, 10.3.7, 11.2.6, 11.3 and and Sections 11.3 and 12.1.

9.5.6.6.1
Where shelving is installed on a wall and is not directly below sprinklers, the shelves, including storage thereon, shall be permitted to extend above the level of a plane located 18 in. (450 mm) below ceiling sprinkler deflectors.

9.5.6.6.2

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Shelving, and any storage thereon, directly below the sprinklers shall not extend above a plane located 18 in. (450 mm) below the ceiling sprinkler deflectors.

9.3

Chapter 10 Installation Requirements for Standard Pendent, Upright, and Sidewall Spray Sprinklers

10.1 General.

Standard pendent, upright, and sidewall sprinklers shall be selected for use and installation as indicated in this chapter and shall be positioned and spaced in accordance with Section 9.5.

10.2 Standard Pendent and Upright Spray Sprinklers.

10.2.1 General.

All requirements of Section 9.5 shall apply to standard pendent and upright spray sprinklers except as modified in Section 10.2.

10.2.2

Upright and pendent spray sprinklers shall be permitted in all occupancy hazard classifications and building construction types unless the requirements of 9.3.2 apply.

10.2.3

Quick-response sprinklers shall not be permitted for use in extra hazard occupancies under the density/area design method.

10.2.4 Protection Areas per Sprinkler (Standard Pendent and Upright Spray Sprinklers).

10.2.4.1 Determination of Protection Area of Coverage.

10.2.4.1.1

Except as permitted by 10.2.4.1.2, the protection area of coverage per sprinkler (A_s) shall be determined in accordance with 9.5.2.1.

10.2.4.1.2

The requirements of 10.2.4.1.1 shall not apply in a small room as defined in 3.3.197.

10.2.4.1.2.1

The protection area of coverage for each sprinkler in the small room shall be the area of the room divided by the number of sprinklers in the room.

10.2.4.2 Maximum Protection Area of Coverage.

10.2.4.2.1*

The maximum allowable protection area of coverage for a sprinkler (A_s) shall be in accordance with the value indicated in Table 10.2.4.2.1(a) through Table 10.2.4.2.1(d).

Table 10.2.4.2.1(a) Protection Areas and Maximum Spacing of Standard Pendent and Upright Spray Sprinklers for Light Hazard

Construction Type	System Type	Maximum Protection Area		Maximum Spacing	
		ft^2	m^2	ft	m
Noncombustible unobstructed	Hydraulically calculated	225	20.9	15	4.6

Construction Type	System Type	Maximum Protection Area		Maximum Spacing	
		ft^2	m^2	ft	m
Noncombustible unobstructed	Pipe schedule	200	18.6	15	4.6
Noncombustible obstructed	Hydraulically calculated	225	20.9	15	4.6
Noncombustible obstructed	Pipe schedule	200	18.6	15	4.6
Combustible unobstructed with no exposed members	Hydraulically calculated	225	20.9	15	4.6
Combustible unobstructed with no exposed members	Pipe schedule	200	18.6	15	4.6
Combustible unobstructed with exposed members 3 ft (910 mm) or more on center	Hydraulically calculated	225	20.9	15	4.6
Combustible unobstructed with exposed members 3 ft (910 mm) or more on center	Pipe schedule	200	18.6	15	4.6
Combustible unobstructed with members less than 3 ft (910 mm) on center	All	130	12.1	15	4.6
Combustible obstructed with exposed members 3 ft (910 mm) or more on center	All	168	15.6	15	4.6
Combustible obstructed with members less than 3 ft (910 mm) on center	All	130	12.1	15	4.6
Combustible concealed spaces in accordance with 8.6.4.1.4	All	120	11.1	15 parallel to the slope 10 perpendicular to the slope*	4.6 parallel to the slope 3.0 perpendicular to the slope*

*See 8.6.4.1.4.4.

Table 10.2.4.2.1(b) Protection Areas and Maximum Spacing of Standard Pendent and Upright Spray Sprinklers for Ordinary Hazard

Construction Type	System Type	Protection Area		Maximum Spacing	
		ft^2	m^2	ft	m
All	All	130	12.1	15	4.6

Table 10.2.4.2.1(c) Protection Areas and Maximum Spacing of Standard Pendent and Upright Spray Sprinklers for Extra Hazard

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Construction Type	System Type	Protection Area		Maximum Spacing	
		ft^2	m^2	ft	m
All	Pipe schedule	90	8.4	12*	3.7*
All	Hydraulically calculated with density ≥0.25	100	9.3	12*	3.7*
All	Hydraulically calculated with density <0.25	130	12.1	15	4.6

*In buildings where solid structural members create bays up to 25 ft (7.6 m) wide, maximum spacing between sprinklers is permitted up to 12 ft 6 in. (3.8 m).

Table 10.2.4.2.1(d) Protection Areas and Maximum Spacing of Standard Pendent and Upright Spray Sprinklers for High-Piled Storage

Construction Type	System Type	Protection Area		Maximum Spacing	
		ft^2	m^2	ft	m
All	Hydraulically calculated with density ≥0.25	100	9.3	12*	3.7*
All	Hydraulically calculated with density <0.25	130	12.1	15	4.6

*In buildings where solid structural members create bays up to 25 ft (7.6 m) wide, maximum spacing between sprinklers is permitted up to 12 ft 6 in. (3.8 m).

10.2.4.2.2
In any case, the maximum area of coverage of a sprinkler shall not exceed 225 ft^2 (20.9 m^2).

10.2.5 Sprinkler Spacing (Standard Pendent and Upright Spray Sprinklers).

10.2.5.1 Maximum Distance Between Sprinklers.
The maximum distance permitted between sprinklers shall comply with Table 10.2.4.2.1(a) through Table 10.2.4.2.1(d).

10.2.5.2 Maximum Distance from Walls.

10.2.5.2.1
The distance from sprinklers to walls shall not exceed one-half of the allowable distance between sprinklers as indicated in Table 10.2.4.2.1(a) through Table 10.2.4.2.1(d).

10.2.5.2.2*
The requirements of 10.2.5.2.1 shall not apply where walls are angled or irregular, and the maximum horizontal distance between a sprinkler and any point of floor area protected by that sprinkler shall not exceed 0.75 times the allowable distance permitted between sprinklers, provided the maximum perpendicular distance is not exceeded.

10.2.5.2.3*
The requirements of 10.2.5.2.1 shall not apply within small rooms as defined in 3.3.197.

10.2.5.2.3.1

Sprinklers shall be permitted to be located not more than 9 ft (2.7 m) from any single wall.

10.2.5.2.3.2
Sprinkler spacing limitations of 10.2.5 and area limitations of Table 10.2.4.2.1(a) shall not be exceeded.

10.2.5.2.4
Under curved surfaces, the horizontal distance shall be measured at the floor level from the wall, or the intersection of the curved surface and the floor to the nearest sprinkler shall not be greater than one-half the allowable distance between sprinklers.

10.2.5.3 Minimum Distances from Walls.
Sprinklers shall be located a minimum of 4 in. (100 mm) from a wall.

10.2.5.4 Minimum Distances Between Sprinklers.

10.2.5.4.1
Unless the requirements of 10.2.5.4.2, 10.2.5.4.3, or 8.6.3.4.4 are met, sprinklers shall be spaced not less than 6 ft (1.8 m) on center.

10.2.5.4.2
Sprinklers shall be permitted to be placed less than 6 ft (1.8 m) on center where the following conditions are satisfied:
(1) Baffles shall be arranged to protect the actuating elements.

(2) Baffles shall be of solid and rigid material that will stay in place before and during sprinkler operation.

(3) Baffles shall be not less than 8 in. (200 mm) long and 6 in. (150 mm) high.

(4) The tops of baffles shall extend between 2 in. and 3 in. (50 mm and 75 mm) above the deflectors of upright sprinklers.

(5) The bottoms of baffles shall extend downward to a level at least even with the deflectors of pendent sprinklers.

10.2.5.4.3
In-rack sprinklers shall be permitted to be placed less than 6 ft (1.8 m) on center.

10.2.6 Deflector Position (Standard Pendent and Upright Spray Sprinklers).

10.2.6.1 Distance Below Ceilings.

10.2.6.1.1 Unobstructed Construction.

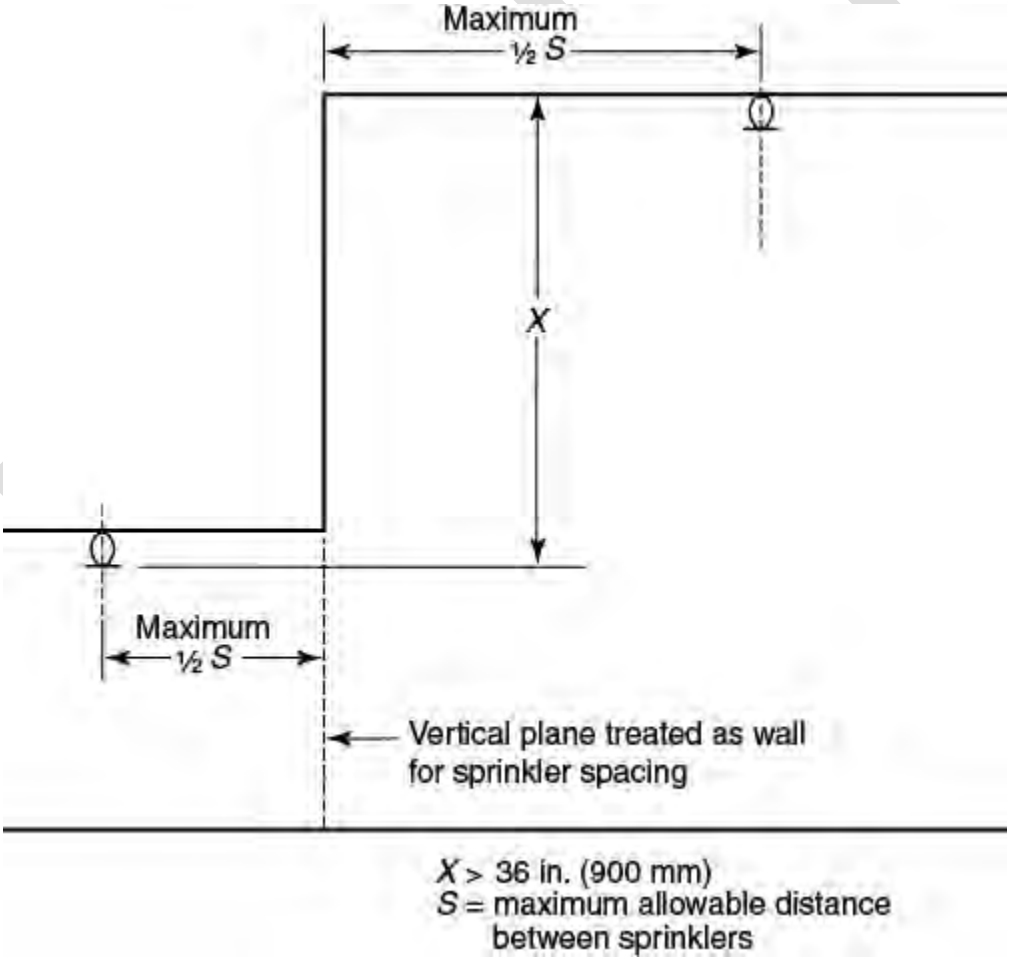
10.2.6.1.1.1
Under unobstructed construction, the distance between the sprinkler deflector and the ceiling shall be a minimum of 1 in. (25 mm) and a maximum of 12 in. (300 mm) throughout the area of coverage of the sprinkler.

10.2.6.1.1.2
The requirements of 10.2.6.1.1.1 shall not apply where ceiling-type sprinklers (concealed, recessed, and flush types) have the operating element above the ceiling and the deflector located nearer to the ceiling where installed in accordance with their listing.

10.2.6.1.1.3
The requirements of 10.2.6.1.1.1 shall not apply for light and ordinary hazard occupancies with ceilings of noncombustible or limited-combustible construction where either 10.2.6.1.1.3(A) or 10.2.6.1.1.3(B) applies.

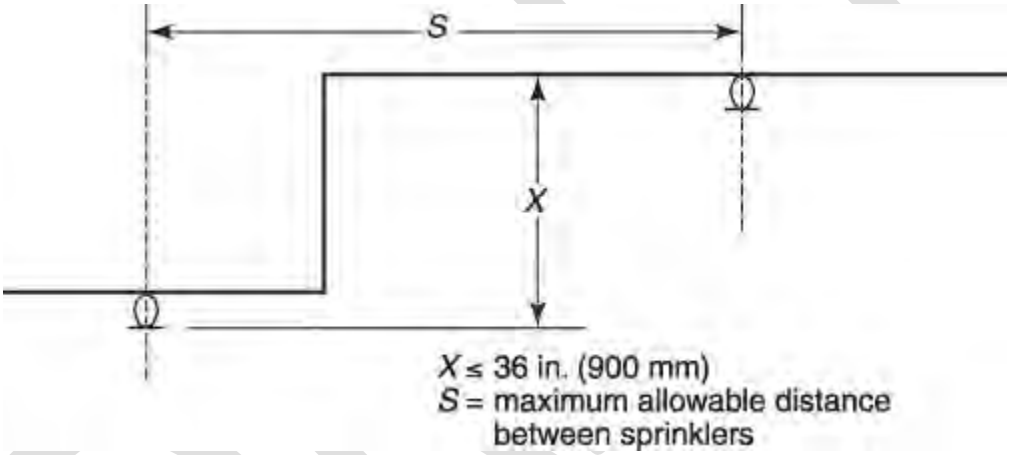
(A)
Where a vertical change in ceiling elevation within the area of coverage of the sprinkler creates a distance of more than 36 in. (900 mm) between the upper ceiling and the sprinkler deflector, a vertical plane extending down from the ceiling at the change in elevation shall be considered a wall for the purpose of sprinkler spacing as shown in Figure 10.2.6.1.1.3(A).

Figure 10.2.6.1.1.3(A) Vertical Change in Ceiling Elevation Greater Than 36 in. (914 mm).



(B)
Where the distance between the upper ceiling and the sprinkler deflector is less than or equal to 36 in. (900 mm), the sprinklers shall be permitted to be spaced as though the ceiling was flat, provided the obstruction rules are observed as shown in Figure 10.2.6.1.1.3(B).

Figure 10.2.6.1.1.3(B) Vertical Change in Ceiling Elevation Less Than or Equal to 36 in. (914 mm).



10.2.6.1.2 Obstructed Construction.
Under obstructed construction, the sprinkler deflector shall be located in accordance with one of the following arrangements:
(1) Installed with the deflectors within the horizontal planes of 1 in. to 6 in. (25 mm to 150 mm) below the structural members and a maximum distance of 22 in. (550 mm) below the ceiling/roof deck

(2) Installed with the deflectors at or above the bottom of the structural member to a maximum of 22 in. (550 mm) below the ceiling/roof deck where the sprinkler is installed in conformance with 10.2.7.1.2

(3) Installed in each bay of obstructed construction, with the deflectors located a minimum of 1 in. (25 mm) and a maximum of 12 in. (300 mm) below the ceiling

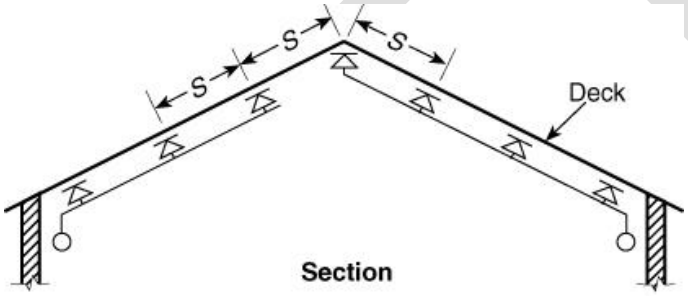
(4) Installed with the deflectors within the horizontal planes 1 in. to 6 in. (25 mm to 150 mm) below composite wood joists to a maximum distance of 22 in. (550 mm) below the ceiling/roof deck only where joist channels are fire-stopped to the full depth of the joists with material equivalent to the web construction so that individual channel areas do not exceed 300 ft² (27.9 m²)

(5) *Installed with deflectors of sprinklers under concrete tee construction with stems spaced less than 7½ ft (2.3 m)on centers, regardless of the depth of the tee, located at or above a horizontal plane 1 in. (25 mm) below the bottom of the stems of the tees and complying with Table 10.2.7.1.2

10.2.6.1.3 Peaked Roofs and Ceilings.

10.2.6.1.3.1
Unless the requirements of 10.2.6.1.3.2 or 10.2.6.1.3.3 are met, sprinklers under or near the peak of a roof or ceiling shall have deflectors located not more than 36 in. (900 mm) vertically down from the peak as indicated in Figure 10.2.6.1.3.1(a) and Figure 10.2.6.1.3.1(b).

Figure 10.2.6.1.3.1(a) Sprinklers Under Pitched Roof with Sprinkler Directly Under Peak; Branch Lines Run Up Slopes.



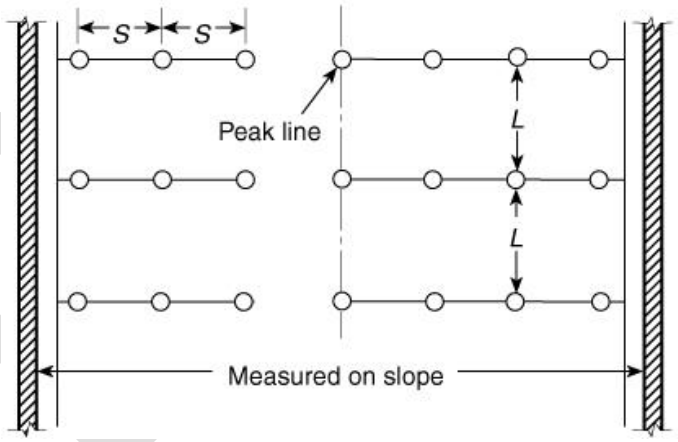
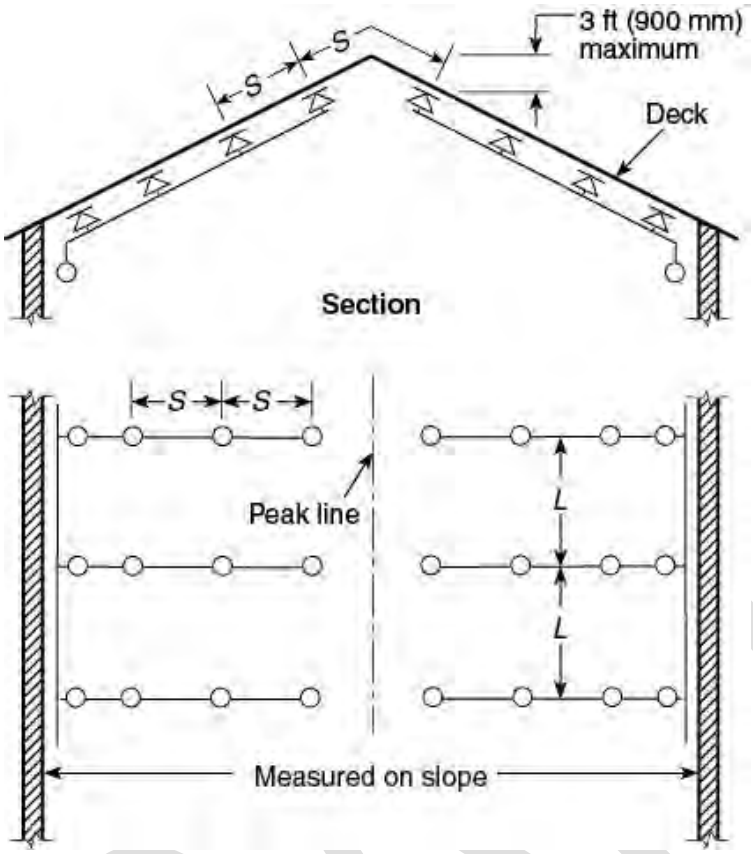


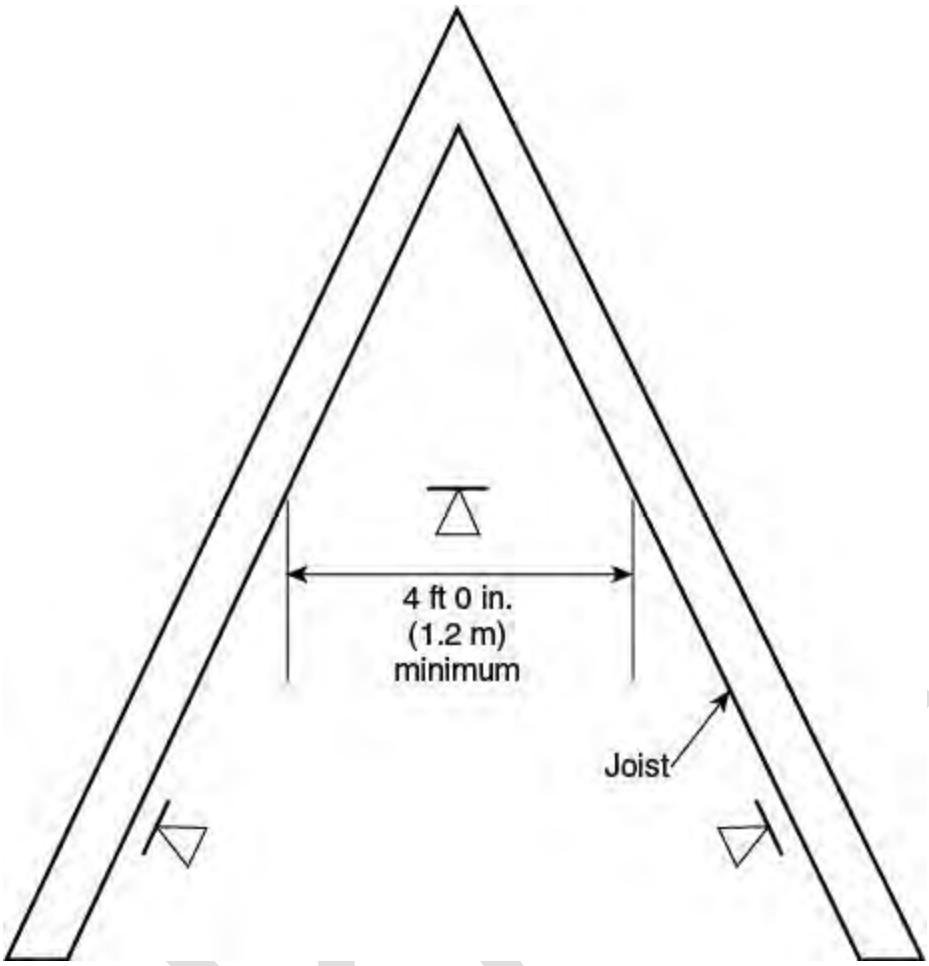
Figure 10.2.6.1.3.1(b) Sprinklers at Pitched Roof; Branch Lines Run Up Slopes.



10.2.6.1.3.2*
Under saw-toothed roofs, sprinklers at the highest elevation shall not exceed a distance of 36 in. (900 mm) measured down the slope from the peak.

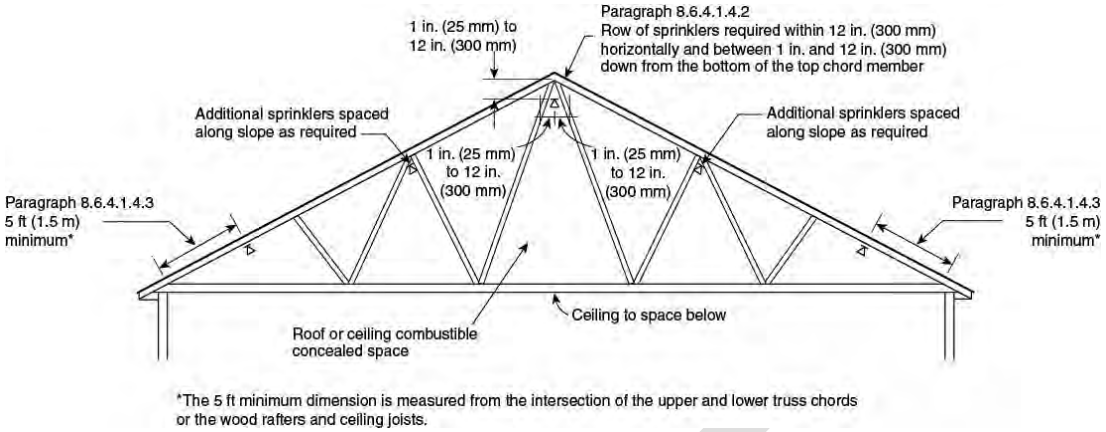
10.2.6.1.3.3*
Under a steeply pitched surface, the distance from the peak to the deflectors shall be permitted to be increased to maintain a horizontal clearance of not less than 24 in. (600 mm) from other structural members as indicated in Figure 10.2.6.1.3.3.

Figure 10.2.6.1.3.3 Horizontal Clearance for Sprinkler at Peak of Pitched Roof.



10.2.6.1.4
Sprinklers under a roof or ceiling in combustible concealed spaces of wood joist or wood truss construction with members less than 3 ft (900 mm) on center with a slope having a pitch of 4 in 12 or greater shall be positioned in accordance with Figure 10.2.6.1.4 and the requirements of 10.2.6.1.4.1 through 10.2.6.1.4.6.

Figure 10.2.6.1.4 Sprinklers Under Roof or Ceiling in Combustible Concealed Spaces of Wood Joist or Wood Truss Construction with Members Less Than 3 ft (0.91 m) on Center with a Slope Having a Pitch of 4 in 12 or Greater.



10.2.6.1.4.1
Sprinklers shall be quick-response.

10.2.6.1.4.2
Sprinklers shall be installed so that a row of sprinklers is installed within 12 in. (300 mm) horizontally of the peak and between 1 in. and 12 in. (25 mm and 300 mm) down from the bottom of the top chord member.

10.2.6.1.4.3*
Sprinklers shall be installed so that the sprinklers installed along the eave are located not less than 5 ft (1.5 m) from the intersection of the upper and lower truss chords or the wood rafters and ceiling joists.

10.2.6.1.4.4*
Sprinklers installed where the dimension perpendicular to the slope exceeds 8 ft (2.4 m) shall have a minimum pressure of 20 psi (1.4 bar).

10.2.6.1.4.5*
The requirements of 10.2.6.1.4.3 or 10.2.6.1.4.4 shall not apply to sprinklers installed at the corner of the eave of a hip type roof where located directly under the hip line spaced in accordance with 10.2.5.2.2 or located on the slope plane not less than 5 ft (1.5 m) from the intersection of the upper and lower truss chords or the wood rafters and ceiling joists on the eave and no more than 5 ft (1.5 m) from the hip line.

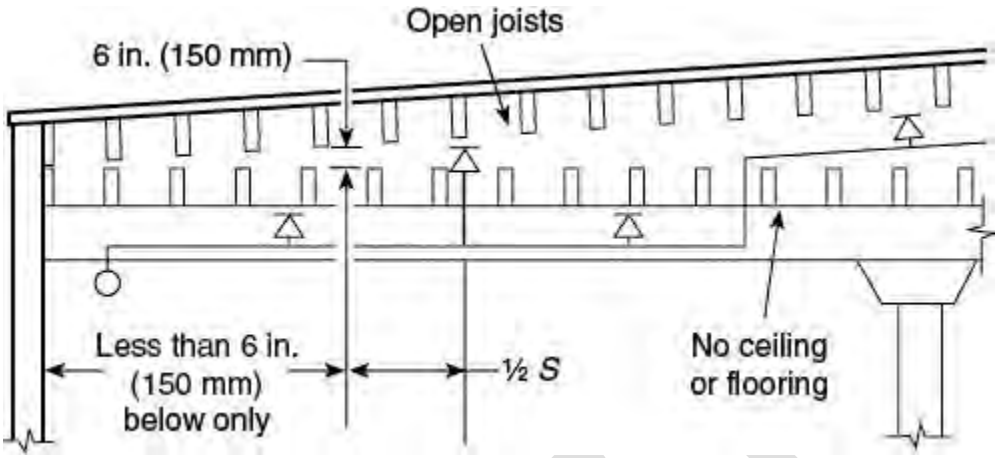
10.2.6.1.4.6
The special requirements of 10.2.4.2.1 and 10.2.6.1.4 shall not apply when the exposed combustible sheathing in the roof or ceiling space are constructed of pressure impregnated fire retardant–treated wood as defined by NFPA 703.

10.2.6.1.5 Double Joist Obstructions.

10.2.6.1.5.1
Unless the requirements of 10.2.6.1.5.2 are met, where two sets of joists are under a roof or ceiling, and no flooring is over the lower set, sprinklers shall be installed above and below the lower set of joists where a clearance of 6 in. (150 mm) or more is between the top of the lower joist and the bottom of the upper joist as indicated in Figure 10.2.6.1.5.1.

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Figure 10.2.6.1.5.1 Arrangement of Sprinklers Under Two Sets of Open Joists — No Sheathing on Lower Joists.



10.2.6.1.5.2
Sprinklers shall be permitted to be omitted from below the lower set of joists where at least 18 in. (450 mm) is maintained between the sprinkler deflector and the top of the lower joist.

10.2.6.2 Deflector Orientation.

10.2.6.2.1
Unless the requirements of 10.2.6.2.2 or 10.2.6.2.3 are met, deflectors of sprinklers shall be aligned parallel to ceilings, roofs, hips, or the incline of stairs.

10.2.6.2.2
Where sprinklers are installed in the peak below a sloped ceiling or roof surface, the sprinkler shall be installed with the deflector horizontal.

10.2.6.2.3
Roofs having a pitch not exceeding 2 in 12 (16.7 percent) are considered horizontal in the application of **10.2.6.2**, and sprinklers shall be permitted to be installed with deflectors horizontal.

10.2.7 Obstructions to Sprinkler Discharge (Standard Pendent and Upright Spray Sprinklers).

10.2.7.1 Performance Objective.

10.2.7.1.1
Sprinklers shall be located so as to minimize obstructions to discharge as defined in 10.2.7.2 and 10.2.7.3, or additional sprinklers shall be provided to ensure adequate coverage of the hazard.

10.2.7.1.2*
Sprinklers shall be arranged to comply with one of the following arrangements:
(1) Subsection 9.5.5.2, Table 10.2.7.1.2, and Figure 10.2.7.1.2(a) shall be followed.

(2) Sprinklers shall be permitted to be spaced on opposite sides of obstructions not exceeding 4 ft (1.2 m) in width, provided the distance from the centerline of the obstruction to the sprinklers does not exceed one-half the allowable distance permitted between sprinklers.

(3) Obstructions located against the wall and that are not over 30 in. (750 mm) in width shall be permitted to be protected in accordance with Figure 10.2.7.1.2(b).

(4) Obstructions located against the wall and that are not over 24 in. (600 mm) in width shall be permitted to be protected in accordance with Figure 10.2.7.1.2(c). The maximum distance between the sprinkler and the wall shall be measured from the sprinkler to the wall behind the obstruction and not to the face of the obstruction.

Table 10.2.7.1.2 Positioning of Sprinklers to Avoid Obstructions to Discharge [Standard Spray Upright/Standard Spray Pendent (SSU/SSP)]

Distance from Sprinklers to Side of Obstruction *(A)*	Maximum Allowable Distance of Deflector Above Bottom of Obstruction *(B)* [in. (mm)]
Less than 1 ft (300 mm)	0 (0)
1 ft (300 mm) to less than 1 ft 6 in. (450 mm)	2½ (65)
1 ft 6 in. (450 mm) to less than 2 ft (600 mm)	3½ (90)
2 ft (600 mm) to less than 2 ft 6 in. (750 mm)	5½(140)
2 ft 6 (750 mm) in. to less than 3 ft (900 mm)	7½ (190)
3 ft (900 mm) to less than 3 ft 6 in. (1.1 m)	9½ (240)
3 ft 6 in. (1.1 m) to less than 4 ft (1.2 m)	12 (300)
4 ft (1.2 m) to less than 4 ft 6 in. (1.4 m)	14 (350)
4 ft 6 in. (1.4 m) to less than 5 ft (1.5 m)	16½ (420)
5 ft (1.5 m) to less than 5 ft 6 in. (1.7 m)	18 (450)
5 ft 6 in. (1.7 m) to less than 6 ft (1.8 m)	20 (510)
6 ft (1.8 m) to less than 6 ft 6 in. (2.0 m)	24 (600)
6 ft 6 in. (2.0 m) to less than 7 ft (2.1 m)	30 (750)
7 ft (2.1 m) to less than 7 ft 6 in. (2.3 m)	35 (875)

For SI units, 1 in. = 25.4 mm; 1 ft = 0.3048 m.

Note: For *A* and *B*, refer to Figure 8.6.5.1.2(a).

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Figure 10.2.7.1.2(a) Positioning of Sprinkler to Avoid Obstruction to Discharge (SSU/SSP).

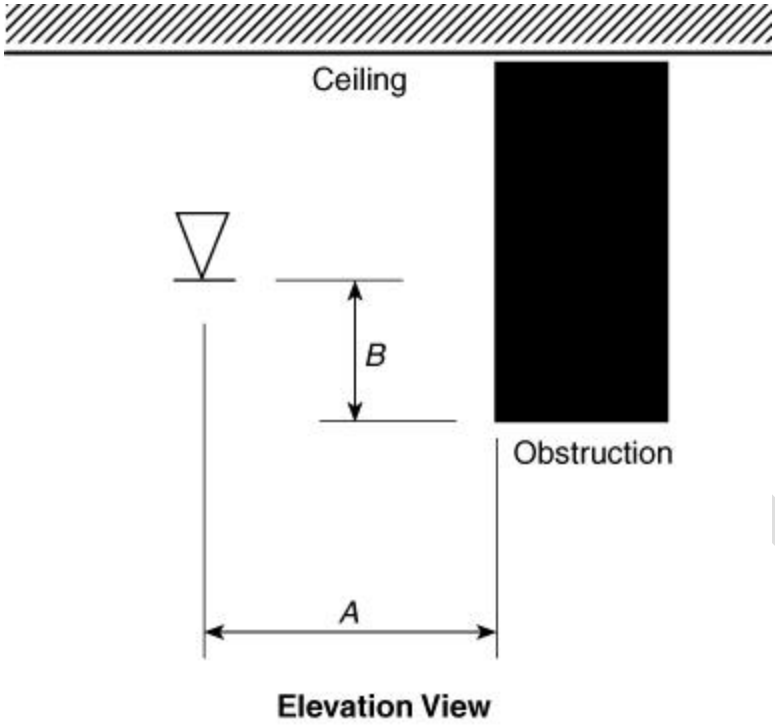


Figure 10.2.7.1.2(b) Obstruction Against Wall (SSU/SSP).

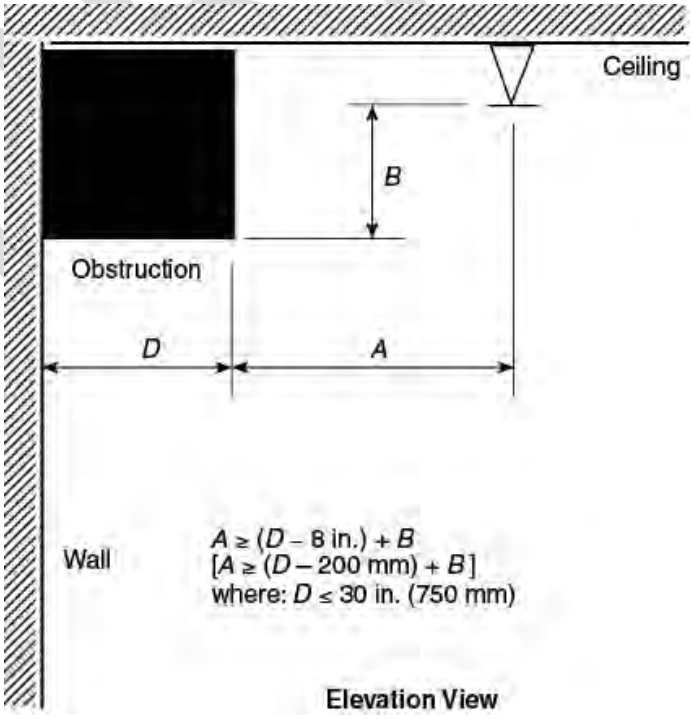
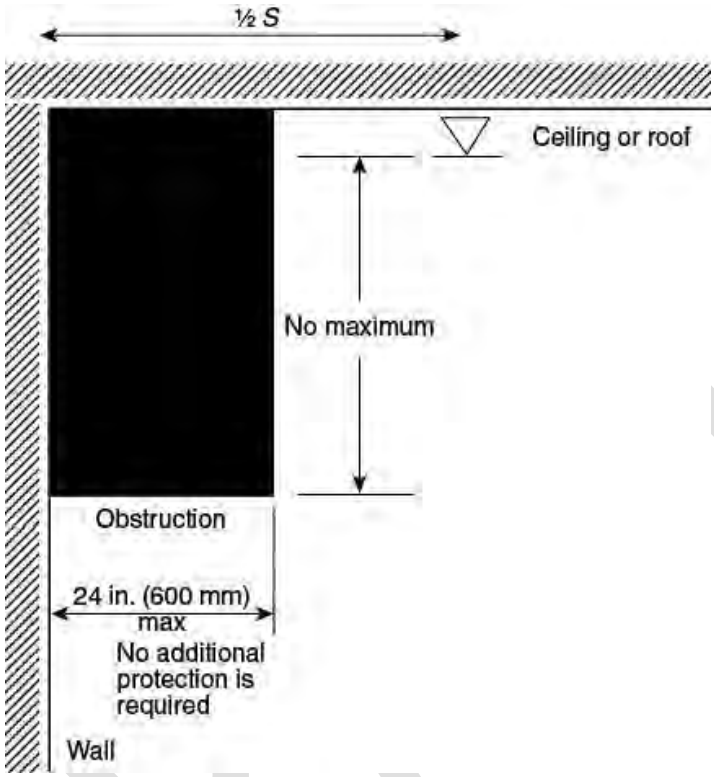


Figure 10.2.7.1.2(c) Obstructions Against Walls (SSU/SSP).



10.2.7.2 Obstructions to Sprinkler Discharge Pattern Development.

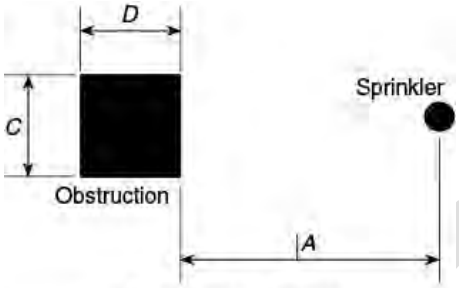
10.2.7.2.1 General.

10.2.7.2.1.1
Continuous or noncontinuous obstructions less than or equal to 18 in. (450 mm) below the sprinkler deflector that prevent the pattern from fully developing shall comply with 10.2.7.2.

10.2.7.2.1.2
Regardless of the rules of 10.2.7.2, solid continuous obstructions, where the top of the obstruction is level with or above the plane of the deflector, shall meet the applicable requirements of 10.2.7.1.2.

10.2.7.2.1.3* Minimum Distance from Obstructions.
Unless the requirements of 10.2.7.2.1.4 through 10.2.7.2.1.9 are met, sprinklers shall be positioned away from obstructions a minimum distance of three times the maximum dimension of the obstruction (e.g., structural members, pipe, columns, and fixtures) in accordance with Figure 10.2.7.2.1.3(a) and Figure 10.2.7.2.1.3(b).

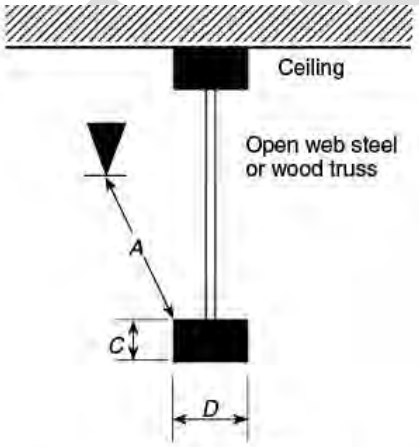
Figure 10.2.7.2.1.3(a) Minimum Distance from an Obstruction in the Vertical Orientation (SSU/SSP).



Plan View of Column
(Obstruction in vertical orientation)

$A \geq 3C$ or $3D$
(Use dimension C or D, whichever is greater)

Figure 10.2.7.2.1.3(b) Minimum Distance from an Obstruction in the Horizontal Orientation (SSU/SSP).



Elevation View of Truss
(Obstruction in horizontal orientation)

$A \geq 3C$ or $3D$
$A \leq 24$ in. (600 mm)
(Use dimension C or D, whichever is greater)

(A)
The maximum clear distance required shall be 24 in. (600 mm).

(B)
The maximum clear distance shall not be applied to obstructions in the vertical orientation (e.g., columns).

10.2.7.2.1.4*
For light and ordinary hazard occupancies, structural members only shall be considered when applying the requirements of 10.2.7.2.1.3.

10.2.7.2.1.5
Sprinklers shall be permitted to be spaced on opposite sides of the obstruction not exceeding 4 ft (1.2 m) in width, where the distance from the centerline of the obstruction to the sprinklers does not exceed one-half the allowable distance between sprinklers.

10.2.7.2.1.6
Sprinklers shall be permitted to be located one-half the distance between the obstructions where the obstruction consists of open trusses 20 in. (500 mm) or greater apart [24 in. (600 mm) on center], provided that all truss members are not greater than 4 in. (100 mm) (nominal) in width.

10.2.7.2.1.7
Sprinklers shall be permitted to be installed on the centerline of a truss or bar joist or directly above a beam, provided that the truss chord or beam dimension is not more than 8 in. (200 mm) and the sprinkler deflector is located at least 6 in. (150 mm) above the structural member and where the sprinkler is positioned at a distance three times greater than the maximum dimension of the web members away from the web members.

10.2.7.2.1.8
The requirements of 10.2.7.2.1.3 shall not apply to sprinkler system piping less than 3 in. (80 mm) in diameter.

10.2.7.2.1.9
The requirements of 10.2.7.2.1.3 shall not apply to sprinklers positioned with respect to obstructions in accordance with 10.2.7.1.2.

10.2.7.2.1.10*
Sprinklers shall be permitted to be placed without regard to the blades of ceiling fans less than 60 in. (1.5 m) in diameter, provided the plan view of the fan is at least 50 percent open.

10.2.7.2.2 Suspended or Floor-Mounted Vertical Obstructions.
The distance from sprinklers to privacy curtains, freestanding partitions, room dividers, and similar obstructions in light hazard occupancies shall be in accordance with Table 10.2.7.2.2 and Figure 10.2.7.2.2.

Table 10.2.7.2.2 Suspended or Floor-Mounted Obstructions in Light Hazard Occupancies Only (SSU/SSP)

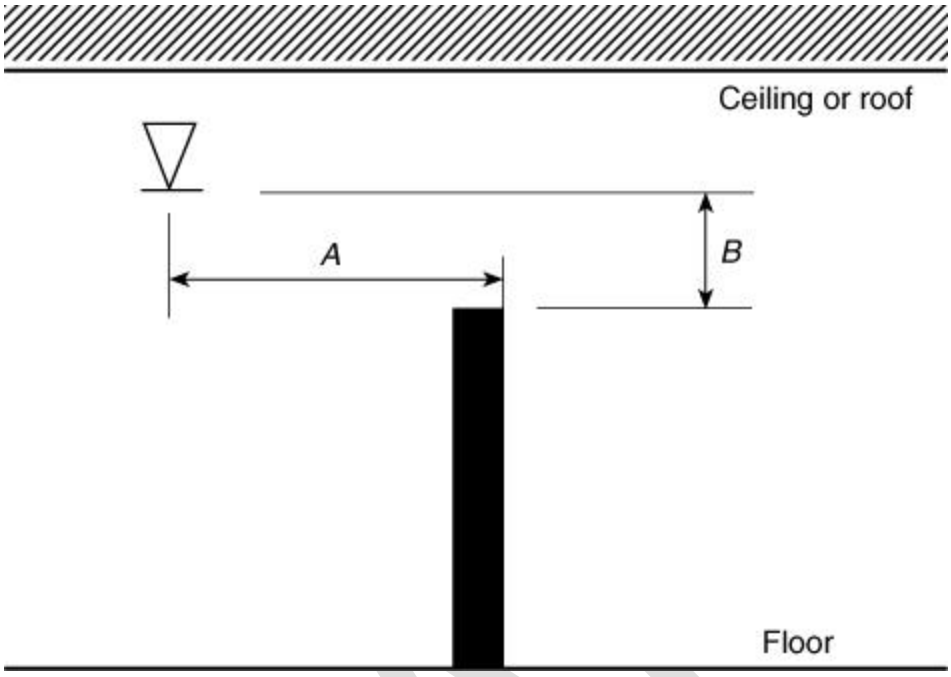
Horizontal Distance *(A)*	Minimum Vertical Distance Below Deflector *(B)* [in. (mm)]
6 in. (150 mm) or less	3 (75)
9 in. (225 mm) or less	4 (100)
12 in. (300 mm) or less	6 (150)
15 in. (375 mm) or less	8 (200)
18 in. (400 mm) or less	9½ (240)
24 in. (600 mm) or less	12½ (315)
30 in. (750 mm) or less	15½ (395)
More than 30 in. (750 mm)	18 (450)

For SI units, 1 in. = 25.4 mm.

Note: For *A* and *B*, refer to Figure 8.6.5.2.2.

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Figure 10.2.7.2.2 Suspended or Floor-Mounted Obstruction in Light Hazard Occupancies Only (SSU/SSP).



10.2.7.2.2.1*
In light hazard occupancies, privacy curtains, as shown in Figure 10.2.7.2.2, shall not be considered obstructions where all of the following are met:

(1) The curtains are supported by fabric mesh on ceiling track.

(2) Openings in the mesh are equal to 70 percent or greater.

(3) The mesh extends a minimum of 22 in. (550 mm) down from ceiling.

10.2.7.3* Obstructions that Prevent Sprinkler Discharge from Reaching Hazard.

10.2.7.3.1
Continuous or noncontinuous obstructions that interrupt the water discharge in a horizontal plane more than 18 in. (450 mm) below the sprinkler deflector in a manner to limit the distribution from reaching the protected hazard shall comply with 10.2.7.3.

10.2.7.3.2*
Sprinklers shall be installed under fixed obstructions over 4 ft (1.2 m) wide.

10.2.7.3.3
Sprinklers installed under open gratings shall be of the intermediate level/rack storage type or otherwise shielded from the discharge of overhead sprinklers.

10.2.7.3.4
The deflector of automatic sprinklers installed under fixed obstructions shall be positioned no more than 12 in. (300 mm) below the bottom of the obstruction.

10.2.7.3.5
Sprinklers installed under round ducts shall be of the intermediate level/rack storage type or otherwise shielded from the discharge of overhead sprinklers.

10.2.8 Clearance to Storage (Standard Pendent and Upright Spray Sprinklers).

10.2.8.1
The clearance between the deflector and the top of storage shall be 18 in. (450 mm) or greater.

10.2.8.2
Where other standards specify greater clearance to storage minimums, they shall be followed.

10.2.9 Ceiling Pockets (Standard Pendent and Upright Spray Sprinklers).

10.2.9.1*
Except as provided in 10.2.9.2 and 10.2.9.3, sprinklers shall be required in all ceiling pockets.

10.2.9.2
Sprinklers shall not be required in ceiling pockets where all of the following are met:
(1) The total volume of the unprotected ceiling pocket does not exceed 1000 ft^3 (28 m^3).

(2) The depth of the unprotected ceiling pocket does not exceed 36 in. (900 mm).

(3) The entire floor under the unprotected ceiling pocket is protected by sprinklers at the lower ceiling elevation.

(4) *The total size of all unprotected ceiling pockets in the same compartment within 10 ft (3 m) of each other does not exceed 1000 ft^3 (28 m^3).

(5) The unprotected ceiling pocket has noncombustible or limited-combustible finishes.

(6) Quick-response sprinklers are utilized throughout the compartment.

10.2.9.3
Sprinklers shall not be required in skylights and similar pockets in accordance with 9.3.17.

10.3 Sidewall Standard Spray Sprinklers.

10.3.1 General.
All requirements of Section 9.5 shall apply to sidewall standard spray sprinklers except as modified in Section 10.3.

10.3.2 Sidewall Spray Sprinklers.
Sidewall sprinklers shall only be installed as follows:
(1) Light hazard occupancies with smooth, horizontal or sloped, flat ceilings

(2) Ordinary hazard occupancies with smooth, flat ceilings where specifically listed for such use

(3) To protect areas below overhead doors

(4) At the top and bottom of elevator hoistways

(5) For the protection of steel building columns

10.3.3 Protection Areas per Sprinkler (Standard Sidewall Spray Sprinklers).

10.3.3.1 Determination of Protection Area of Coverage.

10.3.3.1.1
The protection area of coverage per sprinkler (A_s) shall be determined as follows:
(1) Along the wall as follows:
(a) Determine the distance between sprinklers along the wall (or to the end wall or obstruction in the case of the end sprinkler on the branch line) upstream and downstream

(b) Choose the larger of either twice the distance to the end wall or the distance to the next sprinkler

(c) Define dimension as *S*

(2) Across the room as follows:

(a) Determine the distance from the wall on which the sprinkler is installed to the wall opposite the sprinklers or to the midpoint of the room where sprinklers are installed on two opposite walls *(see 10.3.4.1.5 and 10.3.4.1.6)*

(b) Define dimension as *L*

10.3.3.1.2
The protection area of the sprinkler shall be established by multiplying the *S* dimension by the *L* dimension, as follows:

$$A_s = S \times L$$ **[10.7.2.1.2]**

10.3.3.2 Maximum Protection Area of Coverage.

10.3.3.2.1
The maximum allowable protection area of coverage for a sprinkler (A_s) shall be in accordance with the value indicated in Table 10.3.3.2.1.

Table 10.3.3.2.1 Protection Areas and Maximum Spacing (Standard Sidewall Spray Sprinkler)

	Light Hazard		Ordinary Hazard	
	Combustible Ceiling Finish	**Noncombustible or Limited-Combustible Ceiling Finish**	**Combustible Ceiling Finish**	**Noncombustible or Limited-Combustible Ceiling Finish**
Maximum distance along the wall *(S)* (ft) [m]	14 [4.3]	14 [4.3]	10 [3.0]	10 [3.0]
Maximum room width *(L)* (ft) [m]	12 [3.7]	14 [4.3]	10 [3.0]	10 [3.0]
Maximum protection area (ft^2) [m^2]	120 [11.1]	196 [18.2]	80 [7.4]	100 [9.3]

10.3.3.2.2
In any case, the maximum area of coverage of a sprinkler shall not exceed 196 ft^2 (18.2 m^2).

10.3.4 Sprinkler Spacing (Standard Sidewall Spray Sprinklers).

10.3.4.1 Maximum Distance Between Sprinklers.

10.3.4.1.1
The maximum distance permitted between sidewall spray sprinklers shall be based on the centerline distance between sprinklers on the branch line.

10.3.4.1.2
The maximum distance between sidewall spray sprinklers or to a wall shall be measured along the slope of the ceiling.

10.3.4.1.3
Where sidewall spray sprinklers are installed along the length of a single wall of rooms or bays, they shall be spaced in accordance with the maximum spacing provisions of Table 10.3.3.2.1.

10.3.4.1.4
Sidewall spray sprinklers shall not be installed back-to-back without being separated by a continuous lintel or soffit.

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10.3.4.1.4.1
The maximum width of the lintel or soffit shall not exceed 16 in. (400 mm).

10.3.4.1.4.2
The maximum width of the lintel or soffit can exceed 16 in. (400 mm) when a pendent sprinkler is installed under the lintel or soffit.

10.3.4.1.5
Where sidewall spray sprinklers are installed on two opposite walls or sides of bays, the maximum width of the room or bay shall be permitted to be up to 24 ft (7.3 m) for light hazard occupancy or 20 ft (6.1 m) for ordinary hazard occupancy, with spacing as required by Table 10.3.3.2.1.

10.3.4.1.6
Sidewall spray sprinklers shall be permitted to be installed on opposing or adjacent walls, provided no sprinkler is located within the maximum protection area of another sprinkler.

10.3.4.1.7
Where sidewall standard spray sprinklers are installed to protect areas below overhead doors within ordinary hazard occupancy spaces or rooms, protection area and maximum sprinkler spacing for light hazard as specified in Table 10.3.3.2.1 shall be permitted under the overhead doors.

10.3.4.2 Maximum Distance from Walls.
The distance from sprinklers to the end walls shall not exceed one-half of the allowable distance permitted between sprinklers as indicated in Table 10.3.3.2.1.

10.3.4.3 Minimum Distance from Walls.

10.3.4.3.1
Sprinklers shall be located a minimum of 4 in. (100 mm) from an end wall.

10.3.4.4 Minimum Distance Between Sprinklers.
Sprinklers shall be spaced not less than 6 ft (1.8 m) on center unless required by 10.3.5.1.3.1 or unless the sprinklers are separated by baffles that comply with the following:
(1) Baffles shall be arranged to protect the actuating elements.
(2) Baffles shall be of solid and rigid material that will stay in place before and during sprinkler operation.
(3) Baffles shall be not less than 8 in. (200 mm) long and 6 in. (150 mm) high.
(4) The tops of baffles shall extend between 2 in. and 3 in. (50 mm and 75 mm) above the deflectors.
(5) The bottoms of baffles shall extend downward to a level at least even with the deflectors.

10.3.5 Deflector Position from Ceilings and Walls (Standard Sidewall Spray Sprinklers).

10.3.5.1 Distance Below Ceilings and from Walls.

10.3.5.1.1 Ceilings.

10.3.5.1.1.1
Unless the requirements of 10.3.5.1.1.2 are met, sidewall sprinkler deflectors shall be located not more than 6 in. (150 mm) or less than 4 in. (100 mm) from ceilings.

10.3.5.1.1.2
Horizontal sidewall sprinklers shall be permitted to be located in a zone 6 in. to 12 in. (150 mm to 300 mm) or 12 in. to 18 in. (300 mm to 450 mm) below noncombustible and limited-combustible ceilings where listed for such use.

10.3.5.1.2 Walls.

10.3.5.1.2.1*
Vertical sidewall sprinkler deflectors shall be located not more than 6 in. (150 mm) or less than 4 in. (100 mm) from the wall from which they are projecting.

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10.3.5.1.2.2
Horizontal sidewall sprinkler deflectors shall be located no more than 6 in. (150 mm), and shall be permitted to be located with their deflectors less than 4 in. (100 mm), from the wall on which they are mounted.

10.3.5.1.3 Lintels and Soffits.

10.3.5.1.3.1
Where soffits used for the installation of sidewall sprinklers exceed 8 in. (200 mm) in width or projection from the wall, additional sprinklers shall be installed below the soffit.

10.3.5.1.3.2*
Where soffits used for the installation of sidewall sprinklers are less than or equal to 8 in. (200 mm) in width or projection from the wall, additional sprinklers shall not be required below the soffit when the sidewall sprinkler is installed on the soffit.

10.3.5.1.3.3*
A sidewall sprinkler shall be permitted to be installed under a soffit when both the minimum distance from the sprinkler deflector to the bottom of the soffit and maximum distance from the sprinkler deflector to the high ceiling is maintained.

10.3.5.1.4* Soffits and Cabinets.
Where soffits are used for the installation of sidewall sprinklers, the sprinklers and soffits shall be installed in accordance with 10.3.5.1.4.1, 10.3.5.1.4.2, or 10.3.5.1.4.3.

10.3.5.1.4.1
Where soffits exceed more than 8 in. (200 mm) in width or projection from the wall, pendent sprinklers shall be installed under the soffit.

10.3.5.1.4.2
Sidewall sprinklers shall be permitted to be installed in the face of a soffit located directly over cabinets, without requiring additional sprinklers below the soffit or cabinets, where the soffit does not project horizontally more than 12 in. (300 mm) from the wall.

10.3.5.1.4.3
Where sidewall sprinklers are more than 36 in. (900 mm) above the top of cabinets, the sprinkler shall be permitted to be installed on the wall above the cabinets where the cabinets are no greater than 12 in. (300 mm) from the wall.

10.3.5.2 Deflector Orientation.

10.3.5.2.1
Sidewall sprinklers, where installed under a sloped ceiling with a slope exceeding 2 in 12, shall be located at the high point of the slope and positioned to discharge downward along the slope.

10.3.6 Obstructions to Sprinkler Discharge (Standard Sidewall Spray Sprinklers).

10.3.6.1 Performance Objective.

10.3.6.1.1
Sprinklers shall be located so as to minimize obstructions to discharge as defined in 9.5.5.2 and 9.5.5.3, or additional sprinklers shall be provided to ensure adequate coverage of the hazard.

10.3.6.1.2
Sidewall sprinklers shall not be installed less than 4 ft (1.2 m) from light fixtures or similar obstructions unless the requirements of 10.3.6.1.2.1 or 10.3.6.1.2.2 are met..

10.3.6.1.2.1
For obstructions such as light fixtures, where the greatest dimension of the obstruction is less than 2 ft (0.6 m), sidewall sprinklers shall be permitted to be installed at a minimum distance of three times the greatest dimension.

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10.3.6.1.2.2
The bottom of light fixtures and similar obstructions located less than 4 ft (1.2 m) from the sprinkler shall be above the plane of the sprinkler deflector.

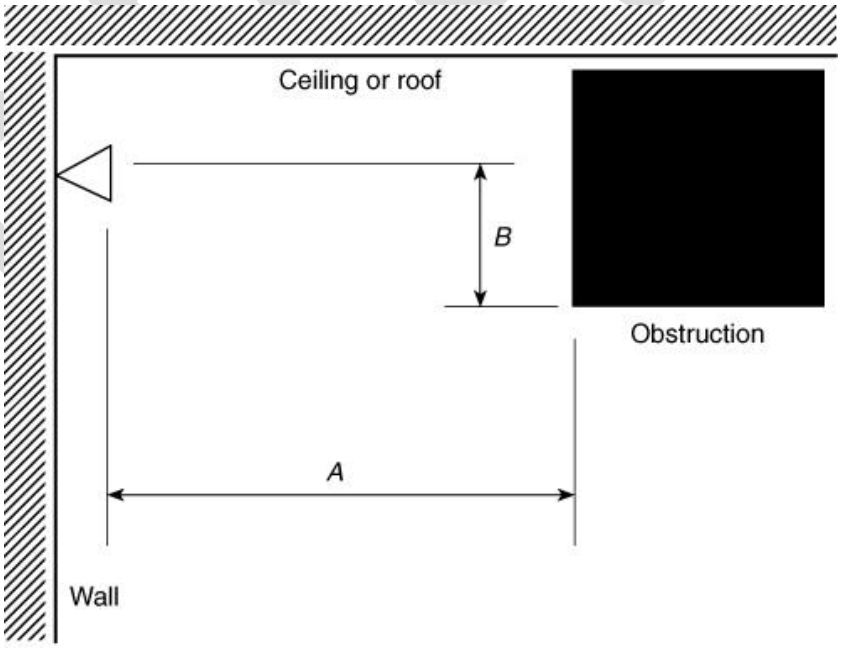
10.3.6.1.3
The distance between light fixtures or similar obstructions located 4 ft (1.2 m) or greater from the sprinkler shall be in conformity with Table 10.3.6.1.3 and Figure 10.3.6.1.3.

Table 10.3.6.1.3 Positioning of Sprinklers to Avoid Obstructions (Standard Sidewall Spray Sprinklers)

Distance from Sidewall Sprinkler to Side of Obstruction *(A)*	Maximum Allowable Distance of Deflector Above Bottom of Obstruction *(B)* [in. (mm)]
4 ft (1.2 m) to less than 5 ft (1.5 m)	1 (25)
5 ft (1.5 m) to less than 5 ft 6 in. (1.7 m)	2 (50)
5 ft 6 in. (1.7 m) to less than 6 ft (1.8 m)	3 (75)
6 ft (1.8 m) to less than 6 ft 6 in. (2.0 m)	4 (100)
6 ft 6 in. (2.0 m) to less than 7 ft (2.1 m)	6 (150)
7 ft (2.1 m) to less than 7 ft 6 in. (2.3 m)	7 (175)
7 ft 6 in. (2.3 m) to less than 8 ft (2.4 m)	9 (225)
8 ft (2.4 m) to less than 8 ft 6 in. (2.6 m)	11 (275)
8 ft 6 in. (2.6 m) or greater	14 (350)

Note: For *A* and *B*, refer to Figure 8.7.5.1.3.

Figure 10.3.6.1.3 Positioning of Sprinkler to Avoid Obstruction (Standard Sidewall Spray Sprinklers).



Elevation View

10.3.6.1.4

Obstructions projecting from the same wall as the one on which the sidewall sprinkler is mounted shall be in accordance with Table 10.3.6.1.4 and Figure 10.3.6.1.4.

Table 10.3.6.1.4 Positioning of Sprinklers to Avoid Obstructions Along Wall (Standard Sidewall Spray Sprinklers)

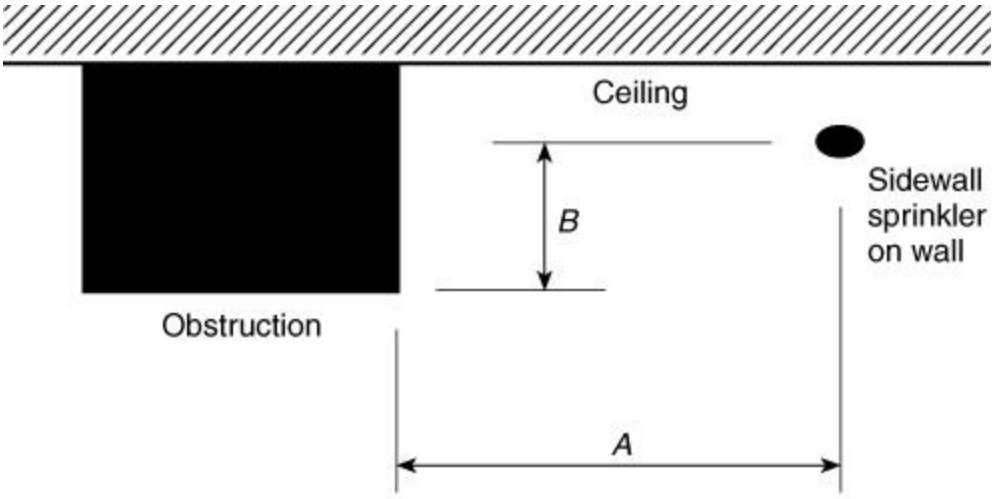
Distance from Sidewall Sprinkler to Side of Obstruction *(A)*	Maximum Allowable Distance of Deflector Above Bottom of Obstruction *(B)* [in. (mm)]
4 in.(100 mm) to less than 6 in. (150 mm)	1 (25)
6 in. (150 mm) to less than 1 ft (300 mm)	2 (50)
1 ft (300 mm) to less than 1 ft 6 in. (450 mm)	3 (75)
1 ft 6 in. (450 mm) to less than 2 ft (600 mm)	4½(115)
2 ft (600 mm) to less than 2 ft 6 in. (750 mm)	5¾(145)
2 ft 6 in. (750 mm) to less than 3 ft (900 mm)	7 (175)
3 ft (900 mm) to less than 3 ft 6 in. (1.1 m)	8 (200)
3 ft 6 in. (1.1 m) to less than 4 ft (1.2 m)	9¼(230)
4 ft (1.2 m) to less than 4 ft 6 in. (1.4 m)	10 (250)
4 ft 6 in. (1.4 m) to less than 5 ft (1.5 m)	11½(290)
5 ft (1.5 m) to less than 5 ft 6 in. (1.7 m)	12¾(325)
5 ft 6 in. (1.7 m) to less than 6 ft (1.8 m)	14 (350)
6 ft (1.8 m) to less than 6 ft 6 in. (2.0 m)	15 (380)
6 ft 6 in. (2.0 m) to less than 7 ft (2.2 m)	16¼(410)
7 ft (2.2 m) to less than 7 ft 6 in. (2.3 m)	17½(440)

For SI units, 1 in. = 25.4 mm; 1 ft = 0.3048 m.

Note: For *A* and *B*, refer to Figure 8.7.5.1.4.

Figure 10.3.6.1.4 Positioning of Sprinkler to Avoid Obstruction Along Wall (Standard Sidewall Spray Sprinklers).

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Elevation View

10.3.6.1.4.1
Isolated obstructions projecting from the same wall as the one on which the sidewall sprinkler is mounted shall be located a minimum of 4 in. (100 mm) from the sidewall sprinkler.

10.3.6.1.5
Sprinklers shall be permitted to be spaced on opposite sides of obstructions less than 4 ft (1.2 m) in width where the distance from the centerline of the obstruction to the sprinklers does not exceed one-half the allowable distance between sprinklers.

10.3.6.1.6*
Obstructions on the wall opposite from the sidewall sprinkler shall be permitted where the obstruction is up to 2 ft (600 mm) deep and 2 ft (600 mm) wide.

10.3.6.2 Obstructions to Sprinkler Discharge Pattern Development.

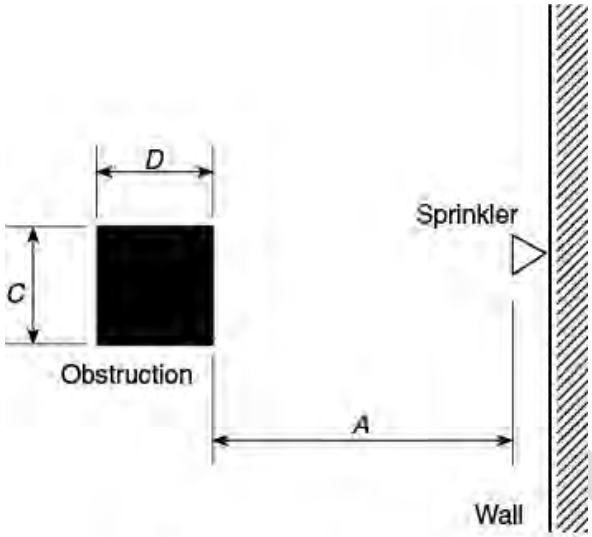
10.3.6.2.1 General.

10.3.6.2.1.1
Continuous or noncontinuous obstructions less than or equal to 18 in. (450 mm) below the sprinkler deflector that prevent the pattern from fully developing shall comply with this section.

10.3.6.2.1.2
Regardless of the rules of this section, solid continuous obstructions shall meet the requirements of 10.3.6.1.2 and 10.3.6.1.3.

10.3.6.2.1.3*
Unless the requirements of 10.3.6.2.1.4 or 10.3.6.2.1.5 are met, sprinklers shall be positioned away from obstructions a minimum distance of three times the maximum dimension of the obstruction (e.g., truss webs and chords, pipe, columns, and fixtures) in accordance with Figure 10.3.6.2.1.3(a) and Figure 10.3.6.2.1.3(b).

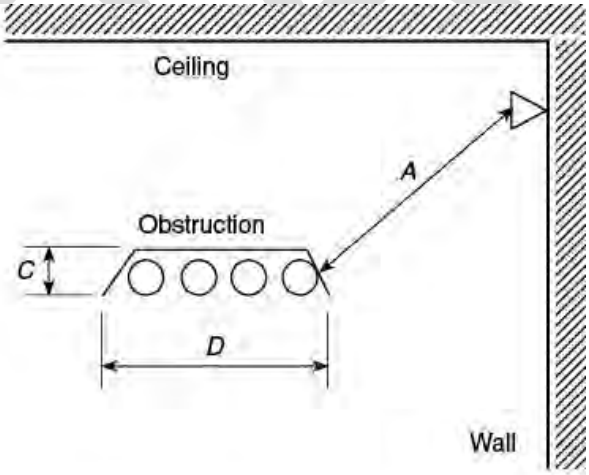
Figure 10.3.6.2.1.3(a) Minimum Distance from an Obstruction in the Vertical Orientation (Standard Sidewall Spray Sprinklers).



Plan View of Column
(Obstruction in vertical orientation)

$A \geq 3C$ or $3D$
(Use dimension C or D, whichever is greater)

Figure 10.3.6.2.1.3(b) Minimum Distance from an Obstruction in the Horizontal Orientation (Standard Sidewall Spray Sprinklers).



Elevation View of Pipe Conduit or Light Fixture

$A \geq 3C$ or $3D$
$A \leq 24$ in. (600 mm)
(Use dimension C or D, whichever is greater)

(A)

The maximum clear distance required to obstructions in the horizontal orientation (e.g., light fixtures and truss chords) shall be 24 in. (600 mm).

(B)
The maximum clear distance shall not be applied to obstructions in the vertical orientation (e.g., columns).

10.3.6.2.1.4
The requirements of 10.3.6.2.1.3 shall not apply to sprinkler system piping less than 3 in. (80 mm) in diameter.

10.3.6.2.1.5
The requirements of 10.3.6.2.1.3 shall not apply where sprinklers are positioned with respect to obstructions in accordance with 10.3.6.1.2, 10.3.6.1.3, and 10.3.6.1.4.

10.3.6.2.1.6*
Sprinklers shall be permitted to be placed without regard to the blades of ceiling fans less than 60 in. (1.5 m) in diameter, provided the plan view of the fan is at least 50 percent open.

10.3.6.2.2 Suspended or Floor-Mounted Vertical Obstructions.
The distance from sprinklers to privacy curtains, free-standing partitions, room dividers, and similar obstructions in light hazard occupancies shall be in accordance with Table 10.3.6.2.2 and Figure 10.3.6.2.2.

Table 10.3.6.2.2 Suspended or Floor-Mounted Obstructions (Standard Sidewall Spray Sprinklers) in Light Hazard Occupancies Only

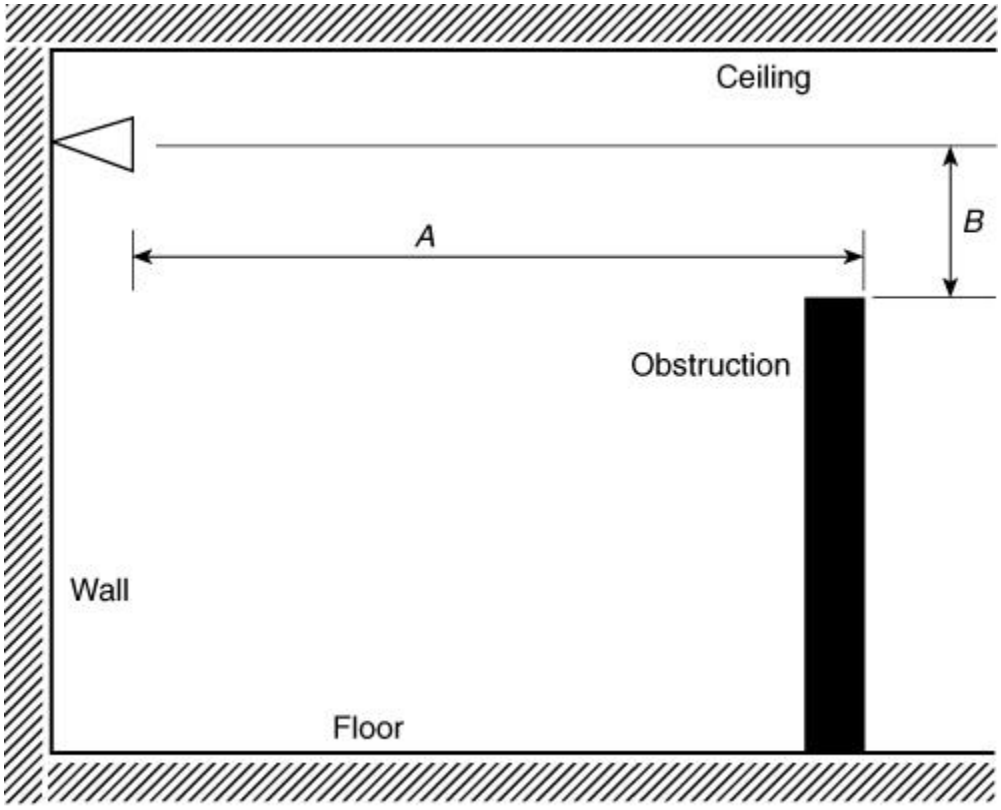
Horizontal Distance *(A)*	Minimum Vertical Distance Below Deflector *(B)*[in. (mm)]
6 in. (150 mm) or less	3 (75)
More than 6 in. (150 mm) to 9 in. (225 mm)	4 (100)
More than 9 in. (225 mm) to 12 in. (300 mm)	6 (150)
More than 12 in. (300 mm) to 15 in. (375 mm)	8 (200)
More than 15 in. (375 mm) to 18 in. (450 mm)	9½ (240)
More than 18 in. (450 mm) to 24 in. (600 mm)	12½ (315)
More than 24 in. (600 mm) to 30 in. (750 mm)	15½ (390)
More than 30 in. (750 mm)	18 (450)

For SI units, 1 in. = 25.4 mm.

Note: For *A* and *B*, refer to Figure 8.7.5.2.2.

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Figure 10.3.6.2.2 Suspended or Floor-Mounted Obstruction (Standard Sidewall Spray Sprinklers) in Light Hazard Occupancy Only.



Elevation View

10.3.6.2.2.1*
In light hazard occupancies, privacy curtains, as shown in Figure 10.3.6.2.2, shall not be considered obstructions where all of the following are met:
(1) The curtains are supported by fabric mesh on ceiling track.
(2) Openings in the mesh are equal to 70 percent or greater.
(3) The mesh extends a minimum of 22 in. (550 mm) down from ceiling.

10.3.6.3* Obstructions that Prevent Sprinkler Discharge from Reaching Hazard.

10.3.6.3.1
Continuous or noncontinuous obstructions that interrupt the water discharge in a horizontal plane more than 18 in. (450 mm) below the sprinkler deflector in a manner to limit the distribution from reaching the protected hazard shall comply with this section.

10.3.6.3.2*
Sprinklers shall be installed under fixed obstructions over 4 ft (1.2 m) wide.

10.3.7* Clearance to Storage (Standard Sidewall Spray Sprinklers).

10.3.7.1
The clearance between the deflector and the top of storage shall be 18 in. (450 mm) or greater.

10.3.7.2
The 18 in. (450 mm) dimension shall not limit the height of shelving on a wall or shelving against a wall in accordance with 10.3.7.

10.3.7.2.1
Where shelving is installed on a wall and is not directly below sprinklers, the shelves, including storage thereon, shall be permitted to extend above the level of a plane located 18 in. (450 mm) below ceiling sprinkler deflectors.

10.3.7.2.2
Shelving, and any storage thereon, directly below the sprinklers shall not extend above a plane located 18 in. (450 mm) below the ceiling sprinkler deflectors.

Chapter 11 Installation Requirements for Extended Coverage Upright, Pendent, Sidewall Spray Sprinkler

11.1 General.
Extended coverage pendent, upright, and sidewall sprinklers shall be selected for use and installation as indicated in this chapter and shall be positioned and spaced in accordance with Section 9.5.

11.2 Extended Coverage Upright and Pendent Spray Sprinklers.

11.2.1 Extended Coverage Sprinklers.
Extended coverage sprinklers shall only be installed as follows:
(1) In unobstructed construction consisting of flat, smooth ceilings with a slope not exceeding a pitch of 1 in 6 (a rise of 2 units in a run of 12 units, a roof slope of 16.7 percent)

(2) In unobstructed or noncombustible obstructed construction, where specifically listed for such use

(3) Within trusses or bar joists having web members not greater than 1 in. (25 mm) maximum dimension or where trusses are spaced greater than 7½ ft (2.3 m) on center and where the ceiling slope does not exceed a pitch of 1 in 6 (a rise of 2 units in a run of 12 units, a roof slope of 16.7 percent)

(4) Extended coverage upright and pendent sprinklers installed under smooth, flat ceilings that have slopes not exceeding a pitch of 1 in 3 (a rise of 4 units in a run of 12 units, a roof slope of 33.3 percent), where specifically listed for such use

(5) Extended coverage sidewall sprinklers installed in accordance with 11.3.5.2.1 in slopes exceeding a ceiling pitch of 2 in 12

(6) In each bay of obstructed construction consisting of solid structural members that extend below the deflector of the sprinkler

(7) Extended coverage sprinklers installed to protect areas below a single overhead door(s)

11.2.2 Protection Areas per Sprinkler (Extended Coverage Upright and Pendent Spray Sprinklers).

11.2.2.1* Determination of Protection Area of Coverage.

11.2.2.1.1
The protection area of coverage (A_s) for extended coverage sprinklers shall be not less than that prescribed by the listing.

11.2.2.1.2
Listing dimensions shall be even-numbered square protection areas as shown in Table 11.2.2.1.2.

Table 11.2.2.1.2 Protection Areas and Maximum Spacing (Extended Coverage Upright and Pendent Spray Sprinklers)

Construction Type	Light Hazard		Ordinary Hazard		Extra Hazard		High-Piled Storage	
	Protection Area ft²(m²)	Spacing ft(m)	Protection Area ft²(m²)	Spacing ft(m)	Protection Area ft²(m²)	Spacing ft(m)	Protection Area ft²(m²)	Spacing ft(m)
Unobstructed	400 (37)	20 (6.1)	400 (37)	20 (6.1)	—	—	—	—
	324 (30)	18 (5.5)	324 (30)	18 (5.5)	—	—	—	—
	256 (23.8)	16 (4.9)	256 (23.8)	16 (4.9)	—	—	—	—
	—	—	196 (18.2)	14 (4.3)	196 (18.2)	14 (4.3)	196 (18.2)	14 (4.3)
	—	—	144 (13.4)	12 (3.7)	144 (13.4)	15 (4.6)	144 (13.4)	15 (4.6)
Obstructed noncombustible (when specifically listed for such use)	400 (37)	20 (6.1)	400 (37)	20 (6.1)	—	—	—	—
	324 (30)	18 (5.5)	324 (30)	18 (5.5)	—	—	—	—
	256 (23.8)	16 (4.9)	256 (23.8)	16 (4.9)	—	—	—	—
	—	—	196 (18.2)	14 (4.3)	196 (18.2)	14 (4.3)	196 (18.2)	14 (4.3)
	—	—	144 (13.4)	12 (3.7)	144 (13.4)	15 4.6	144 (13.4)	15 (4.6)
Obstructed combustible	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

For SI units, 1 ft = 0.3048 m; 1 ft² = 0.0929 m².

11.2.2.1.3
Determination of the protection area of coverage and sprinkler spacing for sprinklers listed for extended coverage extra hazard or high-piled storage shall be permitted to be spaced in accordance with the requirements of 9.5.2 and 9.5.3 and shall not exceed 14 ft (4.3 m) maximum spacing and 196 ft² (18.2 m²) maximum area per sprinkler or 15 ft (4.6 m) maximum spacing and 144 ft² (13.5 m²) maximum area per sprinkler.

11.2.2.2 Maximum Protection Area of Coverage.

11.2.2.2.1*
The maximum allowable area of coverage for a sprinkler (A_s) shall be in accordance with the value indicated in Table 11.2.2.1.2.

11.2.2.2.2
In any case, the maximum area of coverage of a sprinkler shall not exceed 400 ft² (37 m²).

11.2.3 Sprinkler Spacing (Extended Coverage Upright and Pendent Spray Sprinklers).

11.2.3.1 Maximum Distance Between Sprinklers.

11.2.3.1.1
The maximum distance permitted between sprinklers shall be based on the centerline distance between sprinklers on the branch line or on adjacent branch lines.

11.2.3.1.2
The maximum distance shall be measured along the slope of the ceiling.

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11.2.3.1.3
The maximum distance permitted between sprinklers shall comply with Table 11.2.2.1.2.

11.2.3.2 Maximum Distance from Walls.

11.2.3.2.1
The distance from sprinklers to walls shall not exceed one-half of the allowable distance permitted between sprinklers as indicated in Table 11.2.2.1.2.

11.2.3.2.2
The distance from the wall to the sprinkler shall be measured perpendicular to the wall.

11.2.3.2.3
Where walls are angled or irregular, the maximum horizontal distance between a sprinkler and any point of floor area protected by that sprinkler shall not exceed 0.75 times the allowable distance permitted between sprinklers.

11.2.3.3 Minimum Distance from Walls.
Sprinklers shall be located a minimum of 4 in. (100 mm) from a wall unless listed for distances less than 4 in. (100 mm).

11.2.3.4 Minimum Distance Between Sprinklers.

11.2.3.4.1
Unless the requirements of 11.2.3.4.2 are met, sprinklers shall be spaced not less than 8 ft (2.4 m) on center.

11.2.3.4.2
Sprinklers shall be permitted to be placed less than 8 ft (2.4 m) on center where the following conditions are satisfied:
(1) Baffles shall be arranged to protect the actuating elements.

(2) Baffles shall be of solid and rigid material that will stay in place before and during sprinkler operation.

(3) Baffles shall be not less than 8 in. (200 mm) long and 6 in. (150 mm) high.

(4) The tops of baffles shall extend between 2 in. and 3 in. (50 mm and 75 mm) above the deflectors of upright sprinklers.

(5) The bottoms of baffles shall extend downward to a level at least even with the deflectors of pendent sprinklers.

11.2.4 Deflector Position (Extended Coverage Upright and Pendent Spray Sprinklers).

11.2.4.1 Distance Below Ceilings.

11.2.4.1.1 Unobstructed Construction.

11.2.4.1.1.1
Under unobstructed construction, the distance between the sprinkler deflector and the ceiling shall be a minimum of 1 in. (25 mm) and a maximum of 12 in. (300 mm) throughout the area of coverage of the sprinkler.

11.2.4.1.1.2
The requirements of 11.2.4.1.1.1 shall not apply where ceiling-type sprinklers (concealed, recessed, and flush types) have the operating element above the ceiling and the deflector located nearer to the ceiling where installed in accordance with their listing.

11.2.4.1.1.3
The requirements of 11.2.4.1.1.1 shall not apply where sprinklers are listed for use under other ceiling construction features or for different distances where they shall be permitted to be installed in accordance with their listing.

11.2.4.1.1.4
The requirements of 11.2.4.1.1.1 shall not apply for light and ordinary hazard occupancies with ceilings of noncombustible or limited-combustible construction.

(A)*
Where a vertical change in ceiling elevation within the area of coverage of the sprinkler creates a distance of more than 36 in. (900 mm) between the upper ceiling and the sprinkler deflector, a vertical plane extending down from the ceiling at the change in elevation shall be considered a wall for the purpose of sprinkler spacing.

(B)*
Where the distance between the upper ceiling and the sprinkler deflector is less than or equal to 36 in. (900 mm), the sprinklers shall be permitted to be spaced as though the ceiling were flat, provided the obstruction rules are observed.

11.2.4.1.2 Obstructed Construction.
Under obstructed construction, the sprinkler deflector shall be located in accordance with one of the following arrangements:
(1) Installed with the deflectors within the horizontal planes of 1 in. to 6 in. (25 mm to 150 mm) below noncombustible structural members and a maximum distance of 22 in. (550 mm) below the ceiling/roof deck

(2) Installed with the deflectors at or above the bottom of noncombustible structural member to a maximum of 22 in. (550 mm) below the noncombustible ceiling/roof deck where the sprinkler is installed in conformance with 11.2.5.1.2

(3) Installed in each bay of combustible or noncombustible obstructed construction, with the deflectors located a minimum of 1 in. (25 mm) and a maximum of 12 in. (300 mm) below the ceiling

(4) Installed in accordance with their listing where sprinklers are listed for use under other ceiling construction features or for different distances

11.2.4.1.3* Peaked Roofs and Ceilings.
Sprinklers under or near the peak of a roof or ceiling shall have deflectors located not more than 3 ft (900 mm) vertically down from the peak in accordance with Figure 10.2.6.1.3.1(a) and Figure 10.2.6.1.3.1(b).

11.2.4.2 Deflector Orientation.
Deflectors of sprinklers shall be aligned parallel to ceilings or roofs.

11.2.4.2.1
Roofs and ceilings having a pitch not exceeding 2 in 12 (16.7 percent) are considered horizontal in the application of 11.2.4.2, and sprinklers shall be permitted to be installed with deflectors horizontal.

11.2.5 Obstructions to Sprinkler Discharge (Extended Coverage Upright and Pendent Spray Sprinklers).

11.2.5.1 Performance Objective.

11.2.5.1.1
Sprinklers shall be located so as to minimize obstructions to discharge as defined in 11.2.5.2 and 11.2.5.3, or additional sprinklers shall be provided to ensure adequate coverage of the hazard.

11.2.5.1.2*
Sprinklers shall be arranged to comply with one of the following arrangements:
(1) Sprinklers shall be in accordance with 9.5.5.2, Table 11.2.5.1.2, and Figure 11.2.5.1.2(a).

(2) Sprinklers shall be permitted to be spaced on opposite sides of obstructions not exceeding 4 ft (1.2 m) in width provided the distance from the centerline of the obstruction to the sprinklers does not exceed one-half the allowable distance permitted between sprinklers.

(3) Obstructions located against the wall and that are not over 30 in. (750 mm) in width shall be permitted to be protected in accordance with Figure 11.2.5.1.2(b).

(4) Obstructions located against the wall and that are not over 24 in. (600 mm) in width shall be permitted to be protected in accordance with Figure 11.2.5.1.2(c). The maximum distance between the sprinkler and the wall shall be measured from the sprinkler to the wall behind the obstruction and not to the face of the obstruction.

Table 11.2.5.1.2 Position of Sprinklers to Avoid Obstructions to Discharge (Extended Coverage Upright and Pendent Spray Sprinklers)

Distance from Sprinklers to Side of Obstruction *(A)*	Maximum Allowable Distance of Deflector Above Bottom of Obstruction *(B)* [in. (mm)]
Less than 1 ft (300 m)	0 (0)
1 ft (300 m) to less than 1 ft 6 in. (450 m)	0 (0)
1 ft 6 in. (450 m) to less than 2 ft (600 m)	1 (25)
2 ft (600 m) to less than 2 ft 6 in. (750 m)	1 (25)
2 ft 6 in. (750 m) to less than 3 ft (900 m)	1 (25)
3 ft (900 m) to less than 3 ft 6 in. (1.1 m)	3 (75)
3 ft 6 in. (1.1 m) to less than 4 ft (1.2 m)	3 (75)
4 ft (1.2 m) to less than 4 ft 6 in. (1.4 m)	5 (125)
4 ft 6 in. (1.4 m) to less than 5 ft (1.5 m)	7 (175)
5 ft (1.5 m) to less than 5 ft 6 in. (1.7 m)	7 (175)
5 ft 6 in. (1.7 m) to less than 6 ft (1.8 m)	7 (175)
6 ft (1.8 m) to less than 6 ft 6 in. (2 m)	9 (225)
6 ft 6 in. (2 m) to less than 7 ft (2.1 m)	11 (275)
7 ft (2.1 m) to less than 7 ft 6 in. (2.3 m)	14 (350)
7 ft 6 in. (2.3 m) to less than 8 ft (2.4 m)	14 (350)
8 ft (2.4 m) to less than 8 ft 6 in. (2.6 m)	15 (375)
8 ft 6 in. (2.6 m) to less than 9 ft (2.7 m)	17 (425)

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Distance from Sprinklers to Side of Obstruction *(A)*	Maximum Allowable Distance of Deflector Above Bottom of Obstruction *(B)* [in. (mm)]
9 ft (2.7 m) to less than 9 ft 6 in. (2.9 m)	19 (475)
9 ft 6 (2.9 m) in. to less than 10 ft (3.0 m)	21 (525)

Note: For *A* and *B*, refer to Figure 8.8.5.1.2(a).

Figure 11.2.5.1.2(a) Position of Sprinkler to Avoid Obstruction to Discharge (Extended Coverage Upright and Pendent Spray Sprinklers).

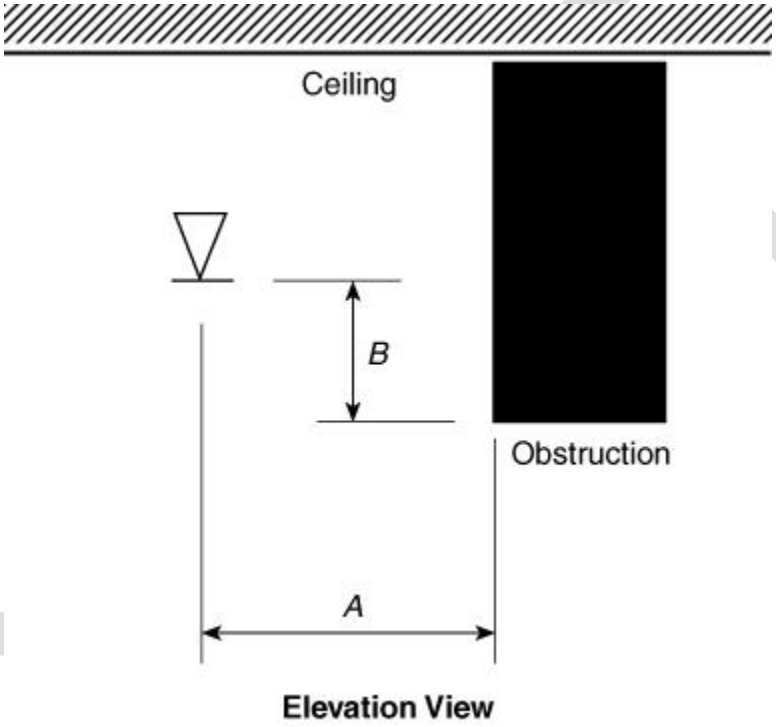


Figure 11.2.5.1.2(b) Obstructions Against Walls (Extended Coverage Upright and Pendent Spray Sprinklers).

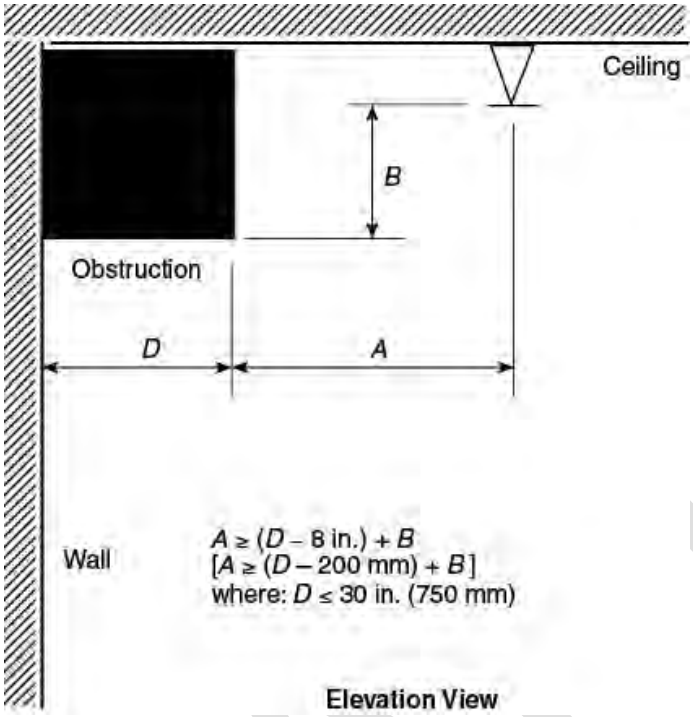
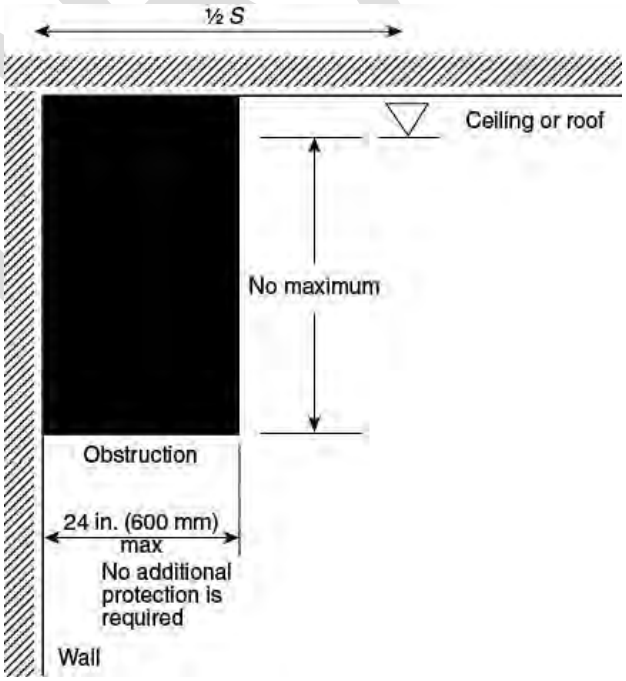


Figure 11.2.5.1.2(c) Obstructions Against Walls (Extended Coverage Upright and Pendent Spray Sprinklers).



11.2.5.2 Obstructions to Sprinkler Discharge Pattern Development.

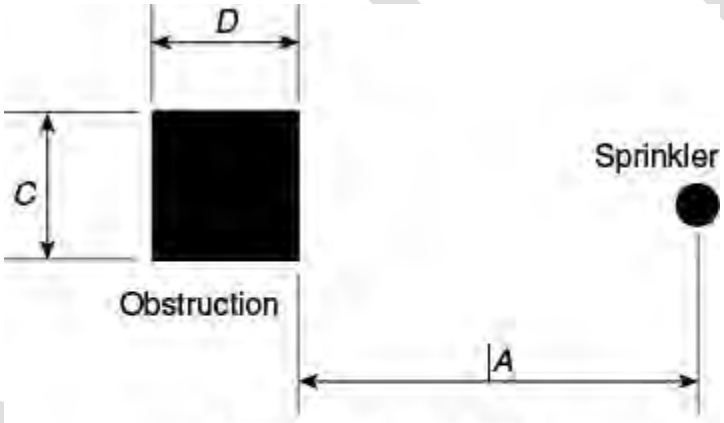
11.2.5.2.1 General.

11.2.5.2.1.1
Continuous or noncontinuous obstructions less than or equal to 18 in. (450 mm) below the sprinkler deflector that prevent the pattern from fully developing shall comply with 11.2.5.2.

11.2.5.2.1.2
Regardless of the rules of this section, solid continuous obstructions shall meet the applicable requirements of 11.2.5.1.2.

11.2.5.2.1.3*
Unless the requirements of 11.2.5.2.1.4 through 11.2.5.2.1.8 are met, sprinklers shall be positioned away from obstructions a minimum distance of four times the maximum dimension of the obstruction (e.g., truss webs and chords, pipe, columns, and fixtures) in accordance with Figure 11.2.5.2.1.3(a) and Figure 11.2.5.2.1.3(b).

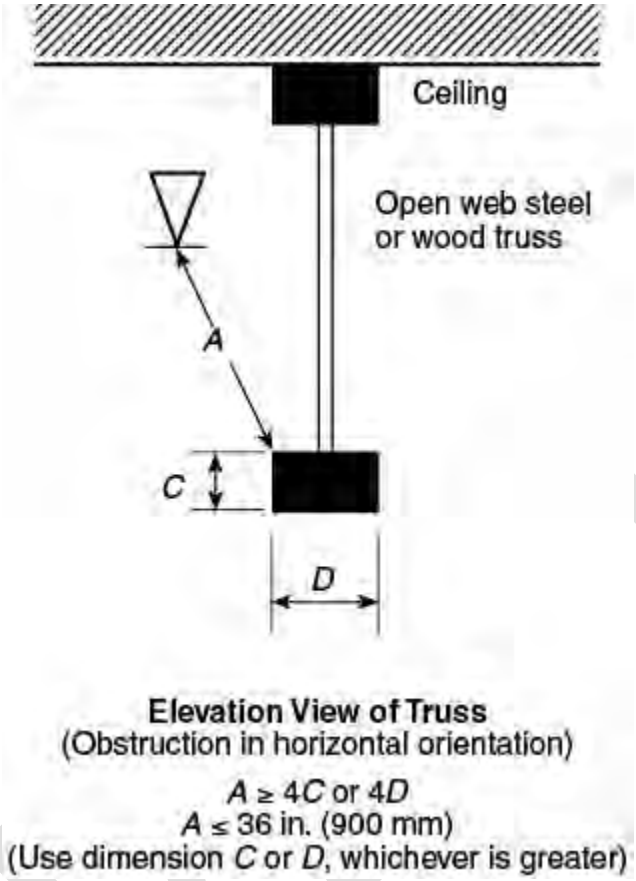
Figure 11.2.5.2.1.3(a) Minimum Distance from an Obstruction in the Vertical Orientation (Extended Coverage Upright and Pendent Spray Sprinkler).



Plan View of Column
(Obstruction in vertical orientation)

$A \geq 4C$ or $4D$
(Use dimension C or D, whichever is greater)

Figure 11.2.5.2.1.3(b) Minimum Distance from an Obstruction in the Horizontal Orientation (Extended Coverage Upright and Pendent Spray Sprinkler).



(A)
The maximum clear distance required to obstructions in the horizontal orientation (e.g., light fixtures and truss chords) shall be 36 in. (900 mm).

(B)
The maximum clear distance shall not be applied to obstructions in the vertical orientation (e.g., columns).

11.2.5.2.1.4
Sprinklers shall be permitted to be spaced on opposite sides of the obstruction where the distance from the centerline of the obstruction to the sprinklers does not exceed one-half the allowable distance between sprinklers.

11.2.5.2.1.5
Sprinklers shall be permitted to be located one-half the distance between the obstructions where the obstruction consists of wood bar joists 20 in. (500 mm) or greater apart, provided that the top and bottom chords of the wood bar joist are not greater than 4 in. (100 mm) (nominal) in width and bar members do not exceed 1 in. (25 mm) in width.

11.2.5.2.1.6
Sprinklers shall be permitted to be installed on the centerline of a truss or bar joist or directly above a beam, provided that the truss chord or beam, dimension is not more than 8 in. (200 mm) and the sprinkler deflector is located at least 6 in. (150 mm) above the structural member and where the sprinkler is positioned at a distance four times greater than the maximum dimension of the web members away from the web members.

11.2.5.2.1.7

The requirements of 11.2.5.2.1.3 shall not apply to sprinkler system piping less than 3 in. (80 mm) in diameter.

11.2.5.2.1.8
The requirements of 11.2.5.2.1.3 shall not apply to sprinklers positioned with respect to obstructions in accordance with 11.2.5.1.2.

11.2.5.2.1.9*
Sprinklers shall be permitted to be placed without regard to the blades of ceiling fans less than 60 in. (1.5 m) in diameter, provided the plan view of the fan is at least 50 percent open.

11.2.5.2.2 Suspended or Floor-Mounted Vertical Obstructions.
The distance from sprinklers to privacy curtains, freestanding partitions, room dividers, and similar obstructions in light hazard occupancies shall be in accordance with Table 11.2.5.2.2 and Figure 11.2.5.2.2.

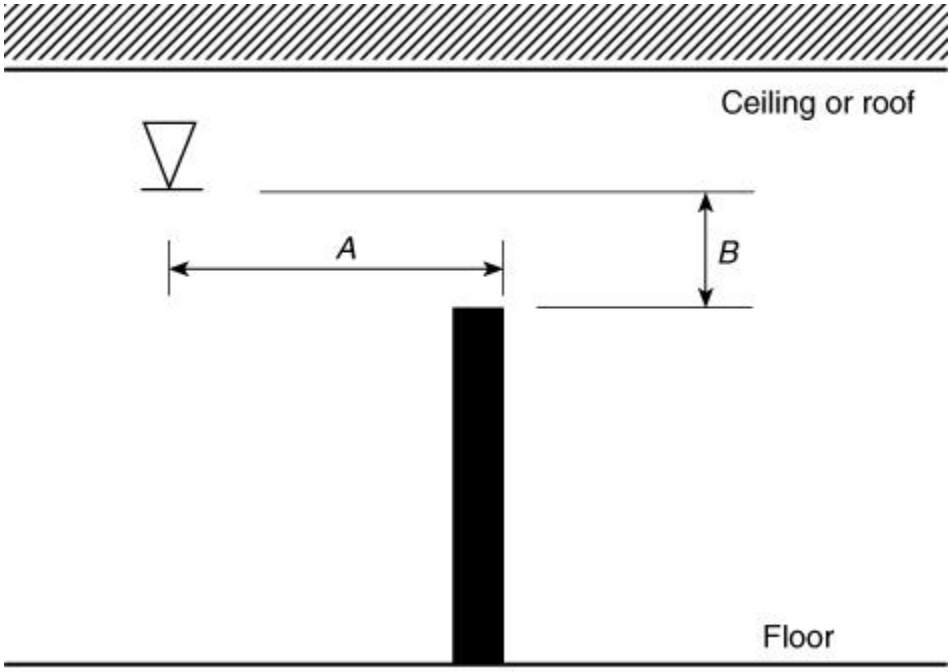
Table 11.2.5.2.2 Suspended or Floor-Mounted Obstructions (Extended Coverage Upright and Pendent Spray Sprinklers) in Light Hazard Occupancies Only

Horizontal Distance *(A)*	Minimum Vertical Distance Below Deflector *(B)* [in. (mm)]
6 in. (150 mm) or less	3 (75)
More than 6 in. (150 mm) to 9 in. (225 mm)	4 (100)
More than 9 in. (225 mm) to 12 in. (300 mm)	6 (150)
More than 12 in. (300 mm) to 15 in. (375 mm)	8 (200)
More than 15 in. (375 mm) to 18 in. (450 mm)	9½ (240)
More than 18 in. (450 mm) to 24 in. (600 mm)	12½(315)
More than 24 in. (600 mm) to 30 in. (750 mm)	15½(390)
More than 30 in. (750 mm)	18 (450)

Note: For *A* and *B*, refer to Figure 8.8.5.2.2.

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Figure 11.2.5.2.2 Suspended or Floor-Mounted Obstruction (Extended Coverage Upright and Pendent Spray Sprinklers) in Light Hazard Occupancy Only.



Elevation View

11.2.5.2.2.1
In light hazard occupancies, privacy curtains, as shown in **Figure 11.2.5.2.2**, shall not be considered obstructions where all of the following are met:
(1) The curtains are supported by fabric mesh on ceiling track.

(2) Openings in the mesh are equal to 70 percent or greater.

(3) The mesh extends a minimum of 22 in. (550 mm) down from ceiling.

11.2.5.3* Obstructions that Prevent Sprinkler Discharge from Reaching Hazard.

11.2.5.3.1
Continuous or noncontinuous obstructions that interrupt the water discharge in a horizontal plane more than 18 in. (450 mm) below the sprinkler deflector in a manner to limit the distribution from reaching the protected hazard shall comply with 11.2.5.3.

11.2.5.3.2*
Sprinklers shall be installed under fixed obstructions over 4 ft (1.2 m) wide.

11.2.5.3.3
Sprinklers shall not be required under obstructions that are not fixed in place such as conference tables.

11.2.5.3.4
Sprinklers installed under open gratings shall be of the intermediate level/rack storage type or otherwise shielded from the discharge of overhead sprinklers.

11.2.5.3.5
Sprinklers installed under round ducts shall be of the intermediate level/rack storage type or otherwise shielded from the discharge of overhead sprinklers.

11.2.6* Clearance to Storage (Extended Coverage Upright and Pendent Spray Sprinklers).

11.2.6.1
The clearance between the deflector and the top of storage shall be 18 in. (450 mm) or greater.

11.2.6.2
Where other standards specify greater clearance to storage minimums, they shall be followed.

11.2.7 Ceiling Pockets (Extended Coverage Upright and Pendent Spray Sprinklers).

11.2.7.1*
Except as provided in 11.2.7.3 and 11.2.7.4, sprinklers shall be required in all ceiling pockets.

11.2.7.2
The 18 in. (450 mm) dimension shall not limit the height of shelving on a wall or shelving against a wall in accordance with 11.2.7.

11.2.7.2.1
Where shelving is installed on a wall and is not directly below sprinklers, the shelves, including storage thereon, shall be permitted to extend above the level of a plane located 18 in. (450 mm) below ceiling sprinkler deflectors.

11.2.7.2.2
Shelving, and any storage thereon, directly below the sprinklers shall not extend above a plane located 18 in. (450 mm) below the ceiling sprinkler deflectors.

11.2.7.3
Sprinklers shall not be required in ceiling pockets where all of the following are met:
(1) The total volume of the unprotected ceiling pocket does not exceed 1000 ft^3 (28 m^3).

(2) The depth of the unprotected ceiling pocket does not exceed 36 in. (900 mm).

(3) The entire floor under the unprotected ceiling pocket is protected by sprinklers at the lower ceiling elevation.

(4) *The total size of all unprotected ceiling pockets in the same compartment within 10 ft (3 m) of each other does not exceed 1000 ft^3 (28 m^3).

(5) The unprotected ceiling pocket has noncombustible or limited-combustible finishes.

(6) Quick-response sprinklers are utilized throughout the compartment.

11.2.7.4
Sprinklers shall not be required in skylights and similar pockets in accordance with 9.3.17.

11.3* Extended Coverage Sidewall Spray Sprinklers.

11.3.1 General.
All requirements of Section 9.5 shall apply to extended coverage sidewall spray sprinklers except as modified in Section 11.3.

11.3.2
Extended coverage sidewall spray sprinklers shall only be installed as follows:
(1) Light hazard occupancies with smooth, horizontal or sloped, flat ceilings

(2) Ordinary hazard occupancies with smooth, flat ceilings where specifically listed for such use

(3) In unobstructed construction consisting of flat, smooth ceilings with a slope not exceeding a pitch of 1 in 6 (a rise of 2 units in a run of 12 units, a roof slope of 16.7 percent)

(4) In unobstructed or noncombustible obstructed construction, where specifically listed for such use

(5) Within trusses or bar joists having web members not greater than 1 in. (25 mm) maximum dimension or where trusses are spaced greater than 7½ ft (2.3 m) on center and where the ceiling slope does not exceed a pitch of 1 in 6 (a rise of 2 units in a run of 12 units, a roof slope of 16.7 percent)

(6) Extended coverage sidewall sprinklers installed in accordance with 11.3.6.2.2 in slopes exceeding a ceiling pitch of 2 in 12

(7) In each bay of obstructed construction consisting of solid structural members that extend below the deflector of the sprinkler

(8) Extended coverage sprinklers installed to protect areas below a single overhead door(s)

11.3.3 Protection Areas per Sprinkler (Extended Coverage Sidewall Spray Sprinklers).

11.3.3.1* Determination of Protection Area of Coverage.

11.3.3.1.1
The protection area of coverage per sprinkler (A_s) for extended coverage sidewall sprinklers shall be not less than that prescribed by the listing.

11.3.3.1.2
Listing dimensions shall be in 2 ft (600 mm) increments up to 28 ft (8.5 m).

11.3.3.2 Maximum Protection Area of Coverage.

11.3.3.2.1
The maximum allowable protection area of coverage for a sprinkler (A_s) shall be in accordance with the value indicated in Table 11.3.3.2.1.

Table 11.3.3.2.1 Protection Area and Maximum Spacing for Extended Coverage Sidewall Spray Sprinklers

Construction Type	Light Hazard				Ordinary Hazard			
	Protection Area		Spacing		Protection Area		Spacing	
	ft^2	m^2	ft	m	ft^2	m^2	ft	m
Unobstructed, smooth, flat	400	37	28	8.5	400	37	24	7.3

11.3.3.2.2
In any case, the maximum area of coverage of a sprinkler shall not exceed 400 ft^2 (37.2 m^2).

11.3.4 Sprinkler Spacing (Extended Coverage Sidewall Spray Sprinklers).

11.3.4.1 Maximum Distance Between Sprinklers.

11.3.4.1.1
The maximum distance permitted between sprinklers shall be based on the centerline distance between sprinklers on the branch line along the wall.

11.3.4.1.2
Where sprinklers are installed along the length of a single wall of rooms or bays, they shall be spaced in accordance with the maximum spacing provisions of Table 11.3.3.2.1.

11.3.4.1.3
Sidewall sprinklers shall not be installed back-to-back without being separated by a continuous lintel, soffit, or baffle.

11.3.4.1.4
Sidewall sprinklers shall be permitted to be installed on opposing or adjacent walls, provided no sprinkler is located within the maximum protection area of another sprinkler.

11.3.4.2 Maximum Distance from Walls.
The distance from sprinklers to the end walls shall not exceed one-half of the allowable distance permitted between sprinklers as indicated in Table 11.3.3.2.1.

11.3.4.3 Minimum Distance from Walls.

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11.3.4.3.1
Sprinklers shall be located a minimum of 4 in. (100 mm) from an end wall.

11.3.4.3.2
The distance from the wall to the sprinkler shall be measured perpendicular to the wall.

11.3.4.4 Minimum Distance Between Sprinklers.
Sprinklers shall be not located within the maximum protection area of any other sprinkler unless required by 11.3.5.1.4.1 or separated by baffles that comply with the following:
(1) Baffles shall be arranged to protect the actuating elements.

(2) Baffles shall be of solid and rigid material that will stay in place before and during sprinkler operation.

(3) Baffles shall be not less than 8 in. (200 mm) long and 6 in. (150 mm) high.

(4) The tops of baffles shall extend between 2 in. and 3 in. (50 mm and 75 mm) above the deflectors.

(5) The bottoms of baffles shall extend downward to a level at least even with the deflectors.

11.3.5 Deflector Position from Ceilings and Walls (Extended Coverage Sidewall Spray Sprinklers).

11.3.5.1 Distance Below Ceilings and from Walls to Which Sprinklers Are Mounted.

11.3.5.1.1 Ceilings.

11.3.5.1.1.1
Unless the requirements of 11.3.5.1.1.2 are met, sidewall sprinkler deflectors shall be located not more than 6 in. (150 mm) nor less than 4 in. (100 mm) from ceilings.

11.3.5.1.1.2
Horizontal sidewall sprinklers shall be permitted to be located in a zone 6 in. to 12 in. (150 mm to 300 mm) or 12 in. to 18 in. (300 mm to 450 mm) below noncombustible or limited-combustible ceilings where listed for such use.

11.3.5.1.2 Walls.

11.3.5.1.2.1*
Sidewall sprinkler deflectors shall be located not more than 6 in. (150 mm) or less than 4 in. (100 mm) from walls on which they are mounted.

11.3.5.1.2.2
Horizontal sidewall sprinklers shall be permitted to be located with their deflectors less than 4 in. (100 mm) from the wall on which they are mounted.

11.3.5.1.3 Lintels and Soffits.

11.3.5.1.3.1*
Where soffits used for the installation of sidewall sprinklers are less than or equal to 8 in. (200 mm) in width or projection from the wall, additional sprinklers shall not be required below the soffit.

11.3.5.1.3.2*
A sidewall sprinkler shall be permitted to be installed under a soffit when both the minimum distance from the sprinkler deflector to the bottom of the soffit and the maximum distance from the sprinkler deflector to the high ceiling are maintained.

11.3.5.1.4* Soffits and Cabinets in Residential Areas/Occupancies.
Where soffits are used for the installation of sidewall sprinklers, the sprinklers and soffits shall be installed in accordance with 11.3.5.1.4.1, 11.3.5.1.4.2, or 11.3.5.1.4.3.

11.3.5.1.4.1
Where soffits exceed more than 8 in. (200 mm) in width or projection from the wall, pendent sprinklers shall be installed under the soffit.

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11.3.5.1.4.2
Sidewall sprinklers shall be permitted to be installed in the face of a soffit located directly over cabinets, without requiring additional sprinklers below the soffit or cabinets, where the soffit does not project horizontally more than 12 in. (300 mm) from the wall.

11.3.5.1.4.3
Where sidewall sprinklers are more than 3 ft (900 mm) above the top of cabinets, the sprinkler shall be permitted to be installed on the wall above the cabinets where the cabinets are no greater than 12 in. (300 mm) from the wall.

11.3.5.2 Deflector Orientation.

11.3.5.2.1
Sidewall sprinklers, where installed under a sloped ceiling with a slope exceeding 2 in 12, shall be located at the high point of the slope and positioned to discharge downward along the slope.

11.3.5.2.2
Sidewall sprinklers specifically listed for other ceiling configurations shall be permitted to be installed in accordance with the listing requirements.

11.3.6 Obstructions to Sprinkler Discharge (Extended Coverage Sidewall Spray Sprinklers).

11.3.6.1 Performance Objective.

11.3.6.1.1
Sprinklers shall be located so as to minimize obstructions to discharge as defined in 9.5.5.2 and 9.5.5.3, or additional sprinklers shall be provided to ensure adequate coverage of the hazard.

11.3.6.1.2
Sidewall sprinklers shall not be installed less than 8 ft (2.4 m) from light fixtures or similar obstructions unless the requirements of 11.3.6.1.2.1 or 11.3.6.1.2.2 are met.

11.3.6.1.2.1
For obstructions such as light fixtures, where the greatest dimension of the obstruction is less than 2 ft (0.6 m), sidewall sprinklers shall be permitted to be installed at a minimum distance of four times the greatest dimension.

11.3.6.1.2.2
For obstructions located 4 in. or greater above the plane of the sprinkler deflector the sprinkler shall be permitted to be located less than 8 ft (2.4 m) from the obstruction.

11.3.6.1.3
The distance between light fixtures or similar obstructions located 8 ft (2.4 m) or greater from the sprinkler shall be in conformance with Table 11.3.6.1.3 and Figure 11.3.6.1.3.

Table 11.3.6.1.3 Positioning of Sprinklers to Avoid Obstructions (Extended Coverage Sidewall Spray Sprinklers)

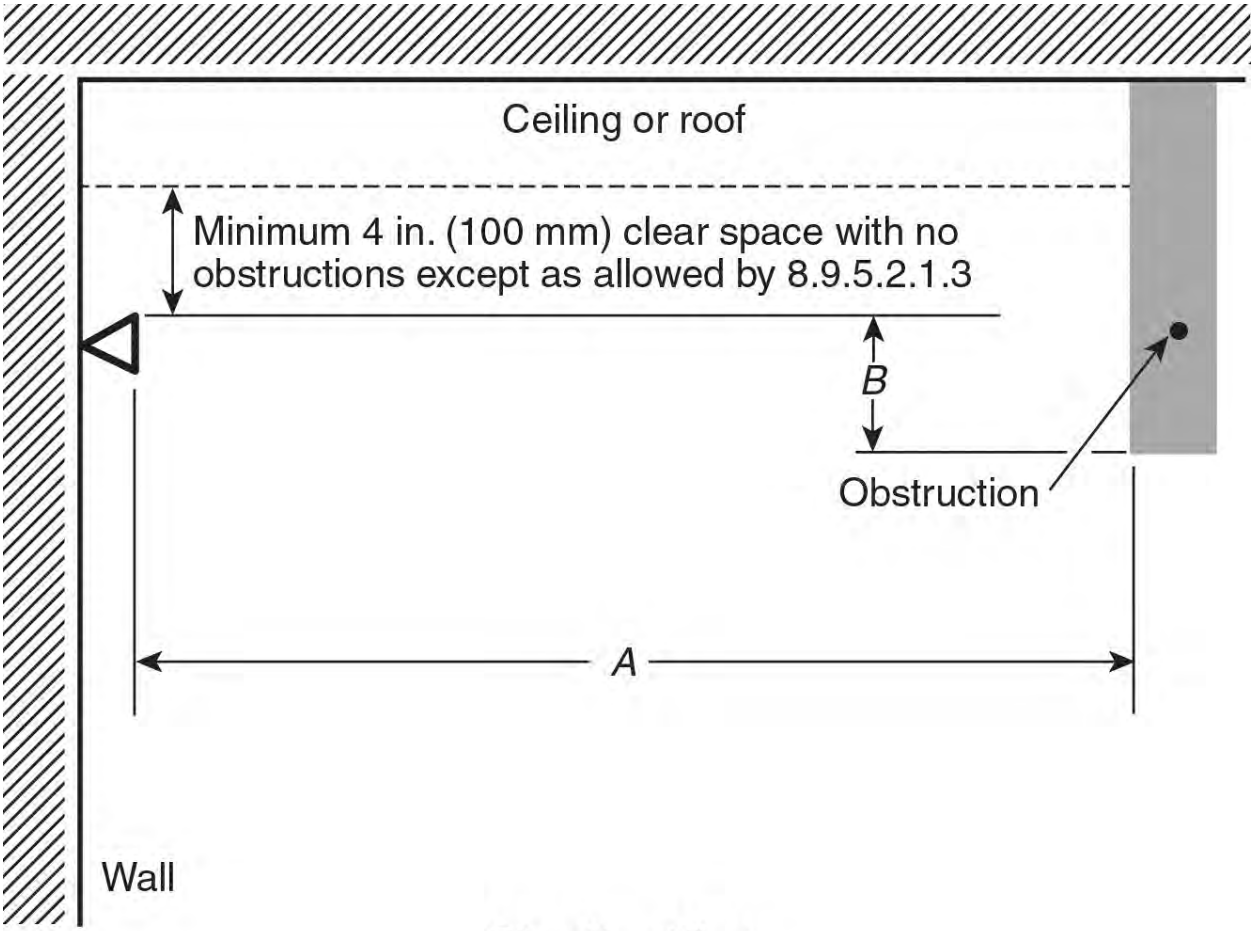
Distance from Sidewall Sprinkler to Side of Obstruction *(A)*	Maximum Allowable Distance of Deflector Above Bottom of Obstruction *(B)* [in. (mm)]
8 ft (2.4 m) to less than 10 ft (3.0 m)	1 (25)
10 ft (3.0 m) to less than 11 ft (3.3 m)	2 (50)
11 ft (3.3 m) to less than 12 ft (3.7 m)	3 (75)
12 ft (3.7 m) to less than 13 ft (4.0 m)	4 (100)
13 ft (4.0 m) to less than 14 ft (4.3 m)	6 (150)
14 ft (4.3 m) to less than 15 ft (4.6 m)	7 (175)

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Distance from Sidewall Sprinkler to Side of Obstruction *(A)*	Maximum Allowable Distance of Deflector Above Bottom of Obstruction *(B)* [in. (mm)]
15 ft (4.6 m) to less than 16 ft (4.9 m)	9 (225)
16 ft (4.9 m) to less than 17 ft (5.2 m)	11 (275)
17 ft (5.2 m) or greater	14 (350)

Note: For *A* and *B*, refer to Figure 8.9.5.1.3.

Figure 11.3.6.1.3 Positioning of Sprinkler to Avoid Obstruction (Extended Coverage Sidewall Spray Sprinklers).



11.3.6.1.4
Continuous obstructions projecting from the same wall as the one on which the sidewall sprinkler is mounted shall be in accordance with one of the following arrangements:
(1) Sprinklers shall be installed in accordance with Table 11.3.6.1.4 and Figure 11.3.6.1.4(a).

(2) Sprinklers shall be permitted to be spaced on opposite sides of obstructions less than 4 ft (1.2 m) in width where the distance from the centerline of the obstruction to the sprinklers does not exceed one-half the allowable distance between sprinklers.

(3) Obstructions located against the wall and that are not over 30 in. (750 mm) in width shall be permitted to be protected in accordance with Figure 11.3.6.1.4(b).

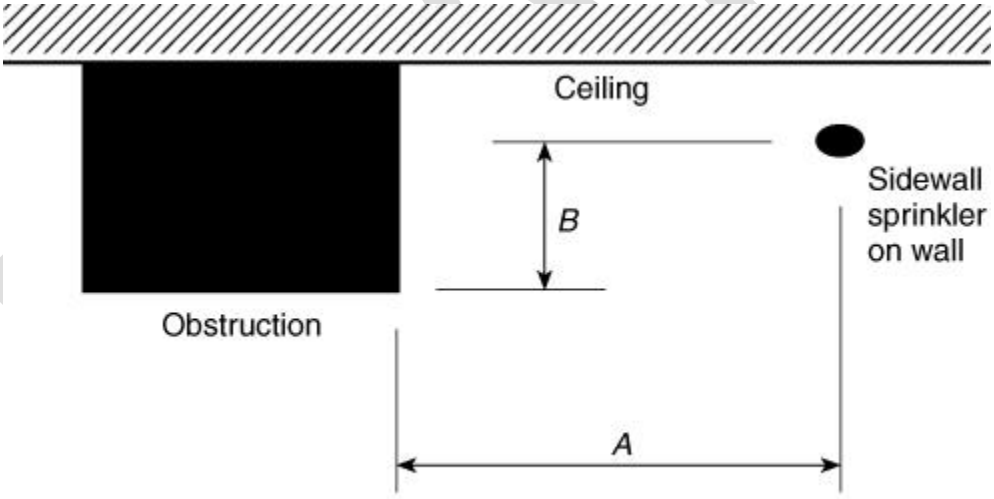
(4) Obstructions located against the wall and that are not over 24 in. (600 mm) in width shall be permitted to be protected in accordance with Figure 11.3.6.1.4(c). The maximum distance between the sprinkler and the wall shall be measured from the sprinkler to the wall behind the obstruction and not to the face of the obstruction.

Table 11.3.6.1.4 Positioning of Sprinklers to Avoid Obstructions Along Wall (Extended Coverage Sidewall Spray Sprinklers)

Distance from Sidewall Sprinkler to Side of Obstruction *(A)*	Maximum Allowable Distance of Deflector Above Bottom of Obstruction *(B)* [in. (mm)]
Less than 1 ft 6 in. (450 mm)	0 (0)
1 ft 6 in. (450 mm) to less than 3 ft (900 mm)	1 (25)
3 ft (900 mm) to less than 4 ft (1.2 m)	3 (75)
4 ft (1.2 m) to less than 4 ft 6 in. (1.4 m)	5 (125)
4 ft 6 in. (1.4 m) to less than 6 ft (1.5 m)	7 (175)
6 ft (1.5 m) to less than 6 ft 6 in. (2.0 m)	9 (225)
6 ft 6 in. (2.0 m) to less than 7 ft (2.1 m)	11 (275)
7 ft (2.1 m) to less than 7 ft 6 in. (2.3 m)	14 (350)

Note: For *A* and *B*, refer to Figure 8.9.5.1.4(a).

Figure 11.3.6.1.4(a) Positioning of Sprinkler to Avoid Obstruction Along Wall (Extended Coverage Sidewall Spray Sprinklers).



Elevation View

Figure 11.3.6.1.4(b) Obstruction Against Wall (Extended Coverage Sidewall Spray Sprinklers).

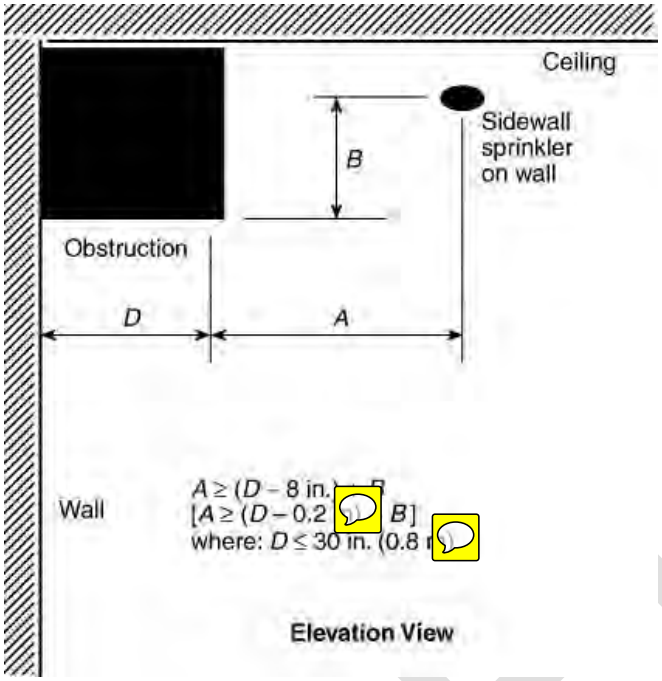
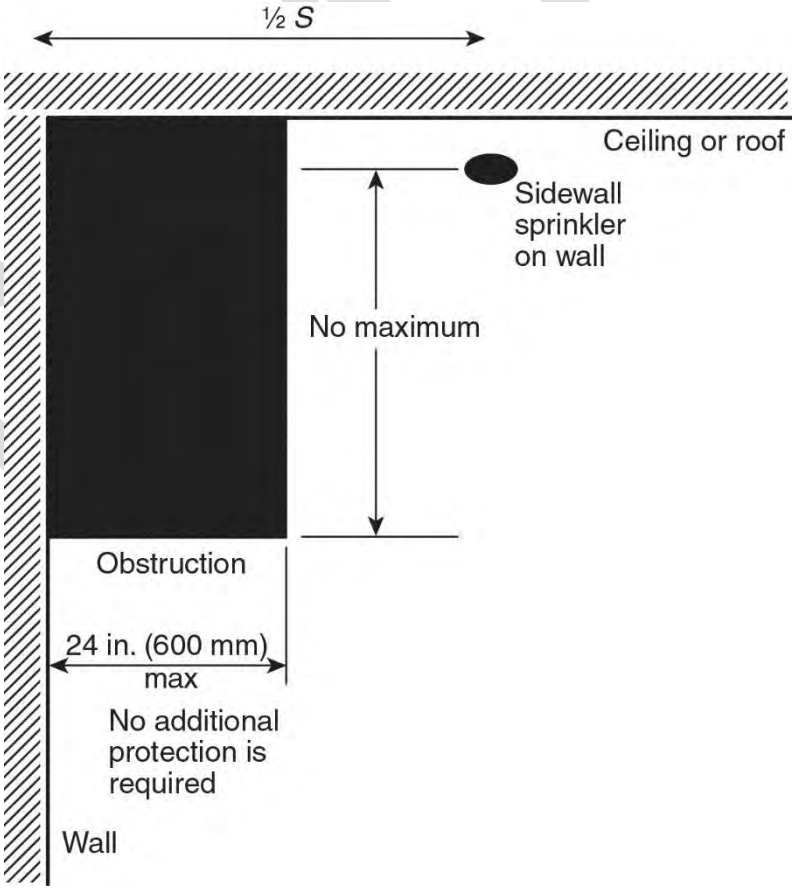


Figure 11.3.6.1.4(c) Obstruction Against Wall (Extended Coverage Sidewall Spray Sprinklers).



11.3.6.1.5 Isolated Obstructions.

Isolated obstructions projecting from the same wall as the one on which the extended coverage sidewall sprinkler is mounted shall be located a minimum of 6 in. (150 mm) from the sidewall sprinkler.

11.3.6.1.6*
Obstructions on the wall opposite from the sidewall sprinkler shall be permitted where the obstruction is up to 2 ft (600 mm) deep and 2 ft (600 mm) wide.

11.3.6.2 Obstructions to Sprinkler Discharge Pattern Development.

11.3.6.2.1 General.

11.3.6.2.1.1
Continuous or noncontinuous obstructions less than or equal to 18 in. (450 mm) below the sprinkler deflector that prevent the pattern from fully developing shall comply with this section.

11.3.6.2.1.2
Regardless of the rules of this section, solid continuous obstructions shall meet the requirements of 11.3.6.1.2 and 11.3.6.1.3.

11.3.6.2.1.3*
Unless the requirements of 11.3.6.2.1.4 through 11.3.6.2.1.5 are met, sprinklers shall be positioned away from obstructions a minimum distance of four times the maximum dimension of the obstruction (e.g., truss webs and chords, pipe, columns, and fixtures) in accordance with Figure 11.3.6.2.1.3(a) and Figure 11.3.6.2.1.3(b).

Figure 11.3.6.2.1.3(a) Minimum Distance from an Obstruction in the Vertical Orientation (Extended Coverage Sidewall).

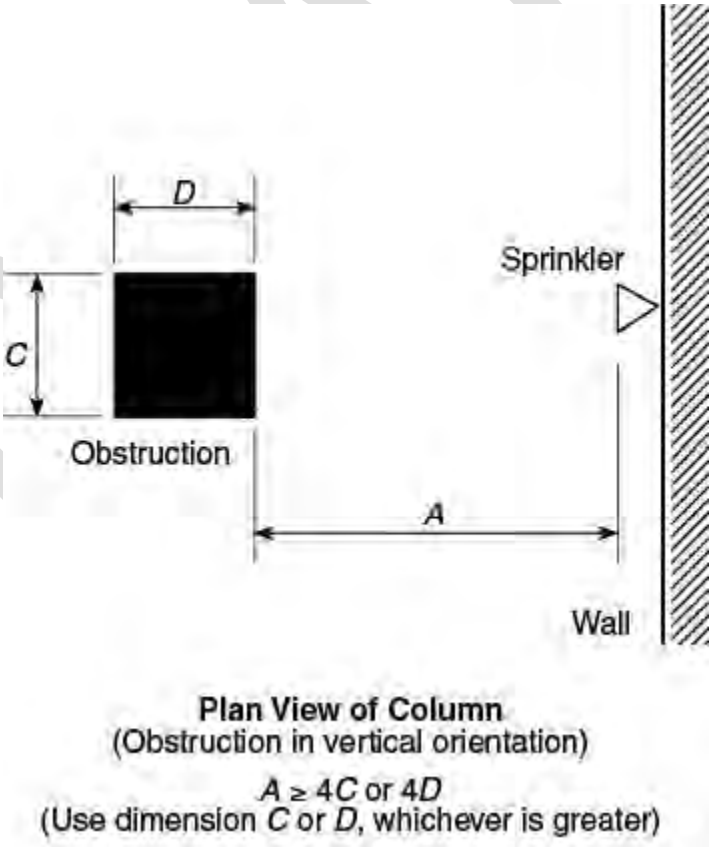
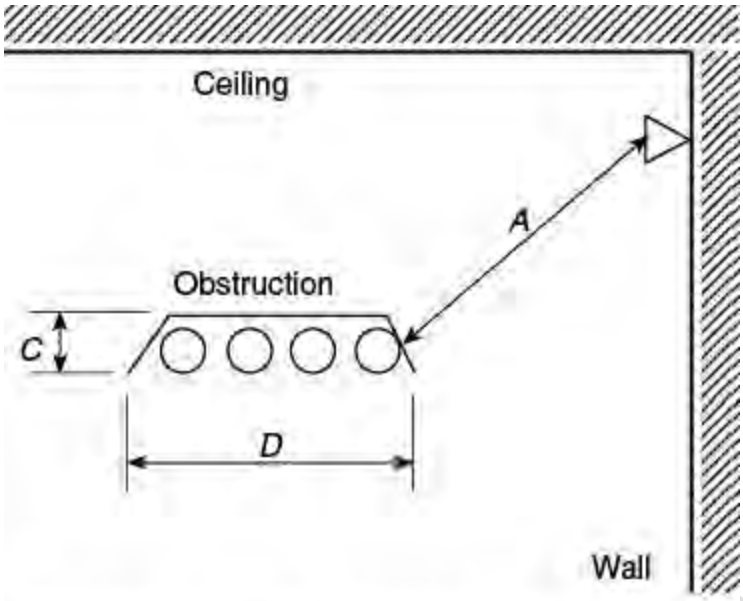


Figure 11.3.6.2.1.3(b) Minimum Distance from an Obstruction in the Horizontal Orientation (Extended Coverage Sidewall).



Elevation View of Pipe Conduit or Light Fixture
(Obstruction in horizontal orientation)
$A \geq 4C$ or $4D$
$A \leq 36$ in. (900 mm)
(Use dimension C or D, whichever is greater)

(A)
The maximum clear distance required to obstructions in the horizontal orientation (e.g., light fixtures and truss chords), shall be 36 in. (900 mm).

(B)
The maximum clear distance shall not be applied to obstructions in the vertical orientation (e.g., columns).

11.3.6.2.1.4
The requirements of 11.3.6.2.1.3 and 11.3.6.2.1.4 shall not apply where sprinklers are positioned with respect to obstructions in accordance with 11.3.6.1.2 and 11.3.6.1.3.

11.3.6.2.1.5
The requirements of 11.3.6.2.1.3 shall not apply to sprinkler system piping less than 3 in. (80 mm) in diameter.

11.3.6.2.1.6*
Sprinklers shall be permitted to be placed without regard to the blades of ceiling fans less than 60 in. (1.5 m) in diameter, provided the plan view of the fan is at least 50 percent open.

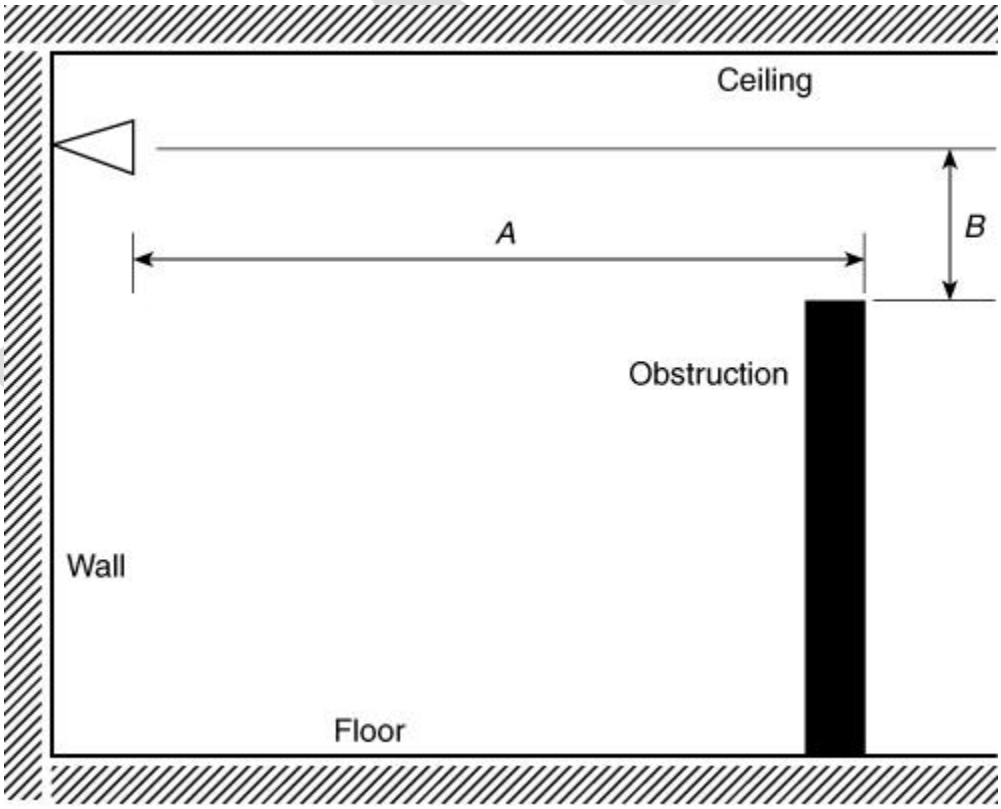
11.3.6.2.2 Suspended or Floor-Mounted Vertical Obstructions.
The distance from sprinklers to privacy curtains, freestanding partitions, room dividers, and similar obstructions in light hazard occupancies shall be in accordance with Table 11.3.6.2.2 and Figure 11.3.6.2.2.

Table 11.3.6.2.2 Suspended or Floor-Mounted Obstructions (Extended Coverage Sidewall Sprinklers) in Light Hazard Occupancies Only

Horizontal Distance *(A)*	Minimum Allowable Distance Below Deflector *(B)* [in. (mm)]
6 in. (150 mm) or less	3 (75)
More than 6 in. (150 mm) to 9 in. (225 mm)	4 (100)
More than 9 in. (225 mm) to 12 in. (300 mm)	6 (150)
More than 12 in. (300 mm) to 15 in. (375 mm)	8 (200)
More than 15 in. (375 mm) to 18 in. (450 mm)	9½(240)
More than 18 in. (450 mm) to 24 in. (600 mm)	12½(315)
More than 24 in. (600 mm) to 30 in. 750 mm)	15½(390)
More than 30 in. (750 mm)	18 (450)

Note: For *A* and *B*, refer to Figure 8.9.5.2.2.

Figure 11.3.6.2.2 Suspended or Floor-Mounted Obstruction (Extended Coverage Sidewall Sprinklers) in Light Hazard Occupancy Only.



Elevation View

11.3.6.2.2.1*
In light hazard occupancies, privacy curtains, as shown in Figure 11.3.6.2.2, shall not be considered obstructions where all of the following are met:
(1) The curtains are supported by fabric mesh on ceiling track.

(2) Openings in the mesh are equal to 70 percent or greater.

(3) The mesh extends a minimum of 22 in. (550 mm) down from ceiling.

11.3.6.3* Obstructions that Prevent Sprinkler Discharge from Reaching Hazard.

11.3.6.3.1
Continuous or noncontinuous obstructions that interrupt the water discharge in a horizontal plane more than 18 in. (450 mm) below the sprinkler deflector in a manner to limit the distribution from reaching the protected hazard shall comply with this section.

11.3.6.3.2*
Sprinklers shall be installed under fixed obstructions over 4 ft (1.2 m) wide.

11.3.6.3.3
Sprinklers shall not be required under obstructions that are not fixed in place, such as conference tables.

11.3.7 Clearance to Storage (Extended Coverage Sidewall Spray Sprinklers).
The clearance between the deflector and the top of storage shall be 18 in. (457 mm) or greater.

Chapter 12 Installation Requirements for Residential Sprinklers

12.1 General.
Residential sprinklers shall be selected for use and installation as indicated in this Chapter and shall be positioned and spaced in accordance with Section 9.5.

12.1.1*
Residential sprinklers shall be permitted in dwelling units and their adjoining corridors, provided they are installed in conformance with their listing and when installed under the following conditions:
(1) A flat, smooth, horizontal ceiling with no beams up to a maximum of 24 ft (7.3 m) above the floor.

(2) A flat, horizontal, beamed ceiling, with a maximum ceiling height of 24 ft (7.3 m), with beams up to 14 in. (355 mm) deep with pendent sprinklers under the beams. The compartment containing the beamed ceiling shall be a maximum of 600 ft^2 (55 m^2) in area. The highest sprinkler in the compartment shall be above all openings from the compartment into any communicating spaces.

(3) A smooth, flat, sloped ceiling with no beams up to a maximum slope of 8 in 12. The highest portion of the ceiling shall not be more than 24 ft (7.3 m) above the floor. The highest sprinkler in the sloped portion of the ceiling shall be above all openings from the compartment containing the sloped ceiling into any communicating spaces.

(4) A sloped ceiling with beams up to 14 in. (355 mm) deep with pendent sprinklers under the beams. The compartment containing the sloped, beamed ceiling shall be a maximum of 600 ft^2 (55 m^2) in area. The slope of the ceiling shall be between 2 in 12 and 8 in 12. The highest portion of the ceiling shall not be more than 24 ft (7.3 m) above the floor. The highest sprinkler in the sloped portion of the ceiling shall be above all openings from the compartment containing the sloped ceiling into any communicating spaces.

(5) A sloped ceiling with beams of any depth with sidewall or pendent sprinklers in each pocket formed by the beams. The compartment containing the sloped, beamed ceiling shall be a maximum of 600 ft^2 (55 m^2) in area. The slope of the ceiling shall be between 2 in 12 and 8 in 12. The highest portion of the ceiling shall not be more than 24 ft (7.3 m) above the floor.

12.1.2

Where construction features or other special conditions exist that are outside the scope of sprinkler listings, listed sprinklers shall be permitted to be installed beyond their listing limitations when acceptable to the authority having jurisdiction.

12.1.3
Residential sprinklers shall be used only in wet systems unless specifically listed for use in dry systems or preaction systems.

12.1.4
Where residential sprinklers are installed in a compartment as defined in 3.3.40, all sprinklers within the compartment shall be residential sprinklers.

12.1.5 Reserved.

12.1.6* Listings.

12.1.6.1
Areas of coverage shall be in accordance with the manufacturer's listing.

12.1.6.2
Residential sprinklers shall not be permitted to be used on ceilings with slopes greater than 8 in 12 or ceiling with heights greater than 24 ft unless specifically listed for this purpose.

12.1.7 Distances Between Sprinklers.

12.1.7.1
Maximum distances between sprinklers shall be in accordance with the manufacturer's listing.

12.1.7.2
The distance between the sprinkler and the wall shall not exceed half the maximum allowable distance between sprinklers per the manufacturer’s listing.

12.1.7.3
The minimum distance between sprinklers within a compartment shall be 8 ft (2.4 m), unless the listing of the sprinkler requires a greater distance, unless required by 12.1.11.1.5.1, or unless separated by baffles that comply with the following:
(1) Baffles shall be arranged to protect the actuating elements.

(2) Baffles shall be of solid and rigid material that will stay in place before and during sprinkler operation.

(3) Baffles shall be not less than 8 in. (200 mm) long and 6 in. (150 mm) high.

(4) The tops of baffles shall extend between 2 in. and 3 in. (50 mm and 75 mm) above the deflectors of upright sprinklers.

(5) The bottoms of baffles shall extend downward to a level at least even with the deflectors of pendent sprinklers.

12.1.7.4
Residential sidewall sprinklers shall be permitted to be installed on opposing or adjacent walls, provided no sprinkler is located within the maximum protection area of another sprinkler or unless separated by baffles that comply with the following:
(1) Baffles shall be arranged to protect the actuating elements.

(2) Baffles shall be of solid and rigid material that will stay in place before and during sprinkler operation.

(3) Baffles shall be not less than 8 in. (200 mm) long and 6 in. (150 mm) high.

(4) The tops of baffles shall extend between 2 in. and 3 in. (50 mm and 75 mm) above the deflectors.

(5) The bottoms of baffles shall extend downward to a level at least even with the deflectors.

12.1.7.5

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The maximum distance shall be measured along the slope of the ceiling as shown in Figure 12.1.7.5(a) and Figure 12.1.7.5(b).

Figure 12.1.7.5(a) Maximum Distance Between Sprinklers with Sloped Ceilings — Arrangement A.

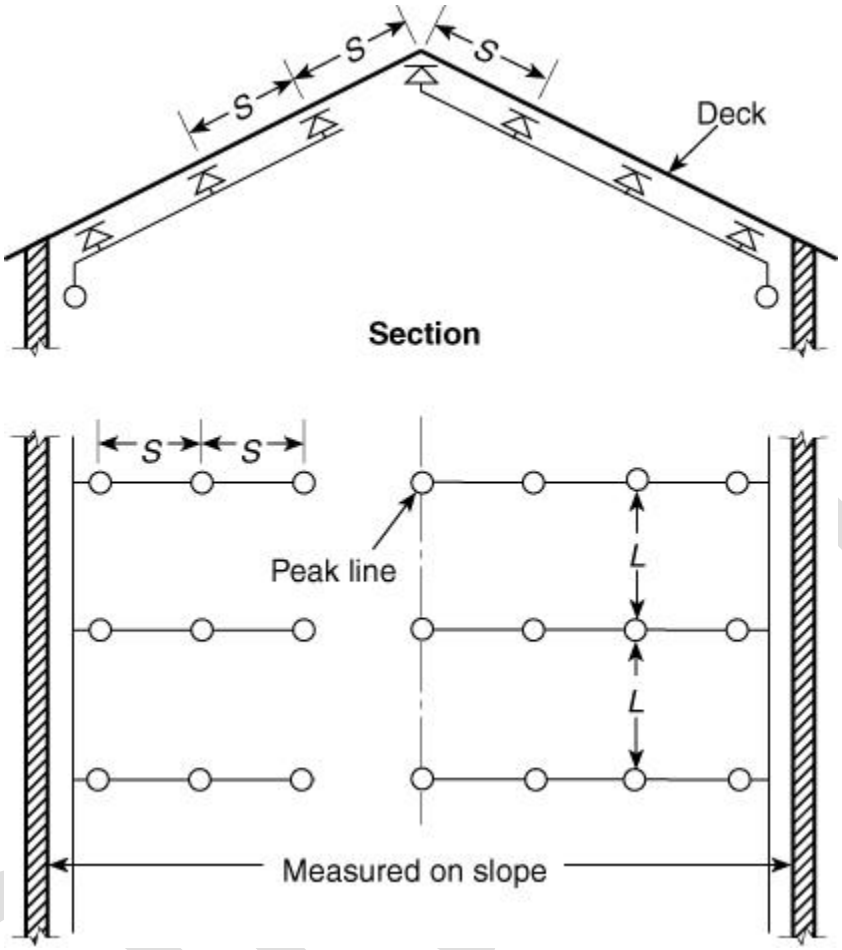
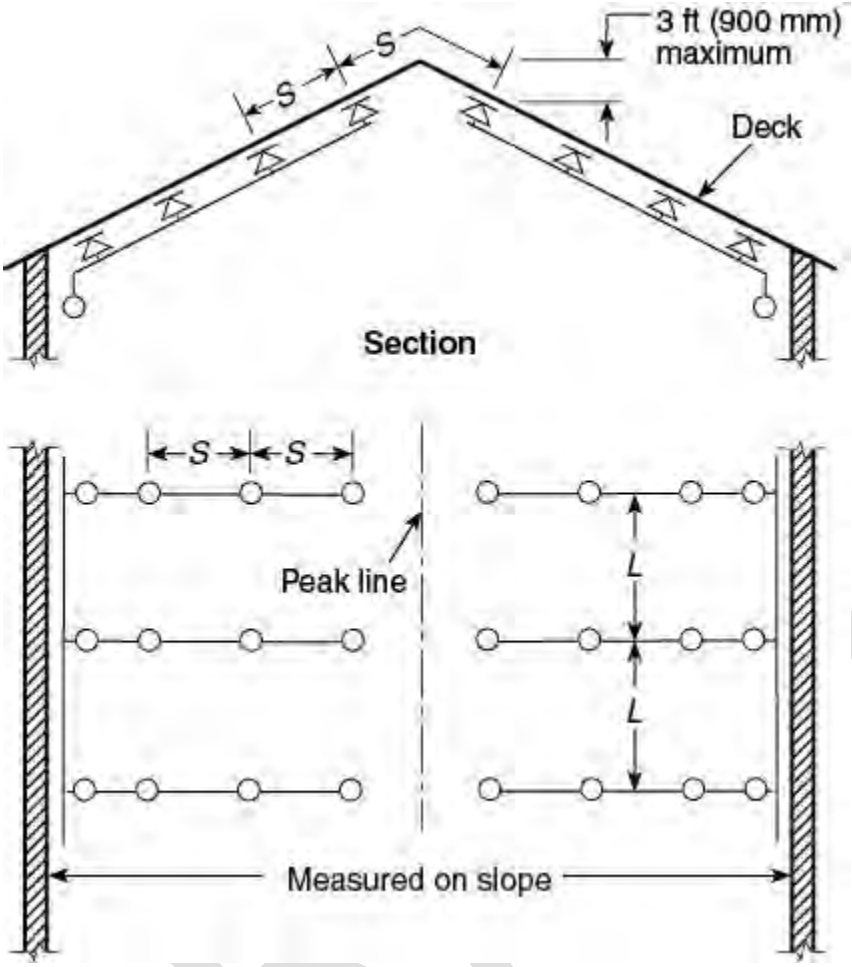


Figure 12.1.7.5(b) Maximum Distance Between Sprinklers with Sloped Ceilings — Arrangement B.



12.1.7.6
Where sprinklers are installed along sloped ceilings, the sprinklers shall maintain the minimum listed spacing, but no less than 8 ft (2.4 m), measured in the plan view from one sprinkler to another as shown in Figure 12.1.7.6(a) and Figure 12.1.7.6(b), or unless separated by baffles that comply with the following:
(1) Baffles shall be arranged to protect the actuating elements.

(2) Baffles shall be of solid and rigid material that will stay in place before and during sprinkler operation.

(3) Baffles shall be not less than 8 in. (200 mm) long and 6 in. (150 mm) high.

(4) The tops of baffles shall extend between 2 in. and 3 in. (50 mm and 75 mm) above the deflectors of upright sprinklers.

(5) The bottoms of baffles shall extend downward to a level at least even with the deflectors of pendent sprinklers.

Figure 12.1.7.6(a) Minimum Distance Between Sprinklers with Sloped Ceilings — Arrangement A.

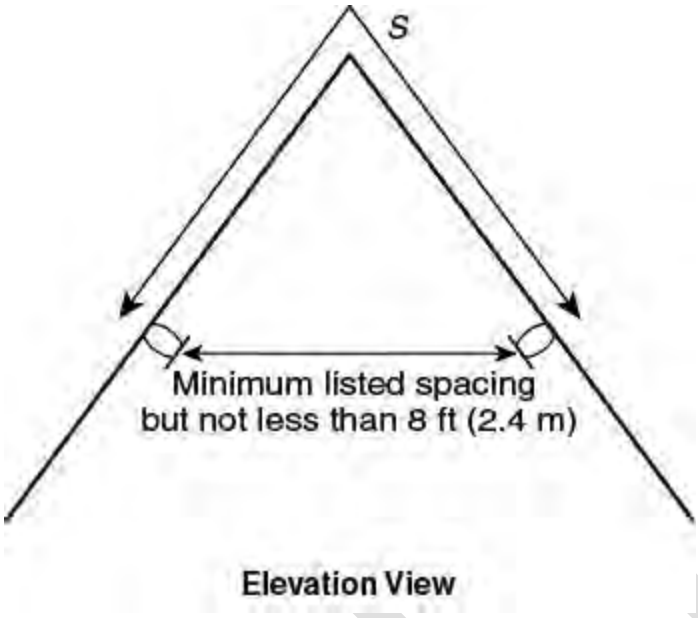
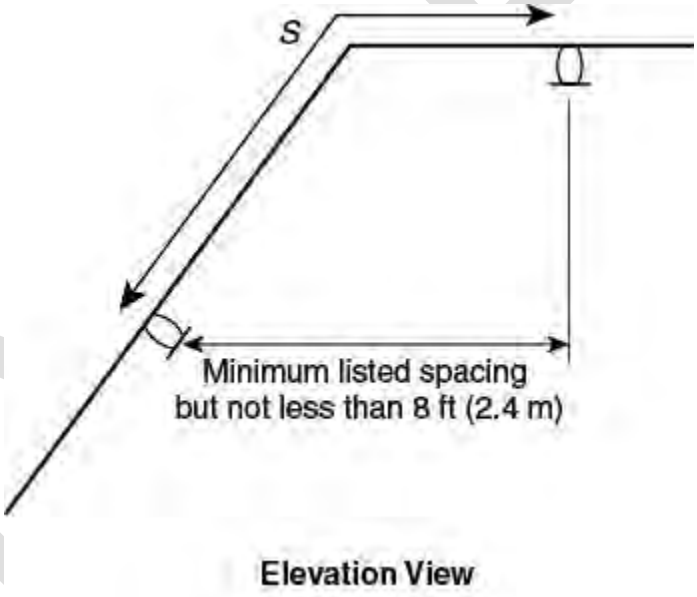


Figure 12.1.7.6(b) Minimum Distance Between Sprinklers with Sloped Ceilings — Arrangement B.



12.1.8 Deflector Position from Ceilings and Walls.

12.1.8.1
Pendent and upright sprinklers shall be positioned so that the deflectors are 1 in. to 4 in. (25 mm to 100 mm) from the ceiling unless the listing allows a greater distance.

12.1.8.1.1
Pendent and upright sprinklers installed under beamed or beamed and sloped ceilings shall be permitted to be installed within 3 in. (75 mm) below beams where all of the following apply:

(1) Maximum beam depth of 14 in. (355 mm)

(2) Maximum ceiling height of 24 ft. (7.3 m)

(3) Maximum ceiling slope of 8 in 12

(4) Maximum compartment size of 600 ft^2 (56 m^2)

12.1.8.1.2
The highest sprinkler in the compartment shall be above all openings from the compartment into any communicated spaces.

12.1.8.2
Sidewall sprinklers shall be positioned so that the deflectors are within 4 in. to 6 in. (100 mm to 150 mm) from the ceiling unless the listing allows greater distances.

12.1.8.3
Where soffits used for the installation of sidewall sprinklers exceed 8 in. (200 mm) in width or projection from the wall, additional sprinklers shall be installed below the soffit.

12.1.8.4
Residential horizontal sidewall sprinkler deflectors shall be located no more than 6 in. (150 mm) from the wall on which they are mounted unless listed for greater distances.

12.1.8.5
The distance from sprinklers to the end walls shall not exceed one-half of the allowable distance permitted between sprinklers as indicated in the sprinkler listing.

12.1.8.6 Minimum Distance from Walls.

12.1.8.6.1
Sprinklers shall be located a minimum of 4 in. (100 mm) from an end wall.

12.1.8.7 Deflector Orientation (Residential Upright and Pendent Spray).

12.1.8.7.1
Unless the requirements of 12.1.8.7.2 or 12.1.8.7.3 are met, deflectors of upright and pendent sprinklers shall be aligned parallel to ceilings, roofs, or the incline of stairs.

12.1.8.7.2
Where upright or pendent sprinklers are installed at the peak below a sloped ceiling or roof surface, the sprinkler shall be installed with the deflector horizontal.

12.1.8.7.3
Roofs and ceilings having a pitch not exceeding 2 in 12 (16.7 percent) are considered horizontal in the application of 12.1.8.7, and upright and pendent sprinklers shall be permitted to be installed with deflectors horizontal.

12.1.9
Residential sprinklers installed in conformance with this standard shall follow the sprinkler obstruction rules of 12.1.10 or 12.1.11 as appropriate for their installation orientation (upright, pendent, or sidewall) and the obstruction criteria specified in the manufacturer's installation instructions.

12.1.10 Obstructions to Sprinkler Discharge (Residential Upright and Pendent Spray Sprinklers).

12.1.10.1 Performance Objective.

12.1.10.1.1
Sprinklers shall be located so as to minimize obstructions to discharge as defined in 12.1.10.2 and 12.1.10.3, or additional sprinklers shall be provided to ensure adequate coverage of the hazard.

12.1.10.1.2
Sprinklers shall be arranged to comply with one of the following arrangements:
(1) Sprinklers shall be in accordance with 9.5.5.2, Table 12.1.10.1.2, and Figure 12.1.10.1.2(a).

(2) Sprinklers shall be permitted to be spaced on opposite sides of obstructions not exceeding 4 ft (1.2 m) in width, provided the distance from the centerline of the obstruction to the sprinklers does not exceed one-half the allowable distance permitted between sprinklers.

(3) Obstructions located against the wall and that are not over 30 in. (750 mm) in width shall be permitted to be protected in accordance with Figure 12.1.10.1.2(b).

(4) Obstructions that are located against the wall and that are not over 24 in. (600 mm) in width shall be permitted to be protected in accordance with Figure 8.10.6.1.2(c). The maximum distance between the sprinkler and the wall shall be measured from the sprinkler to the wall behind the obstruction and not to the face of the obstruction.

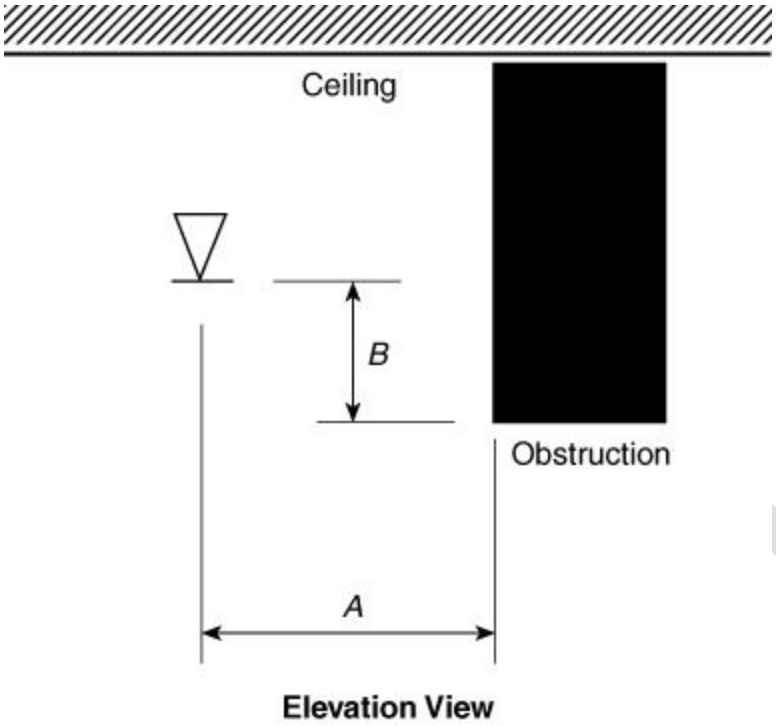
Table 12.1.10.1.2 Positioning of Sprinklers to Avoid Obstructions to Discharge (Residential Upright and Pendent Spray Sprinklers)

Distance from Sprinklers to Side of Obstruction *(A)*	Maximum Allowable Distance of Deflector Above Bottom of Obstruction *(B)* [in. (mm)]
Less than 1 ft (300 mm)	0 (0)
1 ft (300 mm) to less than 1 ft 6 in. (450 mm)	0 (0)
1 ft 6 in. (450 mm) to less than 2 ft (600 mm)	1 (25)
2 ft (600 mm) to less than 2 ft 6 in. (750 mm)	1 (25)
2 ft 6 in. (750 mm) to less than 3 ft (900 mm)	1 (25)
3 ft (900 mm) to less than 3 ft 6 in. (1.1 m)	3 (75)
3 ft 6 in. (1.1 m) to less than 4 ft (1.2 m)	3 (75)
4 ft (1.2 m) to less than 4 ft 6 in. (1.4 m)	5 (125)
4 ft 6 in. (1.4 m) to less than 5 ft (1.5 m)	7 (175)
5 ft (1.5 m) to less than 5 ft 6 in. (1.7 m)	7 (175)
5 ft 6 in. (1.7 m) to less than 6 ft (1.8 m)	7 (175)
6 ft (1.8 m) to less than 6 ft 6 in. (2.0 m)	9 (225)
6 ft 6 in. (2.0 m) to less than 7 ft (2.1 m)	11 (275)
7 ft (2.1 m) and greater	14 (350)

Note: For *A* and *B*, refer to Figure 8.10.6.1.2(a).

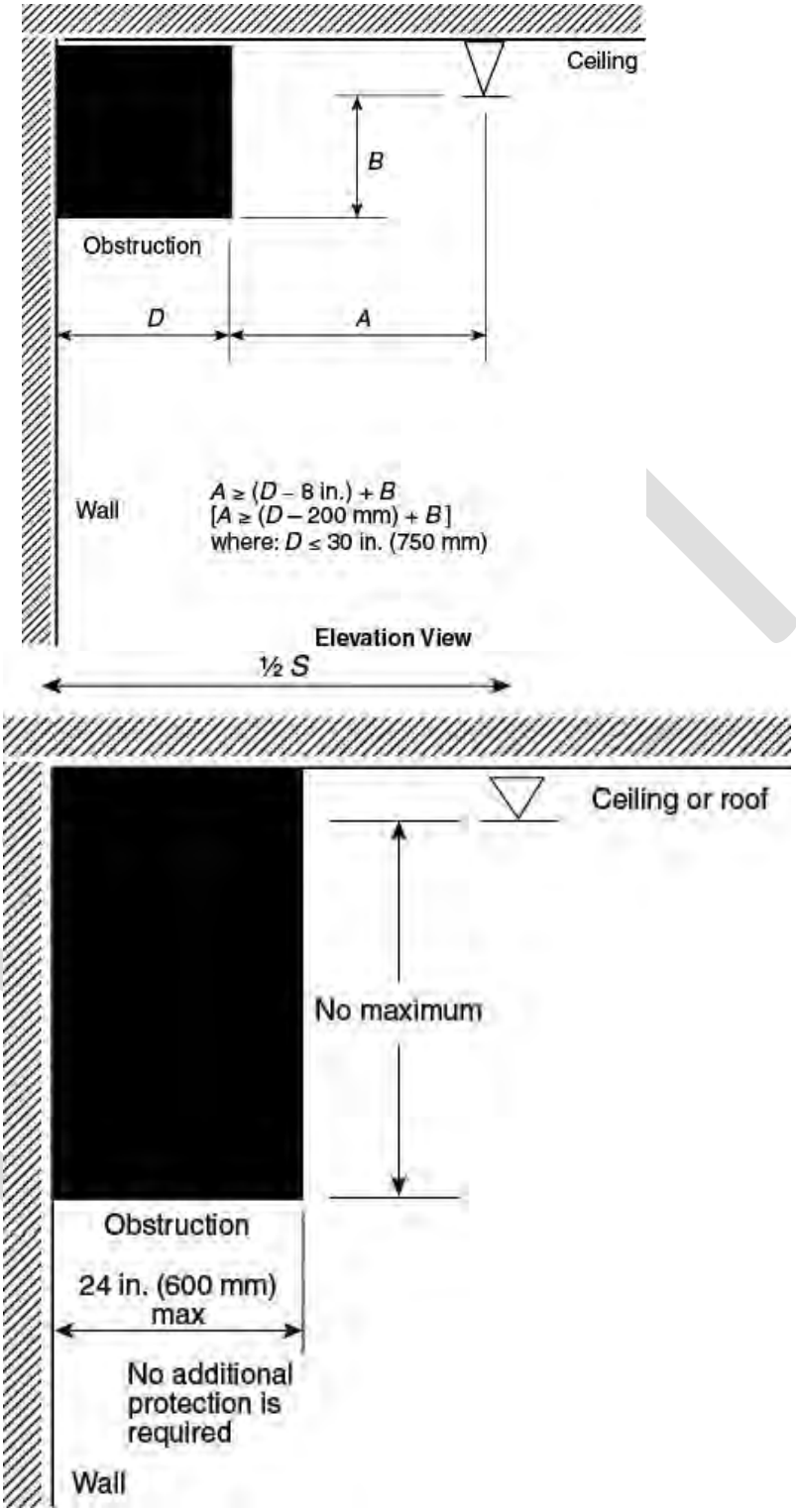
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Figure 12.1.10.1.2(a) Positioning of Sprinkler to Avoid Obstruction to Discharge (Residential Upright and Pendent Spray Sprinklers).



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Figure 12.1.10.1.2(b) Obstructions Against Wall (Residential Upright and Pendent Spray Sprinklers).



12.1.10.2 Obstructions to Sprinkler Discharge Pattern Development.

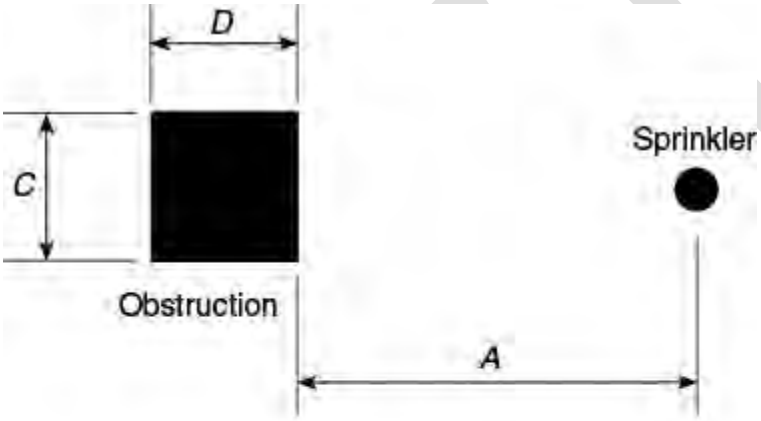
12.1.10.2.1 General.

12.1.10.2.1.1
Continuous or noncontinuous obstructions less than or equal to 18 in. (450 mm) below the sprinkler deflector that prevent the pattern from fully developing shall comply with 12.1.10.2.

12.1.10.2.1.2
Regardless of the rules of this section, solid continuous obstructions shall meet the applicable requirements of 12.1.10.1.2.

12.1.10.2.1.3*
Unless the requirements of 12.1.10.2.1.4 through 12.1.10.2.1.8 are met, sprinklers shall be positioned away from obstructions a minimum distance of four times the maximum dimension of the obstruction (e.g., truss webs and chords, pipe, columns, and fixtures) in accordance with Figure 12.1.10.2.1.3(a) and Figure 12.1.10.2.1.3(b).

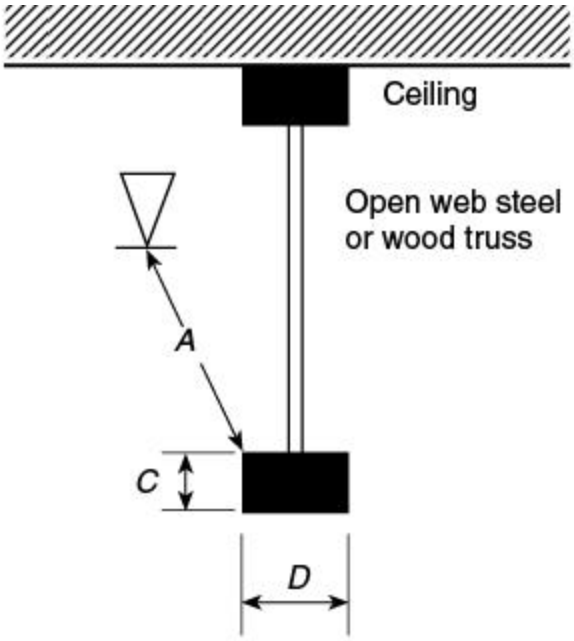
Figure 12.1.10.2.1.3(a) Minimum Distance from an Obstruction in the Vertical Orientation (Residential Upright and Pendent Spray Sprinkler).



Plan View of Column
(Obstruction in vertical orientation)

$A \geq 4C$ or $4D$
(Use dimension C or D, whichever is greater)

Figure 12.1.10.2.1.3(b) Minimum Distance from an Obstruction in the Horizontal Orientation (Residential Upright and Pendent Spray Sprinkler).



Elevation View of Truss
(Obstruction in horizontal orientation)

$A \geq 4C$ or $4D$
$A \leq 36$ in. (900 mm)
(Use dimension C or D, whichever is greater)

(A)
The maximum clear distance required to obstructions in the horizontal orientation (e.g., light fixture and truss chords) shall be 36 in. (900 mm).

(B)
The maximum clear distance shall not be applied to obstructions in the vertical orientation (e.g., columns).

12.1.10.2.1.4
Sprinklers shall be permitted to be spaced on opposite sides of the obstruction where the distance from the centerline of the obstruction to the sprinklers does not exceed one-half the allowable distance between sprinklers.

12.1.10.2.1.5
Sprinklers shall be permitted to be located one-half the distance between the obstructions where the obstruction consists of open trusses 20 in. (500 mm) or greater apart [24 in. (600 mm) on center], provided that all truss members are not greater than 4 in. (100 mm) (nominal) in width and web members do not exceed 1 in. (25 mm) in width.

12.1.10.2.1.6
Sprinklers shall be permitted to be installed on the centerline of a truss or bar joist or directly above a beam provided that the truss chord or beam dimension is not more than 8 in. (200 mm) and the sprinkler deflector is located at least 6 in. (150 mm) above the structural member and where the sprinkler is positioned at a distance four times greater than the maximum dimension of the web members away from the web members.

12.1.10.2.1.7
The requirements of 12.1.10.2.1.3 shall not apply to sprinkler system piping less than 3 in. (80 mm) in diameter.

12.1.10.2.1.8
The requirements of 12.1.10.2.1.3 shall not apply to sprinklers positioned with respect to obstructions in accordance with 12.1.10.1.2.

12.1.10.2.1.9*
Sprinklers shall be permitted to be placed without regard to the blades of a ceiling fan, provided the plan view of the fan is at least 50 percent open.

12.1.10.2.2 Suspended or Floor-Mounted Vertical Obstructions.
The distance from sprinklers to privacy curtains, free-standing partitions, room dividers, and similar obstructions in light hazard occupancies shall be in accordance with Table 12.1.10.2.2 and Figure 12.1.10.2.2.

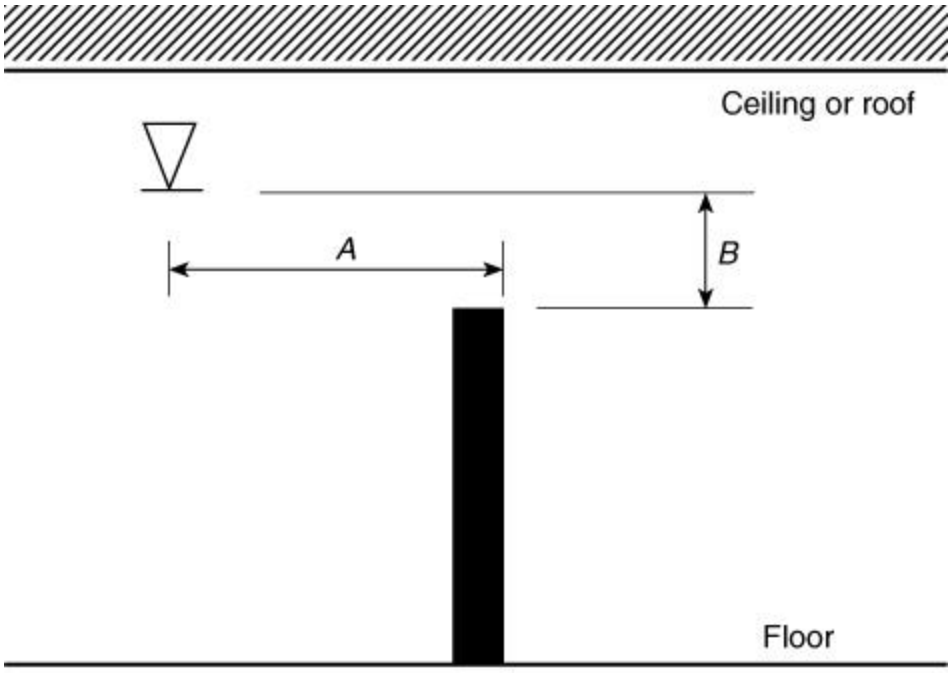
Table 12.1.10.2.2 Suspended or Floor-Mounted Obstructions (Residential Upright and Pendent Spray Sprinklers) in Light Hazard Occupancies Only

Horizontal Distance *(A)*	Minimum Vertical Distance Below Deflector *(B)* [in. (mm)]
6 in. (150 mm) or less	3 (75)
More than 6 in. (150 mm) to 9 in. (225 mm)	4 (100)
More than 9 in. (225 mm) to 12 in. (300 mm)	6 (150)
More than 12 in. (300 mm) to 15 in. (375 mm)	8 (200)
More than 15 in. (375 mm) to 18 in. (450 mm)	9½(240)
More than 18 in. (450 mm) to 24 in. (600 mm)	12½(315)
More than 24 in. (600 mm) to 30 in. (750 mm)	15½(390)
More than 30 in. (750 mm)	18 (450)

Note: For *A* and *B*, refer to Figure 8.10.6.2.2.

Figure 12.1.10.2.2 Suspended or Floor-Mounted Obstruction (Residential Upright and Pendent Spray Sprinklers) in Light Hazard Occupancy Only.

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Elevation View

12.1.10.3* Obstructions that Prevent Sprinkler Discharge from Reaching Hazard.

12.1.10.3.1
Continuous or noncontinuous obstructions that interrupt the water discharge in a horizontal plane more than 18 in. (450 mm) below the sprinkler deflector in a manner to limit the distribution from reaching the protected hazard shall comply with 12.1.10.3.

12.1.10.3.2
Sprinklers shall be installed under fixed obstructions over 4 ft (1.2 m) wide.

12.1.10.3.3
Sprinklers installed under open gratings shall be shielded from the discharge of overhead sprinklers.

12.1.11 Obstructions to Sprinkler Discharge (Residential Sidewall Spray Sprinklers).

12.1.11.1 Performance Objective.

12.1.11.1.1
Sprinklers shall be located so as to minimize obstructions to discharge as defined in 9.5.5.2 and 9.5.5.3, or additional sprinklers shall be provided to ensure adequate coverage of the hazard.

12.1.11.1.2
Sidewall sprinklers shall not be installed less than 8 ft (2.4 m) from light fixtures or similar obstructions unless the requirements of 12.1.11.1.2.1 or 12.1.11.1.2.2 are met.

12.1.11.1.2.1
For obstructions such as light fixtures, where the greatest dimension of the obstruction is less than 2 ft (0.6 m), sidewall sprinklers shall be permitted to be installed at a minimum distance of four times the greatest dimension.

12.1.11.1.2.2
For obstructions located at least 4 in. (100 mm) above the plane of the sprinkler deflector, the sprinkler shall be permitted to be located less than 8 ft (2.4 m) from the obstruction.

12.1.11.1.3

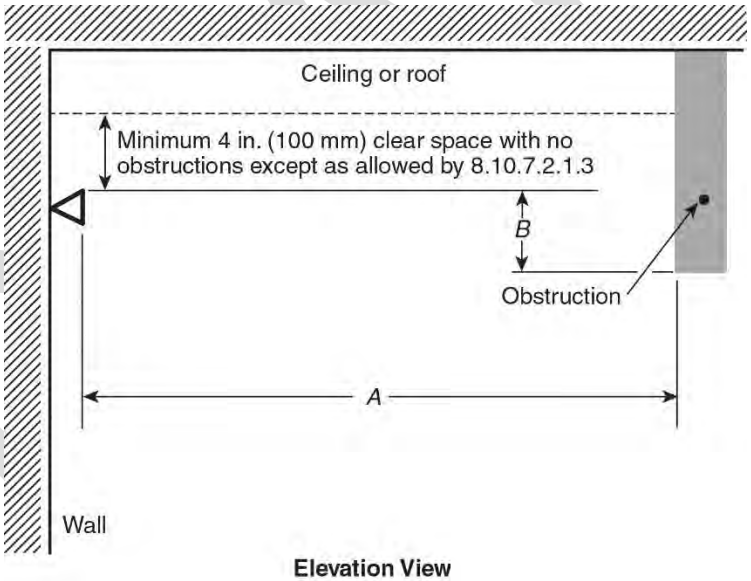
The distance between light fixtures or similar obstructions located 8 ft (2.4 m) or greater from the sprinkler shall be in conformance with Table 12.1.11.1.3 and Figure 12.1.11.1.3.

Table 12.1.11.1.3 Positioning of Sprinklers to Avoid Obstructions (Residential Sidewall Sprinklers)

Distance from Sidewall Sprinkler to Side of Obstruction *(A)*	Maximum Allowable Distance of Deflector Above Bottom of Obstruction *(B)* [in. (mm)]
8 ft (2.4 m) to less than 10 ft (3.0 m)	1 (25)
10 ft (3.0 m) to less than 11 ft (3.3 m)	2 (50)
11 ft (3.3 m) to less than 12 ft (3.7 m)	3 (75)
12 ft (3.7 m) to less than 13 ft (4.0 m)	4 (100)
13 ft (4.0 m) to less than 14 ft (4.3 m)	6 (150)
14 ft (4.3 m) to less than 15 ft (4.6 m)	7 (175)
15 ft (4.6 m) to less than 16 ft (4.9 m)	9 (225)
16 ft (4.9 m)to less than 17 ft (5.2 m)	11 (275)
17 ft (5.2 m) or greater	14 (350)

Note: For *A* and *B*, refer to Figure 8.10.7.1.3.

Figure 12.1.11.1.3 Positioning of Sprinkler to Avoid Obstruction (Residential Sidewall Sprinklers).



Elevation View

12.1.11.1.4

Continuous obstructions projecting from the same wall as the one on which the sidewall sprinkler is mounted shall be in accordance with one of the following arrangements:

(1) Sprinklers shall be in accordance with Table 12.1.11.1.4 and Figure 12.1.11.1.4(a).

(2) Sprinklers shall be permitted to be spaced on opposite sides of obstructions less than 4 ft (1.2 m) in width where the distance from the centerline of the obstruction to the sprinklers does not exceed one-half the allowable distance between sprinklers.

(3) Obstructions located against the wall and that are not over 30 in. (750 mm) in width shall be permitted to be protected in accordance with Figure 12.1.11.1.4(b).

(4) Obstructions located against the wall and that are not over 24 in. (600 mm) in width shall be permitted to be protected in accordance with Figure 12.1.11.1.4(c). The maximum distance between the

sprinkler and the wall shall be measured from the sprinkler to the wall behind the obstruction and not to the face of the obstruction.

Table 12.1.11.1.4 Positioning of Sprinklers to Avoid Obstructions Along Wall (Residential Sidewall Sprinklers)

Distance from Sidewall Sprinkler to Side of Obstruction *(A)*	Maximum Allowable Distance of Deflector Above Bottom of Obstruction *(B)* [in. (mm)]
Less than 1 ft 6 in. (450 mm)	0 (0)
1 ft 6 in. (450 mm) to less than 3 ft (900 mm)	1 (25)
3 ft (900 mm) to less than 4 ft (1.2 m)	3 (75)
4 ft (1.2 m) to less than 4 ft 6 in. (1.4 m)	5 (125)
4 ft 6 in. (1.4 m) to less than 6 ft (1.8 m)	7 (175)
6 ft (1.8 m) to less than 6 ft 6 in. (2.0 m)	9 (225)
6 ft 6 in. (2.0 m) to less than 7 ft (2.1 m)	11 (275)
7 ft (2.1 m) to less than 7 ft 6 in. (2.3 m)	14 (350)

Note: For *A* and *B*, refer to Figure 8.10.7.1.4(a).

Figure 12.1.11.1.4(a) Positioning of Sprinkler to Avoid Obstruction Along Wall (Residential Sidewall Sprinklers).

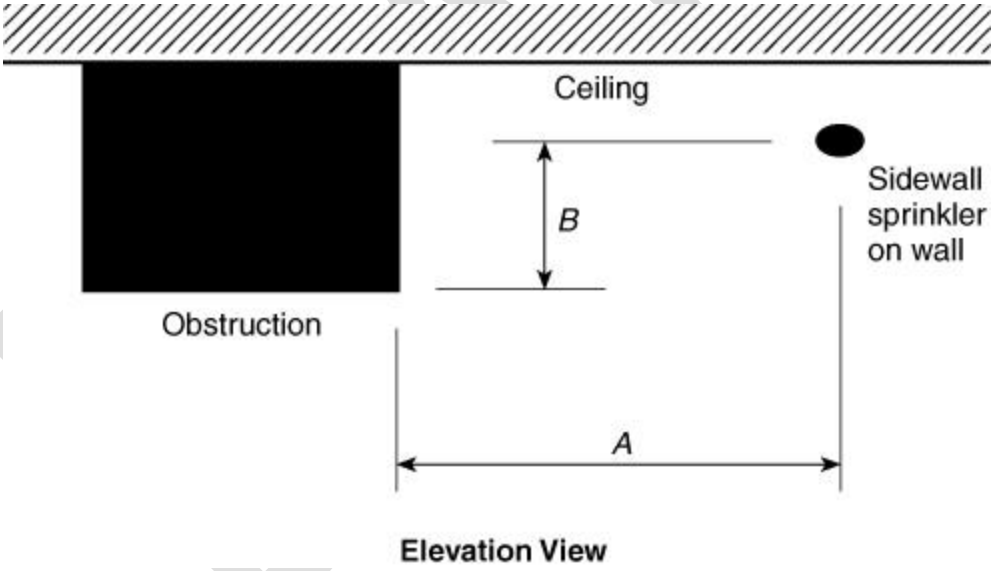


Figure 12.1.11.1.4(b) Obstruction Against Wall (Residential Sidewall Spray Sprinklers).

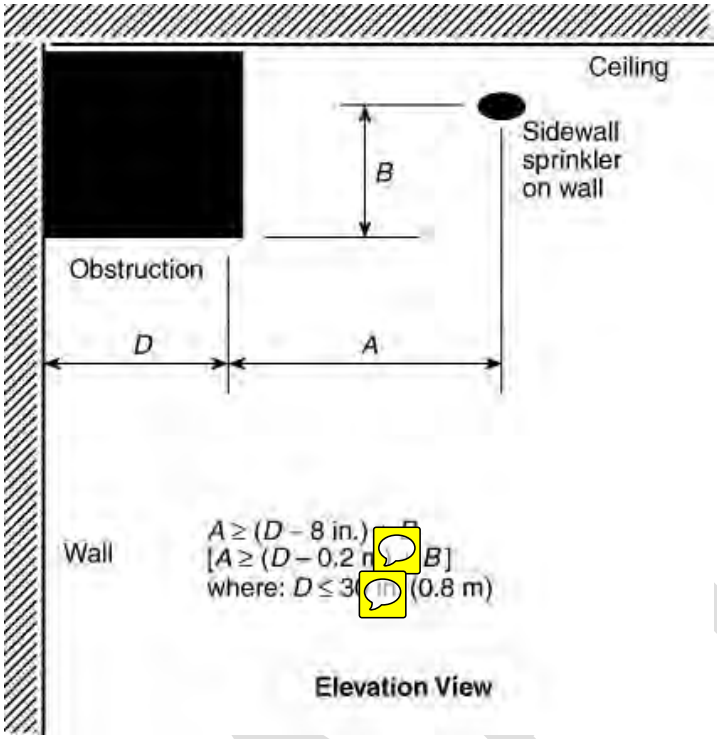
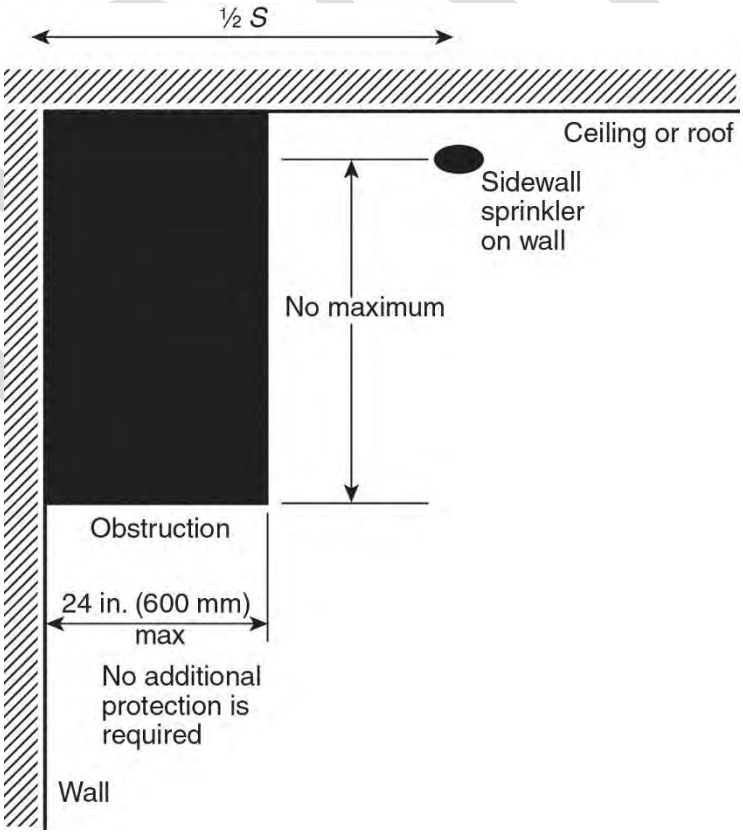


Figure 12.1.11.1.4(c) Obstruction Against Wall (Residential Sidewall Spray Sprinklers).



12.1.11.1.5* Soffits and Cabinets.

Where soffits are used for the installation of sidewall sprinklers, the sprinklers and soffits shall be installed in accordance with 12.1.11.1.5.1, 12.1.11.1.5.2, or 12.1.11.1.5.3.

12.1.11.1.5.1
Where soffits exceed more than 8 in. (200 mm) in width or projection from the wall, pendent sprinklers shall be installed under the soffit.

12.1.11.1.5.2
Sidewall sprinklers shall be permitted to be installed in the face of a soffit located directly over cabinets, without requiring additional sprinklers below the soffit or cabinets, where the soffit does not project horizontally more than 12 in. (300 mm) from the wall.

12.1.11.1.5.3
Where sidewall sprinklers are more than 3 ft (900 mm) above the top of cabinets, the sprinkler shall be permitted to be installed on the wall above the cabinets where the cabinets are no greater than 12 in. (300 mm) from the wall.

12.1.11.1.6*
Obstructions on the wall opposite from the sidewall sprinkler shall be permitted where the obstruction is up to 2 ft (600 mm) deep and 2 ft (600 mm) wide.

12.1.11.2 Obstructions to Sprinkler Discharge Pattern Development.

12.1.11.2.1 General.

12.1.11.2.1.1
Continuous or noncontinuous obstructions less than or equal to 18 in. (450 mm) below the sprinkler deflector that prevent the pattern from fully developing shall comply with this section.

12.1.11.2.1.2
Regardless of the rules of this section, solid continuous obstructions shall meet the requirements of 12.1.11.1.2 and 12.1.11.1.3.

12.1.11.2.1.3*
Unless the requirements of 12.1.11.2.1.4 through 12.1.11.2.1.7 are met, sprinklers shall be positioned away from obstructions a minimum distance of four times the maximum dimension of the obstruction (e.g., truss webs and chords, pipe, columns, and fixtures).

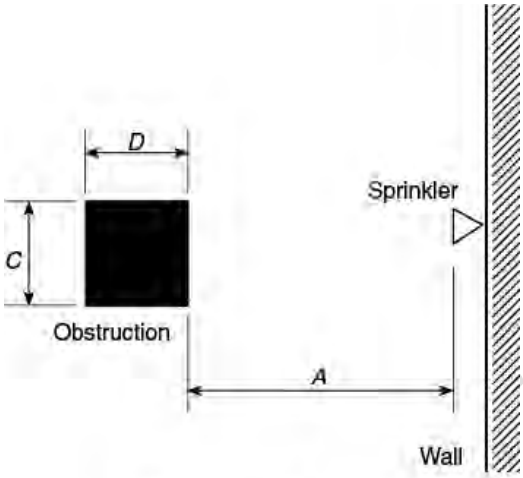
(A)
The maximum clear distance required from obstructions in the horizontal orientation (e.g., light fixtures and truss chords) shall be 36 in. (900 mm).

(B)
The maximum clear distance shall not be applied to obstructions in the vertical orientation (e.g., columns).

12.1.11.2.1.4
Sidewall sprinklers shall be positioned in accordance with Figure 12.1.11.2.1.4(a) and Figure 12.1.11.2.1.4(b) when obstructions are present.

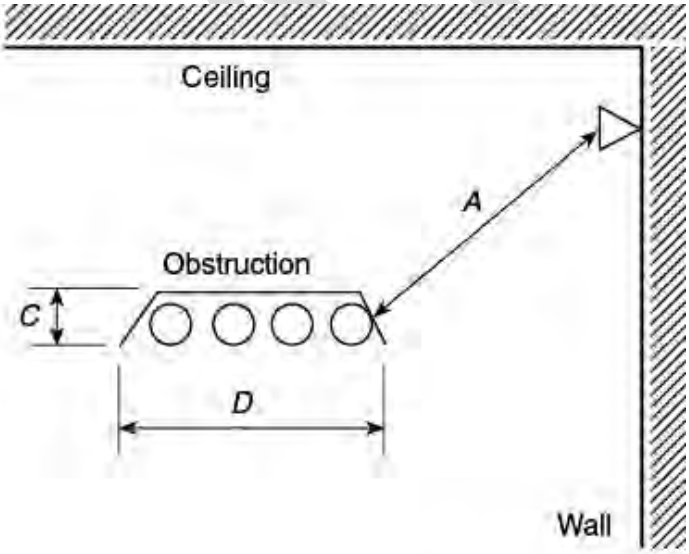
Figure 12.1.11.2.1.4(a) Minimum Distance from an Obstruction in the Vertical Orientation (Residential Sidewall Sprinkler).

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Plan View of Column
(Obstruction in vertical orientation)
$A \geq 4C$ or $4D$
(Use dimension C or D, whichever is greater)

Figure 12.1.11.2.1.4(b) Minimum Distance from an Obstruction in the Horizontal Orientation (Residential Sidewall Sprinkler).



Elevation View of Pipe Conduit or Light Fixture
(Obstruction in horizontal orientation)
$A \geq 4C$ or $4D$
$A \leq 36$ in. (900 mm)
(Use dimension C or D, whichever is greater)

12.1.11.2.1.5

The requirements of 12.1.11.2.1.3 and 12.1.11.2.1.4 shall not apply where sprinklers are positioned with respect to obstructions in accordance with 12.1.11.1.2 and 12.1.11.1.3.

12.1.11.2.1.6
The requirements of 12.1.11.2.1.3 shall not apply to sprinkler system piping less than 3 in. (80 mm) in diameter.

12.1.11.2.1.7*
Sprinklers shall be permitted to be placed without regard to the blades of a ceiling fan, provided the plan view of the fan is at least 50 percent open.

12.1.11.2.2* Suspended or Floor-Mounted Vertical Obstructions.
The distance from sprinklers to privacy curtains, free-standing partitions, room dividers, and similar obstructions shall be in accordance with Table 12.1.11.2.2 and Figure 12.1.11.2.2(a).

Table 12.1.11.2.2 Suspended or Floor-Mounted Obstructions (Residential Sidewall Sprinklers)

Horizontal Distance *(A)*	Minimum Allowable Distance Below Deflector *(B)* [in. (mm)]
6 in. (150 mm) or less	3 (75)
More than 6 in. (150 mm) to 9 in. (225 mm)	4 (100)
More than 9 in. (225 mm) to 12 in. (300 mm)	6 (150)
More than 12 in. (300 mm) to 15 in. (375 mm)	8 (200)
More than 15 in. (375 mm) to 18 in. (450 mm)	9½(240)
More than 18 in. (450 mm) to 24 in. (600 mm)	12½(315)
More than 24 in. (600 mm) to 30 in. (750 mm)	15½(390)
More than 30 in. (750 mm)	18 (450)

For SI units, 1 in. = 25.4 mm.

Note: For *A* and *B*, refer to Figure 8.10.7.2.2.

Figure 12.1.11.2.2(a) Suspended or Floor-Mounted Obstruction (Residential Sidewall Sprinklers).

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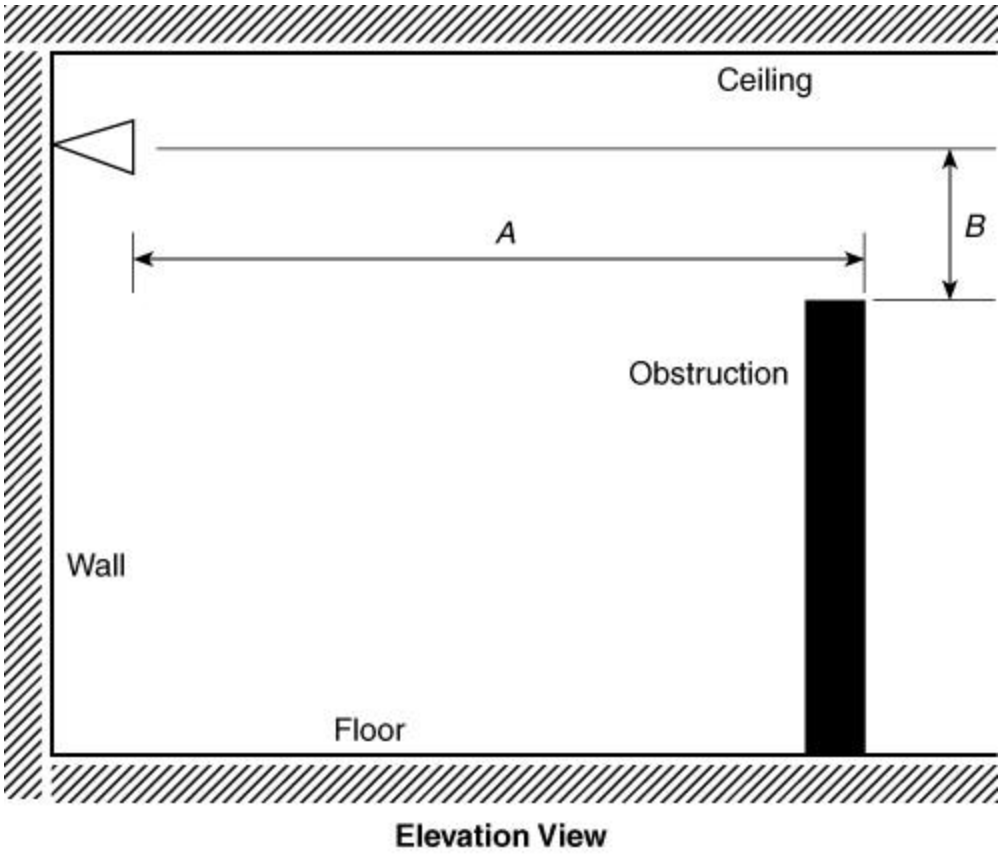


Figure 12.1.11.2.2(b) Suspended or Floor-Mounted Obstructions (Residential Sprinklers). [figure missing?]

12.1.11.3* Obstructions that Prevent Sprinkler Discharge from Reaching Hazard.

12.1.11.3.1
Continuous or noncontinuous obstructions that interrupt the water discharge in a horizontal plane more than 18 in. (450 mm) below the sprinkler deflector in a manner to limit the distribution from reaching the protected hazard shall comply with this section.

12.1.11.3.2*
Sprinklers shall be installed under fixed obstructions over 4 ft (1.2 m) wide.

12.1.11.3.3
Sprinklers installed under open gratings shall be shielded from the discharge of overhead sprinklers.

12.1.11.3.4
The deflector of automatic sprinklers installed under fixed obstructions shall be positioned below the bottom of the obstruction in accordance with their listed distance below ceilings.

12.1.11.3.5
Sprinklers installed under round ducts shall be shielded from the discharge of overhead sprinklers.

12.1.12 Ceiling Pockets.

12.1.12.1
Sprinklers shall be required in all ceiling pockets.

12.1.12.2
The requirement of 12.1.12.1 shall not apply where all of the following requirements are met:
(1) The total volume of the unprotected ceiling pocket does not exceed 100 ft^3 (2.8 m^3).

(2) The depth of the unprotected ceiling pocket does not exceed 12 in. (300 mm).

(3) The entire floor of the unprotected ceiling pocket is protected by the sprinklers at the lower ceiling elevation.

(4) The interior finish of the unprotected ceiling pocket is noncombustible or limited-combustible construction.

Chapter 13 Installation Requirements for CMSA Sprinklers

13.1 General.
Control mode specific application (CMSA) sprinklers shall be selected for use and installation as indicated in this chapter and shall be positioned and spaced in accordance with Section 9.5.

13.2 CMSA Sprinklers.

13.2.1 General.
All requirements of Section 9.5 shall apply to CMSA sprinklers except as modified in Section 13.2.

13.2.1.1
CMSA pendent sprinklers shall be installed in accordance with Section 9.5 and the manufacturer's installation instructions in lieu of the requirements in Section 13.2.

13.2.2
CMSA sprinklers shall be permitted to be used in wet, dry, or preaction systems and shall be installed in accordance with their listing.

13.2.3 Temperature Ratings.

13.2.3.1
Unless the requirements of 13.2.3.2, 13.2.3.3, or 13.2.3.4 are met, sprinkler temperature ratings shall be the same as those indicated in Table 9.4.2.5(a) and Table 9.4.2.5(b) or those used in large-scale fire testing to determine the protection requirements for the hazard involved.

13.2.3.2
Sprinklers of intermediate- and high-temperature ratings shall be installed in specific locations as required by **9.4.2**.

13.2.3.3
In storage occupancies, ordinary, intermediate, or high temperature–rated sprinklers shall be used for wet pipe systems.

13.2.3.4
In storage occupancies, high temperature–rated sprinklers shall be used for dry pipe systems.

13.2.4 Occupancy and Hazard.

13.2.4.1
Quick-response CMSA sprinklers designed to meet any criteria in Chapter 12 through Chapter 20 shall be permitted to protect light and ordinary hazard occupancies.

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13.2.4.2
Standard-response CMSA sprinklers designed to meet any criteria in Chapter 12 through Chapter 20 shall be permitted to protect ordinary hazard occupancies.

13.2.5* Protection Areas per Sprinkler (CMSA Sprinklers).

13.2.5.1 Determination of Protection Area of Coverage.
The protection area of coverage per sprinkler (A_s) shall be determined in accordance with 9.5.2.1.

13.2.5.2 Maximum Protection Area of Coverage.

13.2.5.2.1
The maximum allowable protection area of coverage for a sprinkler (A_s) shall be in accordance with the value indicated in Table 13.2.5.2.1.

Table 13.2.5.2.1 Protection Areas and Maximum Spacing for CMSA Sprinklers

	Protection Area		Maximum Spacing	
Construction Type	**ft²**	**m²**	**ft**	**m**
Noncombustible unobstructed	130	12.1	12	3.7
Noncombustible obstructed	130	12.1	12	3.7
Combustible unobstructed	130	12.1	12	3.7
Combustible obstructed	100	9.3	10	3.0
Rack storage combustible obstructed	100	9.3	10	3.0
Rack storage unobstructed and noncombustible obstructed	100	9.3	12	3.7

13.2.5.2.2
In any case, the maximum area of coverage of any sprinkler shall not exceed 130 ft² (12.1 m²).

13.2.5.3 Minimum Protection Area of Coverage.
The minimum allowable protection area of coverage for a sprinkler (A_s) shall be not less than 80 ft² (7.4 m²).

13.2.6 Sprinkler Spacing (CMSA Sprinklers).

13.2.6.1* Maximum Distance Between Sprinklers.

13.2.6.1.1
Under unobstructed and obstructed noncombustible construction and unobstructed combustible construction, the distance between sprinklers shall be limited to not more than 12 ft (3.7 m) between sprinklers, as shown in Table 13.2.5.2.1.

13.2.6.1.2
Under obstructed combustible construction, the maximum distance shall be limited to 10 ft (3 m).

13.2.6.2 Maximum Distance from Walls.
The distance from sprinklers to walls shall not exceed one-half of the allowable distance permitted between sprinklers as indicated in Table 13.2.5.2.1.

13.2.6.3 Minimum Distance from Walls.
Sprinklers shall be located a minimum of 4 in. (100 mm) from a wall.

13.2.6.4 Minimum Distance Between Sprinklers.
Sprinklers shall be spaced not less than 8 ft (2.4 m) on center.

13.2.7 Deflector Position (CMSA Sprinklers).

13.2.7.1* Distance Below Ceilings.

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13.2.7.1.1 Unobstructed Construction.
Under unobstructed construction, the distance between the sprinkler deflector and the ceiling shall be a minimum of 6 in. (150 mm) and a maximum of 8 in. (200 mm).

13.2.7.1.2 Obstructed Construction.
Under obstructed construction, the sprinkler deflector shall be located in accordance with one of the following arrangements:
(1) Installed with the deflectors located a minimum of 6 in. (150 mm) and a maximum of 12 in. (300 mm) from the ceiling.

(2) Installed with the deflectors within the horizontal planes 1 in. to 6 in. (25 mm to 150 mm) below wood joist, composite wood joist, solid obstructed noncombustible, or solid obstructed limited combustible construction, to a maximum distance of 22 in. (550 mm) below the ceiling/roof or deck. Where CMSA sprinklers are installed under open wood joist construction, their minimum operating pressure shall be 50 psi (3.4 bar) for a K-11.2 (160) sprinkler or 22 psi (1.5 bar) for a K-16.8 (240) sprinkler in accordance with 16.59.2.3, 16.3.2.4, and 17.6.2.3.

(3) Installed with deflectors of sprinklers under concrete tee construction with stems spaced less than 7 ft 6 in. (2.3 m) but more than 3 ft (900 mm) on centers, regardless of the depth of the tee, located at or above a horizontal plane 1 in. (25 mm) below the bottom of the stems of the tees and in compliance with Table 13.2.8.1.2.

13.2.8* Obstructions to Sprinkler Discharge (CMSA Sprinklers).

13.2.8.1 Performance Objective.

13.2.8.1.1
Sprinklers shall be located so as to minimize obstructions to discharge as defined in 9.5.5.2 and 9.5.5.3, or additional sprinklers shall be provided to ensure adequate coverage of the hazard.

13.2.8.1.2
Sprinklers shall be arranged to comply with 9.5.5.2, Table 13.2.8.1.2, and Figure 13.2.8.1.2.

Table 13.2.8.1.2 Positioning of Sprinklers to Avoid Obstructions to Discharge (CMSA Sprinklers)

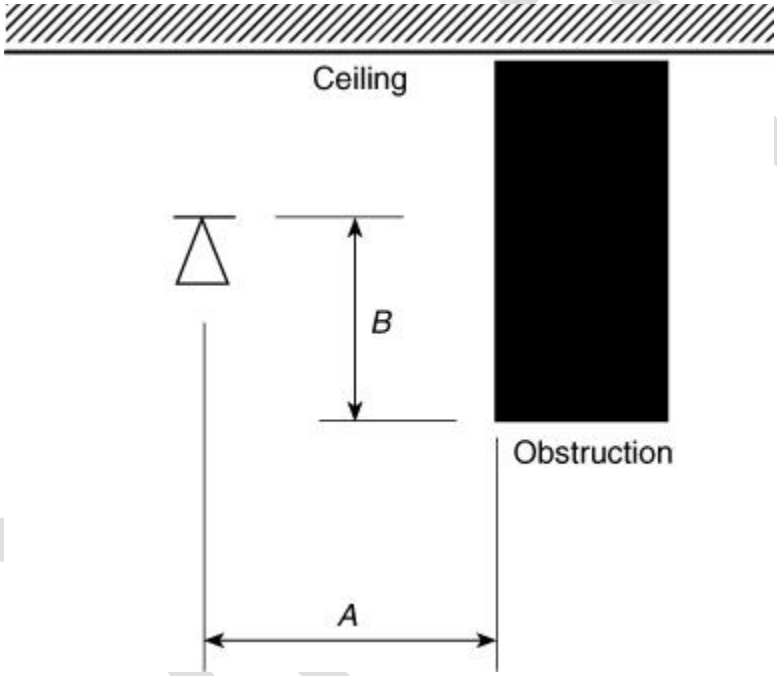
Distance from Sprinkler to Side of Obstruction *(A)*	Maximum Allowable Distance of Deflector Above Bottom of Obstruction *(B)*[in. (mm)]
Less than 1 ft (300 mm)	0 (0)
1 ft (300 mm) to less than 1 ft 6 in. (450 mm)	1½(35)
1 ft 6 in. (450 mm) to less than 2 ft (600 mm)	3 (75)
2 ft (600 mm) to less than 2 ft 6 in. (750 mm)	5½(140)
2 ft 6 in. (750 mm) to less than 3 ft (900 mm)	8 (200)
3 ft (900 mm) to less than 3 ft 6 in. (1.1 m)	10 (250)
3 ft 6 in. (1.1 m) to less than 4 ft (1.2 m)	12 (300)
4 ft (1.2 m) to less than 4 ft 6 in. (1.4 m)	15 (375)

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Distance from Sprinkler to Side of Obstruction *(A)*	Maximum Allowable Distance of Deflector Above Bottom of Obstruction *(B)*[in. (mm)]
4 ft 6 in. (1.4 m) to less than 5 ft (1.5 m)	18 (450)
5 ft (1.5 m) to less than 5 ft 6 in. (1.7 m)	22 (550)
5 ft 6 in. (1.7 m) to less than 6 ft (1.8 m)	26 (650)
6 ft (1.8 m)	31 (775)

Note: For *A* and *B*, refer to Figure 8.11.5.1.2.

Figure 13.2.8.1.2 Positioning of Sprinkler to Avoid Obstruction to Discharge (CMSA Sprinklers).



13.2.8.1.3
The requirements of 13.2.8.1.2 shall not apply where sprinklers are positioned on opposite sides of the obstruction.

13.2.8.2 Obstructions to Sprinkler Discharge Pattern Development.

13.2.8.2.1 General.

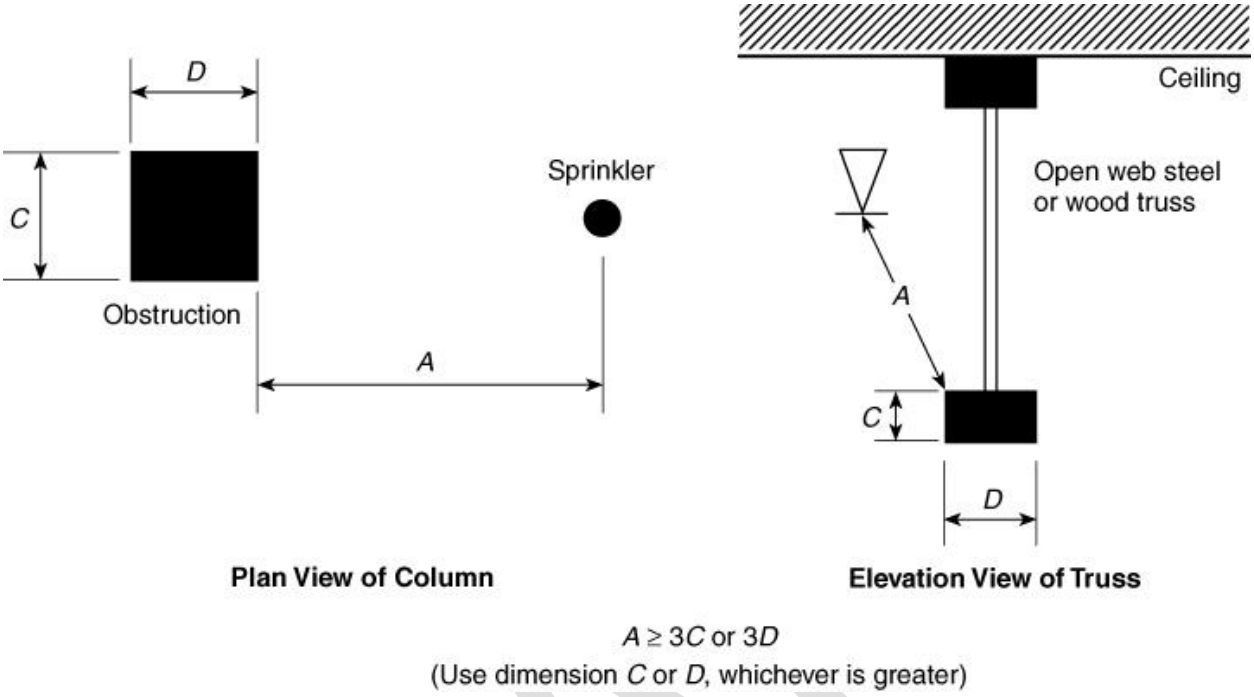
13.2.8.2.1.1
Continuous or noncontinuous obstructions less than or equal to 36 in. (900 mm) below the sprinkler deflector that prevent the pattern from fully developing shall comply with 13.2.8.2.

13.2.8.2.1.2
Regardless of the rules of this section, solid continuous obstructions shall meet the requirements of 13.2.8.1.2 or 13.2.8.1.3.

13.2.8.2.1.3*
Unless the requirements of 13.2.8.1.2 or 13.2.8.1.3 are met, for obstructions 8 in. (200 mm) or less in width, as shown in Figure 13.2.8.2.1.3, sprinklers shall be positioned such that they are located at least a

distance three times greater than the maximum dimension of the obstruction from the sprinkler (e.g., webs and chord members, pipe, columns, and fixtures).

Figure 13.2.8.2.1.3 Minimum Distance from Obstruction (CMSA Sprinklers).



13.2.8.2.2 Branch Lines.
Upright sprinklers shall be positioned with respect to branch lines in accordance with one of the following:
(1) Upright sprinklers shall be permitted to be attached directly to branch lines less than or equal to 4 in. (100 mm) nominal in diameter.

(2) Upright sprinklers shall be permitted to be offset horizontally a minimum of 12 in. (300 mm) from the pipe.

(3) Upright sprinklers shall be permitted to be supplied by a riser nipple (sprig) to elevate the sprinkler deflector a minimum of 12 in. (300 mm) from the centerline of any pipe over 4 in. (100 mm) nominal in diameter.

13.2.8.3* Obstructions that Prevent Sprinkler Discharge from Reaching Hazard.

13.2.8.3.1
Continuous or noncontinuous obstructions that interrupt the water discharge in a horizontal plane below the sprinkler deflector in a manner to limit the distribution from reaching the protected hazard shall comply with 13.2.8.3.

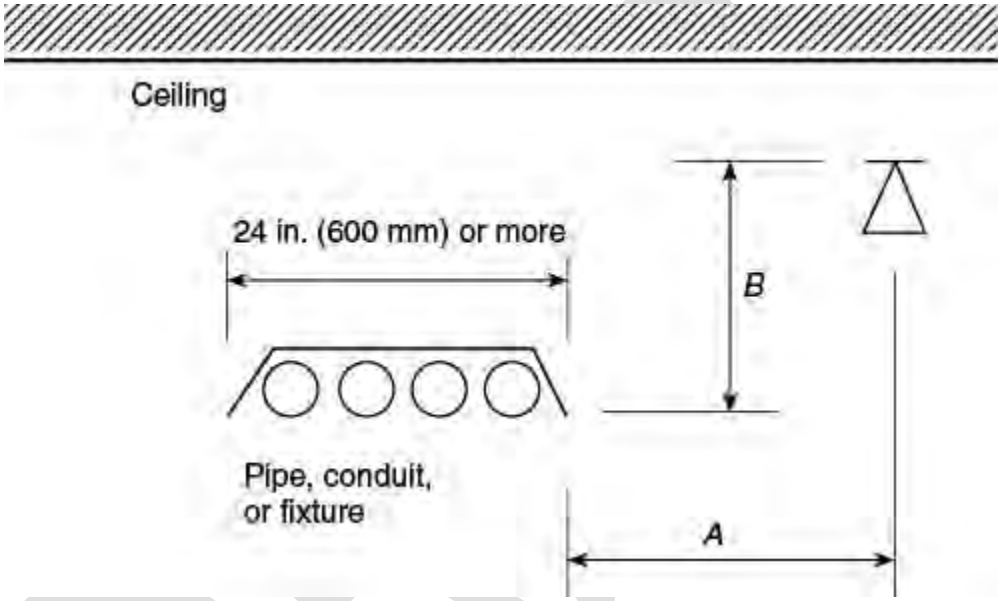
13.2.8.3.2
Sprinklers shall be positioned with respect to fluorescent lighting fixtures, ducts, and obstructions more than 24 in. (600 mm) wide and located entirely below the sprinklers so that the minimum horizontal distance from the near side of the obstruction to the center of the sprinkler is not less than the value specified in Table 13.2.8.3.2 and Figure 13.2.8.3.2.

Table 13.2.8.3.2 Obstruction Entirely Below Sprinkler (CMSA Sprinklers)

Minimum Distance to Side of Obstruction (ft) *(A)*	Distance of Deflector Above Bottom of Obstruction *(B)*[in. (mm)]
Less than 6 in. (150 mm)	1½(35)
6 in. (150 mm) to less than 12 in. (300 mm)	3 (75)
12 in. (300 mm) to less than 18 in. (450 mm)	4 (100)
18 in. (450 mm) to less than 24 in. (600 mm)	5 (125)
24 in. (600 mm) to less than 30 in. (750 mm)	5½(140)
30 in. (750 mm) to less than 36 in. (900 mm)	6 (150)

Note: For *A* and *B*, refer to Figure 8.11.5.3.2.

Figure 13.2.8.3.2 Obstruction Entirely Below Sprinkler (CMSA Sprinklers).



13.2.8.3.3
Sprinklers installed under open gratings shall be shielded from the discharge of overhead sprinklers.

13.2.8.3.4
Where the bottom of the obstruction is located 24 in. (600 mm) or more below the sprinkler deflectors, the following shall occur:
(1) Sprinklers shall be positioned so that the obstruction is centered between adjacent sprinklers in accordance with Figure 13.2.8.3.4.

(2) The obstruction width shall meet the following requirements:
(a) The obstruction shall be limited to a maximum width of 24 in. (600 mm) in accordance with Figure 13.2.8.3.4.

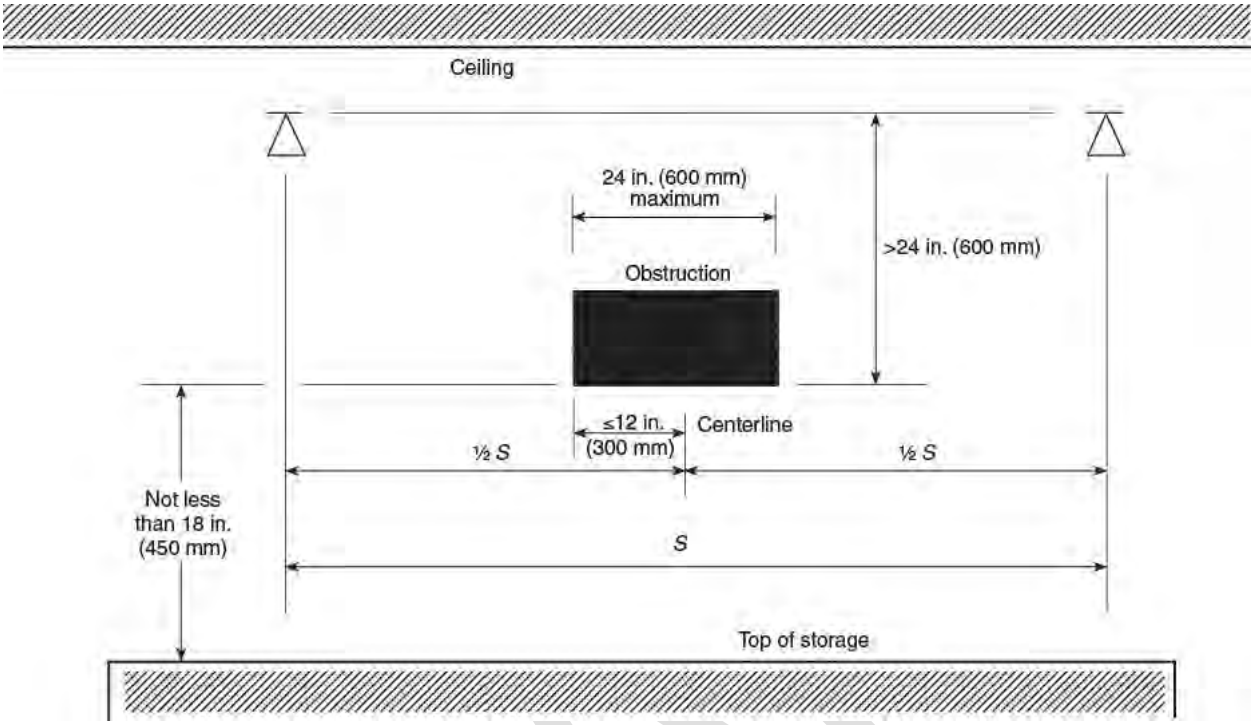
(b) Where the obstruction is greater than 24 in. (600 mm) wide, one or more lines of sprinklers shall be installed below the obstruction.

(3) The obstruction extension shall meet the following requirements:
(a) The obstruction shall not extend more than 12 in. (300 mm) to either side of the midpoint between sprinklers in accordance with Figure 13.2.8.3.4.

(b) Where the extensions of the obstruction exceed 12 in. (300 mm), one or more lines of sprinklers shall be installed below the obstruction.

(4) At least 18 in. (450 mm) clearance shall be maintained between the top of storage and the bottom of the obstruction in accordance with Figure 13.2.8.3.4.

Figure 13.2.8.3.4 Obstruction More Than 24 in. (600 mm) Below Sprinklers (CMSA Sprinklers).



13.2.8.3.5

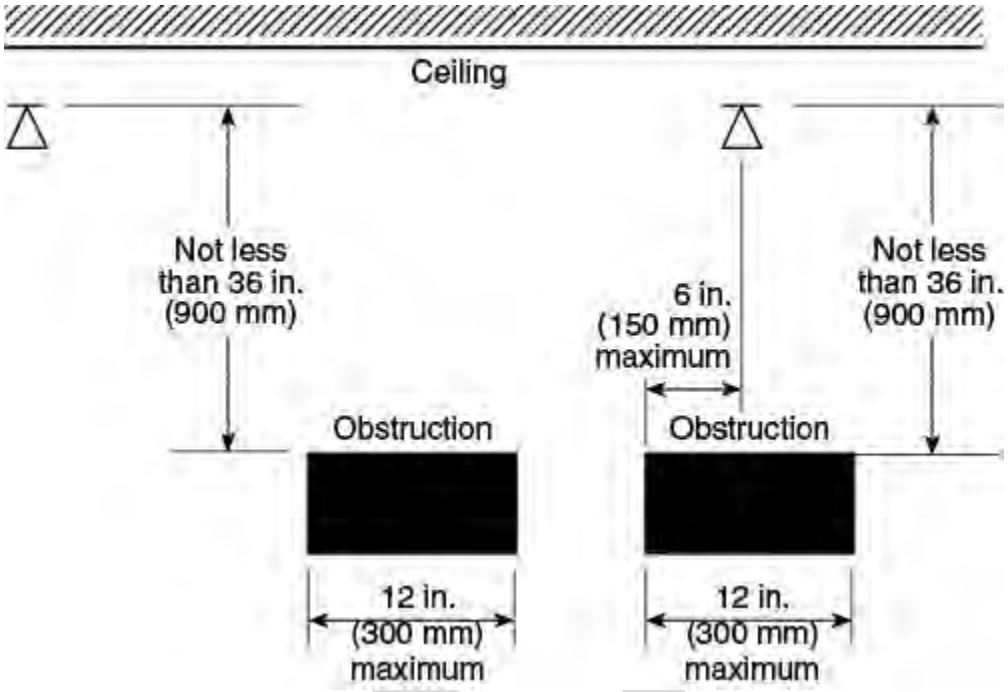
In the special case of an obstruction running parallel to or directly below a branch line, the following shall occur:

(1) The sprinkler shall be located at least 36 in. (900 mm) above the top of the obstruction in accordance with Figure 13.2.8.3.5.

(2) The obstruction shall be limited to a maximum width of 12 in. (300 mm) in accordance with Figure 13.2.8.3.5.

(3) The obstruction shall be limited to a maximum extension of 6 in. (150 mm) to either side of the centerline of the branch line in accordance with Figure 13.2.8.3.5.

Figure 13.2.8.3.5 Obstruction More Than 36 in. (914 mm) Below Sprinklers (CMSA Sprinklers).



13.2.9 Clearance to Storage (CMSA Sprinklers).
The clearance between the deflector and the top of storage shall be 36 in. (900 mm) or greater.

Chapter 14 Installation Requirements for Early Suppression Fast-Response Sprinklers

14.1 General.
Early suppression fast-response (ESFR) sprinklers shall be selected for use and installation as indicated in this chapter and shall be positioned and spaced in accordance with Section 9.5.

14.2 Early Suppression Fast-Response Sprinklers.

14.2.1 General.
All requirements of Section **9.5** shall apply except as modified in Section 14.2.

14.2.2
ESFR sprinklers shall be used only in wet pipe systems unless specifically listed for use in dry systems or preaction systems.

14.2.3
ESFR sprinklers shall be installed only in buildings where roof or ceiling slope above the sprinklers does not exceed a pitch of 2 in 12 (a rise of 2 units in a run of 12 units, a roof slope of 16.7 percent).

14.2.4*
ESFR sprinklers shall be permitted for use in buildings with unobstructed and noncombustible obstructed construction.

14.2.4.1
Where depths of the solid structural members (beams, stem, and so forth) exceed 12 in. (300 mm), ESFR sprinklers shall be installed in each channel formed by the solid structural members.

14.2.4.2

Minimum sprinkler spacing and area of coverage shall comply with the requirements of 14.2.8 and 14.2.9.

14.2.5 Draft Curtains.

14.2.5.1
Where ESFR sprinkler systems are installed adjacent to sprinkler systems with standard-response sprinklers, a draft curtain of noncombustible construction and at least 2 ft (600 mm) in depth shall be required to separate the two areas.

14.2.5.2
A clear aisle of at least 4 ft (1.2 m) centered below the draft curtain shall be maintained for separation.

14.2.6 Temperature Ratings.
Sprinkler temperature ratings for ESFR sprinklers shall be ordinary unless 9.4.2 requires intermediate- or high-temperature ratings.

14.2.7 Occupancy and Hazard.
ESFR sprinklers designed to meet any criteria in Chapter 12 through Chapter 20 shall be permitted to protect light and ordinary hazard occupancies.

14.2.8 Protection Areas per Sprinkler (Early Suppression Fast-Response Sprinklers).

14.2.8.1 Determination of Protection Area of Coverage.
The protection area of coverage per sprinkler *(A_s)* shall be determined in accordance with 9.5.2.1.

14.2.8.2 Maximum Protection Area of Coverage.

14.2.8.2.1
The maximum allowable protection area of coverage for a sprinkler *(A_s)* shall be in accordance with the value indicated in Table 14.2.8.2.1.

Table 14.2.8.2.1 Protection Areas and Maximum Spacing of ESFR Sprinklers

	Ceiling/Roof Heights Up to 30 ft (9.1 m)				Ceiling/Roof Heights Over 30 ft (9.1 m)			
	Protection Area		Spacing		Protection Area		Spacing	
Construction Type	**ft²**	**m²**	**ft**	**m**	**ft²**	**m²**	**ft**	**m**
Noncombustible unobstructed	100	9.3	12	3.7	100	9.3	10	3.0
Noncombustible obstructed	100	9.3	12	3.7	100	9.3	10	3.0
Combustible unobstructed	100	9.3	12	3.7	100	9.3	10	3.0
Combustible obstructed	N/A		N/A		N/A		N/A	

14.2.8.2.2
Unless the requirements of 14.2.8.2.3 are met, the maximum area of coverage of any sprinkler shall not exceed 100 ft² (9.3 m²).

14.2.8.2.3*
Deviations from the maximum sprinkler spacing shall be permitted to eliminate obstructions created by structural elements (such as trusses, bar joists, and wind bracing) by moving a sprinkler along the branch line a maximum of 1 ft (300 mm) from its allowable spacing, provided coverage for that sprinkler does not exceed 110 ft² (10.2 m²) per sprinkler where all of the following conditions are met:
(1) The average actual floor area protected by the moved sprinkler and the adjacent sprinklers shall not exceed 100 ft² (9.3 m²).

(2) Adjacent branch lines shall maintain the same pattern.

(3) In no case shall the distance between sprinklers exceed 12 ft (3.7 m).

14.2.8.2.4
Deviations from the maximum sprinkler spacing shall be permitted to eliminate obstructions by moving a single branch line a maximum of 1 ft (300 mm) from its allowable spacing, provided coverage for the sprinklers on that branch line and the sprinklers on the branch line it is moving away from does not exceed 110 ft^2 (10.2 m^2) per sprinkler where all of the following conditions are met:
(1) The average actual floor area protected by the sprinklers on the moved branch line and the sprinklers on the adjacent branch lines shall not exceed 100 ft^2 (9.3 m^2) per sprinkler.

(2) In no case shall the distance between sprinklers exceed 12 ft (3.7 m).

(3) It shall not be permitted to move a branch line where there are moved sprinklers on a branch line that exceed the maximum sprinkler spacing.

14.2.8.3 Minimum Protection Area of Coverage.
The minimum allowable protection area of coverage for a sprinkler *(A_s)* shall not be less than 64 ft^2 (5.9^2).

14.2.9 Sprinkler Spacing (Early Suppression Fast-Response Sprinklers).

14.2.9.1 Maximum Distance Between Sprinklers.
The maximum distance between sprinklers shall be in accordance with the following:
(1) Where the storage height is less than or equal to 25 ft (7.6 m) and the ceiling height is less than or equal to 30 ft (9.1 m), the distance between sprinklers shall be limited to not more than 12 ft (3.7 m) between sprinklers as shown in Table 14.2.8.2.1.

(2) Unless the requirements of 14.2.9.1(3) or 14.2.9.1(4) are met, where the storage height exceeds 25 ft (7.6 m) and ceiling height exceeds 30 ft (9.1 m), the distance between sprinklers shall be limited to not more than 10 ft (3.0 m) between sprinklers.

(3) *Regardless of the storage or ceiling height arrangement, deviations from the maximum sprinkler spacing shall be permitted to eliminate obstructions created by structural elements (such as trusses, bar joists, and wind bracing) by moving a sprinkler along the branch line a maximum of 1 ft (300 mm) from its allowable spacing, provided coverage for that sprinkler does not exceed 110 ft^2 (10.2 m^2) where all of the following conditions are met:
(a) The average actual floor area protected by the moved sprinkler and the adjacent sprinklers shall not exceed 100 ft^2 (9.3 m^2).

(b) Adjacent branch lines shall maintain the same pattern.

(c) In no case shall the distance between sprinklers exceed 12 ft (3.7 m).

(4) Where branch lines are parallel to trusses and bar joists, deviations from the maximum sprinkler spacing shall be permitted to eliminate obstructions created by structural elements (such as trusses, bar joists, and wind bracing) by moving a single branch line a maximum of 1 ft (300 mm) from its allowable spacing, provided coverage for the sprinklers on that branch line and the sprinklers on the branch line it is moving away from does not exceed 110 ft^2 (10.2 m^2) per sprinkler where all of the following conditions are met:
(a) The average actual floor area protected by the sprinklers on the moved branch line and the sprinklers on the adjacent branch lines shall not exceed 100 ft^2 (9.3 m^2) per sprinkler.

(b) In no case shall the distance between sprinklers exceed 12 ft (3.7 m).

(c) It shall not be permitted to move a branch line where there are moved sprinklers on a branch line that exceed the maximum sprinkler spacing.

14.2.9.2 Maximum Distance from Walls.
The distance from sprinklers to walls shall not exceed one-half of the allowable distance permitted between sprinklers as indicated in Table 14.2.8.2.1.

14.2.9.3 Minimum Distance from Walls.
Sprinklers shall be located a minimum of 4 in. (100 mm) from a wall.

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14.2.9.4 Minimum Distance Between Sprinklers.
Sprinklers shall be spaced not less than 8 ft (2.4 m) on center.

14.2.10 Deflector Position (Early Suppression Fast-Response Sprinklers).

14.2.10.1 Distance Below Ceilings.

14.2.10.1.1
Pendent sprinklers with a nominal K-factor of K-14 (200) shall be positioned so that deflectors are a maximum 14 in. (350 mm) and a minimum 6 in. (150 mm) below the ceiling.

14.2.10.1.2
Pendent sprinklers with a nominal K-factor of K-16.8 (240) shall be positioned so that deflectors are a maximum 14 in. (350 mm) and a minimum 6 in. (150 mm) below the ceiling.

14.2.10.1.3
Pendent sprinklers with a nominal K-factor of K-22.4 (320) and K-25.2 (360) shall be positioned so that deflectors are a maximum 18 in. (450 mm) and a minimum 6 in. (150 mm) below the ceiling.

14.2.10.1.4
Upright sprinklers with a nominal K-factor of K-14 (200) shall be positioned so that the deflector is 3 in. to 12 in. (75 mm to 300 mm) below the ceiling.

14.2.10.1.5
Upright sprinklers with a nominal K-factor of K-16.8 (240) shall be positioned so that the deflector is 3 in. to 12 in. (75 mm to 300 mm) below the ceiling.

14.2.10.1.6
With obstructed construction, the branch lines shall be permitted to be installed across the beams, but sprinklers shall be located in the bays and not under the beams.

14.2.10.2 Deflector Orientation.
Deflectors of sprinklers shall be aligned parallel to ceilings or roofs.

14.2.11* Obstructions to Sprinkler Discharge (Early Suppression Fast-Response Sprinklers).

14.2.11.1 Obstructions at or Near Ceiling.

14.2.11.1.1
Sprinklers shall be arranged to comply with Table 14.2.11.1.1 and Figure 14.2.11.1.1 for obstructions at the ceiling, such as beams, ducts, lights, and top chords of trusses and bar joists.

Table 14.2.11.1.1 Positioning of Sprinklers to Avoid Obstructions to Discharge (ESFR Sprinklers)

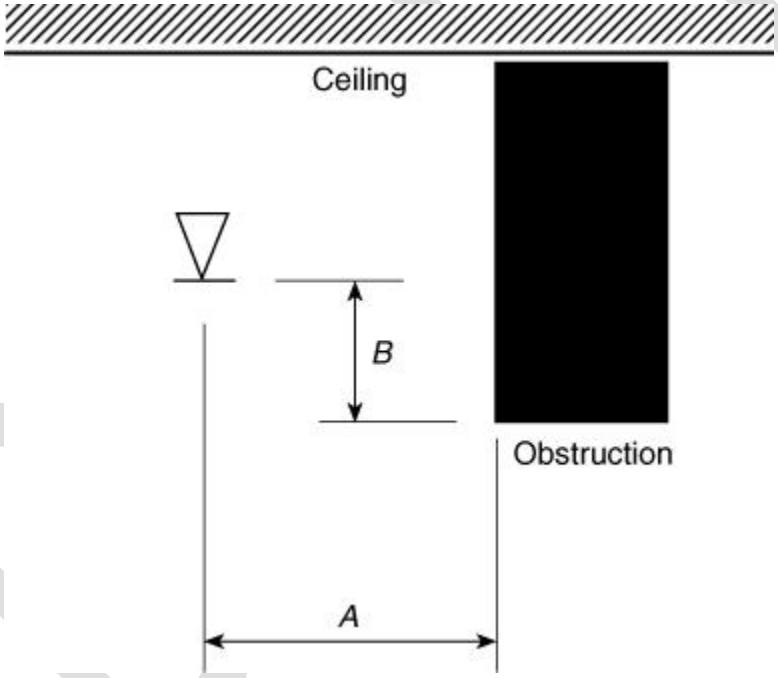
Distance from Sprinkler to Side of Obstruction *(A)*	Maximum Allowable Distance of Deflector Above Bottom of Obstruction *(B)* [in. (mm)]
Less than 1 ft (300 mm)	0 (0)
1 ft (300 mm) to less than 1 ft 6 in. (450 mm)	1½(35)
1 ft 6 in. (450 mm) to less than 2 ft (600 mm)	3 (75)
2 ft (600 mm) to less than 2 ft 6 in. (750 mm)	5½(140)
2 ft 6 in. (750 mm) to less than 3 ft (900 mm)	8 (200)
3 ft (900 mm) to less than 3 ft 6 in. (1.1 m)	10 (250)

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Distance from Sprinkler to Side of Obstruction *(A)*	Maximum Allowable Distance of Deflector Above Bottom of Obstruction *(B)* [in. (mm)]
3 ft 6 in. (1.1 m) to less than 4 ft (1.2 m)	12 (300)
4 ft (1.2 m) to less than 4 ft 6 in. (1.4 m)	15 (375)
4 ft 6 in. (1.4 m) to less than 5 ft (1.5 m)	18 (450)
5 ft (1.5 m) to less than 5 ft 6 in. (1.7 m)	22 (550)
5 ft 6 in. (1.7 m) to less than 6 ft (1.8 m)	26 (650)
6 ft (1.8 m)	31 (775)

Note: For *A* and *B*, refer to Figure 8.12.5.1.1.

Figure 14.2.11.1.1 Positioning of Sprinkler to Avoid Obstruction to Discharge (ESFR Sprinklers).



14.2.11.1.2
The requirements of 14.2.11.1.1 shall not apply where sprinklers are spaced on opposite sides of obstructions less than 24 in. (600 mm) wide, provided the distance from the centerline on the obstructions to the sprinklers does not exceed one-half the allowable distance between sprinklers.

14.2.11.1.3
Sprinklers with a special obstruction allowance shall be installed according to their listing.

14.2.11.2* Isolated Obstructions Below Elevation of Sprinklers.
Sprinklers shall be arranged with respect to obstructions in accordance with one of the following:
(1) Sprinklers shall be installed below isolated noncontinuous obstructions that restrict only one sprinkler and are located below the elevation of sprinklers such as light fixtures and unit heaters.

(2) Additional sprinklers shall not be required where the obstruction is 2 ft (600 mm) or less in width and the sprinkler is located horizontally 1 ft (300 mm) or greater from the nearest edge of the obstruction.

(3) Additional sprinklers shall not be required where sprinklers are positioned with respect to the bottom of obstructions in accordance with 14.2.11.1.

(4) Additional sprinklers shall not be required where the obstruction is 2 in. (50 mm) or less in width and is located a minimum of 2 ft (600 mm) below the elevation of the sprinkler deflector or is positioned a minimum of 1 ft (300 mm) horizontally from the sprinkler.

(5) Sprinklers with a special obstruction allowance shall be installed according to their listing.

14.2.11.3 Continuous Obstructions Below Sprinklers.

14.2.11.3.1 General Continuous Obstructions.
Sprinklers shall be arranged with respect to obstructions in accordance with one of the following:
(1) Sprinklers shall be installed below continuous obstructions, or they shall be arranged to comply with Table 14.2.11.1.1 for horizontal obstructions entirely below the elevation of sprinklers that restrict sprinkler discharge pattern for two or more adjacent sprinklers such as ducts, lights, pipes, and conveyors.

(2) Additional sprinklers shall not be required where the obstruction is 2 in. (50 mm) or less in width and is located a minimum of 2 ft (600 mm) below the elevation of the sprinkler deflector or is positioned a minimum of 1 ft (300 mm) horizontally from the sprinkler.

(3) Additional sprinklers shall not be required where the obstruction is 1 ft (300 mm) or less in width and located a minimum of 1 ft (300 mm) horizontally from the sprinkler.

(4) Additional sprinklers shall not be required where the obstruction is 2 ft (600 mm) or less in width and located a minimum of 2 ft (600 mm) horizontally from the sprinkler.

(5) Ceiling sprinklers shall not be required to comply with Table 14.2.11.1.1 where a row of sprinklers is installed under the obstruction.

14.2.11.3.2 Bottom Chords of Bar Joists or Open Trusses.
ESFR sprinklers shall be positioned a minimum of 1 ft (300 mm) horizontally from the nearest edge to the bottom chord of a bar joist or open truss where the bottom chord does not exceed 1 ft (300 mm) in width.

14.2.11.3.2.1
The requirements of 14.2.11.3.2 shall not apply where upright sprinklers are located over the bottom chords of bar joists or open trusses that are 4 in. (100 mm) maximum in width.

14.2.11.3.3*
For pipes, conduits, or groups of pipes and conduit to be considered individual, they must be separated from the closest adjacent pipe, conduit, cable tray, or similar obstructions by a minimum of three times the width of the adjacent pipe, conduit, cable tray, or similar obstruction.

14.2.11.3.4 Open Gratings.
Sprinklers installed under open gratings shall be of the intermediate level/rack storage type or otherwise shielded from the discharge of overhead sprinklers.

14.2.11.3.5 Overhead Doors.
Quick-response spray sprinklers shall be permitted to be utilized under overhead doors.

14.2.11.3.6 Special Obstruction Allowance.
Sprinklers with a special obstruction allowance shall be installed according to their listing.

14.2.12 Clearance to Storage (Early Suppression Fast-Response Sprinklers).
The clearance between the deflector and the top of storage shall be 36 in. (900 mm) or greater.

Chapter 15 Installation Requirements for Special Sprinklers

15.1 Open Sprinklers.

15.1.1
Open sprinklers shall be permitted to be used in deluge systems to protect special hazards or exposures or in other special locations.

15.1.2
Open sprinklers shall be installed in accordance with all applicable requirements of this standard for their automatic counterpart.

15.2 Special Sprinklers.

15.2.1
Special sprinklers that are intended for the protection of specific hazards or construction features shall be permitted where such devices have been evaluated and listed for performance under the following conditions:
(1) Fire tests related to the intended hazard

(2) Distribution of the spray pattern with respect to wetting of floors and walls

(3) Distribution of the spray pattern with respect to obstructions

(4) Evaluation of the thermal sensitivity of the sprinkler

(5) Performance under horizontal or sloped ceilings

(6) Area of design

(7) Allowable clearance to ceilings

15.2.2
Special sprinklers shall maintain the following characteristics:
(1) K-factor size shall be in accordance with 7.2.2.

(2) Temperature ratings shall be in accordance with Table 7.2.4.1.

(3) The protection area of coverage shall not exceed 400 ft^2 (37 m^2) for light hazard and ordinary hazard occupancies.

(4) The protection area of coverage shall not exceed 196 ft^2 (18.2 m^2) for extra hazard and high-piled storage occupancies.

15.3 Dry Sprinklers.

15.3.1*
Where dry sprinklers are connected to wet pipe sprinkler systems protecting areas subject to freezing temperatures, the minimum exposed length of the barrel of the dry sprinkler shall be in accordance with Table 15.3.1(a) or Table 15.3.1(b).

Table 15.3.1(a) Exposed Barrel Lengths for Dry Sprinklers (U.S. Customary Units)

Ambient Temperature Exposed to Discharge End of Sprinkler (ºF)	Minimum Exposed Barrel Length when Exposed to 40ºF (in.)	Minimum Exposed Barrel Length when Exposed to 50ºF (in.)	Minimum Exposed Barrel Length when Exposed to 60ºF (in.)
40	0	0	0
30	0	0	0
20	4	0	0
10	8	1	0
0	12	3	0

Ambient Temperature Exposed to Discharge End of Sprinkler (ºF)	Minimum Exposed Barrel Length when Exposed to 40ºF (in.)	Minimum Exposed Barrel Length when Exposed to 50ºF (in.)	Minimum Exposed Barrel Length when Exposed to 60ºF (in.)
−10	14	4	1
−20	14	6	3
−30	16	8	4
−40	18	8	4
−50	20	10	6
−60	20	10	6

Table 15.3.1(b) Exposed Barrel Lengths for Dry Sprinklers (Metric Units)

Ambient Temperature Exposed to Discharge End of Sprinkler (ºC)	Minimum Exposed Barrel Length when Exposed to 4ºC (mm)	Minimum Exposed Barrel Length when Exposed to 10ºC (mm)	Minimum Exposed Barrel Length when Exposed to 16ºC (mm)
4	0	0	0
−1	0	0	0
−7	100	0	0
−12	200	25	0
−18	300	75	0
−23	350	100	25
−29	350	150	75
−34	400	200	100
−40	450	200	100
−46	500	250	150
−51	500	250	150

15.3.2
The minimum exposed length shall be measured along the length of the dry sprinkler from the face of the fitting to which the dry sprinkler is installed to the inside surface of the insulation, wall, or ceiling leading to the cold space, whichever is closest to the fitting.

15.3.3*
Where dry sprinklers are connected to wet pipe sprinkler systems protecting insulated freezer structures, the clearance space around the sprinkler barrel shall be sealed.

15.3.4*
Dry sprinklers shall only be installed in fittings as specified by the manufacturer.

15.4 Old-Style Sprinklers.

15.4.1
Unless required by 9.3.12 or 15.4.2, old-style sprinklers shall not be used in a new installation.

15.4.2

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Use of old-style sprinklers shall be permitted where construction features or other special situations require unique water distribution.

15.4.3
Old-style sprinklers protecting fur storage vaults shall be permitted to be placed less than 6 ft (1.8 m) on center.

Chapter 16 Installation of Piping, Valves, and Appurtenances

16.1 Basic Requirements.

16.1.1*
System valves and gauges shall be accessible for operation, inspection, tests, and maintenance.

16.1.2
Materials and components shall be installed in accordance with material compatibility information that is available as a part of a listing or manufacturer's published information.

16.1.3 Reconditioned Components.

16.1.3.1
The use of reconditioned valves and devices as replacement equipment in existing systems shall be permitted.

16.1.3.2
Reconditioned sprinklers shall not be permitted to be utilized on any new or existing system.

16.2 Sprinkler Installation.

16.2.1
Only new sprinklers shall be installed.

16.2.1.1
When a sprinkler is removed from a fitting or welded outlet, it shall not be reinstalled except as permitted by **16.2.1.1.1**.

16.2.1.1.1
Dry sprinklers shall be permitted to be reinstalled when removed in accordance with the manufacturer's installation and maintenance instructions.

16.2.2* Corrosion Resistant.

16.2.2.1
Listed corrosion-resistant sprinklers shall be installed in locations where chemicals, moisture, or other corrosive vapors sufficient to cause corrosion of such devices exist.

16.2.2.1.1*
Unless the requirements of 16.2.2.1.2 are met, corrosion-resistant coatings shall be applied only by the manufacturer of the sprinkler and in accordance with the requirements of 16.2.2.1.2.

16.2.2.1.2
Any damage to the protective coating occurring at the time of installation shall be repaired at once using only the coating of the manufacturer of the sprinkler in the approved manner so that no part of the sprinkler will be exposed after installation has been completed.

16.2.3 Painting.

16.2.3.1

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Where sprinklers have had paint applied by other than the sprinkler manufacturer, they shall be replaced with new listed sprinklers of the same characteristics, including K-factor, thermal response, and water distribution.

16.2.3.2
Where cover plates on concealed sprinklers have been painted by other than the sprinkler manufacturer, the cover plate shall be replaced.

16.2.4 Protective Coverings.

16.2.4.1
Sprinklers protecting spray areas and mixing rooms in resin application areas shall be protected against overspray residue so that they will operate in the event of fire.

16.2.4.2*
Where protected in accordance with 16.2.4.1, cellophane bags having a thickness of 0.003 in. (0.08 mm) or less or thin paper bags shall be used.

16.2.4.3
Sprinklers that have been painted or coated shall be replaced in accordance with the requirements of **16.2.3**.

16.2.5 Escutcheons and Cover Plates.

16.2.5.1
Plates, escutcheons, or other devices used to cover the annular space around a sprinkler shall be metallic or shall be listed for use around a sprinkler.

16.2.5.2*
Escutcheons used with recessed, flush-type, or concealed sprinklers shall be part of a listed sprinkler assembly.

16.2.5.3
Cover plates used with concealed sprinklers shall be part of the listed sprinkler assembly.

16.2.5.4
The use of caulking or glue to seal the penetration or to affix the components of a recessed escutcheon or concealed cover plate shall not be permitted.

16.2.6
Sprinklers subject to mechanical injury shall be protected with listed guards.

16.2.7 Stock of Spare Sprinklers.

16.2.7.1*
A supply of at least six spare sprinklers shall be maintained on the premises so that any sprinklers that have operated or been damaged in any way can be promptly replaced.

16.2.7.2
The sprinklers shall correspond to the types and temperature ratings of the sprinklers in the property.

16.2.7.3
The sprinklers shall be kept in a cabinet located where the temperature to which they are subjected will at no time exceed the maximum ceiling temperatures specified in Table 7.2.4.1 for each of the sprinklers within the cabinet.

16.2.7.4
Where dry sprinklers of different lengths are installed, spare dry sprinklers shall not be required, provided that a means of returning the system to service is furnished.

16.2.7.5
The stock of spare sprinklers shall include all types and ratings installed and shall be as follows:
(1) For protected facilities having under 300 sprinklers — no fewer than six sprinklers

(2) For protected facilities having 300 to 1000 sprinklers — no fewer than 12 sprinklers

(3) For protected facilities having over 1000 sprinklers — no fewer than 24 sprinklers

16.2.7.6*
One sprinkler wrench as specified by the sprinkler manufacturer shall be provided in the cabinet for each type of sprinkler installed to be used for the removal and installation of sprinklers in the system.

16.2.7.7
A list of the sprinklers installed in the property shall be posted in the sprinkler cabinet.

16.2.7.7.1*
The list shall include the following:
(1) Sprinkler Identification Number (SIN) if equipped; or the manufacturer, model, K-factor, deflector type, thermal sensitivity, and pressure rating

(2) General description

(3) Quantity of each type to be contained in the cabinet

(4) Issue or revision date of the list

16.3 Piping Installation.

16.3.1 General.

16.3.1.1
Steel pipe shall be in accordance with 16.3.2, 16.3.3, or 16.3.4.

16.3.1.2
Copper tube shall be in accordance with 16.3.5.

16.3.1.3
Nonmetallic pipe shall be in accordance with 7.3.2.

16.3.1.4
Brass pipe shall be in accordance with 16.3.6.

16.3.1.5
Stainless steel pipe shall be in accordance with 7.3.2.

16.3.2* Steel Pipe — Welded or Roll-Grooved.
When steel pipe referenced in Table 7.3.1.1 is used and joined by welding as referenced in 7.5.2 or by roll-grooved pipe and fittings as referenced in 7.5.3, the minimum nominal wall thickness for pressures up to 300 psi (21 bar) shall be in accordance with Schedule 10 for pipe sizes up to 5 in. (125 mm), 0.134 in. (3.4 mm) for 6 in. (150 mm) pipe, 0.188 in. (4.8 mm) for 8 in. and 10 in. (200 mm and 250 mm) pipe, and 0.330 in. (8.4 mm) for 12 in. (300 mm) pipe.

16.3.3 Steel Pipe — Threaded.
When steel pipe referenced in Table 7.3.1.1 is joined by threaded fittings referenced in 7.5.1 or by fittings used with pipe having cut grooves, the minimum wall thickness shall be in accordance with Schedule 30 pipe [in sizes 8 in. (200 mm) and larger] or Schedule 40 pipe [in sizes less than 8 in. (200 mm)] for pressures up to 300 psi (21 bar).

16.3.4 Specially Listed Steel Pipe.
Pressure limitations and wall thickness for steel pipe specially listed in accordance with **7.3.3** shall be permitted to be in accordance with the pipe listing requirements.

16.3.5 Copper Tube.
Copper tube as specified in the standards listed in Table 7.3.1.1 shall have a wall thickness of Type K, Type L, or Type M where used in sprinkler systems.

16.3.6 Brass Pipe.

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Brass pipe specified in Table 7.3.1.1 shall be permitted in the standard weight in sizes up to 6 in. (150 mm) for pressures up to 175 psig (12 bar) and in the extra strong weight in sizes up to 8 in. (200 mm) for pressures up to 300 psig (21 bar).

16.3.7 Stainless Steel Pipe.
Stainless steel pipe as referenced in the standards listed in Table 7.3.1.1 shall be in accordance with Schedules 10S or 40S pipe.

16.3.8 Metallic Pipe and Tube Bending.

16.3.8.1
Bending of Schedule 10 steel pipe, or any steel pipe of wall thickness equal to or greater than Schedule 10 and Types K and L copper tube, shall be permitted when bends are made with no kinks, ripples, distortions, or reductions in diameter or any noticeable deviations from round.

16.3.8.2
For Schedule 40 and copper tubing, the minimum radius of a bend shall be six pipe diameters for pipe sizes 2 in. (50 mm) and smaller and five pipe diameters for pipe sizes 2½ in. (65 mm) and larger.

16.3.8.3
For all other steel pipe, the minimum radius of a bend shall be 12 pipe diameters for all sizes.

16.3.8.4
Bending of listed pipe and tubing shall be permitted as allowed by the listing.

16.3.9 Nonmetallic Pipe and Tubing.

16.3.9.1
Listed nonmetallic pipe shall be installed in accordance with its listing limitations, including installation instructions.

16.3.9.2
When nonmetallic pipe is used in systems utilizing steel piping internally coated with corrosion inhibitors, the steel pipe coating shall be listed for compatibility with the nonmetallic pipe materials.

16.3.9.3
When nonmetallic pipe is used in systems utilizing steel pipe that is not internally coated with corrosion inhibitors, no additional evaluations shall be required.

16.3.9.4*
When nonmetallic pipe is used in systems utilizing steel pipe, cutting oils and lubricants used for fabrication of the steel piping shall be compatible with the nonmetallic pipe materials in accordance with **16.1.2**.

16.3.9.5
Fire-stopping materials intended for use on nonmetallic piping penetrations shall be compatible with the nonmetallic pipe materials in accordance with 16.1.2.

16.3.9.6
Nonmetallic pipe listed for light hazard occupancies shall be permitted to be installed in ordinary hazard rooms of otherwise light hazard occupancies where the room does not exceed 400 ft^2 (37 m^2).

16.3.9.6.1
Nonmetallic pipe installed in accordance with 16.3.9.6 shall be permitted to be installed exposed, in accordance with the listing.

16.3.9.6.2
Nonmetallic pipe installed in accordance with 16.3.9.6 shall be permitted to be installed in ordinary hazard rooms larger than 400 ft_2 (37 m^2) where the pipe is concealed within a 1-hour fire resistance-rated assembly.

16.3.9.7
Bending of listed nonmetallic pipe or tubing shall be permitted as allowed by the listing.

16.3.10 Listed Metallic Pipe and Tubing.

16.3.10.1
Pipe or tube listed only for light hazard occupancies shall be permitted to be installed in ordinary hazard rooms of otherwise light hazard occupancies where the room does not exceed 400 ft^2 (37 m^2).

16.3.10.1.1
Pipe or tube installed in accordance with 16.3.10.1 shall be permitted to be installed exposed, in accordance with the listing.

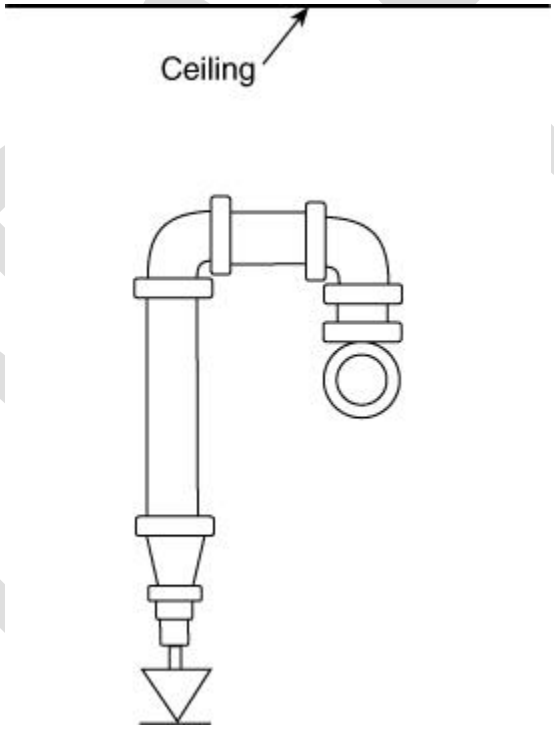
16.3.10.2
Bending of listed pipe and tubing shall be permitted as allowed by the listing.

16.3.11 Return Bends.

16.3.11.1
Unless the requirements of 16.3.11.3, 16.3.11.4, or 16.3.11.5 are met, return bends shall be used where pendent sprinklers are supplied from a raw water source, a mill pond, or open-top reservoirs.

16.3.11.2
Return bends shall be connected to the top of branch lines in order to avoid accumulation of sediment in the drop nipples in accordance with Figure 16.3.11.2.

Figure 16.3.11.2 Return Bend Arrangement.



16.3.11.3
Return bends shall not be required for deluge systems.

16.3.11.4
Return bends shall not be required where dry pendent sprinklers are used.

16.3.11.5
Return bends shall not be required for wet pipe systems where sprinklers with a nominal K-factor of K-11.2 (160) or larger are used.

16.3.12 Piping to Sprinklers Below Ceilings.

16.3.12.1*
In new installations expected to supply sprinklers below a ceiling, minimum 1 in. (25 mm) outlets shall be provided.

16.3.12.2*
In new installations, it shall be permitted to provide minimum 1 in. (25 mm) outlets with hexagonal bushings to accommodate sprinklers attached directly to branch line fittings to allow for future system modifications.

16.4 Protection of Piping.

16.4.1 Protection of Piping Against Freezing.

16.4.1.1*
Where any portion of a system is subject to freezing and the temperatures cannot be reliably maintained at or above 40°F (4°C), the system shall be installed as a dry pipe or preaction system.

16.4.1.1.1
The requirements of 16.4.1.1 shall not apply where alternate methods of freeze prevention are provided in accordance with one of the methods described in 16.4.1.2 through 16.4.1.4.1.

16.4.1.2
Unheated areas shall be permitted to be protected by antifreeze systems or by other systems specifically listed for the purpose.

16.4.1.3
Where aboveground water-filled supply pipes, risers, system risers, or feed mains pass through open areas, cold rooms, passageways, or other areas exposed to temperatures below 40°F (4°C), the pipe shall be permitted to be protected against freezing by insulating coverings, frostproof casings, or other means of maintaining a minimum temperature between 40°F and 120°F (4°C and 49°C).

16.4.1.4
Listed heat-tracing systems shall be permitted in accordance with 16.4.1.4.1 and 16.4.1.4.2.

16.4.1.4.1
Where used to protect branch lines, the heat-tracing system shall be specifically listed for use on branch lines.

16.4.1.4.2
Electric supervision of the heat-tracing system shall provide positive confirmation that the circuit is energized.

16.4.1.5
Water-filled piping shall be permitted to be installed in areas where the temperature is less than 40°F (4°C) when heat loss calculations performed by a professional engineer verify that the system will not freeze.

16.4.2* Protection of Piping Against Corrosion.

16.4.2.1*
Where corrosive conditions are known to exist due to moisture or fumes from corrosive chemicals or both, special types of fittings, pipes, and hangers that resist corrosion shall be used, or a protective coating shall be applied to all unprotected exposed surfaces of the sprinkler system.

16.4.2.2
Where water supplies or environmental conditions are known to have unusual corrosive properties, piping shall have a corrosion resistance ratio (CRR) of 1 or more, and the system shall be treated in accordance with 5.1.5.

16.4.2.3

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Where corrosive conditions exist or piping is exposed to the weather, corrosion-resistant types of pipe, fittings, and hangers or protective corrosion-resistant coatings shall be used.

16.4.2.4
Where steel pipe is used underground, the pipe shall be protected against corrosion.

16.4.3* Protection of Piping in Hazardous Areas.

16.4.3.1
Private service main aboveground piping shall not pass through hazardous areas and shall be located so that it is protected from mechanical and fire damage.

16.4.3.2
Private service main aboveground piping shall be permitted to be located in hazardous areas protected by an automatic sprinkler system.

16.5 Protection of Risers Subject to Mechanical Damage.
Sprinkler risers subject to mechanical damage shall be protected by steel posts, concrete barriers, or other approved means.

16.6 Provision for Flushing Systems.

16.6.1
All sprinkler systems shall be arranged for flushing.

16.6.2
Readily removable fittings shall be provided at the end of all cross mains.

16.6.3
All cross mains shall terminate in 1¼ in. (32 mm) or larger pipe.

16.6.4
All branch lines on gridded systems shall be arranged to facilitate flushing.

16.7* Air Venting.
The vent required by **8.1.5** shall be located near a high point in the system to allow air to be removed from that portion of the system by one of the following methods:
(1) Manual valve, minimum ½ in. (15 mm) size
(2) Automatic air vent
(3) Remote inspector's test valve
(4) Other approved means

16.8 Fitting Installation.

16.8.1 Metallic Fittings.(Reserved)

16.8.2 Nonmetallic Fittings.

16.8.2.1
When nonmetallic fittings are used in systems utilizing internally coated steel piping, the steel pipe shall be listed for compatibility with the nonmetallic fittings.

16.8.2.2*
When nonmetallic fittings are used in systems utilizing steel pipe that is not internally coated with corrosion inhibitors, no additional evaluations are required.

16.8.2.3
When nonmetallic fittings are used in systems utilizing steel pipe, cutting oils and lubricants used for fabrication of the steel piping shall be compatible with the nonmetallic fittings in accordance with 16.1.2.

16.8.2.4

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Fire-stopping materials intended for use on nonmetallic fitting penetrations shall be investigated for compatibility with the nonmetallic fitting materials in accordance with 16.1.2.

16.8.3* Fitting Pressure Limits.

16.8.3.1
Standard weight pattern cast-iron fittings 2 in. (50 mm) in size and smaller shall be permitted where pressures do not exceed 300 psi (21 bar).

16.8.3.2
Standard weight pattern malleable iron fittings 6 in. (150 mm) in size and smaller shall be permitted where pressures do not exceed 300 psi (21 bar).

16.8.3.3
Fittings not meeting the requirements of 16.8.3.1 and 16.8.3.2 shall be extra-heavy pattern where pressures exceed 175 psi (12 bar).

16.8.3.4
Cast bronze threaded fittings in accordance with ASTM B16.15, *Cast Bronze Threaded Fittings*, shall be permitted where pressures do not exceed 200 psi (14 bar) for Class 125 fittings and 400 psi (28 bar) for Class 250 fittings.

16.8.3.5
Listed fittings shall be permitted for system pressures up to the limits specified in their listings.

16.8.4* Couplings and Unions.

16.8.4.1
Screwed unions shall not be used on pipe larger than 2 in. (50 mm).

16.8.4.2
Couplings and unions of other than screwed-type shall be of types listed specifically for use in sprinkler systems.

16.8.5 Reducers and Bushings.

16.8.5.1
Unless the requirements of 16.8.5.2 or 16.8.5.3 are met, a one-piece reducing fitting shall be used wherever a change is made in the size of the pipe.

16.8.5.2
Hexagonal or face bushings shall be permitted in reducing the size of openings of fittings when standard fittings of the required size are not available.

16.8.5.3
Hexagonal bushings as permitted in 16.3.12.2 shall be permitted to be used.

16.8.5.4
The requirements of 16.8.5.1 and 16.8.5.2 shall not apply to CPVC fittings.

16.8.6 Extension Fitting.

16.8.6.1
Extension fittings shall be permitted to be used with sprinklers K-8.0 or smaller.

16.8.6.2
Extension fittings shall be permitted to be used with sprinklers in light hazard and ordinary hazard occupancies only.

16.8.6.3
The internal diameter of extension fittings shall have the same nominal inlet diameter of the attached sprinkler.

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16.8.6.4
A single extension fitting up to a maximum of 2 in. (50 mm) in length shall be permitted to be installed with a sprinkler.

16.8.6.4.1
Extension fittings longer than 2 in. (50 mm) shall not be permitted unless specifically listed.

16.8.6.5
Extension fittings shall be included in the hydraulic calculations.

16.8.6.5.1
Extension fittings 2 in. (50 mm) and less shall not be required to be included in the hydraulic calculations.

16.8.7 Threaded Pipe and Fittings.

16.9 Valves.

16.9.1 General.

16.9.1.1 Drain Valves and Test Valves.
Drain valves and test valves shall be approved.

16.9.1.2 Valve Pressure Requirements.
When water pressures exceed 175 psi (12 bar), valves shall be used in accordance with their pressure ratings.

16.9.2 Wafer-Type Valves.
Wafer-type valves with components that extend beyond the valve body shall be installed in a manner that does not interfere with the operation of any system components.

16.9.3* Control Valves.

16.9.3.1* General.

16.9.3.1.1
Each sprinkler system shall be provided with a listed indicating valve in an accessible location, so located as to control all automatic sources of water supply.

16.9.3.1.2
At least one listed indicating valve shall be installed in each source of water supply.

16.9.3.1.3
The requirements of **16.9.3.1.2** shall not apply to the fire department connection, and there shall be no shutoff valve in the fire department connection.

16.9.3.2 Listed Indicating Valves.
Unless the requirements of 16.9.3.2.1, 16.9.3.2.2, or 16.9.3.2.3 are met, all valves controlling connections to water supplies and to supply pipes to sprinklers shall be listed indicating valves.

16.9.3.2.1
A listed underground gate valve equipped with a listed indicator post shall be permitted.

16.9.3.2.2
A listed water control valve assembly with a reliable position indication connected to a remote supervisory station shall be permitted.

16.9.3.2.3
A nonindicating valve, such as an underground gate valve with approved roadway box, complete with T-wrench, and where accepted by the authority having jurisdiction, shall be permitted.

16.9.3.3* Supervision.

16.9.3.3.1

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Valves on connections to water supplies, sectional control and isolation valves, and other valves in supply pipes to sprinklers and other fixed water-based fire suppression systems shall be supervised by one of the following methods:

(1) Central station, proprietary, or remote station signaling service

(2) Local signaling service that will cause the sounding of an audible signal at a constantly attended point

(3) Valves locked in the correct position

(4) Valves located within fenced enclosures under the control of the owner, sealed in the open position, and inspected weekly as part of an approved procedure

16.9.3.3.2
Floor control valves in high-rise buildings and valves controlling flow to sprinklers in circulating closed loop systems shall comply with 16.9.3.3.1(1) or 16.9.3.3.1(2).

16.9.3.3.3
The requirements of **16.9.3.3.1** shall not apply to underground gate valves with roadway boxes.

16.9.3.3.4
Where control valves are installed overhead, they shall be positioned so that the indicating feature is visible from the floor below.

16.9.3.3.5
A listed backflow prevention assembly shall be permitted to be considered a control valve, provided both control valves are listed for fire protection system use and an additional control valve shall not be required.

16.9.3.4* Control Valve Accessibility.
All control valves shall be located where accessible and free of obstructions.

16.9.3.5 Control Valve Identification.
Identification signs shall be provided at each valve to indicate its function and what it controls.

16.9.4 Automated Valves.

16.9.4.1
A listed indicating valve with automated controls shall be permitted.

16.9.4.2
A listed automated water control valve assembly with a reliable position indication connected to a remote supervisory station shall be permitted.

16.9.4.3
An automated water control valve shall be able to be operated manually as well as automatically.

16.9.5* Check Valves.

16.9.5.1
Where there is more than one source of water supply, a check valve shall be installed in each connection.

16.9.5.2
A listed backflow prevention device shall be considered a check valve, and an additional check valve shall not be required.

16.9.5.3
Where cushion tanks are used with automatic fire pumps, no check valve is required in the cushion tank connection.

16.9.5.4
Check valves shall be installed in a vertical (flow upwards) or horizontal position in accordance with their listing.

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16.9.5.5*
Where a single wet pipe sprinkler system is equipped with a fire department connection, the alarm valve is considered a check valve, and an additional check valve shall not be required.

16.9.6* Control Valves with Check Valves.

16.9.6.1
In a connection serving as one source of supply, listed indicating valves or post-indicator valves shall be installed on both sides of all check valves required in 16.9.5.

16.9.6.2
The city services control valve (non-indicating control valve) shall be permitted to serve as the supply side control valve.

16.9.6.3
The requirements of 16.9.6.1 shall not apply to the check valve located in the fire department connection piping, and there shall be no control valves in the fire department connection piping.

16.9.6.4
The requirements of 16.9.6.1 shall not apply where the city connection serves as the only automatic source of supply to a wet pipe sprinkler system; a control valve is not required on the system side of the check valve or the alarm check valve.

16.9.6.5* Control Valves for Gravity Tanks.
Gravity tanks shall have listed indicating valves installed on both sides of the check valve.

16.9.7* Pumps.
When a pump is located in a combustible pump house or exposed to danger from fire or falling walls, or when a tank discharges into a private fire service main fed by another supply, either the check valve in the connection shall be located in a pit or the control valve shall be of the post-indicator type located a safe distance outside buildings.

16.9.8 Pressure-Reducing Valves.

16.9.8.1
In portions of systems where all components are not listed for pressure greater than 175 psi (12 bar) and the potential exists for normal (nonfire condition) water pressure in excess of 175 psi (12 bar), a listed pressure-reducing valve shall be installed and set for an outlet pressure not exceeding 165 psi (11 bar) at the maximum inlet pressure.

16.9.8.2
Pressure gauges shall be installed on the inlet and outlet sides of each pressure-reducing valve.

16.9.8.3*
A listed relief valve of not less than ½ in. (15 mm) in size shall be provided on the discharge side of the pressure-reducing valve set to operate at a pressure not exceeding the rated pressure of the components of the system.

16.9.8.4
A listed indicating valve shall be provided on the inlet side of each pressure-reducing valve, unless the pressure-reducing valve meets the listing requirements for use as an indicating valve.

16.9.8.5
Means shall be provided downstream of all pressure-reducing valves for flow tests at sprinkler system demand.

16.9.8.6
Such means shall consist of a tee outlet downstream of the pressure-reducing valve identical in size to the sprinkler system feed, available for connection to field testing devices, or other method approved by the authority having jurisdiction.

16.9.9* Post-Indicator Valves.

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16.9.9.1
Where post-indicator valves are used, they shall be set so that the top of the post is 32 in. to 40 in. (800 mm to 1.0 m) above the final grade.

16.9.9.2
Post-indicator valves shall be properly protected against mechanical damage where needed.

16.9.9.3
The requirements of 16.9.9.1 shall not apply to wall post-indicator valves.

16.9.10 Valves in Pits.

16.9.10.1
Where it is impractical to provide a post-indicator valve, valves shall be permitted to be placed in pits with permission of the authority having jurisdiction.

16.9.10.2* Valve Pit Construction.

16.9.10.2.1
When used, valve pits shall be of adequate size and accessible for inspection, operation, testing, maintenance, and removal of equipment contained therein.

16.9.10.2.2
Valve pits shall be constructed and arranged to properly protect the installed equipment from movement of earth, freezing, and accumulation of water.

16.9.10.2.3
Poured-in-place or precast concrete, with or without reinforcement, or brick (all depending upon soil conditions and size of pit) shall be appropriate materials for construction of valve pits.

16.9.10.2.4
Other approved materials shall be permitted to be used for valve pit construction.

16.9.10.2.5
Where the water table is low and the soil is porous, crushed stone or gravel shall be permitted to be used for the floor of the pit. *[See Figure A.16.7.2(b) for a suggested arrangement.]*

16.9.10.2.6
Valve pits located at or near the base of the riser of an elevated tank shall be designed in accordance with Chapter 9 of NFPA 22.

16.9.10.3 Valve Pit Marking.
The location of the valve shall be clearly marked, and the cover of the pit shall be kept free of obstructions.

16.9.11 Floor Control Valve Assemblies.

16.9.11.1
Multistory buildings exceeding two stories in height shall be provided with a floor control valve, check valve, main drain valve, and flow switch for isolation, control, and annunciation of water flow for each individual floor level.

16.9.11.2
The floor control valve, check valve, main drain valve, and flow switch required by 8.2.4.1 shall not be required where sprinklers on the top level of a multistory building are supplied by piping on the floor below.

16.9.11.3
The floor control valve, check valve, main drain valve, and flow switch required by 8.2.4.1 shall not be required where the total area of all floors combined does not exceed the system protection area limitations of 8.2.1.

16.9.11.4

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The requirements of 8.2.4 shall not apply to dry systems in parking garages.

16.9.11.5* System Subdivision.
Where individual floor/zone control valves are not provided, a flanged joint or mechanical coupling shall be used at the riser at each floor for connections to piping serving floor areas in excess of 5000 ft^2 (465 m^2).

16.9.12* Identification of Valves.

16.9.12.1
All control, drain, venting, and test connection valves shall be provided with permanently marked weatherproof metal or rigid plastic identification signs.

16.9.12.2
The identification sign shall be secured with corrosion-resistant wire, chain, or other approved means.

16.9.12.3
The control valve sign shall identify the portion of the building served.

16.9.12.3.1*
Systems that have more than one control valve that must be closed to work on a system or space shall have a sign referring to existence and location of other valves.

16.10 Drainage.

16.10.1 General.
All sprinkler pipe and fittings shall be installed so that the system can be drained.

16.10.2 Wet Pipe Systems.

16.10.2.1
On wet pipe systems, sprinkler pipes shall be permitted to be installed level.

16.10.2.2
Trapped piping shall be drained in accordance with 16.10.5.

16.10.3 Dry Pipe and Preaction Systems.
Piping shall be pitched to drain as stated in 16.10.3.1 through 16.10.3.3.

16.10.3.1 Dry Pipe Systems in Nonrefrigerated Areas.
In dry pipe system, branch lines shall be pitched at least ½ in. per 10 ft (4 mm/m), and mains shall be pitched at least ¼ in. per 10 ft (2 mm/m) in nonrefrigerated areas.

16.10.3.2 Preaction Systems.
In preaction systems, branch lines shall be pitched at least ½ in. per 10 ft (4 mm/m), and mains shall be pitched at least ¼ in. per 10 ft (2 mm/m).

16.10.3.3 Dry Pipe and Preaction Systems in Refrigerated Areas.
Branch lines shall be pitched at least ½ in. per 10 ft (4 mm/m), and mains shall be pitched at least ½ in. per 10 ft (4 mm/m) in refrigerated areas.

16.10.4 System, Main Drain, or Sectional Drain Connections.

16.10.4.1
Provisions shall be made to properly drain all parts of the system.

16.10.4.2
Drain connections for systems supply risers and mains shall be sized as shown in Table 16.10.4.2.

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Table 16.10.4.2 Drain Size

Riser or Main Size [in. (mm)]	Size of Drain Connection [in. (mm)]
Up to 2 (50)	¾(20) or larger
2½(65), 3 (80), 3½(90)	1¼(32) or larger
4 (100) and larger	2 (50) or larger

16.10.4.3
Where an interior sectional or floor control valve(s) is provided, it shall be provided with a drain connection having a minimum size as shown in Table 16.10.4.2 to drain that portion of the system controlled by the sectional valve.

16.10.4.4
Drains shall discharge outside or to a drain connection capable of handling the flow of the drain. *[See Figure A.16.14.1(b).]*

16.10.4.5
For those drains serving pressure-reducing valves, the drain, drain connection, and all other downstream drain piping shall be sized to permit a flow of at least the greatest system demand supplied by the pressure-reducing valve.

16.10.4.6 Main Drain Test Connections.

16.10.4.6.1
Main drain test connections shall be provided at locations that will permit flow tests of water supplies and connections.

16.10.4.6.2
Main drain test connections shall be installed that the valve can be opened wide for a sufficient time to assure a proper test without causing water damage.

16.10.4.6.3
Main drain connections shall be sized in accordance with 16.10.4.2.

16.10.4.7
The test connections required by 16.10.4.6 shall be permitted to be used as main drain connections.

16.10.4.8
Where drain connections for floor control valves are tied into a common drain riser, the drain riser shall be one pipe size larger downstream of each size drain connection tying into it.

16.10.4.9
Where subject to freezing, a minimum 4 ft (1.2 m) of exposed drain pipe shall be in a heated area between the drain valve and the exterior wall when drain piping extends through the wall to the outside.

16.10.5 Auxiliary Drains.

16.10.5.1
Auxiliary drains shall be provided where a change in piping direction prevents drainage of system piping through the main drain valve.

16.10.5.2 Auxiliary Drains for Wet Pipe Systems and Preaction Systems in Areas Not Subject to Freezing.

16.10.5.2.1*
Where the capacity of isolated trapped sections of pipe is 50 gal (200 L) or more, the auxiliary drain shall consist of a valve not smaller than 1 in. (25 mm), piped to an accessible location.

16.10.5.2.2
Where the capacity of isolated trapped sections of pipe is more than 5 gal (20 L) and less than 50 gal (200 L), the auxiliary drain shall consist of a valve ¾ in. (20 mm) or larger and a plug or a nipple and cap.

16.10.5.2.3
Where the capacity of trapped sections of pipes in wet systems is less than 5 gal (20 L), one of the following arrangements shall be provided:
(1) An auxiliary drain shall consist of a nipple and cap or plug not less than ½ in. (15 mm) in size.

(2) An auxiliary drain shall not be required for trapped sections less than 5 gal (20 L) where the system piping can be drained by removing a single pendent sprinkler.

(3) Where flexible couplings or other easily separated connections are used, the nipple and cap or plug shall be permitted to be omitted.

16.10.5.2.4
Tie-in drains shall not be required on wet pipe systems and preaction systems protecting nonfreezing environments.

16.10.5.3 Auxiliary Drains for Dry Pipe Systems and Preaction Systems.

16.10.5.3.1
Auxiliary drains located in areas subject to freezing shall be accessible.

16.10.5.3.2
Auxiliary drains located in areas maintained at freezing temperatures shall be accessible and shall consist of a valve not smaller than 1 in. (25 mm) and a plug or a nipple and cap.

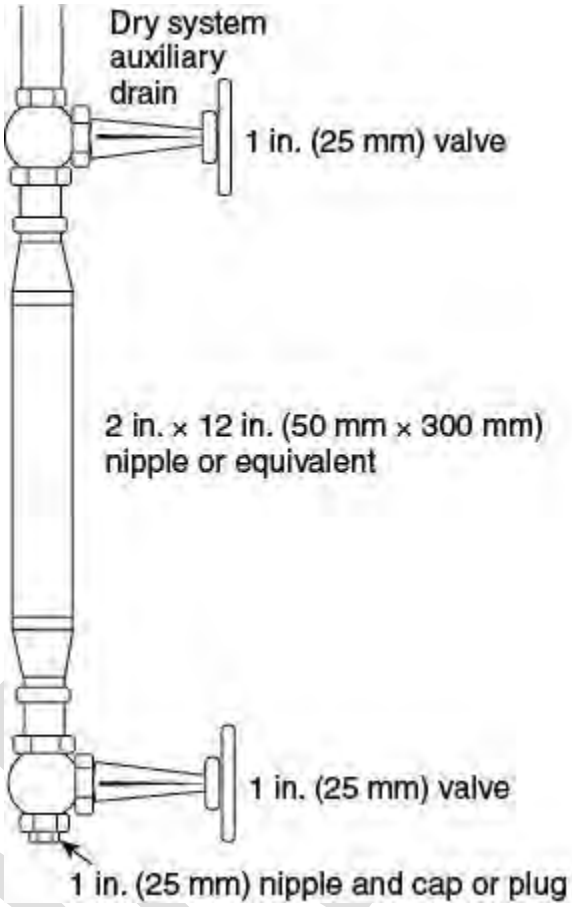
16.10.5.3.3
Where the capacity of trapped sections of pipe is less than 5 gal (20 L), the auxiliary drain shall consist of a valve not smaller than ½ in. (15 mm) and a plug or a nipple and cap.

16.10.5.3.4
Auxiliary drains shall not be required for pipe drops supplying dry pendent sprinklers installed in accordance with 8.2.2, 7.3.25, and 7.7.3.4.

16.10.5.3.5
Where the capacity of isolated trapped sections of system piping is more than 5 gal (20 L), the auxiliary drain shall consist of two 1 in. (25 mm) valves and one 2 in. × 12 in. (50 mm × 300 mm) condensate nipple or equivalent, accessibly located in accordance with Figure 16.10.5.3.5, or a device listed for this service.

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Figure 16.10.5.3.5 Dry System Auxiliary Drain.



16.10.5.3.6
Tie-in drains shall be provided for multiple adjacent trapped branch pipes and shall be only 1 in. (25 mm). Tie-in drain lines shall be pitched a minimum of ½ in. per 10 ft (4 mm/m).

16.10.5.3.7
Systems with low point drains shall have a sign at the dry pipe or preaction valve indicating the number of low point drains and the location of each individual drain.

16.10.6 Discharge of Drain Valves.

16.10.6.1
Direct interconnections shall not be made between sprinkler drains and sewers.

16.10.6.2
The drain discharge shall conform to any health or water department regulations.

16.10.6.3
Where drain pipes are buried underground, approved corrosion-resistant pipe shall be used.

16.10.6.4
Drain pipes shall not terminate in blind spaces under the building.

16.10.6.5
Where exposed to the atmosphere, drain pipes shall be fitted with a turned-down elbow.

16.10.6.6
Drain pipes shall be arranged to avoid exposing any of the water-filled portion of the sprinkler system to freezing conditions.

16.11 System Attachments.

16.11.1 Attachments — General.

16.11.1.1*
An alarm unit shall include a listed mechanical alarm, horn, or siren or a listed electric gong, bell, speaker, horn, or siren.

16.11.1.2*
Outdoor water motor-operated or electrically operated bells shall be weatherproofed and guarded.

16.11.1.3
All piping to water motor-operated devices shall be galvanized steel, brass, copper, or other approved metallic corrosion-resistant material of not less than ¾ in. (20 mm) nominal pipe size.

16.11.1.4
Piping between the sprinkler system and a pressure-actuated alarm-initiating device shall be galvanized steel, brass, copper, or other approved metallic corrosion-resistant material of not less than ⅜ in. (10 mm) nominal pipe size.

16.11.2* Sprinkler Alarms/Waterflow Alarms.

16.11.2.1 Local Waterflow Alarms.
A local waterflow alarm shall be provided on every sprinkler system having more than 20 sprinklers.

16.11.3 Waterflow Detection Devices.

16.11.3.1 Wet Pipe Systems.
The alarm apparatus for a wet pipe system shall consist of a listed alarm check valve or other listed waterflow detection alarm device with the necessary attachments required to give an alarm.

16.11.3.2 Dry Pipe Systems.

16.11.3.2.1
The alarm apparatus for a dry pipe system shall consist of listed alarm attachments to the dry pipe valve.

16.11.3.2.2
Where a dry pipe valve is located on the system side of an alarm valve, connection of the actuating device of the alarms for the dry pipe valve to the alarms on the wet pipe system shall be permitted.

16.11.3.3 Preaction and Deluge Systems.
The alarm apparatus for deluge and preaction systems shall consist of alarms actuated independently by the detection system and the flow of water.

16.11.3.3.1
Deluge and preaction systems activated by pilot sprinklers shall not require an independent detection system alarm.

16.11.3.4* Paddle-Type Waterflow Devices.
Paddle-type waterflow alarm indicators shall be installed in wet systems only.

16.11.4 Retarding Devices.
On each alarm check valve used under conditions of variable water pressure, a retarding device shall be installed.

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16.11.5 Alarm Bypass Test Connections.

16.11.5.1
Alarm, dry pipe, preaction, and deluge valves shall be fitted with an alarm bypass test connection for an electric alarm switch, water motor gong, or both.

16.11.5.2
The alarm bypass test connection for alarm, dry pipe, preaction, and deluge valves shall be made on the water supply side of the system and provided with a control valve and drain for the alarm piping.

16.11.5.3
The alarm bypass test connection for alarm valves at the riser shall be permitted to be made on the system side of an alarm valve.

16.11.5.4
A check valve shall be installed between the intermediate chamber of a dry pipe valve and the waterflow alarm device so as to prevent flow from the alarm bypass test connection from entering the intermediate chamber of a dry pipe valve during an alarm test via the alarm bypass test connection.

16.11.6 Indicating Control Valves.

16.11.6.1
Where a control valve is installed in the connection to pressure-type contactors or water motor-operated alarm devices, it shall be of the indicating type.

16.11.6.2
Such valves shall be sealed, locked, or electrically supervised in the open position.

16.11.7* Attachments — Electrically Operated.

16.11.7.1
Electrically operated alarm attachments forming part of an auxiliary, central station, local protective, proprietary, or remote station signaling system shall be installed in accordance with *NFPA 72*.

16.11.7.2
Sprinkler waterflow alarm systems that are not part of a required protective signaling system shall not be required to be supervised and shall be installed in accordance with *NFPA 70*, Article 760.

16.11.7.3
Outdoor electric alarm devices shall be listed for outdoor use.

16.11.8* Attachments — Mechanically Operated.

16.11.8.1
For all types of sprinkler systems employing water motor-operated alarms, a listed ¾ in. (20 mm) strainer shall be installed at the alarm outlet of the waterflow detecting device.

16.11.8.2
Where a retarding chamber is used in connection with an alarm valve, the strainer shall be located at the outlet of the retarding chamber unless the retarding chamber is provided with an approved integral strainer in its outlet.

16.11.9 Alarm Device Drains.
Drains from alarm devices shall be arranged so that there will be no overflowing at the alarm apparatus, at domestic connections, or elsewhere with the sprinkler drains wide open and under system pressure. *(See 16.10.6.)*

16.11.10* Alarm Attachments — High-Rise Buildings.
When a fire must be fought internally due to the height of a building, the following additional alarm apparatus shall be provided:
(1) Each sprinkler system on each floor shall be equipped with a separate waterflow device. The waterflow device shall be connected to an alarm system in such a manner that operation of one sprinkler

will actuate the alarm system, and the location of the operated flow device shall be indicated on an annunciator and/or register. The annunciator or register shall be located at grade level at the normal point of fire department access, at a constantly attended building security control center, or at both locations.

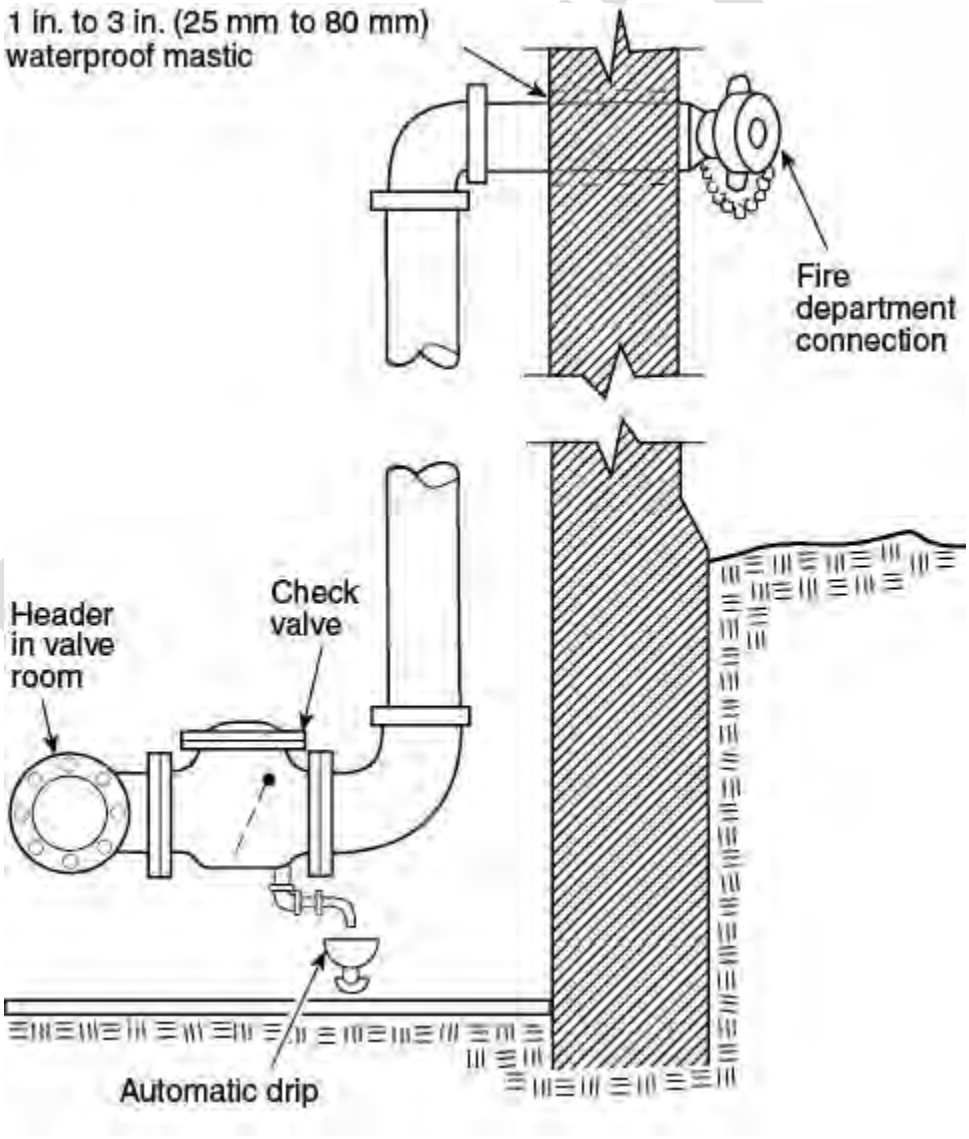
(2) Where the location within the protected buildings where supervisory or alarm signals are received is not under constant supervision by qualified personnel in the employ of the owner, a connection shall be provided to transmit a signal to a remote central station.

(3) A distinct trouble signal shall be provided to indicate a condition that will impair the satisfactory operation of the sprinkler system.

16.12 Fire Department Connections.

16.12.1
Unless the requirements of 16.12.2 are met, a fire department connection shall be provided as described in 16.12 in accordance with Figure 16.12.1.

Figure 16.12.1 Fire Department Connection.



16.12.2
The following systems shall not require a fire department connection:

(1) Buildings located in remote areas that are inaccessible for fire department support

(2) Large-capacity deluge systems exceeding the pumping capacity of the fire department

(3) Single-story buildings not exceeding 2000 ft^2 (185 m^2) in area

16.12.3 Fire Department Connections.

16.12.3.1*
Unless the requirements of 16.12.3.1.1, 16.12.3.1.2, or 16.12.3.1.3 are met, the fire department connection(s) shall consist of two 2½ in. (65 mm) connections using NH internal threaded swivel fitting(s) with "2.5–7.5 NH standard thread," as specified in NFPA 1963.

16.12.3.1.1
Where local fire department connections do not conform to NFPA 1963, the authority having jurisdiction shall be permitted to designate the connection to be used.

16.12.3.1.2
The use of threadless couplings shall be permitted where required by the authority having jurisdiction and where listed for such use.

16.12.3.1.3
A single-outlet fire department connection shall be acceptable where piped to a 3 in. (80 mm) or smaller riser.

16.12.3.2
Fire department connections shall be equipped with approved plugs or caps, properly secured and arranged for easy removal by fire departments.

16.12.3.3
Fire department connections shall be of an approved type.

16.12.4 Size.
The size of the pipe for the fire department connection shall be in accordance with one of the following:
(1) Pipe size shall be a minimum of 4 in. (100 mm) for fire engine connections.

(2) Pipe size shall be a minimum of 6 in. (150 mm) for fire boat connections.

(3) For hydraulically calculated systems, the pipe size shall be permitted to be less than 4 in. (100 mm), but not less than the largest riser being served by that connection.

16.12.5 Arrangement.
See Figure 16.12.1.

16.12.5.1*
The fire department connection shall be on the system side of the water supply check valve.

16.12.5.1.1
The fire department connection shall not be attached to branch line piping.

16.12.5.1.2
The fire department connection shall be located not less than 18 in. (457 mm) and not more than 4 ft (1.2 m) above the level of the adjacent grade or access level.

16.12.5.2
For single systems, the fire department connection shall be installed as follows:
(1) Wet system — on the system side of system control, check, and alarm valves *(see Figure A.16.9.3)*

(2) Dry system — between the system control valve and the dry pipe valve

(3) Preaction system — between the preaction valve and the check valve on the system side of the preaction valve

(4) Deluge system — on the system side of the deluge valve

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16.12.5.3
The fire department connection shall be permitted to be connected to main piping on the wet pipe or deluge system it serves.

16.12.5.4
For multiple systems, the fire department connection shall be connected between the supply control valves and the system control valves.

16.12.5.5
The requirements of 16.12.5.2 and 16.12.5.4 shall not apply where the fire department connection is connected to the underground piping.

16.12.5.6
Where a fire department connection services only a portion of a building, a sign shall be attached indicating the portions of the building served.

16.12.5.7*
Fire department connections shall be located at the nearest point of fire department apparatus accessibility or at a location approved by the authority having jurisdiction.

16.12.5.8 Signs.

16.12.5.8.1
Each fire department connection to sprinkler systems shall be designated by a sign having raised or engraved letters at least 1 in. (25 mm) in height on plate or fitting reading service design — for example, AUTOSPKR., OPEN SPKR., AND STANDPIPE.

16.12.5.8.2
A sign shall also indicate the pressure required at the inlets to deliver the greatest system demand.

16.12.5.8.3
The sign required in 16.12.5.8.2 shall not be required where the system demand pressure is less than 150 psi (10.3 bar).

16.12.5.9
Fire department connections shall not be connected on the suction side of fire pumps.

16.12.5.10
Fire department connections shall be properly supported.

16.12.6 Valves.

16.12.6.1
A listed check valve shall be installed in each fire department connection and shall be located in an accessible location.

16.12.6.2
There shall be no shutoff valve in the fire department connection piping.

16.12.7* Drainage.
The piping between the check valve and the outside hose coupling shall be equipped with an approved automatic drain valve in areas subject to freezing.

16.12.7.1
The automatic drain valve shall be installed in a location that permits inspection and testing as required by NFPA 25.

16.13 Gauges.

16.13.1
A pressure gauge with a connection not smaller than ¼ in. (6 mm) shall be installed at the system main drain, at each main drain associated with a floor control valve, and on the inlet and outlet side of each pressure-reducing valve.

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16.13.2
Each gauge connection shall be equipped with a shutoff valve and provisions for draining.

16.13.3
The required pressure gauges shall be approved and shall have a maximum limit not less than twice the normal system working pressure at the point where installed.

16.13.4
Gauges shall be installed to permit removal and shall be located where they will not be subject to freezing.

16.14 System Connections.

16.14.1 Wet Pipe Systems.

16.14.1.1
An alarm test connection not less than 1 in. (25 mm) in diameter, terminating in a smooth bore corrosion-resistant orifice, giving a flow equal to or less than one sprinkler of a type having the smallest K-factor installed on the particular system, shall be provided to test each waterflow alarm device for each system.

16.14.1.2
The test connection valve shall be accessible.

16.14.1.3
The discharge shall be to the outside, to a drain connection capable of accepting full flow under system pressure, or to another location where water damage will not result.

16.14.1.4
The alarm test connection shall be permitted to be installed in any location on the fire sprinkler system downstream of the waterflow alarm.

16.14.2* Dry Pipe Systems.

16.14.2.1
A trip test connection or manifold not less than 1 in. (25 mm) in diameter, terminating in a smooth bore corrosion-resistant orifice, to provide a flow equivalent to one sprinkler of a type installed on the particular system, shall be installed.

16.14.2.2
The trip test connection or manifold shall be located on the end of the most distant sprinkler pipe in the upper story and shall be equipped with an accessible shutoff valve and a plug not less than 1 in. (25 mm), of which at least one shall be brass.

16.14.2.3
In lieu of a plug, a nipple and cap shall be acceptable.

16.14.2.4
When the capacity (volume) of the dry pipe system has been determined in accordance with 8.2.3.2, 8.2.3.3, 8.2.3.4 or 8.2.3.5, a trip test connection shall be permitted to provide a flow equivalent to one sprinkler in accordance with 16.14.2.1 through 16.14.2.3.

16.14.2.5
When the capacity (volume) of the dry pipe system has been determined in accordance with 8.2.3.7, the following shall apply:
(1) When flow is from four sprinklers, the trip test manifold shall be arranged to simulate two sprinklers on each of two sprinkler branch lines.

(2) When flow is from three sprinklers, the test manifold shall be arranged to simulate two sprinklers on the most remote branch line and one sprinkler on the next adjacent branch line.

(3) When flow is from two sprinklers, the test manifold shall be arranged to simulate two sprinklers on the most remote branch line.

(4) When flow is from one sprinkler, the test manifold shall be installed per the requirements for a trip test connection in accordance with 16.14.2.1 through 16.14.2.3.

16.14.3 Preaction Systems.

16.14.3.1
A test connection shall be provided on a preaction system using supervisory air.

16.14.3.2
The connection used to control the level of priming water shall be considered adequate to test the operation of the alarms monitoring the supervisory air pressure.

16.14.3.3
For double interlock preaction systems, a trip test connection or manifold not less than 1 in. (25 mm) in diameter, terminating in a smooth bore corrosion-resistant orifice to provide a flow equivalent to one sprinkler of a type installed on the particular system, shall be installed.

16.14.3.4
For double interlock preaction systems, the trip test connection or manifold shall be located on the end of the most distant sprinkler pipe in the upper story and shall be equipped with an accessible shutoff valve and a plug not less than 1 in. (25 mm), of which at least one shall be brass.

16.14.3.5
In lieu of a plug, a nipple and cap shall be acceptable.

16.14.3.6
When the capacity (volume) of the double interlock preaction system has been determined in accordance with 8.3.2.3.1.1, 8.3.2.3.1.2, or 8.3.2.3.1.3, a trip test connection shall be permitted to provide a flow equivalent to one sprinkler in accordance with 16.14.3.3 through 16.14.3.5.

16.14.3.7
When the capacity (volume) of the double interlock preaction system has been determined in accordance with 8.3.2.3.1.4, the following shall apply:
(1) When flow is from four sprinklers, the trip test manifold shall be arranged to simulate two sprinklers on each of two sprinkler branch lines.

(2) When flow is from three sprinklers, the test manifold shall be arranged to simulate two sprinklers on the most remote branch line and one sprinkler on the next adjacent branch line.

(3) When flow is from two sprinklers, the test manifold shall be arranged to simulate two sprinklers on the most remote branch line.

(4) When flow is from one sprinkler, the test manifold shall be installed as per the requirements for a trip test connection in accordance with 16.14.3.3 through 16.14.3.5.

16.14.4 Deluge Systems.
A test connection shall not be required on a deluge system.

16.14.5* Backflow Devices.

16.14.5.1 Backflow Prevention Valves.
Means shall be provided downstream of all backflow prevention valves for forward flow tests at a minimum flow rate of the system demand including hose allowance where applicable.

16.14.5.1.1
The arrangement required in 8.17.4.5.1 shall be serviceable, without requiring the owner to modify the system to perform the test.

16.15 Hose Connections.

16.15.1 Small [1½ in. (40 mm)] Hose Connections.
See Section C.5.

16.15.1.1*
Where required, small [1½ in. (40 mm)] hose connections shall be installed.

16.15.1.1.1
Valves shall be available to reach all portions of the area with 100 ft (30 m) of hose plus 30 ft (9.1 m) of hose stream distance.

16.15.1.1.2
Where the building is protected throughout by an approved automatic sprinkler system, the presence of 1½ in. (40 mm) hose lines for use by the building occupants shall not be required, subject to the approval of the authority having jurisdiction.

16.15.1.1.3
Where approved by the authority having jurisdiction, the location of valves shall be permitted to exceed the distances specified in 16.15.1.1.1.

16.15.1.2
The hose connections shall not be required to meet the requirements of Class II hose systems defined by NFPA 14.

16.15.1.3
Hose connections shall be supplied from one of the following:
(1) Outside hydrants

(2) Separate piping system for small hose connections

(3) Valved hose connections on sprinkler risers where such connections are made upstream of all sprinkler control valves

(4) Adjacent sprinkler systems

(5) In rack storage areas, the ceiling sprinkler system in the same area (as long as in-rack sprinklers are provided in the same area and are separately controlled)

(6) In nonstorage occupancies that are not a part of a standpipe system, ceiling sprinkler piping in the same area as the hose connection

16.15.1.4
Hose connections used for fire purposes only shall be permitted to be connected to wet pipe sprinkler systems only, subject to the following restrictions:
(1) Hose connection's supply pipes shall not be connected to any pipe smaller than 2½ in. (65 mm) in diameter.

(2) The requirements of 16.15.1.4(1) shall not apply to hydraulically designed loops and grids, where the minimum size pipe between the hose connection's supply pipe and the source shall be permitted to be 2 in. (50 mm).

(3) For piping serving a single hose connection, pipe shall be a minimum of 1 in. (25 mm) for horizontal runs up to 20 ft (6.1 m), a minimum of 1¼ in. (32 mm) for the entire run for runs between 20 ft and 80 ft (6.1 m and 24 m), and a minimum of 1½ in. (40 mm) for the entire run for runs greater than 80 ft (24 m). For piping serving multiple hose connections, runs shall be a minimum of 1½ in. (40 mm) throughout.

(4) Piping shall be at least 1 in. (25 mm) for vertical runs.

(5) Where the residual pressure at a 1½ in. (40 mm) outlet on a hose connection exceeds 100 psi (7 bar), an approved pressure-regulating device shall be provided to limit the residual pressure at the outlet to 100 psi (7 bar).

(6) Where the static pressure at a 1½ in. (40 mm) hose connection exceeds 175 psi (12 bar), an approved pressure-regulating device shall be provided to limit static and residual pressures at the outlet to 100 psi (7 bar).

16.15.2 Hose Connections for Fire Department Use.

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16.15.2.1
In buildings of light or ordinary hazard occupancy, 2½ in. (65 mm) hose valves for fire department use shall be permitted to be attached to wet pipe sprinkler system risers.

16.15.2.2*
The following restrictions shall apply:
(1) Each connection from a standpipe that is part of a combined system to a sprinkler system shall have an individual control valve and check valve of the same size as the connection.

(2) The minimum size of the riser shall be 4 in. (100 mm) unless hydraulic calculations indicate that a smaller size riser will satisfy sprinkler and hose stream allowances.

(3) Each combined sprinkler and standpipe riser shall be equipped with a riser control valve to permit isolating a riser without interrupting the supply to other risers from the same source of supply. *(For fire department connections serving standpipe and sprinkler systems, refer to Section 16.12.)*

16.16 Electrical Bonding and Grounding.

16.16.1
In no case shall sprinkler system piping be used for the grounding of electrical systems.

16.16.2*
The requirement of 16.16.1 shall not preclude the bonding of the sprinkler system piping to the lightning protection grounding system as required by NFPA 780 in those cases where lightning protection is provided for the structure.

16.17* Signs.
(Reserved)

Chapter 17 Installation Requirements for Hanging and Support of System Piping

17.1* General.

17.1.1
Unless the requirements of 17.1.2 are met, types of hangers shall be in accordance with the requirements of Section 9.1.

17.1.2
Hangers certified by a registered professional engineer to include all of the following shall be an acceptable alternative to the requirements of Section 9.1:
(1) Hangers shall be designed to support five times the weight of the water-filled pipe plus 250 lb (115 kg) at each point of piping support.

(2) These points of support shall be adequate to support the system.

(3) The spacing between hangers shall not exceed the value given for the type of pipe as indicated in Table 17.4.2.1(a) or Table 17.4.2.1(b).

(4) Hanger components shall be ferrous.

(5) Detailed calculations shall be submitted, when required by the reviewing authority, showing stresses developed in hangers, piping, and fittings, and safety factors allowed.

17.1.3 Support of Non-System Components.
17.1.3.1*
Sprinkler piping or hangers shall not be used to support non-system components.

17.1.3.2
Sprinkler piping shall be permitted to utilize shared support structures in accordance with 17.1.4.

17.1.4

(H)
The in-rack sprinkler system shall be designed to supply 6 sprinklers on each line, with a total of 12 sprinklers operating at gauge pressure of 25 psi (172 kPa). [**400:**15.3.2.4.13.5(R)]

(I)
The design of the in-rack sprinkler system shall be independent of, and shall not be required to be balanced with, ceiling sprinkler systems. [**400:**15.3.2.4.13.5(S)]

26.37.1.4.4.5 Sprinkler Criteria for Class 4 Oxidizers.

(A)
Sprinkler protection for Class 4 oxidizers shall be installed on a deluge sprinkler system to provide water density of 0.35 gpm/ft^2 (14.4 L/min/m^2) over the entire storage area. [**400:**15.3.2.5.4.6(A)]

(B)
Sprinkler protection shall be installed in accordance with NFPA 13. [**400:**15.3.2.5.4.6(B)]

26.37.2 Installation Requirements. (Reserved)

Chapter 27 Systems Acceptance

27.1 Approval of Sprinkler Systems and Private Fire Service Mains.
The installing contractor shall do the following:
(1) Notify the authority having jurisdiction and the property owner or the property owner's authorized representative of the time and date testing will be performed

(2) Perform all required acceptance tests *(see Section 27.2)*

(3) Complete and sign the appropriate contractor's material and test certificate(s) *(see Figure 27.1)*

(4) Remove all caps and straps prior to placing the sprinkler system in service

Figure 27.1 Contractor's Material and Test Certificate for Aboveground Piping.

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Contractor's Material and Test Certificate for Aboveground Piping

PROCEDURE

Upon completion of work, inspection and tests shall be made by the contractor's representative and witnessed by the property owner or their authorized agent. All defects shall be corrected and system left in service before contractor's personnel finally leave the job.

A certificate shall be filled out and signed by both representatives. Copies shall be prepared for approving authorities, owners, and contractor. It is understood the owner's representative's signature in no way prejudices any claim against contractor for faulty material, poor workmanship, or failure to comply with approving authority's requirements or local ordinances.

Property name		Date
Property address		
New installation?	❑ Yes	❑ No
Modification? If yes, complete applicable portions of the form.	❑ Yes	❑ No
Provide a description of the scope of work on page 3.		

Plans	Accepted by approving authorities (names)		
	Address		
	Installation conforms to accepted plans	❑ Yes	❑ No
	Equipment used is approved	❑ Yes	❑ No
	If no, explain deviations		
Instructions	Has person in charge of fire equipment been instructed as to location of control valves and care and maintenance of this new equipment? If no, explain	❑ Yes	❑ No
	Have copies of the following been left on the premises?	❑ Yes	❑ No
	1. System components instructions	❑ Yes	❑ No
	2. Care and maintenance instructions	❑ Yes	❑ No
	3. NFPA 25	❑ Yes	❑ No
Location of system	Supplies buildings		

Sprinklers	Make	Model	Year of manufacture	Orifice size	Quantity	Temperature rating

Pipe and fittings

Type of pipe _____

Type of fittings _____

Alarm valve or flow indicator	Alarm device			Maximum time to operate through test connection	
	Type	Make	Model	Minutes	Seconds

Dry pipe operating test	Dry valve			Q. O. D.		
	Make	Model	Serial no.	Make	Model	Serial no.

	Time to trip through test connection[a,b]		Water pressure	Air pressure	Trip point air pressure	Time water reached test outlet[a,b]		Alarm operated properly	
	Minutes	Seconds	psi	psi	psi	Minutes	Seconds	Yes	No
Without Q.O.D.									
With Q.O.D.									

If no, explain

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[a] Measured from time inspector's test connection is opened.
[b] NFPA 13 only requires the 60-second limitation in specific sections.

Deluge and preaction valves

Operation ❑ Pneumatic ❑ Electric ❑ Hydraulics

Piping supervised ❑ Yes ❑ No | Detecting media supervised ❑ Yes ❑ No

Does valve operate from the manual trip, remote, or both control stations? ❑ Yes ❑ No

Is there an accessible facility in each circuit for testing? ❑ Yes ❑ No | If no, explain

Make	Model	Does each circuit operate supervision loss alarm?		Does each circuit operate valve release?		Maximum time to operate release	
		Yes	No	Yes	No	Minutes	Seconds

Pressure-reducing valve test

Location and floor	Make and model	Setting	Static pressure		Residual pressure (flowing)		Flow rate
			Inlet (psi)	Outlet (psi)	Inlet (psi)	Outlet (psi)	Flow (gpm)

Backflow device forward flow test

Indicate means used for forward flow test of backflow device: _____

When means to test device was opened, was system flow demand created? ❑ Yes ❑ No ❑ N/A

Test description

Hydrostatic: Hydrostatic tests shall be made at not less than 200 psi (13.8 bar) for 2 hours or 50 psi (3.4 bar) above static pressure in excess of 150 psi (10.3 bar) for 2 hours. Differential dry pipe valve clappers shall be left open during the test to prevent damage. All aboveground piping leakage shall be stopped.

Pneumatic: Establish 40 psi (2.7 bar) air pressure and measure drop, which shall not exceed 1½ psi (0.1 bar) in 24 hours. Test pressure tanks at normal water level and air pressure and measure air pressure drop, which shall not exceed 1½ psi (0.1 bar) in 24 hours.

Tests

All piping hydrostatically tested at _____ psi (____ bar) for ____ hours | If no, state reason

Dry piping pneumatically tested ❑ Yes ❑ No

Equipment operates properly ❑ Yes ❑ No

Do you certify as the sprinkler contractor that additives and corrosive chemicals, sodium silicate or derivatives of sodium silicate, brine, or other corrosive chemicals were not used for testing systems or stopping leaks? ❑ Yes ❑ No

Drain test	Reading of gauge located near water supply test connection: _____ psi (____ bar)	Residual pressure with valve in test connection open wide: _____ psi (____ bar)

Underground mains and lead-in connections to system risers flushed before connection made to sprinkler piping

Verified by copy of the Contractor's Material and Test Certificate for Underground Piping. ❑ Yes ❑ No | Other | Explain

Flushed by installer of underground sprinkler piping ❑ Yes ❑ No

If powder-driven fasteners are used in concrete, has representative sample testing been satisfactorily completed? ❑ Yes ❑ No | If no, explain

Blank testing gaskets

Number used	Locations	Number removed

Welding

Welding piping ❑ Yes ❑ No

If yes . . .

Do you certify as the sprinkler contractor that welding procedures used complied with the minimum requirements of AWS B2.1, ASME Section IX *Welding and Brazing Qualifications*, or other applicable qualification standard as required by the AHJ? ❑ Yes ❑ No

Do you certify that all welding was performed by welders or welding operators qualified in accordance with the minimum requirements of AWS B2.1, ASME Section IX *Welding and Brazing Qualifications*, or other applicable qualification standard as required by the AHJ? ❑ Yes ❑ No

Do you certify that the welding was conducted in compliance with a documented quality control procedure to ensure that (1) all discs are retrieved; (2) that openings in piping are smooth, that slag and other welding residue are removed; (3) the internal diameters of piping are not penetrated; (4) completed welds are free from cracks, incomplete fusion, surface porosity greater than 1/16 in. (1.6 mm) diameter, undercut deeper than the lesser of 25% of the wall thickness or 1/32 in. (0.8 mm); and (5) completed circumferential butt weld reinforcement does not exceed 3/32 in. (2.4 mm)? ❑ Yes ❑ No

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Cutouts (discs)	Do you certify that you have a control feature to ensure that all cutouts (discs) are retrieved? ❑ Yes ❑ No	
Hydraulic data nameplate	Nameplate provided ❑ Yes ❑ No	If no, explain
Sprinkler contractor removed all caps and straps? ❑ Yes ❑ No		
Remarks	Date left in service with all control valves open	
Signatures	Name of sprinkler contractor	
	Tests witnessed by	
	The property owner or their authorized agent (signed) Title Date	
	For sprinkler contractor (signed) Title Date	

Additional explanations and notes

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27.2 Acceptance Requirements.

27.2.1* Hydrostatic Tests.

27.2.1.1
Unless permitted by 27.2.1.2 through 27.2.1.4, all piping and attached appurtenances subjected to system working pressure shall be hydrostatically tested at 200 psi (13.8 bar) and shall maintain that pressure without loss for 2 hours.

27.2.1.2
Portions of systems normally subjected to system working pressures in excess of 150 psi (10.3 bar) shall be tested as described in 27.2.1.1, at a pressure of 50 psi (3.4 bar) in excess of system working pressure.

27.2.1.3
Where cold weather will not permit testing with water, an interim air test shall be permitted to be conducted as described in 27.2.2. This provision shall not remove or replace the requirement for conducting the hydrostatic test as described in 27.2.1.1.

27.2.1.4*
The test pressure shall be read from a gauge located at the low elevation point of the system or portion being tested. The pressures in piping at higher elevations shall be permitted to be less than 200 psi (13.8 bar) when accounting for elevation losses. Systems or portions of systems that can be isolated shall be permitted to be tested separately.

27.2.1.5*
Additives, corrosive chemicals such as sodium silicate, or derivatives of sodium silicate, brine, or similar acting chemicals shall not be used while hydrostatically testing systems or for stopping leaks.

27.2.1.6
Piping between the exterior fire department connection and the check valve in the fire department inlet pipe shall be hydrostatically tested in the same manner as the balance of the system. After repair or replacement work affecting the fire department connection, the piping between the exterior and the check valve in the fire department inlet pipe shall be isolated and hydrostatically tested at 150 psi (10.3 bar).

27.2.1.7*
When systems are being hydrostatically tested, tests shall be permitted to be conducted with pendent or horizontal sidewall sprinklers or plugs installed in fittings. Any plugs shall be replaced with pendent or horizontal sidewall sprinklers after the test is completed.

27.2.1.8
When deluge systems are being hydrostatically tested, plugs shall be installed in fittings and replaced with open sprinklers after the test is completed, or the operating elements of automatic sprinklers shall be removed after the test is completed.

27.2.1.9
Provision shall be made for the proper disposal of water used for flushing or testing.

27.2.1.10* Test Blanks.

27.2.1.10.1
Test blanks shall have painted lugs protruding in such a way as to clearly indicate their presence.

27.2.1.10.2
The test blanks shall be numbered, and the installing contractor shall have a recordkeeping method ensuring their removal after work is completed.

27.2.1.11
When subject to hydrostatic test pressures, the clapper of a differential-type valve shall be held off its seat to prevent damaging the valve.

27.2.2 Dry Pipe and Double Interlock Preaction System(s) Air Test.

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27.2.2.1
In addition to the standard hydrostatic test, an air pressure leakage test at 40 psi (2.7 bar) shall be conducted for 24 hours. Any leakage that results in a loss of pressure in excess of 1½ psi (0.1 bar) for the 24 hours shall be corrected.

27.2.2.2
Where systems are installed in spaces that are capable of being operated at temperatures below 32°F (0°C), air or nitrogen gas pressure leakage tests required in 27.2.2 shall be conducted at the lowest nominal temperature of the space.

27.2.2.3
Pipe or tube specifically investigated for suitability in dry pipe and double interlock preaction system(s) and listed for this service, shall be permitted to be tested in accordance with their listing limitations.

27.2.3 System Operational Tests.

27.2.3.1 Waterflow Devices.
Waterflow detecting devices including the associated alarm circuits shall be flow tested through the inspector's test connection and shall result in an audible alarm on the premises within 5 minutes after such flow begins and until such flow stops.

27.2.3.2* Dry Pipe Systems.

27.2.3.2.1
A working test of the dry pipe valve shall be made by opening the inspector's test connection.

27.2.3.2.2
Where a quick opening device is present, the trip test described in 27.2.3.2.1 shall be sufficient to test the quick opening device as long as the device trips properly during the test.

27.2.3.2.3*
The test shall measure the time to trip the valve and the time for water to be discharged from the inspector's test connection. All times shall be measured from the time the inspector's test connection is completely opened.

27.2.3.2.3.1*
Dry systems calculated for water delivery in accordance with 8.2.3.6 shall be exempt from any specific delivery time requirement.

27.2.3.2.4
The results shall be recorded using the contractor's material and test certificate for aboveground piping *(see Figure 27.1)* and the general information sign *(see Figure A.27.7)*.

27.2.3.3 Deluge and Preaction Systems.

27.2.3.3.1
The automatic operation of a deluge or preaction valve shall be tested in accordance with the manufacturer's instructions.

27.2.3.3.2
The manual and remote control operation, where present, shall also be tested.

27.2.3.4 Main Drain Valves.

27.2.3.4.1
The main drain valve shall be opened and remain open until the system pressure stabilizes.

27.2.3.4.2*
The static and residual pressures shall be recorded on the contractor's material and test certificate *(see Figure 27.1)* and the sprinkler system general information placard *(see Figure A.27.7)*.

27.2.3.5 Operating Test for Control Valves.

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All control valves shall be fully closed and opened under system water pressure to ensure proper operation.

27.2.4 Pressure-Reducing Valves.

27.2.4.1
Each pressure-reducing valve shall be tested upon completion of installation to ensure proper operation under full flow and no-flow conditions.

27.2.4.2
Testing shall verify that the device properly regulates outlet pressure at both maximum and normal inlet pressure conditions.

27.2.4.3
The results of the flow test of each pressure-reducing valve shall be recorded on the contractor's material and test certificate *(see Figure 27.1)*.

27.2.4.4
The results shall include the static and residual inlet pressures, static and residual outlet pressures, and the flow rate.

27.2.5 Backflow Prevention Assemblies.

27.2.5.1
The backflow prevention assembly shall be forward flow tested to ensure proper operation.

27.2.5.2
The minimum flow rate shall be the system demand, including hose stream allowance where applicable.

27.2.6 Exposure Systems.
Operating tests shall be made of exposure protection systems upon completion of the installation, where such tests do not risk water damage to the building on which they are installed or to adjacent buildings.

27.3 Automated Inspection and Testing Devices and Equipment.

27.3.1
Automated inspection and testing devices and equipment installed on the sprinkler system shall be tested to ensure the desired result of the automated inspection or test is realized.

27.3.1.1
Automated inspection devices and equipment shall be shown to be as effective as a visual examination.

27.3.1.2
Automated testing devices and equipment shall produce the same action required by this standard to test a device.

27.3.1.2.1
The testing shall discharge water where required by this standard and NFPA 25.

27.3.2
Failure of automated inspection and testing devices and equipment shall not impair the operation of the system unless indicated by an audible and visual trouble signal in accordance with *NFPA 72*.

27.3.3
Failure of a system or component to pass automated inspection and testing devices and equipment shall result in an audible and visual trouble signal in accordance with *NFPA 72*.

27.3.4
Failure of automated inspection and testing devices and equipment shall result in an audible and visual trouble signal in accordance with *NFPA 72*.

27.4 Circulating Closed Loop Systems.

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27.4.1
For sprinkler systems with non–fire protection connections, additional information shall be appended to the contractor's material and test certificate for aboveground piping shown in **Figure 27.1** as follows:
(1) Certification that all auxiliary devices, such as heat pumps, circulating pumps, heat exchangers, radiators, and luminaires, if a part of the system, have a pressure rating of at least 175 psi or 300 psi (12.1 bar or 20.7 bar) if exposed to pressures greater than 175 psi (12.1 bar).

(2) All components of sprinkler system and auxiliary system have been pressure tested as a composite system in accordance with 27.2.2.

(3) Waterflow tests have been conducted and waterflow alarms have operated while auxiliary equipment is in each of the possible modes of operation.

(4) With auxiliary equipment tested in each possible mode of operation and with no flow from sprinklers or test connection, waterflow alarm signals did not operate.

(5) Excess temperature controls for shutting down the auxiliary system have been properly field tested.

27.4.2
Discharge tests of sprinkler systems with non–fire protection connections shall be conducted using system test connections described in 6.8.1.

27.4.3
Pressure gauges shall be installed at critical points and readings shall be taken under various modes of auxiliary equipment operation.

27.4.4
Waterflow alarm signals shall be responsive to discharge of water through system test pipes while auxiliary equipment is in each of the possible modes of operation.

27.5 Instructions.
The installing contractor shall provide the property owner or the property owner's authorized representative with the following:
(1) All literature and instructions provided by the manufacturer describing proper operation and maintenance of any equipment and devices installed

(2) *NFPA 25

27.6* Hydraulic Design Information Sign (Hydraulic Data Nameplate).

27.6.1
The installing contractor shall identify a hydraulically designed sprinkler system with a permanently marked weatherproof metal or rigid plastic sign secured with corrosion-resistant wire, chain, or other approved means.

27.6.2
Such signs shall be placed at the alarm valve, dry pipe valve, preaction valve, or deluge valve supplying the corresponding hydraulically designed area.

27.7* General Information Sign.

27.7.1
The installing contractor shall provide a general information sign used to determine system design basis and information relevant to the inspection, testing, and maintenance requirements required by NFPA 25.

27.7.1.1
Such general information shall be provided with a permanently marked weatherproof metal or rigid plastic sign, secured with corrosion-resistant wire, chain, or other acceptable means.

27.7.1.2
Such signs shall be placed at each system control riser, antifreeze loop, and auxiliary system control valve.

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27.7.2
The sign shall include the following information:
(1) Name and location of the facility protected

(2) Occupancy classification

(3) Commodity classification

(4) Presence of high-piled and/or rack storage

(5) Maximum height of storage planned

(6) Aisle width planned

(7) Encapsulation of pallet loads

(8) Presence of solid shelving

(9) Flow test data

(10) Presence of flammable/combustible liquids

(11) Presence of hazardous materials

(12) Presence of other special storage

(13) Location of venting valve

(14) Location of auxiliary drains and low point drains on dry pipe and preaction systems

(15) Original results of main drain flow test

(16) Original results of dry pipe and double interlock preaction valve test

(17) Name of installing contractor or designer

(18) Indication of presence and location of antifreeze or other auxiliary systems

(19) Where injection systems are installed to treat MIC or corrosion, the type of chemical, concentration of the chemical, and where information can be found as to the proper disposal of the chemical

27.7.3
Combination hydraulic design information and general information are permitted.

27.7.4
The sign shall include the following information:
(1) Location of the design area or areas

(2) Discharge densities over the design area or areas

(3) Required flow and residual pressure demand at the base of the riser

(4) Occupancy classification or commodity classification and maximum permitted storage height and configuration

(5) Hose stream allowance included in addition to the sprinkler demand

(6) The name of the installing contractor

Chapter 28 Existing System Modifications

28.1 General.

28.1.1
In addition to the applicable requirements of this standard, the requirements of Chapter 28 shall apply where modifications or additions are made to existing systems.

28.1.2
Torch cutting and welding shall not be permitted as a means of modifying or repairing sprinkler systems.

28.1.3
Additives to existing systems intended for control of microbiological or other corrosion shall be listed for use within fire sprinkler systems.

28.2 Components.

28.2.1
The use of reconditioned valves and devices as replacement equipment in existing systems shall be permitted.

28.2.2
Where all or part of an inactive sprinkler system is abandoned in place, components including sprinklers, hose valves and hoses, and alarm devices shall be removed.

28.2.3
Control valves abandoned in place shall have the operating mechanisms removed.

28.2.4
Sprinkler system piping and/or valves abandoned in place shall be uniquely identified to differentiate them from active system piping and valves.

28.2.5
When pipe schedule or hydraulically designed systems are revamped to accommodate added ceilings, sprinkler outlets utilized for new armover or drop nipples shall have hexagonal bushings removed where present.

28.3 Sprinklers.

28.3.1
Reconditioned sprinklers shall not be permitted on any existing system.

28.3.2
When a sprinkler is removed from a fitting or welded outlet, it shall not be reinstalled except as permitted by **28.3.2.1**.

28.3.2.1
Dry sprinklers shall be permitted to be reinstalled when removed in accordance with the manufacturer's installation and maintenance instructions.

28.3.3
Where modifications or additions are made to existing light hazard systems equipped with standard response sprinklers, new standard response sprinklers shall be permitted to be used.

28.3.4
Where individual standard response sprinklers are replaced in existing light hazard systems, new standard response sprinklers shall be permitted to be used.

28.3.5
Where existing light hazard systems are converted to use quick-response or residential sprinklers, all sprinklers in a compartment shall be changed.

28.3.6

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When replacing residential sprinklers manufactured prior to 2003 that are no longer available from the manufacturer and that are installed using a design density less than 0.05 gpm/ft^2 (2.04 mm/min), a residential sprinkler with an equivalent K-factor (±5 percent) shall be permitted to be used, provided the currently listed coverage area for the replacement sprinkler is not exceeded.

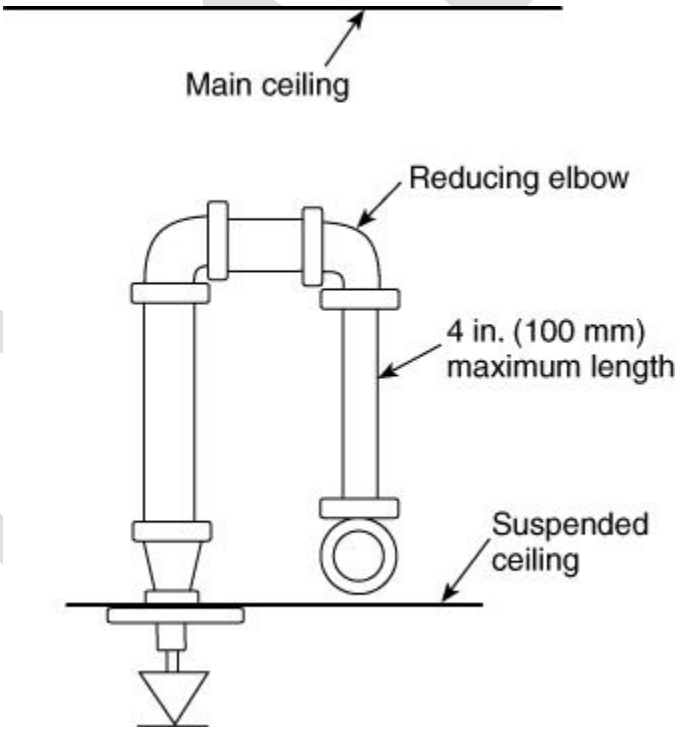
28.3.7
Where cover plates on concealed sprinklers have been painted by other than the sprinkler manufacturer, the cover plates shall be replaced.

28.4 Revamping of Pipe Schedule Systems.

28.4.1
When pipe schedule systems are revamped, a nipple not exceeding 4 in. (100 mm) in length shall be permitted to be installed in the branch line fitting.

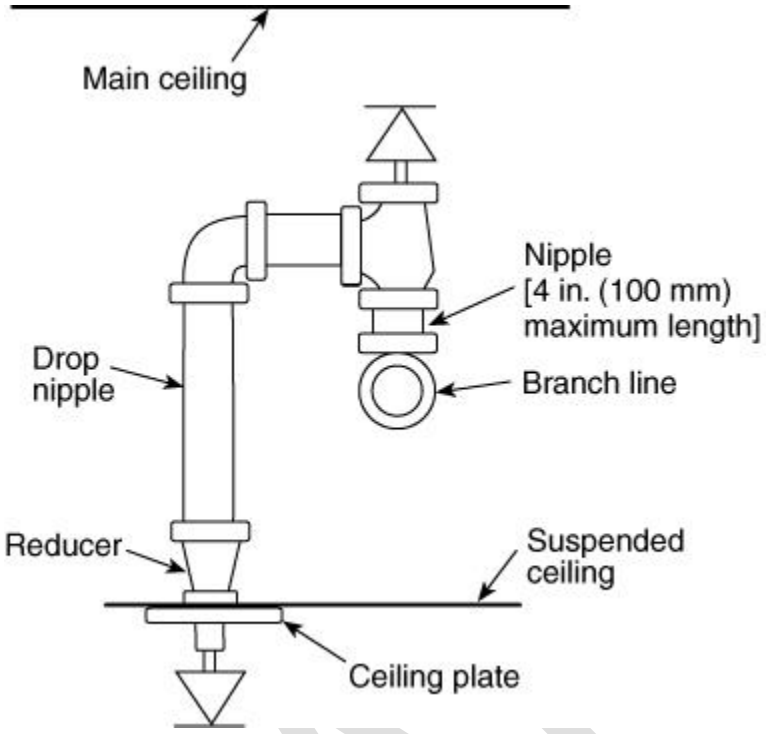
28.4.2
All piping other than the nipple permitted in 28.4.1 and 28.4.3 shall be a minimum of 1 in. (25 mm) in diameter in accordance with Figure 28.4.2.

Figure 28.4.2 Nipple and Reducing Elbow Supplying Sprinkler Below Ceiling.



28.4.3
When it is necessary to pipe two new ceiling sprinklers from an existing outlet in an overhead system, the use of a nipple not exceeding 4 in. (100 mm) in length and of the same pipe thread size as the existing outlet shall be permitted in accordance with Figure 28.4.3, provided that a hydraulic calculation verifies that the design flow rate will be achieved.

Figure 28.4.3 Sprinklers in Concealed Space and Below Ceiling.



28.4.4
Where an armover is attached to connect to a sprinkler, the use of pipe nipples less than 1 in. (25 mm) in diameter shall not be permitted where seismic design is required on the system.

28.5 Revamping of Hydraulic Design Systems.

28.5.1
When hydraulically designed systems are revamped, any existing bushing shall be removed and a nipple not exceeding 4 in. (100 mm) in length shall be permitted to be installed in the branch line fitting.

28.5.2*
Calculations shall be provided to verify that the system design flow rate will be achieved.

28.5.3
When it is necessary to pipe two new ceiling sprinklers from an existing outlet in an overhead system, any bushings shall be removed and the use of a nipple not exceeding 4 in. (100 mm) in length and of the same pipe thread size as the existing outlet shall be permitted, provided that a hydraulic calculation verifies that the design flow rate will be achieved.

28.5.4
Where an armover is attached to connect to a sprinkler, the use of pipe nipples less than 1 in. (25 mm) in diameter shall not be permitted where seismic design is required on the system.

28.6 System Design.

28.6.1
Where an addition or modifications are made to an existing system, enough of the existing system shall be indicated on the plans to make all conditions clear.

28.6.2
The pipe schedule method shall be permitted as follows:
(1) For modifications or additions to existing systems equipped with residential sprinklers, the listed discharge criteria less than 0.1 gpm/ft^2 (4.1 mm/min) shall be permitted to be used.

(2) A hydraulically calculated system for a building, or a hydraulically calculated addition to a system in an existing sprinklered building using the pipe schedule method, shall supersede the rules in this standard governing pipe schedules, except that all systems shall continue to be limited by area.

(3) Unless permitted by 28.6.3, when modifying existing systems protecting general storage, rack storage, rubber tire storage, roll paper storage, and baled cotton storage, using sprinklers with K-factors K-8.0 (115) or less, the requirements of 12.6.2 and 12.6.3 shall not apply.

28.6.3
Where applying the requirements of Figure 25.9.3.1(a) and Figure 25.9.3.1(b) utilizing the design criteria of 0.6 gpm/ft^2 per 2000 ft^2 (24.4 mm/min per 186 m^2) to existing storage applications, standard-response spray sprinklers with a K-factor of K-11.2 (161) or larger that are listed for storage applications shall be used.

28.6.4
For modifications or additions to existing systems equipped with residential sprinklers, the listed discharge criteria less than 0.1 gpm/ft^2 (4.1 mm/min) shall be permitted to be used.

28.6.5 Retroactive Installation.
When backflow prevention devices are to be retroactively installed on existing systems, a thorough hydraulic analysis, including revised hydraulic calculations, new fire flow data, and all necessary system modifications to accommodate the additional friction loss, shall be completed as a part of the installation.

28.6.6
A hydraulically calculated system for a building, or a hydraulically calculated addition to a system in an existing sprinklered building using the pipe schedule method, shall supersede the rules in this standard governing pipe schedules, except that all systems shall continue to be limited by area.

28.6.7
Unless permitted by 28.6.3, when modifying existing systems protecting general storage, rack storage, rubber tire storage, roll paper storage, and baled cotton storage, using sprinklers with K-factors K-8.0 (115) or less, the requirements of 21.1.3 and 21.1.4 shall not apply.

28.7 Testing.

28.7.1
Modifications to existing piping systems shall require testing at system working pressure.

28.7.1.1
Where modification is made to an existing system affecting more than 20 sprinklers, the new portion shall be isolated and tested at not less than 200 psi (13.8 bar) for 2 hours.

28.7.1.2
Modifications that cannot be isolated, such as relocated drops, shall require testing at system working pressure.

28.7.2
Modifications to existing dry pipe or double interlock preaction systems shall be tested for air leakage using one of the following test methods:
(1) An air pressure test at 40 psi (2.7 bar) shall be performed for 2 hours as follows:
(a) The system shall be permitted to lose up to 3 psi (0.2 bar) during the duration of the test.

(b) Air leaks shall be addressed if the system loses more than 3 psi (0.2 bar) during this test.

(2) With the system at normal system air pressure, the air source shall be shut off for 4 hours. If the low pressure alarm goes off within this period, the leaks shall be addressed.

Chapter 29 Marine Systems

29.1 General.

29.1.1
Chapter 26 outlines the deletions, modifications, and additions that shall be required for marine application. The applicability of Chapter **26** shall be determined by the authority having jurisdiction.

29.1.2
All other requirements of this standard shall apply to merchant vessel systems except as modified by this chapter.

29.1.3
The following definitions shall be applicable to this chapter *(see Section 3.3.120)*:
(1) *A-Class Boundary* — A boundary designed to resist the passage of smoke and flame for 1 hour when tested in accordance with ASTM E119, *Standard Test Methods for Fire Tests of Building Construction and Materials*, or ANSI/UL 263, *Standard for Fire Tests of Building Construction and Materials*.

(2) *B-Class Boundary* — A boundary designed to resist the passage of flame for ½ hour when tested in accordance with ASTM E119, *Standard Test Methods for Fire Tests of Building Construction and Materials*, or ANSI/UL 263, *Standard for Fire Tests of Building Construction and Materials*.

(3) *Central Safety Station* — A continuously manned control station from which all of the fire control equipment is monitored. If this station is not the bridge, direct communication with the bridge must be provided by means other than the ship's service telephone.

(4) **Heat-Sensitive Material* — A material whose melting point is below 1700°F (925°C).

(5) *Heel* — The inclination of a ship to one side.

(6) *Heel Angle* — The angle defined by the intersection of a vertical line through the center of a vessel and a line perpendicular to the surface of the water.

(7) *International Shore Connection* — A universal connection to the vessel's fire main to which a shoreside fire-fighting water supply can be connected.

(8) **Marine System* — A sprinkler system installed on a ship, boat, or other floating structure that takes its supply from the water on which the vessel floats.

(9) **Marine Thermal Barrier* — An assembly that is constructed of noncombustible materials and made intact with the main structure of the vessel, such as shell, structural bulkheads, and decks; meetsthe requirements of a B-Class boundary; and is insulated such that, if tested in accordance with ASTM E119, *Standard Test Methods for Fire Tests of Building Construction and Materials,* or ANSI/UL 263, *Standard for Fire Tests of Building Construction and Materials*, for 15 minutes, the average temperature of the unexposed side does not rise more than 250°F (139°C) above the original temperature, nor does the temperature at any one point, including any joint, rise more than 405°F (225°C) above the original temperature.

(10) *Marine Water Supply* — The supply portion of the sprinkler system from the water pressure tank or the sea suction of the designated sprinkler system pump up to and including the valve that isolates the sprinkler system from these two water sources.

(11) *Supervision* — A visual and audible alarm signal given at the central safety station to indicate when the system is in operation or when a condition that would impair the satisfactory operation of the system exists. Supervisory alarms shall give a distinct indication for each individual system component that is monitored.

(12) *Survival Angle* — The maximum angle to which a vessel is permitted to heel after the assumed damage required by stability regulations is imposed.

(13) *Type 1 Stair* — A fully enclosed stair that serves all levels of a vessel in which persons can be employed.

29.1.4* Occupancy Classifications.
Marine environment classifications shall be in accordance with Section 4.3.

29.1.5* Partial Installations.

29.1.5.1
Partial installation of automatic sprinklers shall not be permitted, unless the requirements of 29.1.5.2 or 29.1.5.3 are met.

29.1.5.2
Spaces shall be permitted to be protected with an alternative, approved fire suppression system where such areas are separated from the sprinklered areas with a 1 hour–rated assembly.

29.1.5.3
The requirements of 29.1.5.1 shall not apply where specific sections of this standard permit the omission of sprinklers.

29.2 System Components, Hardware, and Use.

29.2.1*
Sprinklers shall have a K-factor of K-2.8 (40) or greater.

29.2.2*
Sprinkler piping penetrations shall be designed to preserve the fire integrity of the ceiling or bulkhead penetrated.

29.2.3 Spare Sprinklers.

29.2.3.1
The required stock of spare sprinklers shall be carried for each type of sprinkler installed onboard the vessel.

29.2.3.2
Where fewer than six sprinklers of a particular type are installed, 100 percent spares shall be kept in stock.

29.2.3.3
Where applicable, at least one elastometric gasket shall be kept in the cabinet for each fire department connection that is installed onboard the vessel.

29.2.3.4
The cabinet containing spare sprinklers, special wrenches, and elastometric gaskets shall be located in the same central safety station that contains the alarm annunciator panel(s) and supervisory indicators.

29.2.4 System Pipe and Fittings.

29.2.4.1*
When ferrous materials are used for piping between the sea chest and zone control valves, these materials shall be protected against corrosion by hot dip galvanizing or by the use of Schedule 80 piping.

29.2.4.2
Maximum design pressure for copper and brass pipe shall not exceed 250 psi (17.2 bar).

29.2.5 Pipe Support.

29.2.5.1*
Pipe supports shall comply with the following:
(1) Pipe supports shall be designed to provide adequate lateral, longitudinal, and vertical sway bracing.

(2) The design shall account for the degree of bracing, which varies with the route and operation of the vessel.

(3) Bracing shall be designed to ensure the following:

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(a) Slamming, heaving, and rolling will not shift sprinkler piping, potentially moving sprinklers above ceilings, bulkheads, or other obstructions.

(b) Piping and sprinklers will remain in place at a steady heel angle at least equal to the maximum required damaged survival angle.

(4) Pipe supports shall be welded to the structure.

(5) Hangers that can loosen during ship motion or vibration, such as screw-down-type hangers, shall not be permitted.

(6) Hangers that are listed for seismic use shall be permitted to be used in accordance with their listing.

29.2.5.2
Sprinkler piping shall be supported by the primary structural members of the vessel such as beams, girders, and stiffeners.

29.2.5.3*
The components of hanger assemblies that are welded directly to the ship structure shall not be required to be listed.

29.2.5.4*
U-hook sizes shall be no less than that specified in Table 17.2.1.4.

29.2.6 Valves.

29.2.6.1*
All indicating, supply, and zone control valves shall be supervised open from a central safety station.

29.2.6.2
Drain and test valves shall meet the applicable requirements of 46 CFR 56.20 and 56.60.

29.2.6.3
Valve markings shall include the information required by 46 CFR 56.20-5(a).

29.2.7 Fire Department Connections and International Shore Connections.

29.2.7.1*
A fire department connection and an International Shore Connection shall be installed.

29.2.7.2
The requirements for a fire department connection in 29.2.7.1 shall not apply to vessels that operate primarily on international voyages.

29.2.7.3
Connections shall be located near the gangway or other shore access point so that they are accessible to the land-based fire department.

29.2.7.4
Fire department and International Shore Connections shall be colored and marked so that the connections are easily located from the shore access point (i.e., gangway location) and will not be confused with a firemain connection.

29.2.7.5
An 18 in. × 18 in. (450 mm × 450 mm) sign displaying the symbol for fire department connection as shown in Table 5.2.1 of NFPA 170 shall be placed at the connection so that it is in plain sight from the shore access point.

29.2.7.6
Connections on both sides of the vessel shall be provided where shore access arrangements make it necessary.

29.2.7.7*
Fire department connection thread type shall be compatible with fire department equipment.

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29.2.7.8
International shore connections shall comply with ASTM F1121, *Standard Specification for International Shore Connections for Marine Fire Applications*.

29.3 System Requirements.

29.3.1* Relief Valves.
Relief valves shall be provided on all wet pipe systems.

29.3.2 Spare Detection Devices.
The number of spare detection devices or fusible elements used for protection systems that shall be carried per temperature rating is as follows:
(1) Vessels shall have two spare detection devices or fusible elements when operating voyages are normally less than 24 hours.

(2) Vessels shall have four spare detection devices or fusible elements when operating voyages are normally more than 24 hours.

29.3.3 System Piping Supervision.
All preaction sprinkler systems shall be supervised regardless of the number of sprinklers supplied.

29.3.4 Circulating Closed Loop Systems.
Circulating closed loop systems shall not be permitted.

29.4 Installation Requirements.

29.4.1 Temperature Zones.
Intermediate temperature–rated sprinklers shall be installed under a noninsulated steel deck that is exposed to sunlight.

29.4.2* Residential Sprinklers.
Residential sprinklers shall be permitted for use only in sleeping accommodation areas.

29.4.3 Window Protection.
Where required, windows shall be protected by sprinklers installed at a distance not exceeding 1 ft (300 mm) from the glazing at a spacing not exceeding 6 ft (1.8 m) such that the entire glazing surface is wetted at a linear density not less than 6 gpm/ft (75 mm/min), unless listed window sprinkler protection systems are installed in accordance with their installation and testing criteria.

29.4.4* Concealed Spaces.

29.4.4.1
Concealed spaces that are constructed of combustible materials, or materials with combustible finishes or that contain combustible materials, shall be sprinklered.

29.4.4.2
The requirements of 29.4.4.1 shall not apply to concealed spaces that contain only nonmetallic piping that is continuously filled with water.

29.4.5 Vertical Shafts.

29.4.5.1
Sprinklers shall not be required in vertical shafts used as duct, electrical, or pipe shafts that are nonaccessible, noncombustible, and enclosed in an A-Class-rated assembly.

29.4.5.2
Stairway enclosures shall be fully sprinklered.

29.4.6 Bath Modules.
Sprinklers shall be installed in bath modules (full room modules) constructed with combustible materials, regardless of room fire load.

29.4.7 Ceiling Types.

Drop-out ceilings shall not be used in conjunction with sprinklers.

29.4.8 Return Bends.

29.4.8.1
To prevent sediment buildup, return bends shall be installed in all shipboard sprinkler systems where pendent-type or dry pendent-type sprinklers are used in wet systems *(see Figure 16.3.11.2).*

29.4.8.2
Consideration shall be given concerning the intrusion of saltwater into the system.

29.4.8.3
Specifically, sprinklers shall not be rendered ineffective by corrosion related to saltwater entrapment within the return bend.

29.4.9 Hose Connections.
Sprinkler system piping shall not be used to supply hose connections or hose connections for fire department use.

29.4.10 Heat-Sensitive Piping Materials.

29.4.10.1
Portions of the piping system constructed with a heat-sensitive material shall be subject to the following restrictions:
(1) Piping shall be of non–heat-sensitive type from the sea suction up through the penetration of the last A-Class barrier enclosing the space(s) in which the heat-sensitive piping is installed.

(2) B-Class draft stops shall be fitted not more than 45 ft (14 m) apart between the marine thermal barrier *(see definitions in Chapter 3 and 29.1.3)* and the deck or shell.

(3) Portions of a system that are constructed from heat-sensitive materials shall be installed behind a marine thermal barrier, unless the provisions of item (4) are met.

(4) *Piping materials with brazed joints shall not be required to be installed behind a marine thermal barrier, provided the following conditions are met:
(a) The system is of the wet pipe type.

(b) The piping is not located in spaces containing boilers, internal combustion engines, or piping containing flammable or combustible liquids or gases under pressure, cargo holds, or vehicle decks.

(c) A relief valve in compliance with 8.1.2 is installed in each section of piping that is capable of being isolated by a valve(s).

(d) A valve(s) isolating the section of piping from the remainder of the system is installed in accordance with 29.4.10.2 and 29.4.10.3.

29.4.10.2
Each zone in which heat-sensitive piping is installed shall be fitted with a valve capable of segregating that zone from the remainder of the system.

29.4.10.3
The valve shall be supervised and located outside of the zone controlled and within an accessible compartment having A-Class boundaries or within a Type 1 stair.

29.4.11 Discharge of Drain Lines.

29.4.11.1
Drain lines shall not be connected to housekeeping, sewage, or deck drains. Drains shall be permitted to be discharged to bilges.

29.4.11.2
Overboard discharges shall meet the requirements of 46 CFR 56.50-95 and shall be corrosion resistant in accordance with 46 CFR 56.60.

29.4.11.3
Systems that contain water additives that are not permitted to be discharged into the environment shall be specially designed to prevent such discharge.

29.4.11.4
Discharges shall be provided with a down-turned elbow.

29.4.12 Alarm Signals and Devices.

29.4.12.1*
A visual and audible alarm signal shall be given at the central safety station to indicate when the system is in operation or when a condition that would impair the satisfactory operation of the system exists.

29.4.12.2
Alarm signals shall be provided for, but not limited to, each of the following: monitoring position of control valves, fire pump power supplies and operating condition, water tank levels and temperatures, zone waterflow alarms, pressure of tanks, and air pressure on dry pipe valves.

29.4.12.3
Alarms shall give a distinct indication for each individual system component that is monitored.

29.4.12.4
An audible alarm shall be given at the central safety station within 30 seconds of waterflow.

29.4.12.5
Waterflow alarms shall be installed for every zone of the sprinkler system.

29.4.12.6
Sprinkler zones shall not encompass more than two adjacent decks or encompass more than one main vertical zone.

29.4.12.7
Electrically operated alarm attachments shall comply with, meet, and be installed in accordance with the requirements of 46 CFR, Subchapter J, “Electrical Engineering.”

29.4.12.8
All wiring shall be chosen and installed in accordance with IEEE 45, *Recommended Practice for Electrical Installations on Shipboard*.

29.4.13 Test Connections.
Where test connections are below the bulkhead deck, they shall comply with the overboard discharge arrangements of 46 CFR 56.50-95.

29.4.14 Protection of Copper Tubing.
Copper tubing materials shall be protected against physical damage in areas where vehicles and stores handling equipment operate.

29.5 Design Approaches.

29.5.1 Design Options.

29.5.1.1
Marine sprinkler systems shall be designed using the hydraulic calculation procedure of Chapter 23.

29.5.1.2
The pipe schedule method shall not be used to determine the water demand requirements.

29.5.2* Window Protection.
Minimum water demand requirements shall include sprinklers that are installed for the protection of windows as described in 29.4.3.

29.5.3* Hose Stream Allowance.
No allowance for hose stream use shall be required.

29.6 Plans and Calculations.

29.6.1 Additional Information.
The pressure tank size, high-pressure relief setting, high- and low-water alarm settings, low-pressure alarm setting, and pump start pressure shall be provided.

29.6.2
Sprinklers specifically installed for the protection of windows under 29.4.3 shall be permitted to be of a different size from those protecting the remainder of the occupancy classification.

29.6.3
All of the window sprinklers, however, shall be of the same size.

29.6.4*
Marine sprinkler systems shall be designed and installed to be fully operational without a reduction in system performance when the vessel is upright and inclined at the angles of inclination specified in 46 CFR 58.01-40.

29.7 Water Supplies.

29.7.1 General.
The water supply requirements for marine applications shall be in accordance with Section 29.7.

29.7.2 Pressure Tank.

29.7.2.1
Unless the requirements of 29.7.2.2 are met, a pressure tank shall be provided. The pressure tank shall be sized and constructed so that the following occurs:
(1) The tank shall contain a standing charge of freshwater equal to that specified by Table 29.7.2.1.

(2) The pressure tank shall be sized in accordance with 5.2.4.

(3) A glass gauge shall be provided to indicate the correct level of water within the pressure tank.

(4) Arrangements shall be provided for maintaining an air pressure in the tank such that, while the standing charge of water is being expended, the pressure will not be less than that necessary to provide the design pressure and flow of the hydraulically most remote design area.

(5) Suitable means of replenishing the air under pressure and the freshwater standing charge in the tank shall be provided.

(6) Tank construction shall be in accordance with the applicable requirements of 46 CFR, Subchapter F, “Marine Engineering.”

Table 29.7.2.1 Required Water Supply

System Type	Additional Water Volume
Wet pipe system	Flow requirement of the hydraulically most remote system demand for 1 minute
Preaction system Deluge system Dry pipe system	Flow requirement of the hydraulically most remote system demand for 1 minute of system demand plus the volume needed to fill all dry piping

29.7.2.2 Pressure Tank Alternative.
In lieu of a pressure tank, a dedicated pump connected to a freshwater tank shall be permitted to be used, provided the following conditions are met:
(1) The pump is listed for marine use and is sized to meet the required system demand.

(2) The suction for the fire pump is located below the suction for the freshwater system so that there shall be a minimum water supply of at least 1 minute for the required system demand.

(3) Pressure switches are provided in the system and the controller for the pump that automatically start the pump within 10 seconds after detection of a pressure drop of more than 5 percent.

(4) There shall be a reduced pressure zone backflow preventer to prevent contamination of the potable water system by saltwater.

(5) This pump has at least two sources of power. Where the sources of power are electrical, these shall be a main generator and an emergency source of power. One supply shall be taken from the main switchboard, by separate feeder reserved solely for that purpose. This feeder shall be run to an automatic changeover switch situated near the sprinkler unit, and the switch shall normally be kept closed to the feeder from the emergency switchboard. The changeover switch shall be clearly labeled, and no other switch shall be permitted in these feeders.

29.7.2.3 Relief Valves.

29.7.2.3.1
Relief valves shall be installed on the tank to avoid overpressurization and false actuation of any dry pipe valve.

29.7.2.3.2
Relief valves shall comply with 46 CFR 54.15-10.

29.7.2.4 Power Source.

29.7.2.4.1
There shall be not less than two sources of power for the compressors that supply air to the pressure tank.

29.7.2.4.2
Where the sources of power are electrical, these shall be a main generator and an emergency source of power.

29.7.2.4.3
One supply shall be taken from the main switchboard, by separate feeders reserved solely for that purpose.

29.7.2.4.4
Such feeders shall be run to a changeover switch situated near the air compressor, and the switch normally shall be kept closed to the feeder from the emergency switchboard.

29.7.2.4.5
The changeover switch shall be clearly labeled, and no other switch shall be permitted in these feeders.

29.7.2.5 Multiple Tanks.

29.7.2.5.1
More than one pressure tank can be installed, provided that each is treated as a single water source when determining valve arrangements.

29.7.2.5.2
Check valves shall be installed to prohibit flow from tank to tank or from pump to tank, unless the tank is designed to hold only pressurized air.

29.7.2.6
In systems subject to use with saltwater, valves shall be so arranged as to prohibit contamination of the pressure tank with saltwater.

29.7.2.7*
Where applicable, a means shall be provided to restrict the amount of air that can enter the pressure tank from the air supply system. A means shall also be provided to prevent water from backflowing into the air supply system.

29.7.3 Fire Pump.

29.7.3.1
A dedicated, automatically controlled pump that is listed for marine service, which takes suction from the sea, shall be provided to supply the sprinkler system.

29.7.3.2
Where two pumps are required to ensure the reliability of the water supply, the pump that supplies the fire main shall be allowed to serve as the second fire pump.

29.7.3.3*
The pump shall be sized to meet the water demand of the hydraulically most demanding area.

29.7.3.4
Pumps shall be designed to not exceed 120 percent of the rated capacity of the pump.

29.7.3.5
The system shall be designed so that, before the supply falls below the design criteria, the fire pump shall be automatically started and shall supply water to the system until manually shut off.

29.7.3.6
Where pump and freshwater tank arrangement is used in lieu of the pressure tank, there must be a pressure switch that senses a system pressure drop of 25 percent, and the controller must automatically start the fire pump(s) if pressure is not restored within 20 seconds.

29.7.3.7
There shall be not less than two sources of power supply for the fire pumps. Where the sources of power are electrical, these shall be a main generator and an emergency source of power.

29.7.3.8
One supply shall be taken from the main switchboard by separate feeders reserved solely for that purpose.

29.7.3.9
Such feeders shall be run to a changeover switch situated near to the sprinkler unit, and the switch normally shall be kept closed to the feeder from the emergency switchboard.

29.7.3.10
The changeover switch shall be clearly labeled, and no other switch shall be permitted in these feeders.

29.7.3.11 Test Valves.

29.7.3.11.1
A test valve(s) shall be installed on the discharge side of the pump with a short open-ended discharge pipe.

29.7.3.11.2
The area of the pipe shall be adequate to permit the release of the required water output to supply the demand of the hydraulically most remote area.

29.7.3.12 Multiple Pumps.

29.7.3.12.1
Where two fire pumps are required to ensure the reliability of the water supply, each fire pump shall meet the requirements of 29.7.3.1 through 29.7.3.4.

29.7.3.12.2
In addition, a system that is required to have more than one pump shall be designed to accommodate the following features:
(1) *Pump controls and system sensors shall be arranged such that the secondary pump will automatically operate if the primary pump fails to operate or deliver the required water pressure and flow. *[Figure A.29.7.3.12.2(1) is an example of an acceptable dual pump arrangement.]*

(2) Both pumps shall be served from normal and emergency power sources. However, where approved by the authority having jurisdiction, the secondary pump shall be permitted to be nonelectrically driven.

(3) Pump failure or operation shall be indicated at the central safety station.

29.7.3.13*
If not specifically prohibited, the fire pump that supplies the fire main shall be permitted to be used as the second pump, provided the following conditions are met:
(1) The pump is adequately sized to meet the required fire hose and sprinkler system pressure and flow demands simultaneously.

(2) The fire main system is segregated from the sprinkler system by a normally closed valve that is designed to automatically open upon failure of the designated fire pump.

(3) The fire pump that supplies the fire main is automatically started in the event of dedicated fire pump failure or loss of pressure in the sprinkler main. *(See Figure A.29.7.3.13.)*

29.7.4 Water Supply Configurations.

29.7.4.1
The pressure tank and fire pump shall be located in a position reasonably remote from any machinery space of Category A.

29.7.4.2
All valves within the water supply piping system shall be supervised.

29.7.4.3
Only freshwater shall be used as the initial charge within the piping network.

29.7.4.4
The sprinkler system shall be cross-connected with the ship's fire main system and fitted with a lockable screw-down nonreturn valve such that backflow from the sprinkler system to the fire main is prevented.

29.7.4.5
The piping, tanks, and pumps that make up the water supply shall be installed in accordance with the applicable requirements of 46 CFR, Subchapter F, “Marine Engineering.”

29.7.4.6*
When a shorewater supply is to be used during extended dockside periods, the water supply shall be qualified in the manner described in 5.2.2.

29.7.4.7
Tests shall be conducted in accordance with the requirements of the local shore-based authority having jurisdiction.

29.7.4.8
The water supply information listed in Section 4.7 shall then be provided to the authority having jurisdiction.

29.8 System Acceptance.

29.8.1 Hydrostatic Tests.
In addition to the interior piping, the test required by 27.2.1.6 shall also be conducted on all external water supply connections including international shore and fireboat connections.

29.8.2 Alarm Test.
A waterflow test shall result in an alarm at the central safety station within 30 seconds after flow through the test connection begins.

29.8.3 Operational Tests.

29.8.3.1
Pressure tank and pump operation, valve actuation, and waterflow shall also be tested.

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29.8.3.2
Pump operation and performance shall be tested in accordance with Chapter 14 of NFPA 20.

29.9 System Instructions and Maintenance.

29.9.1
Instructions for operation, inspection, maintenance, and testing shall be kept on the vessel.

29.9.2
Records of inspections, tests, and maintenance required by NFPA 25 shall also be kept on the vessel.

Chapter 30 System Inspection, Testing, and Maintenance

30.1* General.
A sprinkler system installed in accordance with this standard shall be properly inspected, tested, and maintained by the property owner or their authorized representative in accordance with NFPA 25 to provide at least the same level of performance and protection as designed.

Annex A Explanatory Material

Annex A is not a part of the requirements of this NFPA document but is included for informational purposes only. This annex contains explanatory material, numbered to correspond with the applicable text paragraphs.

A.1.1
This standard provides a range of sprinkler system approaches, design development alternatives, and component options that are all acceptable. Building owners and their designated representatives are advised to carefully evaluate proposed selections for appropriateness and preference.

A.1.1.2
Various codes and standards allow exceptions and reductions in building fire protection and other construction features where fire sprinkler systems are installed in accordance with NFPA standards. Only after appropriate analysis and evaluation of a tested mist system has been performed for the intended installation, and taking into consideration criteria other than solely fire-fighting performance (visibility, pressure ratings of backup systems, etc.) should exceptions and reductions in building fire protection and other construction features be allowed by the AHJ. These systems are adequately described in NFPA 750.

A.1.1.3
This standard also provides guidance for the installation of systems for exterior protection and specific hazards. Where these systems are installed, they are also designed for protection of a fire from a single ignition source.

A.1.2
Since its inception, this document has been developed on the basis of standardized materials, devices, and design practices. However, Section 1.2 and other subsections such as 7.3.3 and 8.4.8 allow the use of materials and devices not specifically designated by this standard, provided such use is within parameters established by a listing organization. In using such materials or devices, it is important that all conditions, requirements, and limitations of the listing be fully understood and accepted and that the installation be in complete accord with such listing requirements.

A.1.5

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Length					
.003”	.08 mm	7.5”	190 mm	26”	650 mm
.0315”	.8 mm	8”	200 mm	27.6”	690 mm
1/32”	0.8 mm	8.5”	215 mm	28”	700 mm
1/16”	1.6 mm	9”	225 mm	29”	725 mm
3/32”	2 mm	9.25”	230 mm	30”	750 mm
1/8”	3 mm	9.5”	240 mm	30.5”	765 mm
3/16”	5 mm	10”	250 mm	31”	775 mm
¼”	6 mm	11”	275 mm	32”	800 mm
5/16”	8 mm	11.5”	290 mm	33”	825 mm
3/8”	10 mm	12”	300 mm	35”	875 mm
½”	13 mm	12.25”	305 mm	35.4”	885 mm
17/32”	13 mm	12.5”	315 mm	36”	900 mm
9/16”	14 mm	12.75”	320 mm	37”	925 mm
5/8”	16 mm	14”	350 mm	38”	950 mm
¾”	19 mm	15”	375 mm	40”	1000 mm
7/8”	22 mm	15.5”	390 mm	42”	1050 mm
1”	25 mm	16”	400 mm	44”	1100 mm
1.5”	40 mm	16.25”	410 mm	47”	1175 mm
1.75”	45 mm	16.5”	415 mm	48”	1200 mm
2”	50 mm	17”	425 mm	54”	1350 mm
2.5”	65 mm	17.5”	440 mm	55”	1375 mm
2.75”	70 mm	18”	450 mm	57”	1425 mm
3”	75 mm	19”	475 mm	58”	1450 mm
3.5”	90 mm	20”	500 mm	66”	1650 mm
4”	100 mm	21”	525 mm	68”	1700 mm
4.5”	115 mm	22”	550 mm	72”	1800 mm
5”	125 mm	22.5”	565 mm	76”	1900 mm
5.5”	140 mm	23”	575 mm	78”	1950 mm
5.75”	145 mm	24”	600 mm	96”	2400 mm
6”	150 mm	25”	625 mm	102”	2550 mm
7”	175 mm	25.5”	640 mm	120”	3000 mm
				148”	3700 mm

Length					
3.5ft	1.1 m	10’-10”	3.3 m	22’-6”	6.9 m
3’-8”	1.1 m	11’-0”	3.4 m	24ft	7.3 m
4ft	1.2 m	11’-3”	3.4 m	25ft	7.6 m
4’-2”	1.3 m	11’-5”	3.5 m	25’-3”	7.7 m
4.5ft	1.4 m	11’-6”	3.5 m	26ft	7.9 m
4’-7”	1.4 m	11’-611/16”	3.5 m	27ft	8.2 m
4’-9”	1.4 m	11’-8”	3.6 m	28ft	8.5 m
5ft	1.5 m	12ft	3.7 m	28’-8”	8.7 m
5’-2”	1.6 m	12’-4”	3.8 m	29’-8”	9 m
5.5ft	1.7 m	13ft	4.0 m	30ft	9.1 m
5’-8”	1.7 m	13’-6”	4.1 m	32ft	10 m
5’-9 5/16”	1.8 m	13’-71/2”	4.2 m	33ft	10 m
6ft	1.8 m	13’-11”	4.2 m	35ft	11 m
6’-3”	1.9 m	14ft	4.3 m	36ft	11 m
6’-4”	1.9 m	14’-6”	4.4 m	40ft	12 m
6.5ft	2 m	15ft	4.6 m	41’-3”	13 m
6’-10”	2.1 m	15’-4”	4.7 m	45ft	14 m
7ft	2.1 m	16ft	4.9 m	50ft	15 m
7.5ft	2.3 m	16’-6”	5.0 m	51’-6”	16 m
7’-7”	2.3 m	16’-8”	5.1 m	55ft	17 m
7’-9”	2.4 m	17ft	5.2 m	60ft	18 m
8ft	2.4 m	18ft	5.5 m	65ft	20 m
8’-2”	2.5 m	18’-6”	5.6 m	70ft	21 m
8’-4”	2.5 m	19’-2”	5.8 m	75ft	23 m
8’-77/8”	2.6 m	19’-10”	6 m	76ft	23 m
9ft	2.7 m	19’-11”	6.1 m	80ft	24 m
9’-5”	2.9 m	20ft	6.1 m	100ft	30 m
9’-6”	2.9 m	20’-8”	6.3 m	200ft	61 m
10ft	3 m	21’-6”	6.6 m	250ft	76 m
10.5ft	3.2 m	21’-10”	6.7 m	300ft	91 m
10’-9”	3.3 m	22 ft	6.7 m	400ft	120 m

Area					
3.5 ft2	0.3 m2	256 ft2	24 m2	2,700 ft2	250 m2
6 ft2	0.6 m2	300 ft2	28 m2	2,734 ft2	255 m2
10 ft2	0.9 m2	306 ft2	28 m2	2,800 ft2	260 m2
12 ft2	1.1 m2	324 ft2	30 m2	3,000 ft2	280 m2
16 ft2	1.5 m2	395 ft2	37 m2	3,250 ft2	300 m2
18 ft2	1.7m2	400 ft2	37 m2	3,300 ft2	305 m2
20 ft2	1.9m2	450 ft2	42 m2	3,450 ft2	320 m2
24 ft2	2.2m2	504 ft2	47 m2	3,500 ft2	325 m2
25 ft2	2.3 m2	585 ft2	54 m2	3,600 ft2	335 m2
32 ft2	3.0 m2	600 ft2	56 m2	3,750 ft2	350 m2
50 ft2	4.6 m2	648 ft2	60 m2	3,900 ft2	360 m2
55 ft2	5.1 m2	700 ft2	65 m2	4,000 ft2	370 m2
64 ft2	5.9 m2	756 ft2	70 m2	4,100 ft2	380 m2
70 ft2	6.5 m2	768 ft2	71 m2	4,500 ft2	420 m2
80 ft2	7.4 m2	800 ft2	74 m2	4,800 ft2	445 m2
90 ft2	8.4 m2	1,000 ft2	93 m2	5,000 ft2	465 m2
100 ft2	9 m2	1,200ft2	112 m2	6,000 ft2	555 m2
110 ft2	10 m2	1,300 ft2	120 m2	6,400 ft2	595 m2
120 ft2	11 m2	1,365 ft2	125 m2	8,000 ft2	740 m2
124 ft2	12 m2	1,400 ft2	130 m2	8,800 ft2	820 m2
130 ft2	12 m2	1,500 ft2	140 m2	10,000 ft2	930 m2
144 ft2	13 m2	1,700 ft2	160 m2	13,100 ft2	1 215 m2
150 ft2	14 m2	1,800 ft2	165 m2	25,000 ft2	2 320 m2
168 ft2	16 m2	1,950 ft2	180 m2	40,000 ft2	3 720 m2
175 ft2	16 m2	2,000 ft2	185 m2	50,000 ft2	4 650 m2
196 ft2	18 m2	2,300 ft2	215 m2	52,000 ft2	4 830 m2
200 ft2	18 m2	2,500 ft2	230m2	100,000 ft2	9 230 m2
225 ft2	20 m2	2,535 ft2	235 m2		
250 ft2	23 m2	2,600 ft2	240 m2		

Volume			
1.76 cuin	28 ml	160 ft3	4.5 m3
15.5 ft3	0.5 m3	400 ft3	11 m3
17.4 ft3	0.5 m3	1,000 ft3	28 m3
17.6 ft3	0.5 m3	1,800 ft3	51 m3
20.7 ft3	0.6 m3	2,100 ft3	59 m3
21.1 ft3	0.6 m3	2,300 ft3	65 m3
22 ft3	0.6 m3	6,500 ft3	184 m3
100 ft3	2.8 m3	2.25M ft3	63,720 m3

Capacity	
16 oz.	0.5 l
32 oz.	1 l
1 gal	4 l
5 gal	20 l
40 gal	150 l
100 gal	380 l
150 gal	570 l
250 gal	950 l
500 gal	1900 l
750 gal	2850 l
300,000 gal	1,135,500 l

Drill Size	
3/32”	2,3 mm
1/8”	3,2 mm
3/8”	10 mm

Density of Cotton Bales	
22.0 lb/ft^3	350 kg/m^3
22.7 lb/ft^3	365 kg/m^3
24.2 lb/ft^3	390 kg/m^3
28.4 lb/ft^3	455 kg/m^3
28.7 lb/ft^3	460 kg/m^3
32.2 lb/ft^3	515 kg/m^3

Flow					
30 gpm	115 lpm	300 gpm	1150 lpm	1000 gpm	3800 lpm
15 gpm	57 lpm	400 gpm	1500 lpm	1500 gpm	5700 lpm
20 gpm	75 lpm	500 gpm	1900 lpm	1992 gpm	7540 lpm
50 gpm	190 lpm	600 gpm	2250 lpm	1993 gpm	7543 lpm
60 gpm	230 lpm	700 gpm	2650 lpm	2156 gpm	8160 lpm
100 gpm	380 lpm	750 gpm	2850 lpm	2575 gpm	9750 lpm
102.8 gpm	390 lpm	800 gpm	3050 lpm	4907 gpm	18,572 lpm
200 gpm	760 lpm	850 gpm	3200 lpm		
215.8 gpm	815 lpm	900 gpm	3400 lpm		
250 gpm	950 lpm				

Pressure			
5 psi	0.3 bar	75	5.2 bar
7	0.5 bar	90	6.2 bar
10	0.7 bar	100	6.9 bar
11	.8 bar	150	10 bar
15	1.0 bar	165	11 bar
20	1.4 bar	175	12 bar
22	15 bar	189	13 bar
25	1.7 bar	200	14 bar
30	2.1 bar	259	17 bar
35	2.4 bar	300	21 bar
50	3.4 bar	400	28 bar
63	4.3 bar		

Gauge	
12	2.8 mm
14	1.98 mm
16	1.57 mm
22	.78 mm
24	.63mm

Weight			
6 lb	2.7 kg	350 lb	160 kg
10 lb	4.5 kg	440 lb	200 kg
20 lb	9.1 kg	520 lb	235 kg
40 lb	18 kg	750 lb	340 kg
61 lb	27 kg	787 lb	355 kg
91 lb	41 kg	1200 lb	544 kg
131 lb	59 kg	1634 lb	740 kg
200 lb	91 kg	2000 lb	907 kg
250 lb	115 kg	2300 lb	1043 kg
		4000 lb	1815 kg

Velocity	
30 mph	49 km/h

Discharge Density			
gpm/ft2	mm/min	gpm/ft2	mm/min
.005	.2	.425	17.3
.05	2.04	.426	17.4
.1	4.1	.44	17.9
.15	6.1	.45	18.3
.16	6.5	.46	18.7
.17	7.0	.49	20
.18	7.3	.5	20.4
.19	7.7	.55	22.4
.2	8.2	.56	22.8
.21	8.6	.57	23.2
.225	9.2	.6	24.5
.24	9.8	.61	24.9
.25	10.2	.65	26.5
.26	10.6	.68	27.7
.28	11.4	.7	28.5
.29	11.8	.74	30.2
.3	12.2	.75	30.6
.31	12.6	.77	31.4
.32	13.0	.8	32.6
.33	13.4	.85	34.6
.34	13.9	.9	36.7
.35	14.3	.92	37.5
.37	15.1	.96	39.1
.375	15.3	1.1	44.8
.39	15.9	1.2	48.9
.4	16.3	6.0	245
.42	17.1	7.5	306

Second Revision No. 461-NFPA 13-2017 [Sections 1.7.2.1, 1.7.2.2]

~~1.7.2.1*~~

~~Devices and equipment utilized to perform automated inspection and testing procedures that are not subjected to system pressure shall not be required to be listed.~~

~~A.1.7.2.1~~

~~Certain devices and equipment that might be used to perform inspection and testing procedures from a distant location are not integral to the system and do not affect system performance. Automated inspection and testing devices and equipment, such as a digital camera, could be in the riser room or attached to the system externally but are not an integral part of the system. Such devices do not need to be listed.~~

~~1.7.2.2*~~

~~Devices and equipment utilized to perform distance monitoring of system or component status that are not subjected to system pressure shall not be required to be listed.~~

~~A.1.7.2.2~~

~~Certain devices and equipment that might be used to monitor system or component status from a distance are not integral to the system and do not affect system performance. Distance monitoring devices, such as an external thermometer, could be attached to the system externally and therefore are not subjected to system pressure. Such devices do not need to be listed.~~

Submitter Information Verification

Submitter Full Name: AUT-SSI
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Tue Jun 27 11:39:49 EDT 2017

Committee Statement

Committee Statement: During the Technical Committee 1st Draft Meeting the TC voted to resolve this item, because it was felt that Chapter 1 was not the appropriate place to discuss listing requirements for these devices.

Additionally, the changes to A.7.1.1.5 in accordance with FR-722 provides sufficient guidance on this subject, so the text added to Sections 1.7.2.1, A.7.1.2.1, 1.7.2.2 and A.1.7.2.2 is all redundant.

Response Message:

Public Comment No. 165-NFPA 13-2017 [Sections 1.7.2.1, 1.7.2.2]

Second Revision No. 508-NFPA 13-2017 [Section No. 2.3.4]

2.3.4 ASTM Publications.

ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959.

ASTM A53/A53M, *Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless*, 2012.

ASTM A106/A106M, *Standard Specification for Seamless Carbon Steel Pipe for High Temperature Service*, 2015.

ASTM A135/A135M, *Standard Specification for Electric-Resistance-Welded Steel Pipe*, 2009, reapproved 2014.

ASTM A153A/153M, *Standard Specification for Zinc Coating (Hot Dip) on Iron and Steel Hardware*, 2016.

~~ASTM A234/A234M, *Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service* , 2015.~~

ASTM A312/A312M, *Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes* , 2017.

ASTM A403/A403M, *Standard Specification for Wrought Austenitic Stainless Steel Piping Fittings* , 2016.

ASTM A536, *Standard Specification for Ductile Iron Castings*, 2014.

ASTM A795/A795M, *Standard Specification for Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless Steel Pipe for Fire Protection Use*, 2013.

ASTM B32, *Standard Specification for Solder Metal*, 2008, reapproved 2014.

ASTM B43, *Standard Specification for Seamless Red Brass Pipe, Standard Sizes*, 2015.

ASTM B75/B75M, *Standard Specification for Seamless Copper Tube*, 2011.

ASTM B88, *Standard Specification for Seamless Copper Water Tube*, 2014.

ASTM B251, *Standard Specification for General Requirements for Wrought Seamless Copper and Copper-Alloy Tube*, 2010.

ASTM B446, *Standard Specification for Nickel-Chromium-Molybdenum-Columbium Alloy (UNS N06625), ~~and~~ Nickel-Chromium-Molybdenum-Silicon Alloy (UNS N06219), and Nickel-Chromium-Molybdenum-Tungsten Alloy (UNS N06625) Rod and Bar*, 2003, reapproved 2014.

ASTM B813, *Standard Specification for Liquid and Paste Fluxes for Soldering ~~Applications~~ of Copper and Copper Alloy Tube*, 2016.

ASTM B828, *Standard Practice for Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings*, 2002, reapproved 2010.

ASTM C635/C635M, *Standard Specification for the Manufacture, Performance, and Testing of Metal Suspension Systems for Acoustical Tile and Lay-In Panel Ceilings*, 2013a.

ASTM C636/C636M, *Standard Practice for Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-In Panels*, 2013.

ASTM E84, *Standard Test Method for Surface Burning Characteristics of Building Materials*, ~~2015b~~ 2016 .

ASTM E119, *Standard Test Methods for Fire Tests of Building Construction and Materials*, ~~2016~~ 2016a .

ASTM E136, *Standard Test Method for Behavior of Materials in a Vertical Tube Furnace at 750°C*, ~~2016~~ 2016a .

ASTM E2652, *Standard Test Method for Behavior of Materials in a Tube Furnace with a Cone-shaped Airflow Stabilizer, at 750°C* , 2016.

ASTM E2768, *Standard Test Method for Extended Duration Surface Burning Characteristics of Building Materials (30 min Tunnel Test)*, 2011.

ASTM F437, *Standard Specification for Threaded Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80*, 2015.

ASTM F438, *Standard Specification for Socket-Type Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 40*, 2015.

ASTM F439, *Standard Specification for ~~Socket-Type~~ Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80*, 2013.

ASTM F442/F442M, *Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe (SDR-PR)*, 2013e1.

ASTM F1121, *Standard Specification for International Shore Connections for Marine Fire Applications*, 1987, reapproved 2015.

ASTM SI10, *Standard for Use of the International System of Units (SI): The Modern Metric System*, 2010.

Submitter Information Verification

Submitter Full Name: AUT-SSI

Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Thu Jul 13 11:21:53 EDT 2017

Committee Statement

Committee Statement: Update a few dates and add reference to ASTM E2652, needed for linked PC
Response Message:

Public Comment No. 56-NFPA 13-2017 [Section No. 2.3.4]

Second Revision No. 1037-NFPA 13-2017 [Section No. 2.4]

2.4 References for Extracts in Mandatory Sections.

NFPA 1, *Fire Code,* 2018 edition.

NFPA 20, *Standard for the Installation of Stationary Pumps for Fire Protection,* 2019 edition.

NFPA 24, *Standard for the Installation of Private Fire Service Mains and Their Appurtenances,* 2019 edition.

NFPA 33, *Standard for Spray Application Using Flammable or Combustible Materials,* 2018 edition.

NFPA 36, *Standard for Solvent Extraction Plants,* 2017 edition.

NFPA 37, *Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines,* 2018 edition.

NFPA 40, *Standard for the Storage and Handling of Cellulose Nitrate Film,* 2019 edition.

NFPA 45, *Standard on Fire Protection for Laboratories Using Chemicals,* 2015 edition.

NFPA 51, *Standard for the Design and Installation of Oxygen–Fuel Gas Systems for Welding, Cutting, and Allied Processes,* 2018 edition.

~~NFPA 51A, *Standard for Acetylene Cylinder Charging Plants,* 2012 edition.~~

NFPA 55, *Compressed Gases and Cryogenic Fluids Code,* ~~2019~~ 2016 edition.

NFPA 59, *Utility LP-Gas Plant Code,* ~~2015~~ 2018 edition.

NFPA 59A, *Standard for the Production, Storage, and Handling of Liquefied Natural Gas (LNG),* 2016 edition.

NFPA 70®, National Electrical Code®, 2017 edition.

NFPA 75, *Standard for the Fire Protection of Information Technology Equipment,* 2017 edition.

NFPA 76, *Standard for the Fire Protection of Telecommunications Facilities,* 2016 edition.

NFPA 82, *Standard on Incinerators and Waste and Linen Handling Systems and Equipment,* 2014 edition.

NFPA 86, *Standard for Ovens and Furnaces,* 2019 edition.

NFPA 91, *Standard for Exhaust Systems for Air Conveying of Vapors, Gases, Mists, and Particulate Solids,* 2015 edition.

NFPA 99, *Health Care Facilities Code,* 2018 edition.

NFPA 99B, *Standard for Hypobaric Facilities,* 2018 edition.

NFPA 120, *Standard for Fire Prevention and Control in Coal Mines,* 2015 edition.

NFPA 122, *Standard for Fire Prevention and Control in Metal/Nonmetal Mining and Metal Mineral Processing Facilities,* 2015 edition.

NFPA 130, *Standard for Fixed Guideway Transit and Passenger Rail Systems,* 2017 edition.

NFPA 140, *Standard on Motion Picture and Television Production Studio Soundstages, Approved Production Facilities, and Production Locations,* 2018 edition.

NFPA 150, *Standard on Fire and Life Safety in Animal Housing Facilities,* 2019 edition.

NFPA 214, *Standard on Water-Cooling Towers,* 2016 edition.

NFPA 307, *Standard for the Construction and Fire Protection of Marine Terminals, Piers, and Wharves,* 2016 edition.

NFPA 318, *Standard for the Protection of Semiconductor Fabrication Facilities,* 2018 edition.

NFPA 400, *Hazardous Materials Code,* ~~2016~~ 2019 edition.

NFPA 415, *Standard on Airport Terminal Buildings, Fueling Ramp Drainage, and Loading Walkways,* 2016 edition.

NFPA 423, *Standard for Construction and Protection of Aircraft Engine Test Facilities,* 2016 edition.

NFPA 804, *Standard for Fire Protection for Advanced Light Water Reactor Electric Generating Plants,* 2015 edition.

NFPA 805, *Performance-Based Standard for Fire Protection for Light Water Reactor Electric Generating Plants,* 2015 edition.

NFPA 909, *Code for the Protection of Cultural Resource Properties — Museums, Libraries, and Places of Worship,* 2017 edition.

Submitter Information Verification

Submitter Full Name: AUT-SSI

Organization: National Fire Protection Assoc

Street Address:
City:
State:
Zip:
Submittal Date: Fri Aug 25 08:03:58 EDT 2017

Committee Statement

Committee Statement: Editorial, includes NFPA 20 as an extract reference.
Response Message:

Second Revision No. 507-NFPA 13-2017 [Section No. 3.3.9]

3.3.9 Automated Inspection and Testing.

The ~~use of procedures or equipment for the~~ performance of inspections and ~~testing of components~~ tests at a distance from the system or component being inspected or tested through the use of electronic devices or equipment installed for the purpose.

Submitter Information Verification

Submitter Full Name: AUT-SSI
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Thu Jul 13 11:08:44 EDT 2017

Committee Statement

Committee Statement: This comment is in support of the definition for Automated Inspection and Testing but seeks consistency between the related NFPA Standards. This language was approved by the NFPA 20 committee and should be correlated with NFPA 13, NFPA 13R and NFPA 14.

Response Message:

Public Comment No. 128-NFPA 13-2017 [Section No. 3.3.9]

Second Revision No. 404-NFPA 13-2017 [Section No. 3.3.34]

3.3.33 Cloud Ceiling.

Any ceiling system, not including sloped ceilings, installed in the same plane with horizontal openings to the structure above on ~~all~~ two or more sides. ~~This does not include sloped ceilings as defined in 3.3.27.3 .~~

Submitter Information Verification

Submitter Full Name: AUT-SSI
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Mon Jun 26 08:33:18 EDT 2017

Committee Statement

Committee Statement: The original research used four open sides because that created a more challenging scenario. Rejecting this allowance for fewer openings whereby less heat can get past the lower ceiling needs better justification than simply blindly applying the test protocol without considering the impact of a change. Sound fire protection engineering supports this change. I considered repeating the other PI that had no reference to sides but a single opening likely is not viewed as a cloud ceiling but just a small opening in the ceiling which is already addressed under concealed spaces.

Response Message:

Public Comment No. 299-NFPA 13-2017 [Section No. 3.3.34]

Second Revision No. 405-NFPA 13-2017 [Section No. 3.3.40]

3.3.39 Compartment.

A space completely enclosed by walls and a ceiling. Each wall in the compartment is permitted to have openings to an adjoining space if the openings have a minimum lintel depth of 8 in. (200 mm) from the ceiling and the total width of the openings in each wall does not exceed 8 ft (2.4 m) ~~every 40 linear feet~~ . A single opening of 36 in. (900 mm) or less in width without a lintel is permitted where there are no other openings to adjoining spaces ~~every 40 linear feet~~ .

Submitter Information Verification

Submitter Full Name: AUT-SSI
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Mon Jun 26 08:35:47 EDT 2017

Committee Statement

Committee Statement: This was noted to be a CI during the first draft meetings and should not have been accepted as a FR.
Response Message:

Public Comment No. 256-NFPA 13-2017 [Section No. 3.3.40]

Second Revision No. 1031-NFPA 13-2017 [Section No. 3.3.135.3]

3.3.135.3 Light Hazard Occupancies.

~~Light hazard occupancies shall be defined as occupancies~~ Occupancies or portions of other occupancies where the quantity and/or combustibility of contents is low and fires with relatively low rates of heat release are expected.

Submitter Information Verification

Submitter Full Name: AUT-SSI
Organization: National Fire Protection Assoc
Street Address:
City:
State:
Zip:
Submittal Date: Thu Aug 17 10:53:49 EDT 2017

Committee Statement

Committee Statement: Editorial to match that of ordinary and extra hazard definitions.
Response Message:

Second Revision No. 1002-NFPA 13-2017 [Section No. 3.3.206.4]

3.3.207* Sprinkler System.

A system, commonly activated by heat from a fire and discharges water over the fire area, that consists of an integrated network of piping designed in accordance with fire protection engineering standards that includes a water supply source, a water control valve, a waterflow alarm, and a drain. The portion of the sprinkler system above ground is a network of specifically sized or hydraulically designed piping installed in a building, structure, or area, generally overhead, and to which sprinklers are attached in a systematic pattern. ~~The system is commonly activated by heat from a fire and discharges water over the fire area.~~

3.3.207.1 Antifreeze Sprinkler System.

A wet pipe system using automatic sprinklers that contains a liquid solution to prevent freezing of the system, intended to discharge the solution upon sprinkler operation, followed immediately by water from a water supply.

~~**3.3.207.2** Circulating Closed-Loop Sprinkler System.~~

~~A wet pipe sprinkler system having non–fire protection connections to automatic sprinkler systems in a closed-loop piping arrangement for the purpose of utilizing sprinkler piping to conduct water for heating or cooling, where water is not removed or used from the system but only circulated through the piping system.~~

3.3.207.2 Combined Dry Pipe–Reaction Sprinkler System.

A sprinkler system employing automatic sprinklers attached to a piping system containing air under pressure with a supplemental detection system installed in the same areas as the sprinklers. Operation of the detection system actuates tripping devices that open dry pipe valves simultaneously and without loss of air pressure in the system. The detection system also serves as an automatic fire alarm system.

3.3.207.3 Deluge Sprinkler System.

A sprinkler system employing open sprinklers or nozzles that are attached to a piping system that is connected to a water supply through a valve that is opened by the operation of a detection system installed in the same areas as the sprinklers or the nozzles. When this valve opens, water flows into the piping system and discharges from all sprinklers or nozzles attached thereto.

3.3.207.4 Dry Pipe Sprinkler System.

A sprinkler system employing automatic sprinklers that are attached to a piping system containing air or nitrogen under pressure, the release of which (as from the opening of a sprinkler) permits the water pressure to open a valve known as a dry pipe valve, and the water then flows into the piping system and out the opened sprinklers.

3.3.207.4.1 Differential Dry Pipe Valve.

A valve that is held in the closed position by the system gas pressure exposed to the larger surface area on the air/nitrogen side of the clapper where it is at least 5 times that of the surface area on the water supply side.

3.3.207.4.2 Mechanical Dry Pipe Valve.

A valve that uses a series of mechanical devices such as levers, springs, diaphragms, and latches to hold the valve in the closed position with air/nitrogen pressure and without using the clapper surface areas to provide a differential between air/nitrogen and water pressures.

3.3.207.5* Gridded Sprinkler System.

A sprinkler system in which parallel cross mains are connected by multiple branch lines, causing an operating sprinkler to receive water from both ends of its branch line while other branch lines help transfer water between cross mains.

3.3.207.6* Looped Sprinkler System.

A sprinkler system in which multiple cross mains are tied together so as to provide more than one path for water to flow to an operating sprinkler and branch lines are not tied together.

3.3.207.7 Multicycle System.

A type of sprinkler system capable of repeated on–off flow cycles in response to heat.

3.3.207.8 Pipe Schedule System.

A sprinkler system in which the pipe sizing is selected from a schedule that is determined by the occupancy classification and in which a given number of sprinklers are allowed to be supplied from specific sizes of pipe.

3.3.207.9* Preaction Sprinkler System.

A sprinkler system employing automatic sprinklers that are attached to a piping system that contains air that might or might not be under pressure, with a supplemental detection system installed in the same areas as the sprinklers.

3.3.207.10 Wet Pipe Sprinkler System.

A sprinkler system employing automatic sprinklers attached to a piping system containing water and connected to a water supply so that water discharges immediately from sprinklers opened by heat from a fire.

~~**3.3.208** Sprinkler System.~~

~~See 3.3.206.4 .~~

Supplemental Information

File Name	Description	Approved
13-SSI_SR-1002_3.3.206.4_leg_changes.docx	For staff use.	

Submitter Information Verification

Submitter Full Name: AUT-SSI
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Mon Jul 24 12:39:31 EDT 2017

Committee Statement

Committee Statement: As it is currently entered in the First draft Report, the definitions for a sprinkler system and for the various types of sprinkler system are sandwiched in between the sections for the types of sprinkler by installation orientation and the sprinkler system types. This location is obscure. It is not intuitive to look for the definition of a wet pipe system immediately before the definition of a CMDA sprinkler. The systems (types) should have their section. Associated annex material is also moved.

Circulating Closed loops have been removed from NFPA 13. This language no longer applies to new installations.

New sub-definitions being added to Dry Pipe Sprinkler System. A PI was submitted to address low differential dry pipe valves, defining it to be where the air/nitrogen to water ratio is greater than 1 in 6. Debate was had during the first draft meeting on to the accuracy of this. Per discussion at the NFSA's Engineering and Standards committee, it was noted that the issue is between differential dry pipe valves and mechanical valves, where water columns adversely affect differential type dry pipe valves of any ratio. This is not an issue with mechanical type dry pipe valves. Definitions are needed to clarify the distinction between the two types.

Response Message:

Public Comment No. 117-NFPA 13-2017 [Section No. A.3.3.206.4.7]

Public Comment No. 112-NFPA 13-2017 [New Section after A.3.3.206.5.15]

Public Comment No. 108-NFPA 13-2017 [Section No. 3.3.206.4]

Public Comment No. 113-NFPA 13-2017 [New Section after A.3.3.206.5.15]

Public Comment No. 107-NFPA 13-2017 [Section No. 3.3.207]

Public Comment No. 115-NFPA 13-2017 [Section No. A.3.3.206.4]

Public Comment No. 129-NFPA 13-2017 [New Section after 3.3.206.4.5]

Public Comment No. 130-NFPA 13-2017 [New Section after 3.3.206.4.5]

Public Comment No. 116-NFPA 13-2017 [Section No. A.3.3.206.4.6]

Public Comment No. 114-NFPA 13-2017 [New Section after A.3.3.206.5.15]

Public Comment No. 118-NFPA 13-2017 [Section No. A.3.3.206.4.10]

Public Comment No. 111-NFPA 13-2017 [New Section after A.3.3.206.5.15]

Public Comment No. 105-NFPA 13-2017 [Section No. 3.3.206.4.2]

Second Revision No. 409-NFPA 13-2017 [Section No. 3.3.206.5]

3.3.206.4 Sprinkler Types.

The following sprinklers are defined according to design and/or performance characteristics.

3.3.206.4.1* Control Mode Density/Area (CMDA) Sprinkler.

A type of spray sprinkler intended to provide fire control in storage applications using the design density/area criteria described in this standard.

3.3.206.4.2* Control Mode Specific Application (CMSA) Sprinkler.

A type of spray sprinkler that is capable of producing characteristic large water droplets and that is listed for its capability to provide fire control of specific high-challenge fire hazards.

3.3.206.4.3 Corrosion-Resistant Sprinkler.

A sprinkler fabricated with corrosion-resistant material, or with special coatings or platings, to be used in an atmosphere that would normally corrode sprinklers.

3.3.206.4.4* Dry Sprinkler.

A sprinkler secured in an extension nipple that has a seal at the inlet end to prevent water from entering the nipple until the sprinkler operates.

3.3.206.4.5* Early Suppression Fast-Response (ESFR) Sprinkler.

A type of fast-response sprinkler that has a thermal element with an RTI of 50 (meters-seconds)$^{1/2}$ or less and is listed for its capability to provide fire suppression of specific high-challenge fire hazards.

3.3.206.4.6 Extended Coverage Sprinkler.

A type of spray sprinkler with maximum coverage areas as specified in Sections 11.2 and 11.3 ~~of this standard~~ .

3.3.206.4.7 Institutional Sprinkler.

A sprinkler specially designed for resistance to load-bearing purposes and with components not readily converted for use as weapons.

3.3.206.4.8 Intermediate-Level Sprinkler/Rack Storage Sprinkler.

A sprinkler equipped with integral shields to protect its operating elements from the discharge of sprinklers installed at higher elevations.

3.3.206.4.9 ~~Nozzles~~ Nozzle .

A device for use in applications requiring special water discharge patterns, directional spray, or other unusual discharge characteristics.

3.3.206.4.10 Old-Style/Conventional Sprinkler.

A sprinkler that directs from 40 percent to 60 percent of the total water initially in a downward direction and that is designed to be installed with the deflector either upright or pendent.

3.3.206.4.11 Open Sprinkler.

A sprinkler that does not have actuators or heat-responsive elements.

3.3.206.4.12 Ornamental/Decorative Sprinkler.

A sprinkler that has been painted or plated by the manufacturer.

3.3.206.4.13 Pilot Line Detector.

A standard spray sprinkler or thermostatic fixed-temperature release device used as a detector to pneumatically or hydraulically release the main valve, controlling the flow of water into a fire protection system.

3.3.206.4.14* Quick-Response Early Suppression (QRES) Sprinkler.

A type of quick-response sprinkler that has a thermal element with an RTI of 50 (meter-seconds)$^{1/2}$ or less and is listed for its capability to provide fire suppression of specific fire hazards.

3.3.206.4.15 Quick-Response Extended Coverage Sprinkler.

A type of quick-response sprinkler that has a thermal element with an RTI of 50 (meter-seconds)$^{1/2}$ or less and complies with the extended protection areas defined in Chapter 8.

3.3.206.4.16* Quick-Response (QR) Sprinkler.

A type of spray sprinkler that has a thermal element with an RTI of 50 (meter-seconds)$^{1/2}$ or less and is listed as a quick-response sprinkler for its intended use.

3.3.206.4.17 Residential Sprinkler.

A type of fast-response sprinkler having a thermal element with an RTI of 50 (meters-seconds)$^{1/2}$ or less that has been specifically investigated for its ability to enhance survivability in the room of fire origin and that is listed for use in the protection of dwelling units.

3.3.206.4.18 Special Sprinkler.

A sprinkler that has been tested and listed as prescribed in Section 15.2.

3.3.206.4.19 Spray Sprinkler.

A type of sprinkler listed for its capability to provide fire control for a wide range of fire hazards.

3.3.206.4.20 Standard Spray Sprinkler.

A spray sprinkler with maximum coverage areas as specified in Sections 10.2 and 10.3 ~~of this standard~~ .

Submitter Information Verification

Submitter Full Name: AUT-SSI
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Mon Jun 26 09:18:32 EDT 2017

Committee Statement

Committee Statement: In the First Draft Report, Section 3.3.206.5 is entitled "Needs a Title". The title and the corresponding text offered here is borrowed right from the 2016 edition of the standard for the same definitions.

Response Message:

Public Comment No. 109-NFPA 13-2017 [Section No. 3.3.206.5]

Public Comment No. 77-NFPA 13-2017 [Section No. 3.3.206.5.4]

Second Revision No. 413-NFPA 13-2017 [Section No. 7.4.1]

7.4.1

Fittings used in sprinkler systems shall meet or exceed the standards in Table 7.4.1 or be in accordance with 7.4.2 or 7.4.4.

Table 7.4.1 Fittings Materials and Dimensions

Materials and Dimensions	Standard
Cast Iron	
~~Cast~~ Gray Iron Threaded Fittings, ~~Class~~ Classes 125 and 250	ASME B16.4
~~Cast~~ Gray Iron Pipe Flanges and Flanged Fittings, Classes 25, 125, and 250	ASME B16.1
Malleable Iron	
Malleable Iron Threaded Fittings, ~~Class~~ Classes 150 and 300	ASME B16.3
Steel	
Factory-Made Wrought ~~Steel Buttweld~~ Buttwelding Fittings	ASME B16.9
Buttwelding Ends ~~for Pipe, Valves, Flanges, and Fittings~~	ASME B16.25
Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and ~~Elevated Temperatures~~ High Temperature Service	ASTM A234/A234M
~~Steel~~ Pipe Flanges and Flanged Fittings, NPS ½ through NPS 24 Metric/Inch Standard	ASME B16.5
Forged ~~Steel~~ Fittings, Socket ~~Welded~~ -Welding and Threaded	ASME B16.11
Copper	
Wrought Copper and Copper Alloy Solder Joint Pressure Fittings	ASME B16.22
Cast Copper Alloy Solder Joint Pressure Fittings	ASME B16.18
CPVC	
~~Chlorinated Polyvinyl Chloride (CPVC) Specification for Schedule 80 CPVC Threaded Fittings~~ Standard Specification for Threaded Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80	ASTM F437
~~Specification for Schedule 40 CPVC Socket Type Fittings~~ Standard Specification for Socket-Type Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 40	ASTM F438
~~Specification for Schedule 80 CPVC Socket Type Fittings~~ Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80	~~ASTM~~ ASME F439
Bronze Fittings	
Cast Copper Alloy Threaded Fittings, Classes 125 and 250	~~ASTM~~ ASME B16.15
Stainless Steel	
Standard Specification for Wrought Austenitic Stainless Steel ~~Pipe~~ Piping Fittings	ASTM A403/A403M
~~**Ductile Iron Fittings**~~	~~ASTM A536~~

Submitter Information Verification

Submitter Full Name: AUT-SSI
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Mon Jun 26 10:13:45 EDT 2017

Committee Statement

Committee Statement: The ASTM A536 standard is a general document for ductile iron castings. There does not seem to be a standard for the manufacture of ductile iron threaded fittings comparable to ASME B16.5 for malleable iron fittings. In a search of the internet, all of the ductile iron threaded fittings located (Tyco, Sigma, Shurjoint, Anvil, SCI, etc.) were seen to be

UL listed and/or FM approved. Therefore, ductile iron threaded fittings should not be referenced in Table 7.4.1 (formerly Table 6.4.1). Instead they should be covered under Section 7.4.4 (formerly 6.4.4) for other types of fittings listed for sprinkler service.

Response Message:

Public Comment No. 211-NFPA 13-2017 [Section No. 7.4.1]

Second Revision No. 414-NFPA 13-2017 [Section No. 7.5.3.1 [Excluding any Sub-Sections]]

Pipe, fittings, valves, and devices to be joined with grooved couplings shall contain cut, rolled, ~~swaged,~~ or cast grooves ~~in accordance with standard grooved coupling manufacturer dimensions.~~ that are dimensionally compatible with the couplings.

Submitter Information Verification

Submitter Full Name: AUT-SSI
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Mon Jun 26 10:25:31 EDT 2017

Committee Statement

Committee Statement: Swaged is already permitted.
Response Message:

Public Comment No. 304-NFPA 13-2017 [Section No. 7.5.3.1 [Excluding any Sub-Sections]]

Second Revision No. 415-NFPA 13-2017 [Section No. 8.1.1.2.2]

8.1.1.2.2

Pressure gauges below check valves required by 16.9.11 and 16.15.2.2(1) shall not be required.

Submitter Information Verification

Submitter Full Name: AUT-SSI
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Mon Jun 26 10:47:39 EDT 2017

Committee Statement

Committee Statement: This PC is intended to add floor control valves (section 16.9.11) to this section. There is no reason to to install a pressure gauge on the supply side of a floor control valve. Multiple gauges reading the pressure of a common supply pipe such as those on the supply to floor control valves would be providing redundant information.

Response Message:

Public Comment No. 79-NFPA 13-2017 [Section No. 8.1.1.2.2]

Public Comment No. 80-NFPA 13-2017 [Section No. A.8.1.1.2]

Second Revision No. 416-NFPA 13-2017 [Section No. 8.2.5.4.2]

8.2.5.4.2 ~~Low~~ Differential Dry Pipe Valve.

Protection against accumulation of water above the clapper shall be provided for ~~low~~ differential dry pipe valves in accordance with 8.2.5.4.3.

Submitter Information Verification

Submitter Full Name: AUT-SSI
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Mon Jun 26 10:49:41 EDT 2017

Committee Statement

Committee Statement: With the updated definition for differential dry pipe valves, "low" is not longer required.
Response Message:

Public Comment No. 202-NFPA 13-2017 [Section No. 8.2.5.4.2]

Public Comment No. 81-NFPA 13-2017 [Section No. 8.2.5.4.2]

Second Revision No. 417-NFPA 13-2017 [Section No. 8.2.6.4.2.1]

8.2.6.4.2.1

~~For systems that are filled manually, a~~ A listed or approved shutoff valve of either the renewable disc or ball valve type shall be installed on the supply side of this check valve ~~and shall remain closed unless filling the system~~ .

Submitter Information Verification

Submitter Full Name: AUT-SSI
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Mon Jun 26 10:56:21 EDT 2017

Committee Statement

Committee Statement: During the first draft meeting the committee agreed to delete "For Systems that are filled manually" and "and shall remained closed unless filling the system". This comment proposes to delete this language as agreed during the first draft meeting. In essence the committee has stated that that automatic filling of the system is required.

Response Message:

Public Comment No. 85-NFPA 13-2017 [Section No. 8.2.6.4.2.1]

Second Revision No. 418-NFPA 13-2017 [New Section after 8.2.6.8.4]

8.2.6.8.5

The requirements of 8.2.6.8.4 shall not apply in refrigerated spaces maintained below 5°F (−15°C), where normal system air pressure shall be permitted to be restored within 60 minutes.

Submitter Information Verification

Submitter Full Name: AUT-SSI
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Mon Jun 26 10:59:18 EDT 2017

Committee Statement

Committee Statement: At the First Draft Meeting the committee added a new section to allow a 60 minute fill time for freezers allowed by 8.2.6.3.3. This new section, however does not appear in the first draft report. The reason for this new section is: as 8.2.6.3.3 already allows a 60 minute fill time for restoring normal pressure for freezers when using air, the same fill time also needs to be allowed when using nitrogen or other approved gas.

Response Message:

Public Comment No. 86-NFPA 13-2017 [New Section after 8.2.6.8.4]

Second Revision No. 419-NFPA 13-2017 [New Section after 8.3.1.2]

8.3.1.2.1 Actuator Supervision.

Effective January 1, 2021, removal of an electric actuator from the preaction or deluge valve that it controls shall result in an audible and visual indication of system impairment at the system releasing control panel.

Submitter Information Verification

Submitter Full Name: AUT-SSI
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Mon Jun 26 11:01:06 EDT 2017

Committee Statement

Committee Statement: This proposal is to bring back PI-262 which was resolved in the the first draft. This was not a good decision by the committee. The committee statement indicated that this provision would be better handled by NFPA 72. While this may be true, the fact is that NFPA 72 does not address this issue and as such NFPA 13 needs to. Currently if a solenoid coil is removed from a pre-action or deluge system, there is no indication at the releasing control panel that the system will not work if smoke or heat is detected. This proposal will ensure that pre-action systems and deluge system will operate as they are intended.

Response Message:

Public Comment No. 104-NFPA 13-2017 [New Section after 8.3.1.2]

Public Comment No. 61-NFPA 13-2017 [New Section after 8.3.2.4]

Second Revision No. 420-NFPA 13-2017 [Section No. 8.7.7]

8.7.7 Gauge Connections.

~~An approved~~ A pressure gauge conforming to Section 16.13 shall be installed immediately below the control valve of each system.

Submitter Information Verification

Submitter Full Name: AUT-SSI
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Mon Jun 26 11:12:28 EDT 2017

Committee Statement

Committee Statement: During the First Draft Meeting, the committee voted to delete the word "approved" as it is redundant. Section 16.13.3 already requires the gauge to be approved so it is not necessary to repeat this requirement.
Response Message:

Public Comment No. 87-NFPA 13-2017 [Section No. 8.7.7]

Second Revision No. 421-NFPA 13-2017 [Section No. 8.9.2]

8.9.2* Sprinklers and Automatic Spray Nozzles.

8.9.2.1

~~Unless the requirements of~~ 8.9.2.2 ~~are met, standard~~ Standard spray sprinklers or automatic spray nozzles shall be so located as to provide for the protection of exhaust ducts, hood exhaust duct collars, and hood exhaust plenum chambers.

~~8.9.2.2~~

~~Sprinklers or automatic spray nozzles in ducts, duct collars, and plenum chambers shall not be required where all cooking equipment is served by listed grease extractors.~~

8.9.2.2

Unless the requirements of 8.9.2.4 are met, standard spray sprinklers or automatic spray nozzles shall be so located as to provide for the protection of cooking equipment and cooking surfaces.

8.9.2.3

Hoods containing automatic fire-extinguishing systems are protected areas; therefore, these hoods are not considered obstructions to overhead sprinkler systems and shall not require floor coverage underneath.

8.9.2.4

Cooking equipment below hoods that contain automatic fire-extinguishing equipment is protected and shall not require protection from the overhead sprinkler system.

Submitter Information Verification

Submitter Full Name: AUT-SSI
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Mon Jun 26 11:14:35 EDT 2017

Committee Statement

Committee Statement: The modifications submitted as part of PI-588 should be reconsidered. The requirement of 8.9.2.2 permitting omission of sprinklers or nozzles creates a conflict with the requirements of NFPA 96. Use of a grease extractor could mean a grease filter, which should not be considered equivalent to sprinkler protection or a fire suppression system. This type of equipment does not remove all grease and if not cleaned will allow for collection of grease. The current language could allow an omission of protection from these areas, which were only intended if specifically approved by the AHJ.

Substantiation by Original Submitter, Russell Fleming:

7.9.2.2 is an exception to the requirement for protection of commercial cooking equipment exhaust ducts, hood exhaust ducts, and hood exhaust plenum chambers, provided that the cooking equipment is served by “listed grease extractors”. However, the term “listed grease extractors” is today associated with listed grease filters, and the NFPA Committee on Venting Systems for Cooking Appliances that writes NFPA 96 does not recognize such filters to substitute for a fire extinguishing system.

This section originally appeared as an exception to the base requirement in the 1987 edition of NFPA 13, when a full rewrite of commercial cooking equipment protection took place. As originally proposed, this allowance was only to be given by special permission of the authority having jurisdiction. That condition was dropped during the public comment stage without explanation.

Commentary following this exception in the 1987 Automatic Sprinkler Systems Handbook gives some indication of the original intent: “Subject to acceptance by the authority having jurisdiction, if all cooking equipment is served by listed grease extractors, the sprinkler protection may be limited to the cooking surfaces. Some manufacturers of exhaust systems incorporating listed grease extractors provide listed built-in water spray fire protection for cooking surfaces in a preengineered package ready for connection to the sprinkler system.” As such, there may have been some confusion with the development of what are now being termed “water-wash systems” or, if listed for the application, “water-wash extinguishing systems.”

This change took place in a day prior to the development of UL 300 to address the hazard of vegetable-based cooking oils, and the resulting use of wet chemical systems instead of dry chemical systems. The use of the UL-300 compliant wet chemical systems to protect the hood and ducts up to 75 ft in length continues to be acknowledged in Sections 7.9.2.4, 7.9.2.5, and 7.9.3.4.1 of NFPA 13. However, the NFPA 96 committee does not recognize the ability of listed grease extraction devices to substitute for fire-extinguishing equipment, and neither should NFPA 13.

The submitter serves as a liaison from the NFPA Sprinkler Project to the Committee on Venting Systems for Cooking Appliances.

Response Message:

Public Comment No. 192-NFPA 13-2017 [Section No. 8.9.2]

Public Comment No. 326-NFPA 13-2017 [Sections 8.9.2.1, 8.9.2.2]

Second Revision No. 423-NFPA 13-2017 [Section No. 9.2.1.1.3]

~~9.2.1.1.3~~

~~The space above cloud ceilings meeting the requirements in 9.2.7.1 and having openings with a combined total area of not more than 20 percent of the ceiling, construction feature, or plane used to determine the boundaries of the concealed space shall be permitted.~~

Submitter Information Verification

Submitter Full Name: AUT-SSI
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Mon Jun 26 13:57:59 EDT 2017

Committee Statement

Committee Statement: This section is redundant as FR 716 moved these requirements to section 9.2.7.1. The requirement that the total size of the openings in a cloud ceiling be no more than 20% of the ceiling has not changed but have been relocated to the cloud ceiling section.

This comment and related comments will divorce the cloud ceiling rules from those of concealed spaces without making any substantial technical changes. The committee has been divided upon whether the spaces above cloud ceilings are in fact a type of concealed space. This proposal along with related proposals and FR 715 will separate these ceiling features from concealed spaces.and by adding the new subsection 9.2.7.1 (4), the concerns of those who believe these features should be under the concealed space section have been addressed.

Related proposals (PC 93 and PC 94) will require require that the spaces above cloud ceilings be of noncombustible or limited combustible construction and will add a deflector distance of 1 - 12 inches for the sprinklers below the cloud.

Response Message:

Public Comment No. 95-NFPA 13-2017 [Section No. 9.2.1.1.3]

Public Comment No. 303-NFPA 13-2017 [Section No. 9.2.1.1.3]

Second Revision No. 424-NFPA 13-2017 [Section No. 9.2.1.15]

9.2.1.15

~~Vertical~~ Sprinklers shall not be required in vertical pipe chases under 10 ft^2 (0.9 m^2) ~~that are firestopped at each floor using materials equivalent to the floor construction, and where such pipe chases shall contain no sources of ignition, piping shall be water-filled, limited combustible or noncombustible, and pipe penetrations at each floor shall be properly sealed and shall not require sprinkler protection~~ .

9.2.1.15.1

Pipe chases in accordance with 9.2.1.15 shall contain no sources of ignition.

9.2.1.15.2

In buildings having more than a single story, pipe penetrations at each floor shall be firestopped using materials equivalent to the floor construction.

Submitter Information Verification

Submitter Full Name: AUT-SSI
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Mon Jun 26 14:10:08 EDT 2017

Committee Statement

Committee Statement: A pipe chase in a single story building less than 10 square feet should not be required to be have sprinkler protection. Currently this section applies to 2 story or taller buildings (multifloor). In addition, the committee should seriously look at the requirement to only allow non combustible piping when non water filled. This contradicts section 8.15.1.2.1 which allows minimal combustible loading. Once could infer that a space above an acoustical ceiling containing PVC piping for Drain and Waste should be protected.

Response Message:

Public Comment No. 91-NFPA 13-2017 [Section No. 9.2.1.15]

Second Revision No. 425-NFPA 13-2017 [Section No. 9.2.3]

9.2.3* Exterior Projections.

A.9.2.3

Exterior projections include, but are not limited to, exterior roofs, canopies, porte-cocheres, balconies, decks, or similar projections.

9.2.3.1

Unless the requirements of 9.2.3.2 , 9.2.3.3 , or 9.2.3.4 are met, sprinklers shall be installed under exterior projections exceeding 4 ft (1.2 m) in width.

9.2.3.2*

Sprinklers shall be permitted to be omitted where the exterior canopies, roofs, porte-cocheres, balconies, decks, and similar projections are constructed with materials that are noncombustible, limited-combustible, or fire retardant–treated wood as defined in NFPA 703, or where the projections are constructed utilizing a noncombustible frame, limited-combustibles, or fire retardant–treated wood with an inherently flame-resistant fabric overlay as demonstrated by Test Method 2 in accordance with NFPA 701.

A.9.2.3.2

Vehicles that are temporarily parked are not considered storage. Areas located at drive-in bank windows or porte-cocheres at hotels and motels normally do not require sprinklers where there is no occupancy above, where the area is entirely constructed of noncombustible or limited-combustible materials or fire retardant–treated lumber, and where the area is not the only means of egress.

9.2.3.3

Sprinklers shall be permitted to be omitted from below the exterior projections of combustible construction, provided the exposed finish material on the exterior projections are noncombustible, limited-combustible, or fire retardant–treated wood as defined in NFPA 703, and the exterior projections contain only sprinklered concealed spaces or any of the following unsprinklered combustible concealed spaces:

(1) Combustible concealed spaces filled entirely with noncombustible insulation

(2) Light or ordinary hazard occupancies where noncombustible or limited-combustible ceilings are directly attached to the bottom of solid wood joists so as to create enclosed joist spaces 160 ft^3 (4.5 m^3) or less in volume, including space below insulation that is laid directly on top or within the ceiling joists in an otherwise sprinklered attic *[see ~~19.3.3.1.4 (4)(d)~~ 19.3.3.1.5.2(4)]*

(3) Concealed spaces over isolated small exterior projections not exceeding 55 ft^2 (5.1 m^2) in area

9.2.3.4

Sprinklers shall be permitted to be omitted from an exterior exit corridor where the exterior wall of the corridor is at least 50 percent open and where the corridor is entirely of noncombustible construction.

9.2.3.5

Sprinklers shall be installed under all exterior projections greater than 2 ft (600 mm) where combustibles are stored.

Supplemental Information

File Name	Description	Approved
13-SSI_SR-425_A.9.2.3.1_leg_changes.docx	For staff use.	

Submitter Information Verification

Submitter Full Name: AUT-SSI
Organization: [Not Specified]
Street Address:
City:

State:

Zip:

Submittal Date: Mon Jun 26 14:11:54 EDT 2017

Committee Statement

Committee Statement: During the editing / restructuring of the standard, the charging sentence for the sprinklering of Exterior Projections was omitted. No public input called for this and there is no substantiation for the omission. Consequently, the missing text should be re-inserted.

Additionally, while the width of overhang was debated, no action was proposed to delete the requirement for sprinklers under overhangs with storage below. This text too should be re-inserted.

In contract with the actions recorded in FR-743, according to my notes, at the 1st Draft Meeting, in response to PI-470, it was agreed to just revise the Annex text by deleting the last sentence, because it was considered to be a building code issue, so NFPA should not be making such recommendations either way. However, in the 1st Draft Report the first sentence has also been lost. Neither the first sentance nor the last was moved to the body of the standard as per FR-743. With this, the explanation that cars that are temporarily parked do not need to be considered as storage has been lost. Without that text there is a conflict. One part of the standard says that sprinklers are not required under porte-cocheres and another area says storage (ie. parked cars) needs sprinkler protection.

New annex: When the Annex material on loading dock protection with a dry pendent sprinkler turned to 45° was deleted, the explanatory text with examples of exterior projections was also deleted. This text should be re-inserted.

Changes to existing annex: As stated in L. Keeping's & T. Victor's negative ballots, the first sentence of this annex note (Vehicles that are temporarily parked are not considered storage) was not intended to be deleted. At first draft meeting the committee agreed only to delete that last sentence. The first sentence needs to be included in this annex note as without this sentence there is a conflict - one part of the standard states that sprinklers are not required under drive-in bank windows or porte-cocheres however another section says where there is storage - sprinklers are required. Without the first sentence (vehicles that are temporary parked is not considered storage), cars parked for a short time under porte-cocheres could be considered as storage and sprinkler protection would be required. This was not the intent of the committee or FR 743.

Response Message:

Public Comment No. 208-NFPA 13-2017 [New Section after A.9.2.1.18]

Public Comment No. 43-NFPA 13-2017 [New Section after 9.2.3.1]

Public Comment No. 200-NFPA 13-2017 [Section No. 9.2.3]

Public Comment No. 101-NFPA 13-2017 [Section No. A.9.2.3.1]

Public Comment No. 207-NFPA 13-2017 [Section No. A.9.2.3.1]

Second Revision No. 426-NFPA 13-2017 [Section No. 9.2.6]

9.2.6*

Sprinklers shall not be required in electrical equipment rooms where all of the following conditions are met:

(1) The room is dedicated to electrical equipment only.

(2) Only dry-type or liquid-type with listed K-class fluid electrical equipment is used.

(3) Equipment is installed in a 2-hour fire-rated enclosure including protection for penetrations.

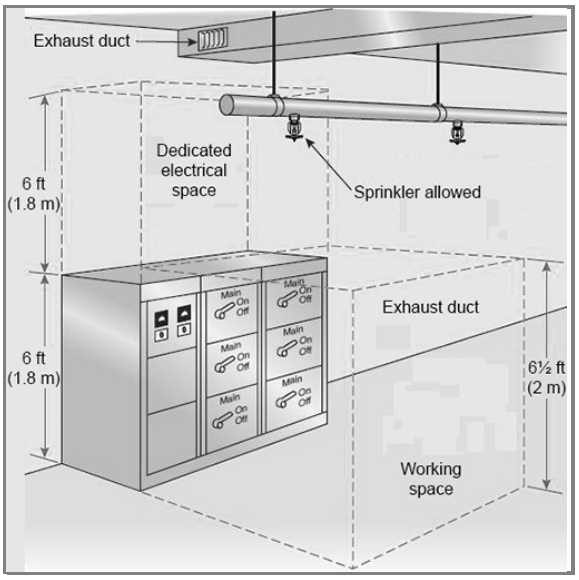
(4) ~~No storage~~ Storage is not permitted ~~to be stored~~ in the room.

A.9.2.6

Sprinklers and sprinkler piping is permitted in and is permitted to pass through an electrical room as long as the piping is not within the "dedicated electrical space" as defined by *NFPA 70* .

In 110.26(E)(1)(a) of *NFPA 70* , a dedicated electrical space is defined as the space equal to the width and the depth of the equipment extending from the floor to a height of 6 ft (1.8 m) above the equipment or the structural ceiling, whichever is lower. This section further states that no foreign systems are allowed in this zone. So, as long as the sprinkler piping does not run through this dedicated electrical space, it can go in and out of the electric room without issue. Paragraph 110.26(E)(1)(b) of *NFPA 70* allows foreign systems in the area above the dedicated electrical space as long as the electrical equipment is properly protected against leaks or breaks in the foreign system. So the sprinkler piping can run above the dedicated electrical space [6 ft (1.8 m) above equipment] as long as the equipment below is protected from leaks. Additionally, sprinklers and sprinkler piping are not permitted to be located directly within the working space for the equipment as defined by *NFPA 70* . See Figure A.9.2.6 .

Figure A.9.2.6 The Working Space and the Dedicated Electrical Space.



Supplemental Information

File Name	Description	Approved
Figure_A9.2.6..pdf	For staff use.	

Submitter Information Verification

Submitter Full Name: AUT-SSI
Organization: [Not Specified]
Street Address:
City:

State:

Zip:

Submittal Date: Mon Jun 26 15:00:16 EDT 2017

Committee Statement

Committee Statement: Adopted changes to the 2018 Canadian Electrical Code will permit liquid filled electrical equipment to be installed within buildings but outside of electrical equipment vaults. Subrule 5 of Rule 26-012 will now permit the following:

26-012 Dielectric liquid-filled equipment — Indoors (see Appendices B and G)

(1) Except as permitted in Subrule (5), dielectric liquid-filled electrical equipment containing more than 23 L of liquid in one tank, or more than 69 L in a group of tanks, shall be located in an electrical equipment vault.

…

(5) Dielectric liquid-filled equipment located indoors with more than 23 L of liquid in one tank, or more than 69 L in a group of tanks shall be permitted to be installed in accordance with Subrule (2) provided the following additional conditions are met:

(a) the equipment is protected from mechanical damage either by location or guarding;

(b) the equipment contains a non-propagating liquid having a flash point of 275 °C or higher;

(c) for equipment other than transformers, a means of absorbing gases generated by arcing inside the case, or a pressure relief device is provided;

(d) for transformers with ratings exceeding 25 kV•A at 25 Hz or exceeding 37.5 kV•A at 60 Hz, a means of absorbing gases generated by arcing inside the tank, or a pressure relief vent is provided; and

(e) where transformers referred to in item (d) are rated at 15 000 V or more, the service room is accessible only to authorized persons.

The problem to be resolved is that electrical rooms (not vaults) which were not previously permitted by the CEC to contain liquid filled equipment will now contain K-class equipment (subject to the requirements above). Some electrical AHJs still will not accept sprinklers within electrical rooms whereas the plumbing AHJs still require compliance with NFPA 13. Currently NFPA 13 does not recognize the differing fire hazards between the different types of liquid dielectrics, and does not permit this type of 'less-flammable' or 'non-propagating' liquid dielectric fluid within an unsprinklered electrical room.

Listed IEC K-Class fluids are required to have a fire point above 300°C and a net heat release of less than 42 MJ/kg as compared to conventional mineral oil fluids which have a fire point of ~170°C .

Factory Mutual has reviewed failure history of these types of devices and found no examples of fire resulting from fluid release from the device (FMRC J.I. 0003014446, November 2002). Factory Mutual Datasheet 5-4 does not require fire protection for transformers containing approved less-flammable liquids provided that they are located within rooms separated from the remainder of the building with a 1 hour fire separation.

NFPA 70 recognizes less flammable liquids as requiring less fire protection than conventional oil filled transformers.

New annex: There is a common misconception that sprinklers and sprinkler piping is not permitted in electrical rooms or is not permitted to pass through electrical areas. This is untrue. The NEC permits both situations under certain conditions. This annex note attempts to clarify these requirements.

Response Message:

Public Comment No. 41-NFPA 13-2017 [Section No. 9.2.6]

Public Comment No. 92-NFPA 13-2017 [New Section after A.9.2.5]

Second Revision No. 422-NFPA 13-2017 [Section No. 9.2.7.1]

9.2.7.1*

Sprinklers shall be permitted to be omitted above cloud ceilings where all of the following apply:

(1)* The combined total area of the openings around the cloud are less than or equal to 20 percent of the area of the ceiling, construction feature, or plane used to determine the boundaries of the compartment.

(2) The width of the gap and the maximum sprinkler protection area ~~shall meet~~ are in accordance with Table 9.2.7.1.

(3) The requirements of 9.2.7.2 are met.

(4) Spaces above cloud ceilings contain either noncombustible or limited-combustible construction with minimal combustible loading.

Table 9.2.7.1 Maximum Sprinkler Protection Area Based on Ceiling Cloud Width and Opening Width

Ceiling Cloud — Minimum Width Dimension (ft)	Maximum Area (ft^2) — Opening Width ≤0.5 in./ft of Ceiling Height	Maximum Area (ft^2) — Opening Width ≤0.75 in./ft of Ceiling Height	Maximum Area (ft^2) — Opening Width ≤1 in./ft of Ceiling Height
2–<2.5	175	70	NP
2.5–4	225	120	70
>4	225	150	150

Supplemental Information

File Name	Description	Approved
Cloud_Ceiling_TG_proposed_changes_-draft.docx		

Submitter Information Verification

Submitter Full Name: AUT-SSI
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Mon Jun 26 13:46:23 EDT 2017

Committee Statement

Committee Statement: This proposed comment will specifically require that the spaces above cloud ceilings be of noncombustible or limited combustible construction. This was, we believe the intent of the rules from the beginning, however this was not directly stated. Additionally, this comment and related comments will divorce the cloud ceiling rules from those of concealed spaces without making any substantial technical changes. The committee has been divided upon whether the spaces above cloud ceilings are in fact a type of concealed space. This proposal along with related proposals and FR 715 will separate these ceiling features from concealed spaces.and by adding the new subsection (4), the concerns of those who believe these features should be under the concealed space section have been addressed.

There are related proposal to delete section 9.2.1.1.3 (as these requirements are now in this section) and to add a deflector distance of 1 - 12 inches below the cloud.

Response Message:

Public Comment No. 93-NFPA 13-2017 [Section No. 9.2.7.1]

Public Comment No. 96-NFPA 13-2017 [New Section after 9.2.1.1.1]

Public Comment No. 94-NFPA 13-2017 [New Section after 9.2.7.2.1]

9.2.7 Cloud Ceilings

9.2.7.1 Sprinklers shall be permitted to be omitted above cloud ceilings where ~~both~~ all of the following apply:

1. Spaces above cloud ceilings shall be noncombustible or limited combustible construction with minimal combustible loading.
2. * ~~The openings around the cloud and the maximum sprinkler protection area meet the requirements of 8.15.1.2.1.2 and Table 8.15.24.1~~ Combined total area of the openings around the cloud are less than or equal to 20 percent of the area of the ceiling, construction feature, or plane used to determine the boundaries of the compartment.
3. The width of the gap and the maximum sprinkler protection area shall meet Table 9.2.7.1 .
4. The requirements of 9.2.7.2 are met.

Table 9.2.7.1 Maximum Sprinkler Protection Area Based on Ceiling Cloud Width and Opening Width

Ceiling Cloud — Minimum Width Dimension (ft)	Maximum Area (ft^2) — Opening Width ≤0.5 in./ ft of Ceiling Height	Maximum Area (ft^2) — Opening Width ≤0.75 in./ ft of Ceiling Height	Maximum Area (ft^2) — Opening Width ≤1 in./ ft of Ceiling Height
2–<2.5	175	70	NP
2.5–4	225	120	70
>4	225	150	150

(Note - above changed by FR-715)

9.2.7.2 All sprinklers shall be quick response standard spray or extended coverage pendent or upright sprinklers.

9.2.7.2.1 Sprinklers shall be located in accordance with 10.2.6.1.

~~**9.2.7.2.1** Where extended coverage sprinklers are used, the maximum distance between sprinklers shall not exceed 16 ft (4.9 m~~).

9.2.7.2.2 Maximum cloud ceiling height shall not exceed 20 ft (6.1 m).

9.2.7.2.3 Maximum spacing shall not exceed the maximum requirements of Table 10.2.4.2.1 (a) for light hazard and Table 10.2.4.2.1(b) for ordinary hazard.

9.2.7.2.3.1 Where extended coverage sprinklers are used, the maximum distance between sprinklers shall not exceed 16 ft (4.9 m).

9.2.7.2.4 Cloud ceilings shall be of smooth flat horizontal ceiling construction.

9.2.7.2.5* For purposes of applying Table 9.2.7.1, irregular shaped ceiling clouds (not rectangular) the minimum width dimension shall be the smallest width dimension of the cloud and for the gap shall be the greatest dimension between clouds or adjacent walls as applicable.

~~9.2.1.1.3 The space above cloud ceilings meeting the requirements in 8.15.24.1 and having openings with a combined total area of not more than 20 percent of the ceiling, construction feature, or plane used to determine the boundaries of the concealed space shall be permitted.~~

Second Revision No. 462-NFPA 13-2017 [New Section after 9.2.17]

9.2.17.1

Skylights that allow venting, other than smoke and heat venting per 12.1.1 , shall be provided with sprinkler protection installed in the skylight.

Submitter Information Verification

Submitter Full Name: AUT-SSI
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Tue Jun 27 13:52:00 EDT 2017

Committee Statement

Committee Statement: The new sections proposed for the 2019 are additional clarifications being added to a clarification added in 2016. The proposed new sections will provide needed guidance to match the testing done in 2002.

In 2016 a new section 8.5.7.1.1 was added and the substantiation was simply to provide clarification. There was no testing or research associated with the proposal to support the new section. The proposal's only substantiation was to provide clarity that sprinklers are not required to comply with the maximum allowable distances below the ceiling. The new sections proposed for 2019 are also needed in the same way, to provide clarification.

The section 8.5.7 added in 2002 was based on testing of sprinkler activation under obstructed construction. The objective of the 2002 additions was to eliminate the need for additional sprinklers up inside a skylight. It must be noted that the construction used in the testing used to develop the new sections in 2002 did not have any openings or ventilation in the deck or pockets.

Back in 2002 the new Section 8.5.7 permits the omission of additional sprinklers up in skylights was added to the 2002 edition. It was the result of committee action which rejected ROP proposal 13-108 and ROC accepted comment 13-57 (Log #96). The discussion and focus of this proposal and comment was to establish that additional sprinklers were needed up inside the skylight open ceiling pocket. There was no specific testing or research data referenced or associated with the section added in ROC 13-57 (Log #96) for the 2002 edition. The only possible data referenced is in ROC 15-55 (Log #130) which address the effects of ceiling pocket size limits for collecting heat within obstructed construction. The original research addresses the effects of ceiling pocket, not the effect of sprinkler heat elements being further down from the ceiling that the maximum allowable limits. The section added in the 2002 edition did not eliminate the requirements of sprinklers being more than the maximum allowable distance below the ceiling. Sprinklers were not permitted to exceed the maximum distances below the ceiling. Even within obstruction construction sprinklers are required to be no more than 22" below the deck. The statements, recommendations, substantiations and committee action used in the development of the new section in the 2002 edition do not address sprinkler distance below a surface for heat collection.

The revisions I have proposed is specific to skylights which have vented openings or may be completely open to the sky in the event of a fire. A closed skylight ceiling pocket is not affected by this proposed revision. A ventilated skylight or an opened skylight will not collect heat. Heat is not trapped but rather released. These skylights are often also "heat vents" designed to open automatically and therefore let out the very heat needed to activate a sprinkler. It seems counter intuitive to expect sprinklers to operate effectively under an open hole in the roof.

The limitations created by the new proposed additions are compliant with the testing done to create the sections in 2002.

Response Message:

Public Comment No. 121-NFPA 13-2017 [New Section after 9.2.17]

Second Revision No. 428-NFPA 13-2017 [Section No. 9.3.6]

9.3.6 Elevator ~~Hoistways and~~ Machine Rooms, Machinery Spaces, Control Rooms, Control Spaces, and Hoistways .

9.3.6.1

Sidewall spray sprinklers shall be installed at the bottom of each elevator hoistway not more than 2 ft (600 mm) above the floor of the pit.

9.3.6.2

Automatic fire sprinklers shall not be required in ~~elevator~~ machine rooms, elevator machinery spaces, control rooms, control spaces, or hoistways of traction elevators installed in accordance with the applicable provisions in NFPA *101* or the applicable building code, where all of the following conditions are met:

(1) The elevator machine room, machinery space, control room, control space, or hoistway of traction elevator is dedicated to elevator equipment only.

(2) The elevator ~~machine room,~~ machine room, machinery space, control room, ~~or~~ control space, or hoistway of traction elevators is protected by smoke detectors or other automatic fire detection installed in accordance with *NFPA 72*.

(3) The elevator machine room, machinery space, control room, control space, or hoistway of traction elevators is separated from the remainder of the building by walls and floor/ceiling or roof/ceiling assemblies having a fire resistance rating of not less than that specified by the applicable building code.

(4) No materials unrelated to elevator equipment are permitted to be stored in elevator machine rooms, machinery spaces, control rooms, control spaces, or hoistways ~~of traction elevators~~ .

(5) The elevator machinery is not of the hydraulic type.

9.3.6.3*

~~Automatic~~ Where required, automatic sprinklers in elevator machine rooms, elevator machinery spaces, or at the tops of hoistways shall be of ordinary- or intermediate-temperature rating.

9.3.6.4*

Upright, pendent, or sidewall spray sprinklers shall be installed at the top of elevator hoistways.

9.3.6.5

The sprinkler required at the top of the elevator hoistway by 9.3.6.4 shall not be required where the hoistway for ~~passenger~~ elevators is noncombustible or limited-combustible and the car enclosure materials meet the requirements of ASME A17.1/CSA B44 , *Safety Code for Elevators and Escalators*.

9.3.6.6 Combustible Suspension in Elevators.

9.3.6.6.1

Sprinklers shall be installed at the top and bottom of elevator hoistways where elevators utilize combustible suspension means such as noncircular elastomeric-coated or polyurethane-coated steel belts.

9.3.6.6.2

The sprinklers in the elevator hoistway shall not be required where the suspension means provide not less than an FT-1 rating when tested to the vertical burn test requirements of UL 2556, *Wire and Cable Test Methods* ~~(Tri-national standard, with NMX-J-556-ANCE and CSA 22.2 No. 2556)~~ .

9.3.6.6.3

The suspension means shall not continue to burn for more than 60 seconds nor shall the indicator flag be burned more than 25 percent.

Supplemental Information

File Name	Description	Approved
13_SSI_SR-428_leg_changes.docx	For staff use.	

Submitter Information Verification

Submitter Full Name: AUT-SSI
Organization: [Not Specified]
Street Address:
City:

State:

Zip:

Submittal Date: Mon Jun 26 15:38:27 EDT 2017

Committee Statement

Committee Statement: To be consistent with the elevator associated spaces throughout this section. To indicate that all freight elevators (traction and hydraulic types) must have sprinkler protection at their top of hoistway (the term "freight elevator" is specifically indicated to help clarify that if the elevator is not passenger it is freight as defined in the A17.1 elevator safety code). To clarify that storage of materials unrelated to elevator equipment is not allowed for any elevator.

New 9.3.6.1: This comment seeks to return to language of the 2016 edition of NFPA 13. Upon review of available documentation, the NFSA E&S committee sees no technical justification for removing the requirement to install sprinklers in the elevator pit. Sprinklers need to be required at the bottom of elevator hoistways.

Response Message:

Public Comment No. 90-NFPA 13-2017 [New Section after 9.3.6]

Public Comment No. 203-NFPA 13-2017 [Section No. 9.3.6]

Public Comment No. 89-NFPA 13-2017 [New Section after 9.3.6]

Second Revision No. 429-NFPA 13-2017 [Section No. 9.3.16]

9.3.16* ~~Vestibules~~ Vestibule .

Sprinkler protection shall not be required within an entrance ~~vestibules~~ vestibule of noncombustible and limited-combustible construction that ~~do~~ does not contain combustibles and ~~are~~ is 150 ft^2 (13.9 m^2) or less in area.

A.9.3.16

Combustible mats or floor covering are permitted within the vestibule.

Submitter Information Verification

Submitter Full Name: AUT-SSI
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Mon Jun 26 16:04:21 EDT 2017

Committee Statement

Committee Statement: Limited-Combustible needs to be included to allow gypsum to be used in the construction of the vestibule.

Mats, rugs, or similar non-slip surfaces need to be allowed within the vestibule enclosure.

Response Message:

Public Comment No. 154-NFPA 13-2017 [Section No. 9.3.16]

Second Revision No. 1001-NFPA 13-2017 [Section No. 9.5.4.1.3]

9.5.4.1.3

For ceilings that have insulation installed directly against underside of the ceiling or roof structure, the deflector distance shall be measured from the bottom of the insulation and shall be in accordance with 9.5.4.1.3.1 , 9.5.4.1.3.2 ~~or~~ , and 9.5.4.1.3.3.

9.5.4.1.3.1

Insulation used to measure sprinkler deflector distance shall be batt insulation or insulation that withstands 3 lb/ft^2 (0.13 kg/m^2) uplift force.

9.5.4.1.3.2

For insulation that is installed directly against the ceiling or roof structure and is installed flat and parallel to the ceiling or roof structure, the deflector distance shall be measured to the underside of the insulation.

9.5.4.1.3.3

For insulation that is installed in a manner that causes it to deflect or sag down from the ceiling or roof structure, the deflector distance shall be measured as half of the distance of the deflection from the insulation high point to the insulation low point.

(A)

If the deflection or sag in the insulation exceeds 6 in. (150 mm), the deflector distance shall be measured to the high point of the insulation.

(B)

The deflector shall not be positioned above the low point of the insulation.

Submitter Information Verification

Submitter Full Name: AUT-SSI
Organization: [Not Specified]
Street Address:
City:
State:
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Submittal Date: Mon Jul 24 09:13:51 EDT 2017

Committee Statement

Committee Statement: This was previously submitted and resolved with the resolution substantiation being that "Submitter provides data that is unenforceable". This standard relies on all sorts of building requirements to work with the sprinkler system. Example of this is the requirement for fire rated walls when using the room design method or the omission of sprinklers in a fire rated elevator shaft. If other requirements are somehow enforceable then a this requirement is also enforceable.

A fire can have a strong uplift force and a surface of unknown strength may not remain intact long enough for timely sprinkler activation. If the heat element of a sprinkler is not close enough to whatever is collecting the heat it will not be as responsive as needed and its operation will be retarded allowing the fire to grow. The use of paper or other such weak materials should not be used to measure sprinkler deflector distances to. The standard should provided some minimum qualification for the surface needed for heat collection and sprinkler activation. The justification for the 3 pounds per square foot is from FM Global data sheet 2-0 which does qualify a performance requirement when a false ceiling is needed for heat collection.

Response Message:

Public Comment No. 123-NFPA 13-2017 [Section No. 9.5.4.1.3 [Excluding any Sub-Sections]]

Second Revision No. 431-NFPA 13-2017 [Section No. 9.5.5.3.1.2]

9.5.5.3.1.2*

Sprinklers ~~shall be located~~ located under obstructions shall comply with one of the following:

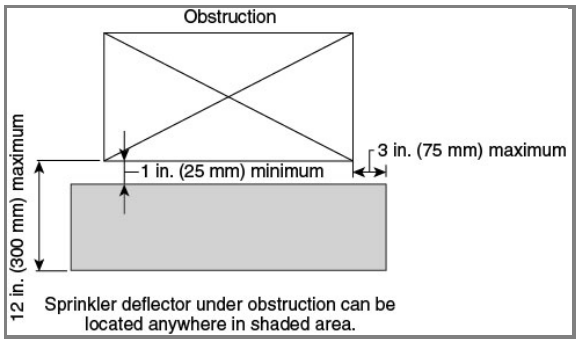
(1) Installed below the obstruction ~~and~~

(2) Installed adjacent to the obstruction not more than 3 in. (75 mm) from the outside edge of the obstruction

A.9.5.5.3.1.2

See Figure A.9.5.5.3.1.2 .

Figure A.9.5.5.3.1.2 Sprinkler Location Below Obstruction.



Submitter Information Verification

Submitter Full Name: AUT-SSI
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Mon Jun 26 16:50:30 EDT 2017

Committee Statement

Committee Statement: This comment is to clarify the intent of this requirement. As currently written the language may be interpreted to mean that the sprinkler must be installed within 3 in to the inside or to the outside of the outer edge of the obstruction. This was not the intent of the committee. Sprinklers installed under obstructions are permitted to be positioned anywhere underneath the obstruction or the sprinkler may be positioned up to 3 in to the outside of the obstruction. This proposed changed seeks to clarify the original intent of the committee. An annex figure has also been submitted to clarify.

The new figure was added to the annex, however as an alternative it could be put into the body of the standard

Response Message:

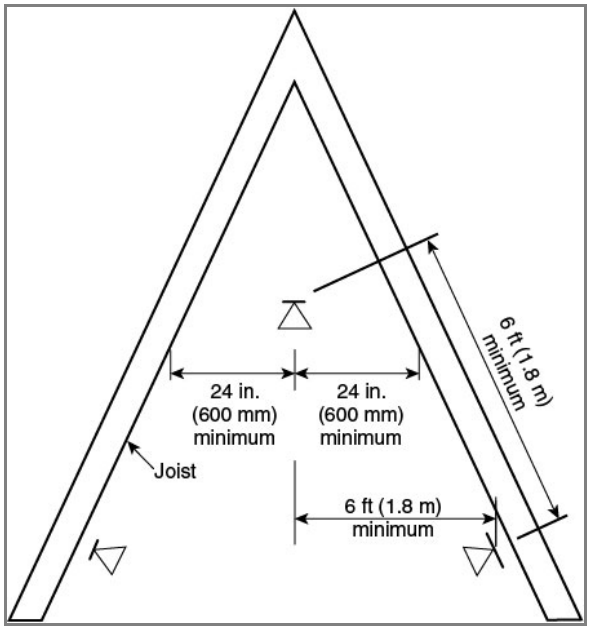
Public Comment No. 137-NFPA 13-2017 [Section No. 9.5.5.3.1.2]

Second Revision No. 432-NFPA 13-2017 [Section No. 10.2.6.1.3.3]

10.2.6.1.3.3*

Under a steeply pitched surface, the distance from the peak to the deflectors shall be permitted to be increased to maintain a horizontal clearance of not less than 24 in. (600 mm) from other structural members as indicated in Figure 10.2.6.1.3.3.

Figure 10.2.6.1.3.3 Horizontal Clearance for Sprinkler at Peak of Pitched Roof.

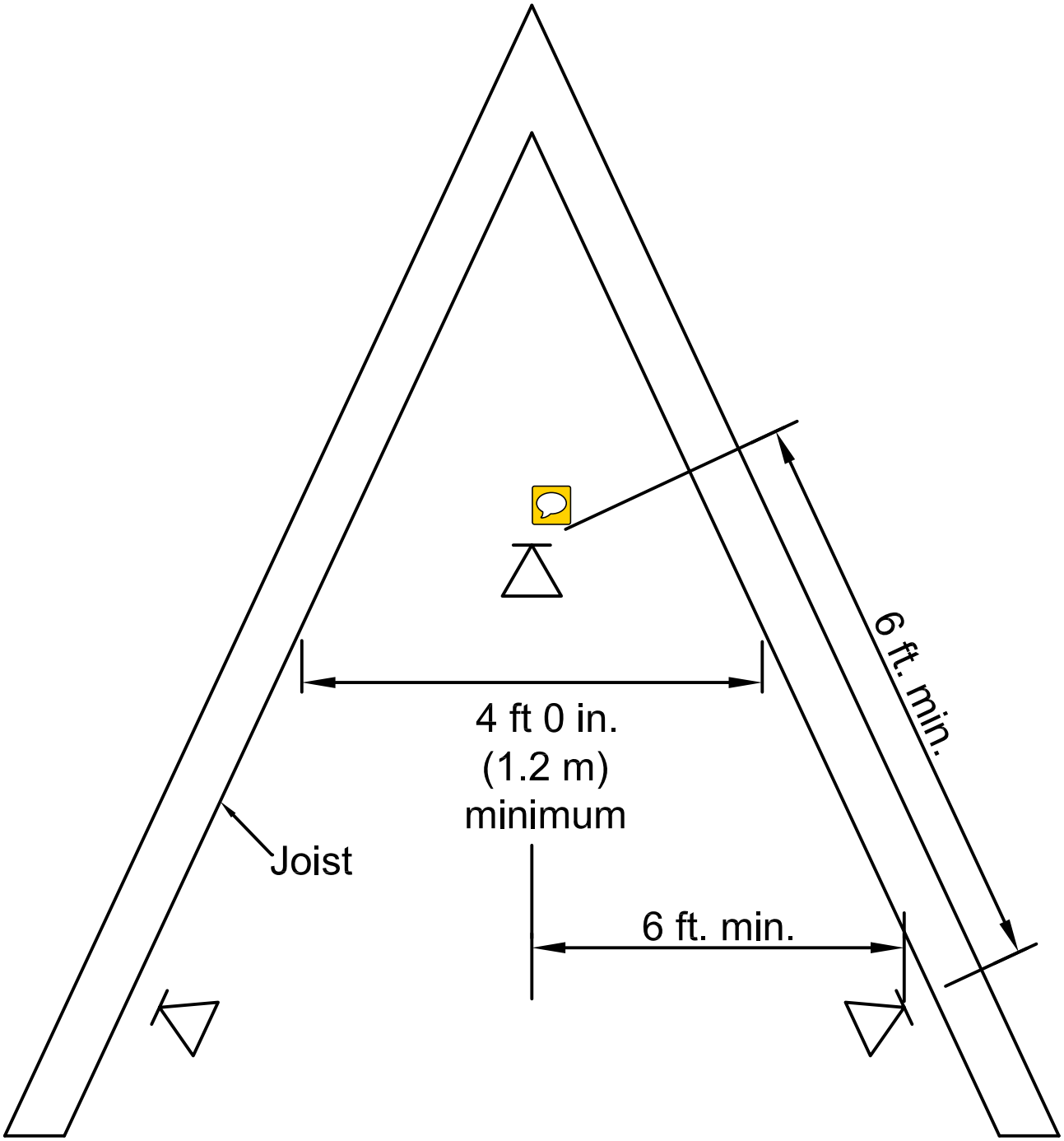


Supplemental Information

File Name	Description	Approved
PC_ro_2nd_draft_FR-924.pdf		

Submitter Information Verification

Submitter Full Name: AUT-SSI


6 ft. min.
4 ft 0 in.
(1.2 m)
minimum
Joist
6 ft. min.

Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Mon Jun 26 17:08:54 EDT 2017

Committee Statement

Committee Statement: This comment is in support of FR-924 but with modifications to the figure. The figure should show the 6 ft. minimum distance between sprinklers (to prevent cold soldering). See attached figure.

Response Message:

Public Comment No. 147-NFPA 13-2017 [Section No. 10.2.6.1.3.3]

Public Comment No. 214-NFPA 13-2017 [Section No. 10.2.6.1.3.3]

Second Revision No. 440-NFPA 13-2017 [Section No. 10.2.7.2.2 [Excluding any Sub-Sections]]

The distance from sprinklers to privacy curtains, freestanding partitions, room dividers, and similar obstructions in light hazard occupancies shall be in accordance with Table 10.2.7.2.2 and Figure 10.2.7.2.2.

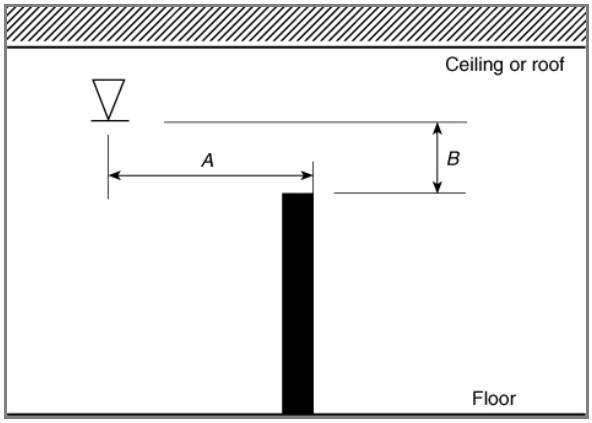
Table 10.2.7.2.2 Suspended or Floor-Mounted Obstructions in Light Hazard Occupancies Only (SSU/SSP)

Horizontal Distance *(A)*	Minimum Vertical Distance Below Deflector *(B)* [in. (mm)]
6 in. (150 mm) or less	3 (75)
More than 6 in. (150 mm) to 9 in. (225 mm) ~~or less~~	4 (100)
More than 9 in. (225 mm) to 12 in. (300 mm) ~~or less~~	6 (150)
More than 12 in. (300 mm) to 15 in. (375 mm) ~~or less~~	8 (200)
More than 15 in. (375 mm) to 18 in. (~~400~~ 450 mm) ~~or less~~	9½ (240)
More than 18 in. (450 mm) to 24 in. (600 mm) ~~or less~~	12½ (315)
More than 24 in. (600 mm) to 30 in. (750 mm) ~~or less~~	15½ (395)
More than 30 in. (750 mm)	18 (450)

For SI units, 1 in. = 25.4 mm.

Note: For *A* and *B*, refer to Figure ~~8.6.5.2.2~~ 10.2.7.2.2 .

Figure 10.2.7.2.2 Suspended or Floor-Mounted Obstruction in Light Hazard Occupancies Only (SSU/SSP).



Submitter Information Verification

Submitter Full Name: AUT-SSI
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Tue Jun 27 07:44:50 EDT 2017

Committee Statement

Committee Statement: This proposal is to express the horizontal distance as it was in the 2016 edition of the standard. The change represented in FR-683 is more difficult to interpret and apply than the existing verbiage and could easily lead to errors or misunderstandings. For example, for "15 in. (375 mm) or less" it states that the minimum "B" dimension is 8 in (200 mm). However, 12 in. (300 mm) is less than 18 in. and the "B" may be as small as 4 in. (100 mm). Thus the FR wording is less technically accurate than the existing text, and should not be adopted.

Additional, this Comment also proposes to correct the typographical error in the metris conversionn for 18 inches.

Response Message:

Public Comment No. 181-NFPA 13-2017 [Section No. 10.2.7.2.2 [Excluding any Sub-Sections]]

Second Revision No. 433-NFPA 13-2017 [Section No. 10.3.2]

10.3.2 Sidewall Spray Sprinklers.

Sidewall sprinklers shall only be installed as follows:

(1) Light hazard occupancies with smooth, horizontal or sloped, flat ceilings

(2) Ordinary hazard occupancies with smooth, flat ceilings where specifically listed for such use

(3) To protect areas below overhead doors

(4) At the top and bottom of elevator hoistways

(5) For the protection of steel building columns

(6) Under obstructions that require sprinklers

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Submitter Full Name: AUT-SSI
Organization: [Not Specified]
Street Address:
City:
State:
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Submittal Date: Mon Jun 26 17:36:30 EDT 2017

Committee Statement

Committee Statement: Sidewall sprinklers are commonly used to protect under various obstructions and this use should be spelled out in this section.

Response Message:

Public Comment No. 102-NFPA 13-2017 [Section No. 10.3.2]

Second Revision No. 434-NFPA 13-2017 [Section No. 11.2.7]

11.2.7 ~~Ceiling Pockets~~ Clearance to Storage (Extended Coverage Upright and Pendent Spray Sprinklers).

11.2.7.1*

~~Except as provided in 11.2.7.3 and 11.2.7.4 , sprinklers shall be required in all ceiling pockets.~~ The clearance between the deflector and top of storage shall be 18 in. (460 mm) or greater.

11.2.7.2

~~The 18 in. (450 mm) dimension shall not limit the height of shelving on a wall or shelving against a wall in accordance with 11.2.7.~~ The 18 in. (460 mm) dimension shall not limit the height of shelving on a wall or shelving against a wall in accordance with 11.2.7 .

11.2.7.2.1

Where shelving is installed on a wall and is not directly below sprinklers, the shelves, including storage thereon, shall be permitted to extend above the level of a plane located 18 in. (~~450~~ 460 mm) below ceiling sprinkler deflectors.

11.2.7.2.2

Shelving, and any storage thereon, directly below the sprinklers shall not extend above a plane located 18 in. (~~450~~ 460 mm) below the ceiling sprinkler deflectors.

11.2.8 Ceiling Pockets (Extended Coverage Upright and Pendent Spay Sprinklers).

11.2.8.1

Except as allowed in 11.2.8.2 and 11.2.8.3 , sprinklers shall be required in all ceiling pockets.

11.2.8.2

Sprinklers shall not be required in ceiling pockets where all of the following are met:

(1) The total volume of the unprotected ceiling pocket does not exceed 1000 ft^3 (28 m^3).

(2) The depth of the unprotected ceiling pocket does not exceed 36 in. (900 mm).

(3) The entire floor under the unprotected ceiling pocket is protected by sprinklers at the lower ceiling elevation.

(4)* The total size of all unprotected ceiling pockets in the same compartment within 10 ft (3 m) of each other does not exceed 1000 ft^3 (28 m^3).

(5) The unprotected ceiling pocket has noncombustible or limited-combustible finishes.

(6) Quick-response sprinklers are utilized throughout the compartment.

11.2.8.3

Sprinklers shall not be required in skylights and similar pockets in accordance with ~~9.3.17~~ 9.3.16 .

Submitter Information Verification

Submitter Full Name: AUT-SSI
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Mon Jun 26 17:47:24 EDT 2017

Committee Statement

Committee Statement: The text for EC deflector Clearance to Storage was mixed in with the subject of Ceiling Pockets. The referenced text should be edited so that Clearance to Storage is in Section 11.2.7 and the text for Ceiling Pockets should be placed in a new Section 11.2.8.

Response Message:

Public Comment No. 120-NFPA 13-2017 [Section No. 11.2.7]

Second Revision No. 435-NFPA 13-2017 [Section No. 11.3.6.1.3]

11.3.6.1.3

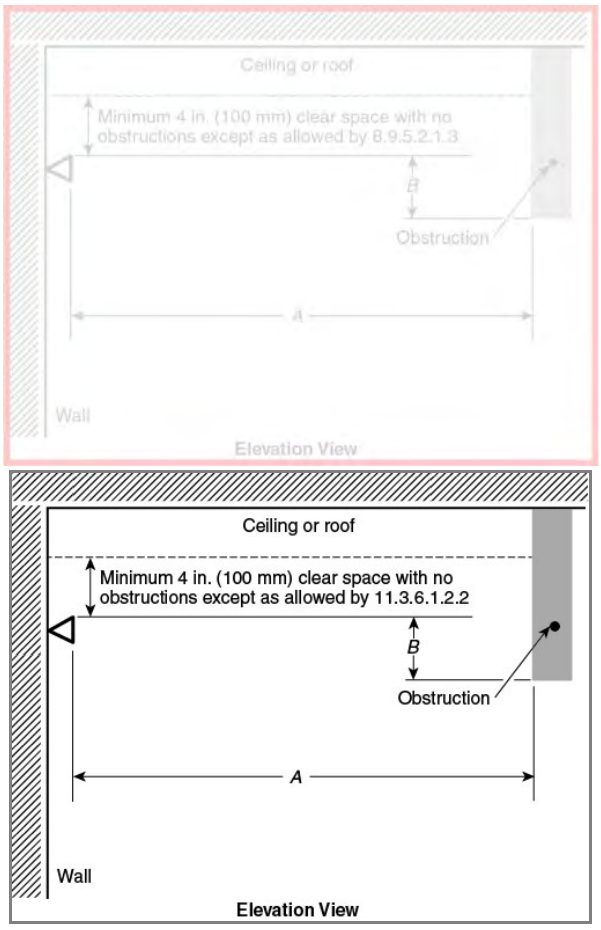
The distance between light fixtures or similar obstructions located 8 ft (2.4 m) or greater from the sprinkler shall be in conformance with Table 11.3.6.1.3 and Figure 11.3.6.1.3.

Table 11.3.6.1.3 Positioning of Sprinklers to Avoid Obstructions (Extended Coverage Sidewall Spray Sprinklers)

Distance from Sidewall Sprinkler to Side of Obstruction *(A)*	Maximum Allowable Distance of Deflector Above Bottom of Obstruction *(B)* [in. (mm)]
8 ft (2.4 m) to less than 10 ft (3.0 m)	1 (25)
10 ft (3.0 m) to less than 11 ft (3.3 m)	2 (50)
11 ft (3.3 m) to less than 12 ft (3.7 m)	3 (75)
12 ft (3.7 m) to less than 13 ft (4.0 m)	4 (100)
13 ft (4.0 m) to less than 14 ft (4.3 m)	6 (150)
14 ft (4.3 m) to less than 15 ft (4.6 m)	7 (175)
15 ft (4.6 m) to less than 16 ft (4.9 m)	9 (225)
16 ft (4.9 m) to less than 17 ft (5.2 m)	11 (275)
17 ft (5.2 m) or greater	14 (350)

Note: For *A* and *B*, refer to Figure ~~8.9.5.1.3~~ 11.3.6.1.3 .

Figure 11.3.6.1.3 Positioning of Sprinkler to Avoid Obstruction (Extended Coverage Sidewall Spray Sprinklers).



Submitter Information Verification

Submitter Full Name: AUT-SSI

Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Mon Jun 26 17:48:38 EDT 2017

Committee Statement

Committee Statement: This comment is to correct the reference in Figure 11.3.6.1.3. Figure should reference 11.3.6.1.2.2 not 8.9.5.2.1.3

Response Message:

Public Comment No. 136-NFPA 13-2017 [Section No. 11.3.6.1.3]

Second Revision No. 436-NFPA 13-2017 [New Section after 12.1.8.1.1]

12.1.8.1.2

Pendent-type residential sprinklers located under or adjacent to beams shall be installed in accordance with one of the following:

(1) Pendent, recessed pendent, and flush-type pendent sprinklers shall be permitted to be installed directly under a beam having a maximum depth of 14 in. (350 mm) with the sprinkler deflector 1 in. to 2 in. (25 mm to 50 mm) below the beam, or in accordance with the manufacturer's instructions for recessed or flush sprinklers if the deflector is less than 1 in. (25 mm) below the beam, as shown in Figure 12.1.8.1.2(a) .

(2) Pendent sprinklers shall be permitted to be installed adjacent to beams where the vertical centerline of the sprinkler is no greater than 2 in. (50 mm) from the edge of the beam and with the sprinkler deflector 1 in. to 2 in. (25 mm to 50 mm) below the beam, or in accordance with the manufacturer's instructions for flush sprinklers if the deflector is less than 1 in. (25 mm) below the beam, as shown in Figure 12.1.8.1.2(b) .

Figure 12.1.8.1.2(a) Position of Sprinkler Under Beam.

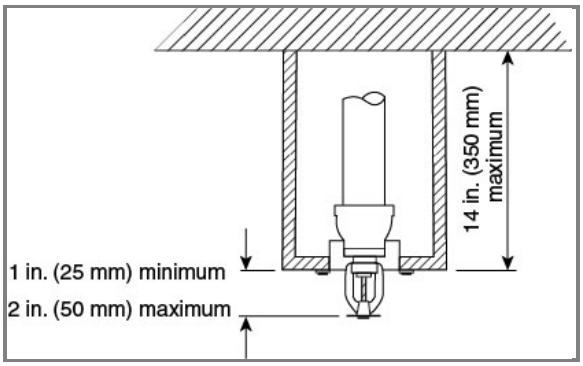
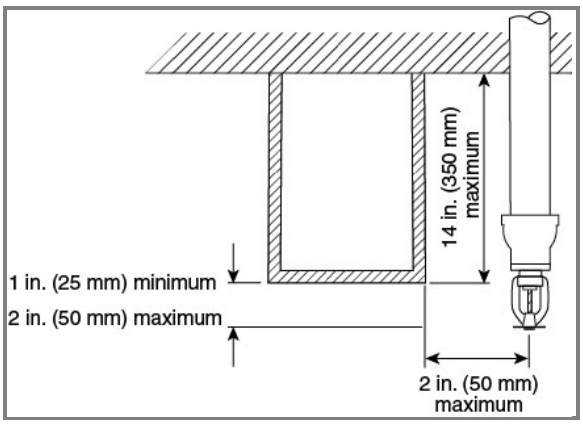


Figure 12.1.8.1.2(b) Position of Sprinkler Adjacent to Beam.



Submitter Information Verification

Submitter Full Name: AUT-SSI
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Mon Jun 26 17:50:16 EDT 2017

Committee Statement

Committee This proposal seeks to correlate the position requirements for residential sprinklers under beams with the

Statement: language of NFPA 13D and NFPA 13R. Also see related comment (PC-245)

Note to committee: In subsection (2) for sprinklers adjacent to beam: is it needed to specify flush-type pendents?

Response Message:

Public Comment No. 249-NFPA 13-2017 [New Section after 12.1.8.1.1]

Second Revision No. 438-NFPA 13-2017 [New Section after 12.1.8.1.1]

12.1.8.1.3

Concealed sprinklers shall be permitted to be installed in beams not greater than 4 in. (100 mm) in depth.

Submitter Information Verification

Submitter Full Name: AUT-SSI
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Mon Jun 26 17:58:26 EDT 2017

Committee Statement

Committee Statement: Following discussions at the first draft meeting on the installation of residential pendent sprinklers below beams, the question was raised if this would also apply to concealed sprinklers. Upon review of existing test data, a recommendation was made to limit concealed sprinklers installed under beams to no greater than 4 inches in depth. This language would clarify that the previous section would not apply to concealed sprinklers.

Response Message:

Public Comment No. 255-NFPA 13-2017 [New Section after 12.1.8.1.1]

Second Revision No. 439-NFPA 13-2017 [Section No. 12.1.8.1.1]

12.1.8.1.1

Pendent and upright sprinklers installed under beamed or beamed and sloped ceilings shall be permitted to be installed ~~within 3 in. (75 mm) below beams~~ where all of the following apply:

(1) Maximum beam depth of 14 in. (355 mm)

(2) Maximum ceiling height of 24 ft (7.3 m)

(3) Maximum ceiling slope of 8 in 12

(4) Maximum compartment size of 600 ft^2 (56 m^2)

Submitter Information Verification

Submitter Full Name: AUT-SSI
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Mon Jun 26 18:07:01 EDT 2017

Committee Statement

Committee Statement: This proposal seeks to correlate the requirements for residential sprinklers under beams with the language of NFPA 13D and NFPA 13R. The residential standards state that the sprinkler deflector must be installed 1 in. to 2 in. below the beam and not up to 3 inches below beam as stated in in FR 695.This 3 inch dimension was deleted and a new section was added added with the positioning requirements (from NFPA 13D/13R).

See related comment bringing in the positioning requirements from the residential standards.

Response Message:

Public Comment No. 245-NFPA 13-2017 [Section No. 12.1.8.1.1]

Second Revision No. 441-NFPA 13-2017 [New Section after 12.1.10.2.2]

12.1.10.2.3* Shadow Areas.

Shadow areas created by walls and partitions shall be permitted in the protection area of a sprinkler as long as the cumulative dry areas do not exceed 15 ft^2 (1.4 m^2) per sprinkler.

A.12.1.10.2.3

See A.9.1.1(3), Figure A.9.1.1(3)(a), and Figure A.9.1.1(3)(b).

Submitter Information Verification

Submitter Full Name: AUT-SSI
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Tue Jun 27 07:55:03 EDT 2017

Committee Statement

Committee Statement: Add shadow area rules for residential sprinklers. This is consistent with NFPA 13R and NFPA 13D. The language is very specific that it only applies to walls and partitions and not horizontal obstructions such as ducts, pipes, etc as there are other rules (4 times rule) for those obstructions.

Also, add the annex language and details as found in A.9.1.1.(3)(a) & (b) as found in the FDR to this section

Response Message:

Public Comment No. 193-NFPA 13-2017 [New Section after 12.1.11.3.5]

Public Comment No. 47-NFPA 13-2017 [New Section after 12.1.10.2.2]

Second Revision No. 442-NFPA 13-2017 [Section No. 12.1.10.2.2]

12.1.10.2.2 Suspended or Floor-Mounted Vertical Obstructions.

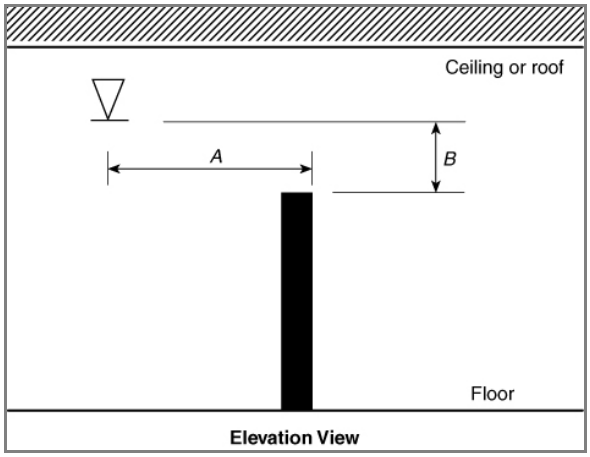
The distance from sprinklers to privacy curtains, free-standing partitions, room dividers, and similar obstructions ~~in light hazard occupancies~~ shall be in accordance with Table 12.1.10.2.2 and Figure 12.1.10.2.2.

Table 12.1.10.2.2 Suspended or Floor-Mounted Obstructions (Residential Upright and Pendent Spray Sprinklers) ~~in Light Hazard Occupancies Only~~

Horizontal Distance *(A)*	Minimum Vertical Distance Below Deflector *(B)* [in. (mm)]
6 in. (150 mm) or less	3 (75)
More than 6 in. (150 mm) to 9 in. (225 mm)	4 (100)
More than 9 in. (225 mm) to 12 in. (300 mm)	6 (150)
More than 12 in. (300 mm) to 15 in. (375 mm)	8 (200)
More than 15 in. (375 mm) to 18 in. (450 mm)	9½(240)
More than 18 in. (450 mm) to 24 in. (600 mm)	12½(315)
More than 24 in. (600 mm) to 30 in. (750 mm)	15½(390)
More than 30 in. (750 mm)	18 (450)

Note: For *A* and *B*, refer to Figure ~~8.10.6.2.2~~ 12.1.10.2.2 .

Figure 12.1.10.2.2 Suspended or Floor-Mounted Obstruction (Residential Upright and Pendent Spray Sprinklers) ~~in Light Hazard Occupancy Only~~ .



Submitter Information Verification

Submitter Full Name: AUT-SSI
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Tue Jun 27 08:07:40 EDT 2017

Committee Statement

Committee Statement: In FR-697, the TC action on PI-457, the Committee opted to delete the "in light hazard occupancies only" text from 12.1.11.2.2, Table 12.1.11.2.2 and Figure 12.1.11.2.2(a). For consistency, this same action should also be applied to 12.1.10.2.2, Table 12.1.10.2.2 and Figure 12.1.10.2.2

Response Message:

Public Comment No. 189-NFPA 13-2017 [Section No. 12.1.10.2.2]

Second Revision No. 443-NFPA 13-2017 [Section No. 12.1.11.1.3]

12.1.11.1.3

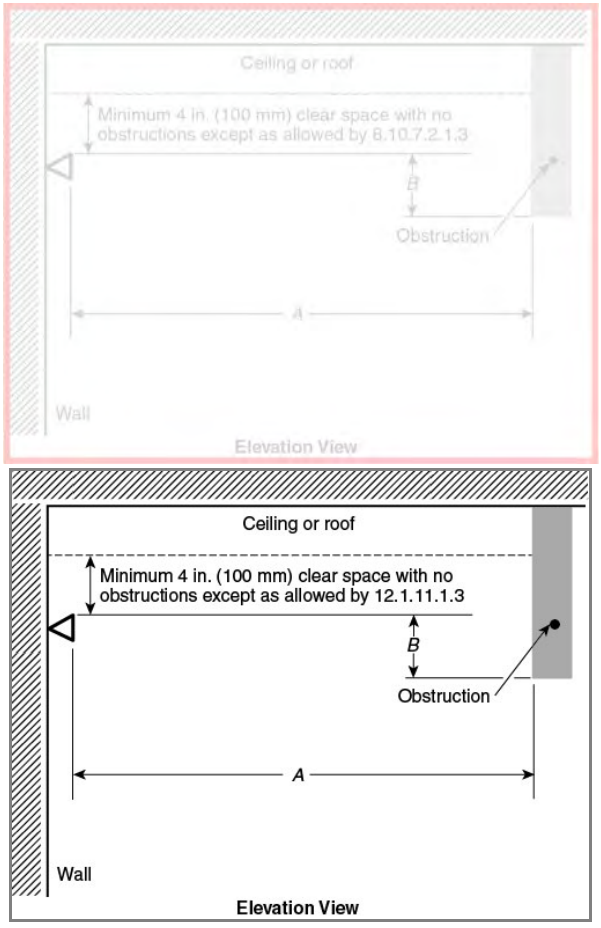
The distance between light fixtures or similar obstructions located 8 ft (2.4 m) or greater from the sprinkler shall be in conformance with Table 12.1.11.1.3 and Figure 12.1.11.1.3.

Table 12.1.11.1.3 Positioning of Sprinklers to Avoid Obstructions (Residential Sidewall Sprinklers)

Distance from Sidewall Sprinkler to Side of Obstruction *(A)*	Maximum Allowable Distance of Deflector Above Bottom of Obstruction *(B)* [in. (mm)]
8 ft (2.4 m) to less than 10 ft (3.0 m)	1 (25)
10 ft (3.0 m) to less than 11 ft (3.3 m)	2 (50)
11 ft (3.3 m) to less than 12 ft (3.7 m)	3 (75)
12 ft (3.7 m) to less than 13 ft (4.0 m)	4 (100)
13 ft (4.0 m) to less than 14 ft (4.3 m)	6 (150)
14 ft (4.3 m) to less than 15 ft (4.6 m)	7 (175)
15 ft (4.6 m) to less than 16 ft (4.9 m)	9 (225)
16 ft (4.9 m) to less than 17 ft (5.2 m)	11 (275)
17 ft (5.2 m) or greater	14 (350)

Note: For *A* and *B*, refer to Figure ~~8.10.7.1.3~~ 12.1.11.1.3 .

Figure 12.1.11.1.3 Positioning of Sprinkler to Avoid Obstruction (Residential Sidewall Sprinklers).



Submitter Information Verification

Submitter Full Name: AUT-SSI

Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Tue Jun 27 08:11:51 EDT 2017

Committee Statement

Committee Statement: This comment is to correct the reference in Figure 12.1.11.1.3. Figure should reference 12.1.11.1.3 not 8.10.7.2.1.3

Response Message:

Public Comment No. 199-NFPA 13-2017 [Section No. 12.1.11.1.3]

Second Revision No. 444-NFPA 13-2017 [Section No. 14.2.4 [Excluding any Sub-Sections]]

ESFR sprinklers shall be permitted for use in buildings with unobstructed ~~and noncombustible~~ or obstructed construction.

Submitter Information Verification

Submitter Full Name: AUT-SSI
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Tue Jun 27 08:19:23 EDT 2017

Committee Statement

Committee Statement: This comment continues the modifications from PI-477 as to where ESFR sprinklers can be used.

The use of ESFR sprinklers under obstructed combustible construction is permitted within the sprinkler manufactures data sheets and correlates with the provisions of FM data sheet 2-0

Response Message:

Public Comment No. 82-NFPA 13-2017 [Section No. 14.2.4 [Excluding any Sub-Sections]]

Second Revision No. 445-NFPA 13-2017 [Section No. 14.2.8.2.4]

14.2.8.2.4

Deviations from the maximum sprinkler spacing shall be permitted to eliminate obstructions created by structural elements (such as trusses, bar joists, and wind bracing) by moving a ~~single~~ sprinkler along the branch line a maximum of 1 ft (300 mm) from its allowable spacing, provided coverage for ~~the sprinklers on that branch line and the sprinklers on the branch line it is moving away from~~ that sprinkler does not exceed 110 ft^2 (10.2 m^2) per sprinkler where all of the following conditions are met:

(1) The average actual floor area protected by the ~~sprinklers on the~~ moved ~~branch line~~ sprinkler and the ~~sprinklers on the~~ adjacent ~~branch lines~~ sprinklers shall not exceed 100 ft^2 (9.3 m^2) ~~per sprinkler.~~ .

(2) Adjacent branch lines shall maintain the same pattern.

(3) In no case shall the distance between sprinklers exceed 12 ft (3.7 m).

~~It shall not be permitted to move a branch line where there are moved sprinklers on a branch line that exceed the maximum sprinkler spacing.~~

Supplemental Information

File Name	Description	Approved
13-SSI_SR-445_leg_changes.docx	For staff use.	

Submitter Information Verification

Submitter Full Name: AUT-SSI
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Tue Jun 27 08:24:50 EDT 2017

Committee Statement

Committee Statement: This issue was resolved in Committee and should not have proceeded to the First Draft. Return to 2016 edition language,

Response Message:

Public Comment No. 138-NFPA 13-2017 [Section No. 14.2.8.2.4]

Second Revision No. 446-NFPA 13-2017 [New Section after 16.3.9.6.2]

16.3.9.6.2

Where nonmetallic pipe installed in accordance with 16.3.9.6 supplies sprinklers in a private garage within a dwelling unit not exceeding 1000 ft^2 (93 m^2) in area, it shall be permitted to be protected from the garage compartment by not less than the same wall or ceiling sheathing that is required by the applicable building code.

Submitter Information Verification

Submitter Full Name: AUT-SSI
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Tue Jun 27 08:45:38 EDT 2017

Committee Statement

Committee Statement: NFPA 13 currently describes automobile parking and showrooms as a Group 1 Ordinary Hazard (A.5.3.1). Generally, the occupancy classification of "automobile parking" is applied to floors and basements of buildings and also to separate structures where large numbers of cars are clustered together, accessible by any person that is a guest of the building or client of the facility within which it is located. But the standard is mute regarding private parking garages within dwelling units, which are addressed separately in the International Building Code. The intent of the building code appears to be that these compartments are considered differently than automobile parking that would be classified as S-2 (public) or U (private). NFPA 13R is very clear regarding its intent that private garages are considered part of the dwelling units and excepts the designer from these OH 1 provisions (7.3.3 and 7.3.3.1).

Though IBC 406.3.1 classifies private garages as Group U, 406.3.4 very specifically excludes private garages adjacent to dwelling units from the separation requirements of 508, which would otherwise be 1-hour for U/R2. Instead, 406.3.4.1 prescribes a single layer of 5/8" Type X gyp board at the ceiling and a single layer of at least 1/2" non-rated gyp board, "... applied to structures supporting the separation from habitable rooms above the garage", which are generally the walls of the garage on which the joists of the floor/ceiling rest. Unless those walls are the separating ones between the subject and an adjacent unit, in which case they must be one-hour. In this arrangement, the private garages are, "... usually considered accessory to the building they serve", according to the 2015 International Building Code Commentary. When they are private and within the dwelling unit, these garages are incidental use areas and considered part of the primary occupancy in which they are located. It's important to also note that IBC 406.3.1 limits a private garage to 1,000 sq.ft. in area, which discourages and arguably precludes using such spaces for automotive service uses and more hazardous fire loading. This harmonizes and coincides with the committee's acceptance of FR 656 and the 1,000 sq. ft. area limit for use of non-metallic piping in OH compartments.

Response Message:

Public Comment No. 58-NFPA 13-2017 [New Section after 16.3.9.6.2]

Second Revision No. 447-NFPA 13-2017 [Section No. 16.3.9.6.2]

~~16.3.9.6.3~~

~~Nonmetallic pipe installed in accordance with 16.3.9.6 shall be permitted to be installed in ordinary hazard rooms larger than 400 ft 2 (37 m 2) where the pipe is concealed within a 1-hour fire resistance-rated assembly.~~

Submitter Information Verification

Submitter Full Name: AUT-SSI
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Tue Jun 27 09:12:10 EDT 2017

Committee Statement

Committee Statement: The provision allows the pipe to be used outside of its listing.
Response Message:

Second Revision No. 449-NFPA 13-2017 [Section No. 16.9.3.3.2]

16.9.3.3.2

Floor control valves in high-rise buildings ~~and valves controlling flow to sprinklers in circulating closed loop systems~~ shall comply with 16.9.3.3.1(1) or 16.9.3.3.1(2).

Submitter Information Verification

Submitter Full Name: AUT-SSI
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Tue Jun 27 10:11:36 EDT 2017

Committee Statement

Committee Statement: Circulating closed loop provisions has been eliminated form the standard.
Response Message:

Second Revision No. 509-NFPA 13-2017 [Section No. 16.9.8.6]

~~16.9.8.6~~

~~Such means shall consist of a tee outlet downstream of the pressure-reducing valve identical in size to the sprinkler system feed, available for connection to field testing devices, or other method approved by the authority having jurisdiction.~~

Submitter Information Verification

Submitter Full Name: AUT-SSI
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Thu Jul 13 11:52:47 EDT 2017

Committee Statement

Committee Statement: This text provides one appropriate method to achieve the performance requirement of 16.9.8.5 but arbitrarily excludes others. It should be relocated to the annex as a suggested but not required means of compliance.

Response Message:

Public Comment No. 142-NFPA 13-2017 [Section No. 16.9.8.6]

Second Revision No. 1056-NFPA 13-2017 [Section No. 16.9.10.2.5]

16.9.10.2.5

Where the water table is low and the soil is porous, crushed stone or gravel shall be permitted to be used for the floor of the pit. ~~*[See Figure A.16.7.2(b) for a suggested arrangement.]*~~

Submitter Information Verification

Submitter Full Name: AUT-SSI
Organization: National Fire Protection Assoc
Street Address:
City:
State:
Zip:
Submittal Date: Mon Oct 23 08:18:16 EDT 2017

Committee Statement

Committee Statement: The referenced figure no longer illustrates the use of crushed stone or gravel for the floor of the valve pit.
Response Message:

Second Revision No. 450-NFPA 13-2017 [Section No. 16.9.11]

16.9.11 Floor Control Valve Assemblies.

16.9.11.1

Multistory buildings exceeding two stories in height shall be provided with a floor control valve, check valve, main drain valve, and flow switch for isolation, control, and annunciation of water flow for each individual floor level.

16.9.11.2

The floor control valve, check valve, main drain valve, and flow switch required by ~~8.2.4.1~~ 16.9.11.1 shall not be required where sprinklers on the top level of a multistory building are supplied by piping on the floor below.

16.9.11.3

The floor control valve, check valve, main drain valve, and flow switch required by ~~8.2.4.1~~ 16.9.11.1 shall not be required where the total area of all floors combined does not exceed the system protection area limitations of ~~8.2.1~~ 4.5.1 .

16.9.11.4

The requirements of ~~8.2.4~~ 16.9.11 shall not apply to dry systems in parking garages.

16.9.11.5* ~~System Subdivision.~~

Where individual floor/zone control valves are not provided, a flanged joint or mechanical coupling shall be used at the riser at each floor for connections to piping serving floor areas in excess of 5000 ft^2 (465 m^2).

Submitter Information Verification

Submitter Full Name: AUT-SSI
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Tue Jun 27 10:13:49 EDT 2017

Committee Statement

Committee Statement: In Section 16.9.11 for Floor Control Valves, the text still references sections from the 2016 edition of the standard (ie. 8.2.1, 8.2.4 & 8.2.4.1). Those references need to be updated to call up the appropriate sections from the new Chapter structure.

Response Message:

Public Comment No. 119-NFPA 13-2017 [Section No. 16.9.11]

Second Revision No. 451-NFPA 13-2017 [Section No. 16.10.4]

16.10.4 System, Main Drain, or Sectional Drain Connections.

16.10.4.1

Provisions shall be made to properly drain all parts of the system.

16.10.4.2

Drain connections for ~~systems~~ system supply risers and mains shall be sized as shown in Table 16.10.4.2.

Table 16.10.4.2 Drain Size

Riser or Main Size [in. (mm)]	Size of Drain Connection [in. (mm)]
Up to 2 (50)	¾ (20) or larger
2½ (65), 3 (80), 3½ (90)	1¼ (32) or larger
4 (100) and larger	2 (50) or larger

16.10.4.3

Where an interior sectional or floor control valve(s) is provided, it shall be provided with a drain connection having a minimum size as shown in Table 16.10.4.2 to drain that portion of the system controlled by the sectional valve.

16.10.4.4

Drains shall discharge outside or to a drain connection capable of handling the flow of the drain. *[~~See Figure A.16.14.1(b).~~]*

16.10.4.5

For those drains serving pressure-reducing valves, the drain, drain connection, and all other downstream drain piping shall be sized to permit a flow of at least the greatest system demand supplied by the pressure-reducing valve.

See SR-521

16.10.4.6* Main Drain Test Connections.

16.10.4.6.1

Main drain test connections shall be provided at locations that will permit flow tests of water supplies and connections.

16.10.4.6.2

Main drain test connections shall be installed that the valve can be opened wide for a sufficient time to assure a proper test without causing water damage.

16.10.4.6.3

Main drain connections shall be sized in accordance with 16.10.4.2.

16.10.4.7

The test connections required by 16.10.4.6 shall be permitted to be used as main drain connections.

16.10.4.8

Where drain connections for floor control valves are tied into a common drain riser, the drain riser shall be one pipe size larger downstream of each size drain connection tying into it.

16.10.4.9

Where subject to freezing, a minimum 4 ft (1.2 m) of exposed drain pipe shall be in a heated area between the drain valve and the exterior wall when drain piping extends through the wall to the outside.

Submitter Information Verification

Submitter Full Name: AUT-SSI
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Street Address:
City:
State:
Zip:

Submittal Date: Tue Jun 27 10:21:36 EDT 2017

Committee Statement

Committee Statement: During the rewrite / editing a number of Annex Section A.8.16.2.4 and the corresponding Figure A.8.16.2.4(a) and Figure A.8.16.2.4(b) were deleted, with no substantiation or explanation. The text and the illustrations should be reinstated as Annex Section A.16.10.4, Figure A.16.10.4(a) and Figure A.16.10.4(b). The missing text and illustrations have stood the test of time and provide extremely valuable information / guidance. They should not be lost as part of the editing process.

Additionally, Annex Section A.8.16.2.4.1 was similarly omitted without substantiation and it too should be retained, as Annex Section A.16.10.4.1.

Response Message:

Public Comment No. 37-NFPA 13-2017 [Section No. 16.10.4.2]

Public Comment No. 69-NFPA 13-2017 [Section No. 16.10.4]

Public Comment No. 72-NFPA 13-2017 [Section No. 16.10.4.6]

Public Comment No. 71-NFPA 13-2017 [New Section after A.16.12.3.1]

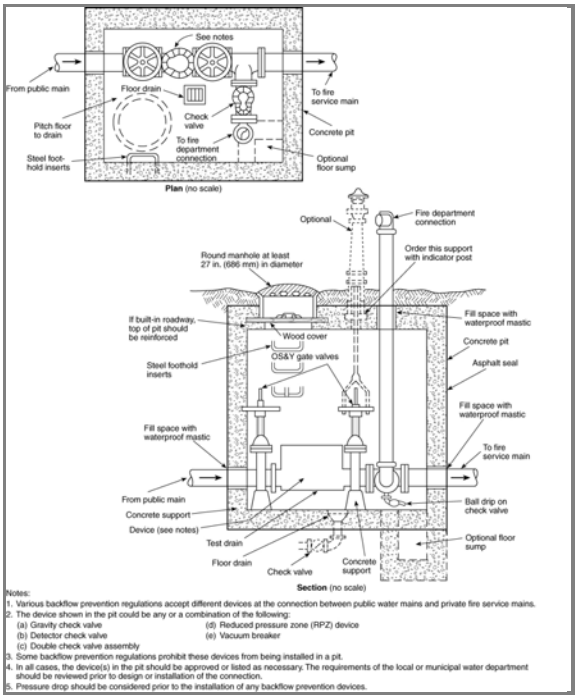
Second Revision No. 1054-NFPA 13-2017 [Section No. 16.12]

16.12* Fire Department Connections.

A.16.12

The fire department connection should be located not less than 18 in. (500 mm) and not more than 4 ft (1.2 m) above the level of the adjacent grade or access level. Typical fire department connections are shown in Figure A.16.12 . See NFPA 13E .

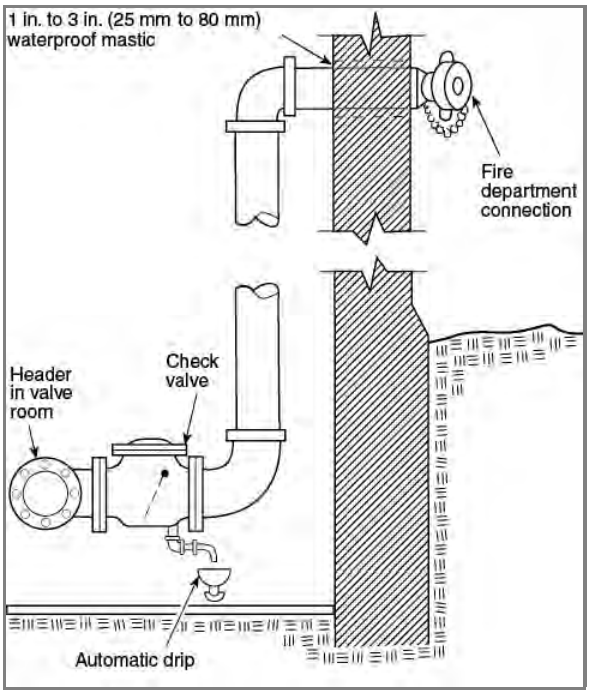
Figure A.16.12 Typical City Water Pit — Valve Arrangement.



16.12.1*

Unless the requirements of 16.12.2 are met, a fire department connection shall be provided as described in Section 16.12 in accordance with Figure 16.12.1.

Figure 16.12.1 Fire Department Connection.



A.16.12.1

Fire department connections should be located and arranged so that hose lines can be readily and conveniently attached without interference from nearby objects, including buildings, fences, posts, or other fire department connections. Where a hydrant is not available, other water supply sources such as a natural body of water, a tank, or a reservoir should be utilized. The water authority should be consulted when a nonpotable water supply is proposed as a suction source for the fire department.

16.12.2

The following systems shall not require a fire department connection:

(1) Buildings located in remote areas that are inaccessible for fire department support

(2) Large-capacity deluge systems exceeding the pumping capacity of the fire department

(3) Single-story buildings not exceeding 2000 ft^2 (185 m^2) in area

16.12.3 Fire Department ~~Connections~~ Connection Types .

16.12.3.1*

Unless the requirements of 16.12.3.1.1, 16.12.3.1.2, or 16.12.3.1.3 are met, the fire department connection(s) shall consist of two 2½ in. (65 mm) connections using NH internal threaded swivel fitting(s) with "2.5–7.5 NH standard thread," as specified in NFPA 1963.

16.12.3.1.1

Where local fire department connections do not conform to NFPA 1963, the authority having jurisdiction shall be permitted to designate the connection to be used.

16.12.3.1.2

The use of threadless couplings shall be permitted where required by the authority having jurisdiction and where listed for such use.

16.12.3.1.3

A single-outlet fire department connection shall be acceptable where piped to a 3 in. (80 mm) or smaller riser.

16.12.3.2

Fire department connections shall be equipped with approved plugs or caps, properly secured and arranged for easy removal by fire departments.

16.12.3.3

Fire department connections shall be of an approved type.

16.12.4* Size.

The size of the pipe for the fire department connection shall be in accordance with one of the following:

(1) Pipe size shall be a minimum of 4 in. (100 mm) for fire engine connections.

(2) Pipe size shall be a minimum of 6 in. (150 mm) for fire boat connections.

(3) For hydraulically calculated systems, the pipe size shall be permitted to be less than 4 in. (100 mm), but not less than the largest riser being served by that connection.

A.16.12.4

The purpose of a fire department connection is to supplement the pressure to an automatic fire sprinkler system. It is not the intent to size the fire department connection piping based on system demand. For multiple system risers supplied by a manifold, the fire department connection need not be larger than that for an individual system.

16.12.5* Arrangement.

~~See~~ The fire department connection shall be arranged in accordance with Figure 16.12.1.

16.12.5.1*

The fire department connection shall be on the system side of the water supply check valve.

16.12.5.1.1

The fire department connection shall not be attached to branch line piping.

16.12.5.1.2

The fire department connection shall be located not less than 18 in. (~~457~~ 450 mm) and not more than 4 ft (1.2 m) above the level of the adjacent grade or access level.

16.12.5.2

For single systems, the fire department connection shall be installed as follows:

(1) Wet system — on the system side of system control, check, and alarm valves *(see Figure A.16.9.3)*

(2) Dry system — between the system control valve and the dry pipe valve

(3) Preaction system — between the preaction valve and the check valve on the system side of the preaction valve

(4) Deluge system — on the system side of the deluge valve

16.12.5.3

The fire department connection shall be permitted to be connected to the main piping on the wet pipe or deluge system it serves.

16.12.5.4

For multiple systems, the fire department connection shall be connected between the supply control valves and the system control valves.

16.12.5.5*

The requirements of 16.12.5.2 and 16.12.5.4 shall not apply where the fire department connection is connected to the underground piping.

A.16.12.5.5

Figure A.16.12.5.5(a) and Figure A.16.12.5.5(b) depict fire department connections to the underground pipe.

Figure A.16.12.5.5(a) Fire Department Connection to Underground Piping for a Single System.

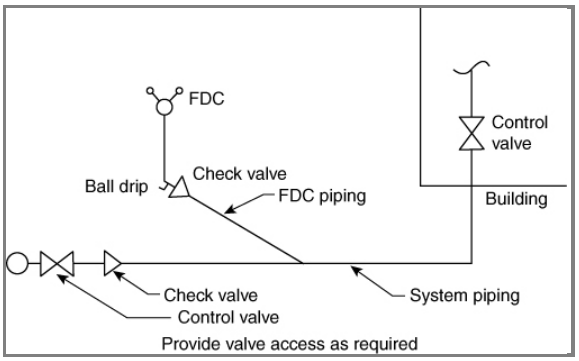
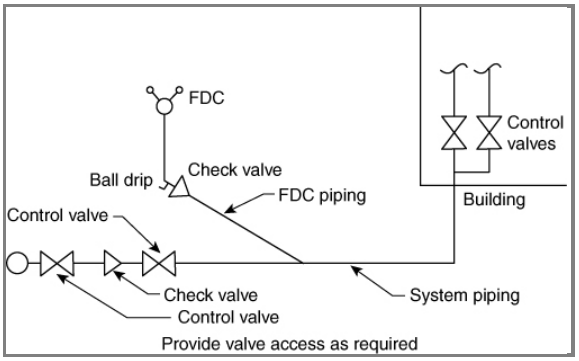


Figure A.16.12.5.5(b) Fire Department Connection to Underground Piping for Multiple Systems.



16.12.5.6

Where a fire department connection services only a portion of a building, a sign shall be attached indicating the portions of the building served.

16.12.5.7*

Fire department connections shall be located at the nearest point of fire department apparatus accessibility or at a location approved by the authority having jurisdiction.

16.12.5.8 Signs.

16.12.5.8.1

Each fire department connection to sprinkler systems shall be designated by a sign having raised or engraved letters at least 1 in. (25 mm) in height on plate or fitting reading service design — for example, AUTOSPKR., OPEN SPKR., AND STANDPIPE.

16.12.5.8.2

A sign shall also indicate the pressure required at the inlets to deliver the greatest system demand.

16.12.5.8.3

The sign required in 16.12.5.8.2 shall not be required where the system demand pressure is less than 150 psi (10.3 bar).

16.12.5.9

Fire department connections shall not be connected on the suction side of fire pumps.

16.12.5.10

Fire department connections shall be properly supported.

16.12.6 Valves.

16.12.6.1

A listed check valve shall be installed in each fire department connection and shall be located in an accessible location.

16.12.6.2

There shall be no shutoff valve in the fire department connection piping.

16.12.7* Drainage.

The piping between the check valve and the outside hose coupling shall be equipped with an approved automatic drain valve in areas subject to freezing.

16.12.7.1

The automatic drain valve shall be installed in a location that permits inspection and testing as required by NFPA 25.

Supplemental Information

File Name	Description	Approved
SR_1054_Section_16.12_Fire_Department_Connections.docx	Section 16.12 Fire Department Connections. For staff use	

Submitter Information Verification

Submitter Full Name: AUT-SSI
Organization: National Fire Protection Assoc
Street Address:
City:
State:
Zip:
Submittal Date: Wed Oct 18 10:01:01 EDT 2017

Committee Statement

Committee Statement: Reinserts text inadvertently dropped in the re-organization of NPFA 13.
Response Message:

Second Revision No. 1055-NFPA 13-2017 [Section No. 16.14.1]

16.14.1* Wet Pipe Systems.

A.16.14.1

The purpose of this alarm test connection is to make sure the alarm device is sensitive enough to determine the flow from a single sprinkler and sound an alarm. The purpose of this test connection is not to ensure that water will flow through the entire system. When this test connection is installed on the upper story, and at the end of the most remote branch line, the user is able to tell that there is water flowing in one path through the system, but there is no assurance that water will flow to other branch lines. Putting the test connection at the most remote portion of the system causes the introduction of fresh oxygen into a large part of the system each time the alarm is tested and increases the corrosion that will occur in the piping. The discharge should be at a point where it can be readily observed. In locations where it is not practical to terminate the test connection outside the building, the test connection is permitted to terminate into a drain capable of accepting full flow under system pressure. In this event, the test connection should be made using an approved sight test connection containing a smooth bore corrosion-resistant orifice giving a flow equivalent to one sprinkler simulating the least flow from an individual sprinkler in the system. *[See Figure A.16.14.1(a) and Figure A.16.14.1(b).]* The test valve should be located at an accessible point and preferably not over 7 ft (2.1 m) above the floor. The control valve on the test connection should be located at a point not exposed to freezing.

Figure A.16.14.1(a) System Test Connection on Wet Pipe System.

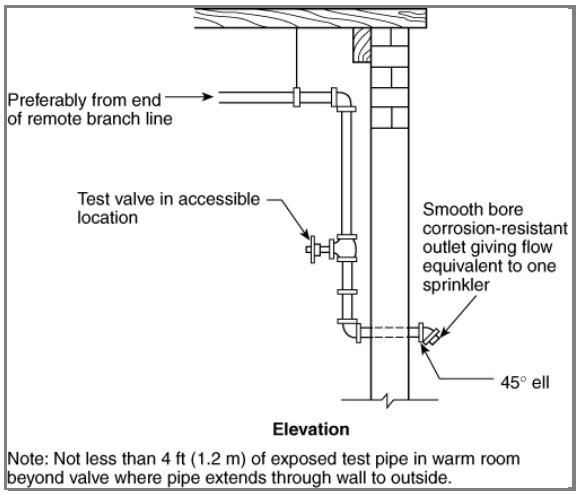
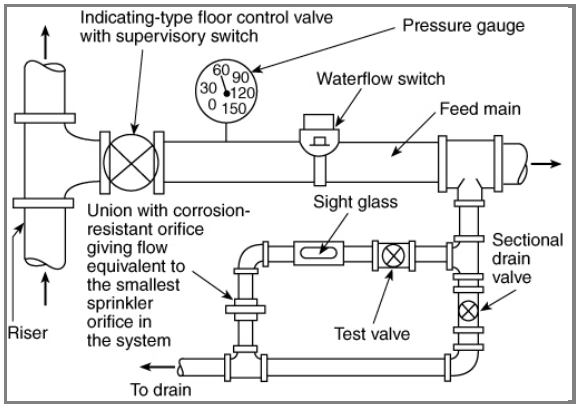


Figure A.16.14.1(b) Zone Control Station System Test Connection on Wet Pipe System.



16.14.1.1

An alarm test connection not less than 1 in. (25 mm) in diameter, terminating in a smooth bore corrosion-resistant orifice, giving a flow equal to or less than one sprinkler of a type having the smallest K-factor installed on the particular system, shall be provided to test each waterflow alarm device for each system.

16.14.1.2

The test connection valve shall be accessible.

16.14.1.3

The discharge shall be to the outside, to a drain connection capable of accepting full flow under system pressure, or to another location where water damage will not result.

16.14.1.4

The alarm test connection shall be permitted to be installed in any location on the fire sprinkler system downstream of the waterflow alarm.

Supplemental Information

File Name	Description	Approved
SR_1055_Wet_System_Test_Connections.docx	Wet System Test Connections. For staff use.	

Submitter Information Verification

Submitter Full Name: AUT-SSI
Organization: National Fire Protection Assoc
Street Address:
City:
State:
Zip:
Submittal Date: Wed Oct 18 10:12:24 EDT 2017

Committee Statement

Committee Statement: Reinserts text that was inadvertently dropped in re-organization of NFPA 13.
Response Message:

Second Revision No. 452-NFPA 13-2017 [Section No. 16.14.5.1]

16.14.5.1* Backflow Prevention Valves.

Means shall be provided downstream of all backflow prevention valves for forward flow tests at a minimum flow rate of the system demand including hose allowance where applicable.

A.16.14.5.1

System demand refers to flow rate and pressure. This test is only concerned with testing at the proper flow rate.

The full flow test of the backflow prevention valve can be performed with a test header or other connection downstream of the valve. A bypass around the check valve in the fire department connector line with a control valve in the normally closed position can be an acceptable arrangement. When flow to a visible drain cannot be accomplished, closed loop flow can be acceptable if a flowmeter or site glass is incorporated into the system to ensure flow. When a backflow prevention device is retroactively installed on a pipe schedule system, the revised hydraulic calculation still follows the pipe schedule method of 19.3.2 with the inclusion of friction loss for the device.

16.14.5.1.1

The arrangement required in ~~8.17.4.5.1~~ 16.14.5.1 shall be serviceable without requiring the owner to modify the system to perform the test.

Submitter Information Verification

Submitter Full Name: AUT-SSI
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Tue Jun 27 10:24:37 EDT 2017

Committee Statement

Committee Statement: Annex language for this section from the 2016 edition appears to have been removed from this first draft. This annex language, which has been in the standard for years, is very useful to the user. This annex language has always served as explanatory material for both new and retroactive installations, so I also advise the portion of the restored language related to retroactive installations be placed into a new A.28.6.5

Note from submitter - Terra View did not provide the option to add this comment in A.16.14.5.1

(From 2016 A.8.17.4.5.1) System demand refers to flow rate and pressure.This test is only concerned with testing at the proper flow rate.

The full flow test of the backflow prevention valve can be performed with a test header or other connection downstream of the valve. A bypass around the check valve in the fire department connector line with a control valve in the normally closed position can be an acceptable arrangement.

When flow to a visible drain cannot be accomplished, closed loop flow can be acceptable if a flowmeter or site glass is incorporated

into the system to ensure flow. When a backflow prevention device is retroactively installed on a pipe schedule system, the revised hydraulic calculation still follows the pipe schedule method of 11.2.2 with the inclusion of friction loss for the device.

Response Message:

Public Comment No. 38-NFPA 13-2017 [Section No. 16.14.5.1]

Second Revision No. 1057-NFPA 13-2017 [Section No. 16.15.1.4]

16.15.1.4*

Hose connections used for fire purposes only shall be permitted to be connected to wet pipe sprinkler systems only, subject to the following restrictions:

(1) Hose connection's supply pipes shall not be connected to any pipe smaller than 2½ in. (65 mm) in diameter.

(2) The requirements of 16.15.1.4(1) shall not apply to hydraulically designed loops and grids, where the minimum size pipe between the hose connection's supply pipe and the source shall be permitted to be 2 in. (50 mm).

(3) For piping serving a single hose connection, pipe shall be a minimum of 1 in. (25 mm) for horizontal runs up to 20 ft (6.1 m), a minimum of 1¼ in. (32 mm) for the entire run for runs between 20 ft and 80 ft (6.1 m and 24 m), and a minimum of 1½ in. (40 mm) for the entire run for runs greater than 80 ft (24 m). For piping serving multiple hose connections, runs shall be a minimum of 1½ in. (40 mm) throughout.

(4) Piping shall be at least 1 in. (25 mm) for vertical runs.

(5) Where the residual pressure at a 1½ in. (40 mm) outlet on a hose connection exceeds 100 psi (7 bar), an approved pressure-regulating device shall be provided to limit the residual pressure at the outlet to 100 psi (7 bar).

(6) Where the static pressure at a 1½ in. (40 mm) hose connection exceeds 175 psi (12 bar), an approved pressure-regulating device shall be provided to limit static and residual pressures at the outlet to 100 psi (7 bar).

A.16.15.1.4

This standard covers 1 ½ in. (40 mm) hose connections for use in storage occupancies and other locations where standpipe systems are not required. Where Class II standpipe systems are required, see the appropriate provisions of NFPA 14 with respect to hose stations and water supply for hose connections from sprinkler systems.

Supplemental Information

File Name	Description	Approved
SR_1057.docx	Annex material for 16.15.1.4. For staff use.	

Submitter Information Verification

Submitter Full Name: AUT-SSI
Organization: National Fire Protection Assoc
Street Address:
City:
State:
Zip:
Submittal Date: Mon Oct 23 08:20:52 EDT 2017

Committee Statement

Committee Statement: Adds back in annex material that was inadvertently dropped in the re-organization of NFPA 13.
Response Message:

Second Revision No. 463-NFPA 13-2017 [Section No. 27.2.1.1]

28.2.1.1

Unless permitted by 28.2.1.3 through 28.2.1.5, all piping and attached appurtenances subjected to system working pressure shall be hydrostatically tested at 200 psi (13.8 bar) and shall maintain that pressure without loss for 2 hours.

28.2.1.2

Loss shall be determined by a drop in gauge pressure or visual leakage.

Submitter Information Verification

Submitter Full Name: AUT-SSI
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Tue Jun 27 15:29:23 EDT 2017

Committee Statement

Committee Statement: Text was inadvertenently dropped from the 2016 edition.
Response Message:

Second Revision No. 453-NFPA 13-2017 [Section No. 27.2.3.1]

28.2.3.1 Waterflow Devices.

Waterflow detecting devices including the associated alarm circuits shall be flow tested through the inspector's test connection and shall result in an audible alarm on the premises within 5 minutes after such flow begins and until such flow stops.

28.2.3.1.1

Where a fire alarm system is monitoring waterflow, an alarm signal shall activate in accordance with the requirements of the adopted fire alarm code.

Submitter Information Verification

Submitter Full Name: AUT-SSI
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Tue Jun 27 10:46:01 EDT 2017

Committee Statement

Committee Statement: Added information correlates with NFFPA 72-17.12.2 requirement that waterflow signal is to be activated within 90 seconds of waterflow switch activation. Five minute requirement historically may be for water motor gong without fire alarm system.

Response Message:

Public Comment No. 40-NFPA 13-2017 [Section No. 27.2.3.1]

Second Revision No. 454-NFPA 13-2017 [Section No. 27.4]

~~**27.4** Circulating Closed Loop Systems.~~

~~**27.4.1**~~

~~For sprinkler systems with non-fire protection connections, additional information shall be appended to the contractor's material and test certificate for aboveground piping shown in Figure 27.1 as follows:~~

~~Certification that all auxiliary devices, such as heat pumps, circulating pumps, heat exchangers, radiators, and luminaires, if a part of the system, have a pressure rating of at least 175 psi or 300 psi (12.1 bar or 20.7 bar) if exposed to pressures greater than 175 psi (12.1 bar).~~

~~All components of sprinkler system and auxiliary system have been pressure tested as a composite system in accordance with 27.2.2 .~~

~~Waterflow tests have been conducted and waterflow alarms have operated while auxiliary equipment is in each of the possible modes of operation.~~

~~With auxiliary equipment tested in each possible mode of operation and with no flow from sprinklers or test connection, waterflow alarm signals did not operate.~~

~~Excess temperature controls for shutting down the auxiliary system have been properly field tested.~~

~~**27.4.2**~~

~~Discharge tests of sprinkler systems with non-fire protection connections shall be conducted using system test connections described in 6.8.1.~~

~~**27.4.3**~~

~~Pressure gauges shall be installed at critical points and readings shall be taken under various modes of auxiliary equipment operation.~~

~~**27.4.4**~~

~~Waterflow alarm signals shall be responsive to discharge of water through system test pipes while auxiliary equipment is in each of the possible modes of operation.~~

Submitter Information Verification

Submitter Full Name: AUT-SSI
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Tue Jun 27 11:02:40 EDT 2017

Committee Statement

Committee Statement: During the Technical Committee's First Draft Meeting it was decided to delete the requirements for acceptance testing for circulating closed loop systems, but those provisions are still evident in the new Section 27.4. Since the standard no longer addresses those type of systems, the acceptance test criteria should be deleted.

Response Message:

Public Comment No. 74-NFPA 13-2017 [Section No. 27.4]

Second Revision No. 455-NFPA 13-2017 [New Section after 27.6.2]

28.5.3

The sign shall include the following information:

(1) Location of the design area or areas

(2) Size (area) of or number of sprinklers in the design area

(3) Discharge densities over the design area or areas

(4) Required flow and residual pressure demand at the base of the riser or fire pump where applicable

(5) Occupancy classification or commodity classification and maximum permitted storage height and configuration

(6) Hose stream allowance included in addition to the sprinkler demand

(7) Name of the installing contractor

Submitter Information Verification

Submitter Full Name: AUT-SSI
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Tue Jun 27 11:03:42 EDT 2017

Committee Statement

Committee Statement: 27.6.3 restores the item requirement list from 25.5.2 in the 2016 edition and adds item 2 which is basic information that should be included on the sign.

Response Message:

Public Comment No. 75-NFPA 13-2017 [New Section after 27.6.2]

Public Comment No. 188-NFPA 13-2017 [New Section after 27.6.2]

Public Comment No. 76-NFPA 13-2017 [Section No. 27.7.4]

Second Revision No. 456-NFPA 13-2017 [Section No. 28.1]

29.1 General.

29.1.1

In addition to the applicable requirements of this standard, the requirements of Chapter 29 shall apply where modifications or additions are made to existing systems.

29.1.2

Where additions or modifications are made to an existing system, enough of the existing system shall be indicated on the plans to make all conditions clear.

29.1.3

When backflow prevention devices are to be retroactively installed on existing systems, a thorough hydraulic analysis, including revised hydraulic calculations, new fire flow data, and all necessary modifications to accommodate the additional friction loss, shall be completed as a part of the installation.

29.1.4

A hydraulically calculated system for a building, or a hydraulically calculated addition to a system in an existing sprinklered building using the pipe schedule method, shall supersede the requirements in this standard governing pipe schedules, except that all systems shall continue to be limited by area.

29.1.5

Unless permitted by 29.1.5.1 , when modifying existing systems protecting general storage, rack storage, rubber tire storage, roll paper storage, and baled cotton storage, using sprinklers with K-factors K-8.0 (115) or less, the requirements of 21.1.3 and 21.1.4 shall not apply.

29.1.5.1

Where applying the requirements of Figure 21.5.1.1(b) and Figure 21.5.1.1(c) utilizing the design criteria of 0.6 gpm/ft^2 per 2000 ft^2 (24.4 mm/min per 186 m^2) to existing storage applications, standard-response spray sprinklers with a K-factor of K-11.2 (160) or larger that are listed for storage applications shall be used.

29.1.6

For modifications or additions to existing systems equipped with residential sprinklers, the listed discharge criteria less than 0.1 gpm/ft^2 (4.1 mm/min) shall be permitted to be used.

29.1.7

Torch cutting and welding shall not be permitted as a means of modifying or repairing sprinkler systems.

29.1.8

Additives to existing systems intended for control of microbiological or other corrosion shall be listed for use within fire sprinkler systems.

Submitter Information Verification

Submitter Full Name: AUT-SSI
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Tue Jun 27 11:09:00 EDT 2017

Committee Statement

Committee Statement: Editorial. With the exception of the provisions for pipe schedule systems, as currently proposed in the First Draft Report, the items in Section 28.6 and entitled "System Design" all general requirements that should be brought forward to the beginning of the chapter.

The provisions for pipe schedule systems should be moved to Section 28.4, Revamping of Pipe Schedule Systems.

Response Message:

Public Comment No. 158-NFPA 13-2017 [Section No. 28.6]

Public Comment No. 155-NFPA 13-2017 [Section No. 28.1]

Public Comment No. 162-NFPA 13-2017 [Section No. 28.6.2]

Second Revision No. 511-NFPA 13-2017 [Section No. 28.2.5]

~~28.2.5~~

~~When pipe schedule or hydraulically designed systems are revamped to accommodate added ceilings, sprinkler outlets utilized for new armover or drop nipples shall have hexagonal bushings removed where present.~~

Submitter Information Verification

Submitter Full Name: AUT-SSI
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Thu Jul 13 13:59:00 EDT 2017

Committee Statement

Committee Statement: Editorial. All of the provisions in this chapter relating to pipe schedule systems should be moved to Section 28.4, Revamping of Pipe Schedule Systems, for better clariity / continuity.
Response Message:

Public Comment No. 161-NFPA 13-2017 [Section No. 28.2.5]

Second Revision No. 458-NFPA 13-2017 [Section No. 28.4]

29.4 Revamping of Pipe Schedule Systems.

29.4.1

The pipe schedule method shall be permitted as follows:

(1) Additions or modifications to existing pipe schedule systems sized according to the pipe schedules of Section 27.4

(2) Additions or modifications to existing extra hazard pipe schedule systems

29.4.2

When pipe schedule systems are revamped to accommodate added ceilings, sprinkler outlets utilized for new armover or drop nipples shall have hexagonal bushings removed when present.

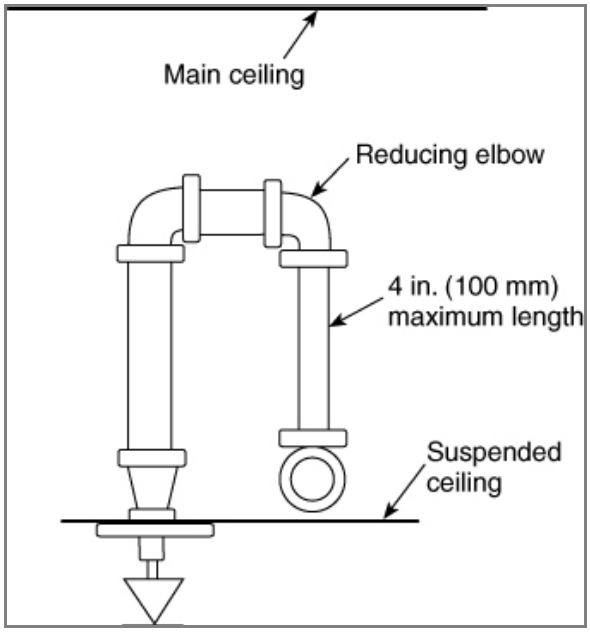
29.4.3

When pipe schedule systems are revamped, a nipple not exceeding 4 in. (100 mm) in length shall be permitted to be installed in the branch line fitting.

29.4.4

All piping other than the nipple permitted in 29.4.3 and 29.4.5 shall be a minimum of 1 in. (25 mm) in diameter in accordance with Figure 29.4.4.

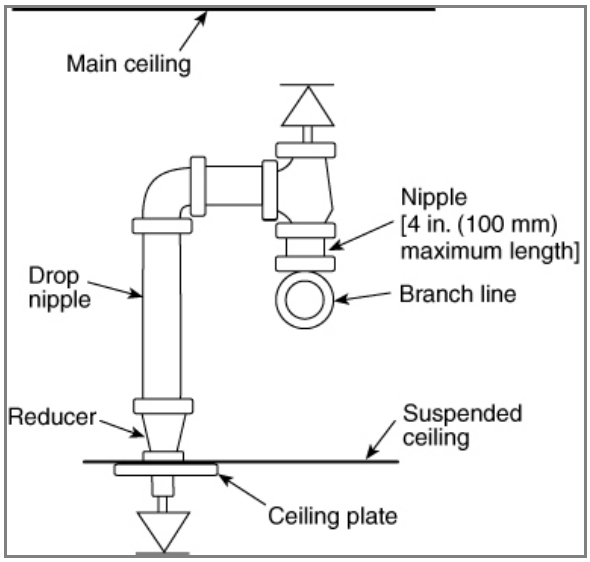
Figure 29.4.4 Nipple and Reducing Elbow Supplying Sprinkler Below Ceiling.



29.4.5

When it is necessary to pipe two new ceiling sprinklers from an existing outlet in an overhead system, the use of a nipple not exceeding 4 in. (100 mm) in length and of the same pipe thread size as the existing outlet shall be permitted in accordance with Figure 29.4.5, provided that a hydraulic calculation verifies that the design flow rate will be achieved.

Figure 29.4.5 Sprinklers in Concealed Space and Below Ceiling.



29.4.6

Where an armover is attached to connect to a sprinkler, the use of pipe nipples less than 1 in. (25 mm) in diameter shall not be permitted where seismic design is required on the system.

Submitter Information Verification

Submitter Full Name: AUT-SSI
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Tue Jun 27 11:11:59 EDT 2017

Committee Statement

Committee Statement: Editorial. All of the provisions in this chapter relating to pipe schedule systems should be moved to Section 28.4, Revamping of Pipe Schedule Systems, for better clariity / continuity.

Response Message:

Public Comment No. 159-NFPA 13-2017 [Section No. 28.4]

Second Revision No. 459-NFPA 13-2017 [Section No. 29.1.3]

~~29.1.3~~

The following definitions shall be applicable to this chapter *(see Section 3.3.120)* :

A-Class Boundary — A boundary designed to resist the passage of smoke and flame for 1 hour when tested in accordance with ASTM E119, *Standard Test Methods for Fire Tests of Building Construction and Materials* , or ANSI/UL 263, *Standard for Fire Tests of Building Construction and Materials* .

B-Class Boundary — A boundary designed to resist the passage of flame for 1½ hour when tested in accordance with ASTM E119, *Standard Test Methods for Fire Tests of Building Construction and Materials* , or ANSI/UL 263, *Standard for Fire Tests of Building Construction and Materials* .

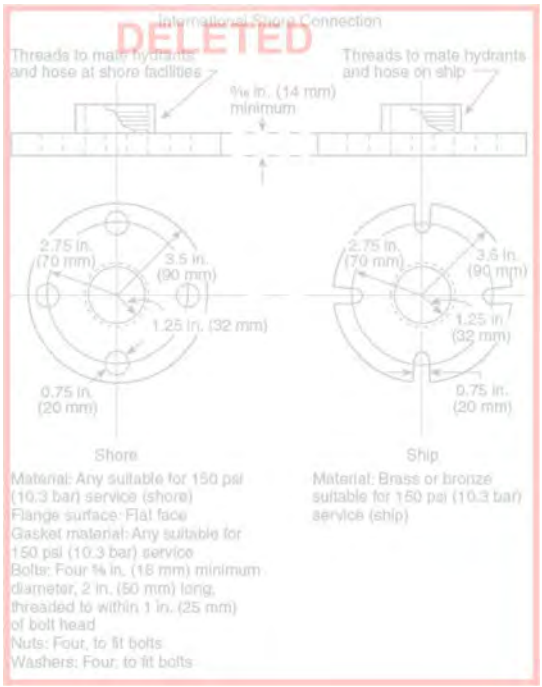
Central Safety Station — A continuously manned control station from which all of the fire control equipment is monitored. If this station is not the bridge, direct communication with the bridge must be provided by means other than the ship's service telephone.

* *Heat-Sensitive Material* — A material whose melting point is below 1700°F (925°C).

A.29.1.3(4) –

The backbone of the fire protection philosophy for U.S. flagged vessels and passenger vessels that trade internationally is limiting a fire to the compartment of origin by passive means. Materials that do not withstand a 1-hour fire exposure when tested in accordance with ASTM E119, *Standard Test Methods for Fire Tests of Building Construction and Materials* , or ANSI/UL 263, *Fire Tests of Building Construction Materials* , are considered "heat sensitive." *[See Figure A.29.1.3(4) .]*

Figure A.29.1.3(4) International Shore Fire Connection.



Heel — The inclination of a ship to one side.

Heel Angle — The angle defined by the intersection of a vertical line through the center of a vessel and a line perpendicular to the surface of the water.

International Shore Connection — A universal connection to the vessel's fire main to which a shoreside fire-fighting water supply can be connected.

* *Marine System* — A sprinkler system installed on a ship, boat, or other floating structure that takes its supply from the water on which the vessel floats.

A.29.1.3(8) –

Some types of sprinkler systems can closely resemble marine systems, such as a system installed on a floating structure that has a permanent water supply connection to a public main. For these types of systems, judgment should be used in determining if certain aspects of Chapter 26 are applicable.

~~* *Marine Thermal Barrier* — An assembly that is constructed of noncombustible materials and made intact with the main structure of the vessel, such as shell, structural bulkheads, and decks; meetsthe requirements of a B-Class boundary; and is insulated such that, if tested in accordance with ASTM E119, *Standard Test Methods for Fire Tests of Building Construction and Materials,* or ANSI/UL 263, *Standard for Fire Tests of Building Construction and Materials* , for 15 minutes, the average temperature of the unexposed side does not rise more than 250°F (139°C) above the original temperature, nor does the temperature at any one point, including any joint, rise more than 405°F (225°C) above the original temperature.~~

~~*Marine Water Supply* — The supply portion of the sprinkler system from the water pressure tank or the sea suction of the designated sprinkler system pump up to and including the valve that isolates the sprinkler system from these two water sources.~~

~~*Supervision* — A visual and audible alarm signal given at the central safety station to indicate when the system is in operation or when a condition that would impair the satisfactory operation of the system exists. Supervisory alarms shall give a distinct indication for each individual system component that is monitored.~~

~~*Survival Angle* — The maximum angle to which a vessel is permitted to heel after the assumed damage required by stability regulations is imposed.~~

~~*Type 1 Stair* — A fully enclosed stair that serves all levels of a vessel in which persons can be employed.~~

Submitter Information Verification

Submitter Full Name: AUT-SSI
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Tue Jun 27 11:15:59 EDT 2017

Committee Statement

Committee Statement: The definitions for Marine Systems should be either in Chapter 3 or in Chapter 29 (formerly Chapter 26), but not in both as currently proposed. Providing these definitions twice is redundant.

Response Message:

Public Comment No. 166-NFPA 13-2017 [Section No. 29.1.3]

Second Revision No. 512-NFPA 13-2017 [Section No. A.8.2.6.4.1]

A.8.2.6.4.1

The connection from an air compressor to the dry pipe valve should be of a type recommended by the manufacturer and approved by the authority having jurisdiction, taking into consideration the pressures, temperatures, and vibrations that the connection and adjacent equipment will endure. Flexible hose should be considered suitable when capable of withstanding expected vibration, a maximum pressure of 175 psi (12 bar) or greater, and a maximum temperature of 150°F (66°C) or greater.

Submitter Information Verification

Submitter Full Name: AUT-SSI
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Fri Jul 14 14:58:34 EDT 2017

Committee Statement

Committee Statement: The air compressor manufacturer will be able to identify appropriate materials for use in connecting the air compressor to the sprinkler system and manufacturers commonly specify flexible hoses .

Response Message:

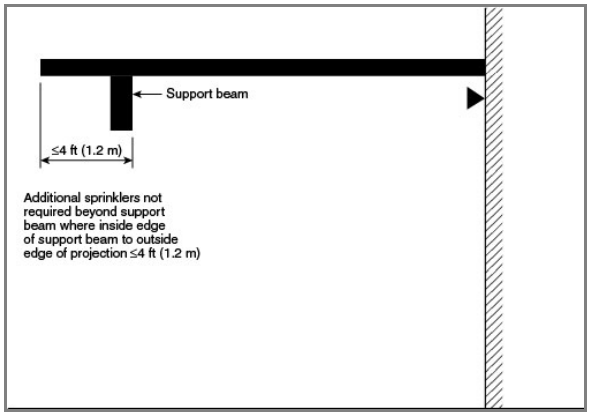
Public Comment No. 83-NFPA 13-2017 [Section No. A.8.2.6.4.1]

Second Revision No. 516-NFPA 13-2017 [Section No. A.9.3.20.1]

A.9.3.20.1

Sprinkler protection under exterior projections should not be required to spray beyond the support beam on the exterior edge of the exterior projection as long as the maximum distance from the interior edge of support beam to the exterior edge of the projection does not exceed 4 ft (1.2 m) . An additional line of sprinklers on the exterior edge is not required due to obstruction rules. This is considered a reasonable level of protection ~~since~~ because sprinklers are located between the structure and the exterior edge. See Figure A.9.3.20.1 .

Figure A.9.3.20.1 Exterior Projection with Sprinklers.



Submitter Information Verification

Submitter Full Name: AUT-SSI
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Fri Jul 14 15:08:36 EDT 2017

Committee Statement

Committee Statement: This comment is in in support of FR-712 with the addition of a 4 ft maximum distance from the inside edge of the support beam to the outside edge of the exterior projection in order to omit sprinkler coverage beyond the support beam. If this distance exceeds 4 ft, the possibility of significant storage exists and sprinkler coverage should be mandated. To illustrate a figure is included.

Response Message:

Public Comment No. 132-NFPA 13-2017 [Section No. A.9.3.20.1]

Second Revision No. 517-NFPA 13-2017 [Section No. A.9.4.2.1]

A.9.4.2.1

~~For protection of baled cotton, fire tests and actual fire experience indicate an initial low heat release; thus, sprinklers in the ordinary-temperature range should offer some advantage by opening faster than those of intermediate- or high-temperature classifications under similar conditions.~~ It is acceptable to install ordinary-temperature sprinklers throughout a building, intermediate-temperature sprinklers throughout a building, or a mix of ordinary- and intermediate-temperature sprinklers throughout a building.

Submitter Information Verification

Submitter Full Name: AUT-SSI
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Fri Jul 14 15:13:50 EDT 2017

Committee Statement

Committee Statement: This comment is intended to clarify that it is acceptable to install intermediate temperature sprinklers in a building even when that sprinkler will not be exposed to ambient temperature in excess of 100F. Additionally it is acceptable to mix ordinary temperature sprinklers with intermediate temperature sprinklers. Although the allowance to allow intermediate temperature sprinklers throughout a building is not new, many AHJ's are only allowing intermediate temperature sprinklers where elevated temperatures are present.

Also a separate comment seeks to move the existing A.9.4.2.1 which deals with Baled cotton to section section A.21.10 which is the baled cotton section

Response Message:

Public Comment No. 98-NFPA 13-2017 [Section No. A.9.4.2.1]

Second Revision No. 518-NFPA 13-2017 [Section No. A.9.4.2.5]

A.9.4.2.5

A diffuser in ceiling sheathing labeled by the manufacturer as “horizontal discharge” has directional vanes to move air further along the ceiling, and sprinklers located within the 2 ft 6 in. (750 mm) radius should have an intermediate-temperature rating. See Figure A.9.4.2.5(a)~~and~~ through Figure A.9.4.2.5(d).

Figure A.9.4.2.5(a) ~~Recessed Fireplace.~~ Ordinary-Temperature Sprinkler over Recessed Fireplace.

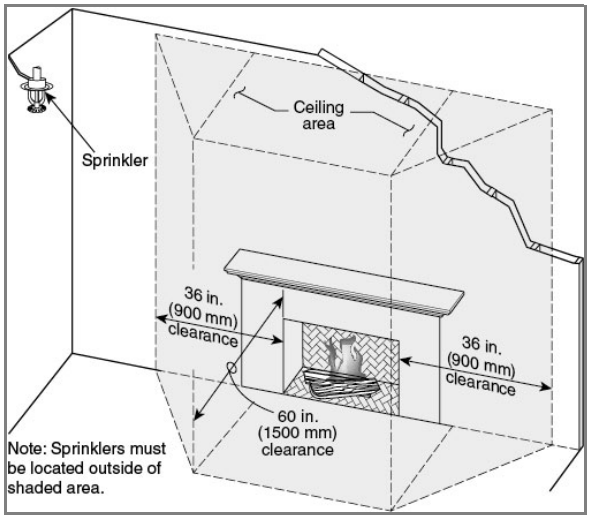


Figure A.9.4.2.5(b) ~~Open Fireplace.~~ Intermediate-Temperature Sprinkler over Recessed Fireplace.

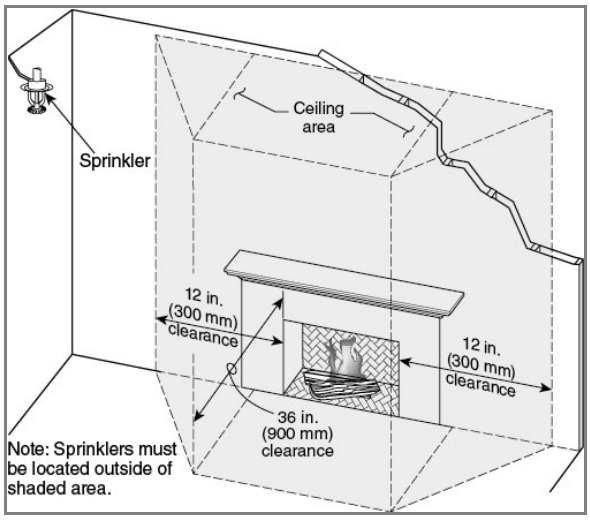


Figure A.9.4.2.5(c) Ordinary-Temperature Sprinkler over Open Fireplace.

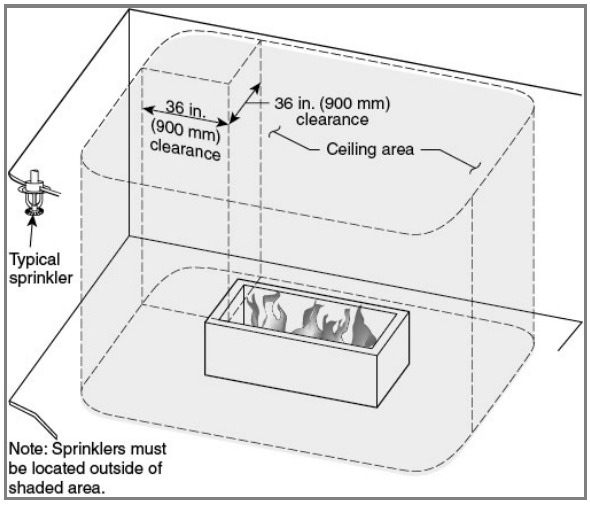
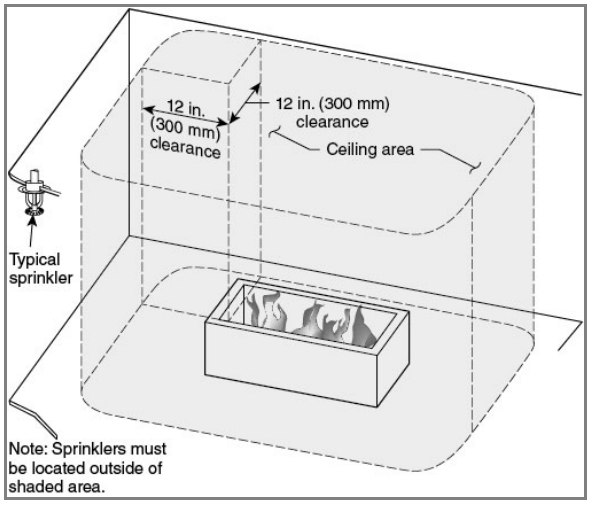


Figure A.9.4.2.5(d) Intermediate-Temperature Sprinkler over Open Fireplace.



Submitter Information Verification

Submitter Full Name: AUT-SSI
Organization: [Not Specified]
Street Address:
City:

State:

Zip:

Submittal Date: Fri Jul 14 15:15:25 EDT 2017

Committee Statement

Committee Statement: Improved drawings have been submitted to illustrate the concept accepted in the First Revision. This should be correlated across NFPA 13R and NFPA 13D.

Response Message:

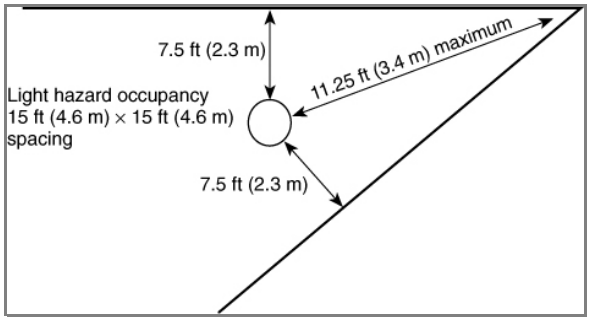
Public Comment No. 127-NFPA 13-2017 [Section No. A.9.4.2.5]

Second Revision No. 519-NFPA 13-2017 [Section No. A.10.2.5.2.2]

A.10.2.5.2.2

~~See~~ The example in Figure A.10.2.5.2.2 is for a light hazard occupancy. However, the irregular-shaped room allowance also applies to ordinary and extra hazard occupancies.

Figure A.10.2.5.2.2 Maximum Distance from Walls.



Submitter Information Verification

Submitter Full Name: AUT-SSI
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Fri Jul 14 15:17:01 EDT 2017

Committee Statement

Committee Statement: The purpose of FR 735 (based upon PI 415) was to indicate that this figure is applicable to all occupancy types even though the figure shows light hazard spacing. The following language (from PI 415) needs to be added: "The above example is shown for a light hazard occupancy. However, the irregular shape room allowance also applies to ordinary and extra hazard occupancies."

Response Message:

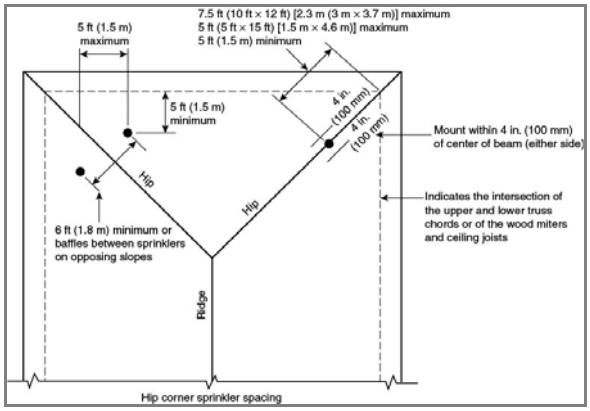
Public Comment No. 173-NFPA 13-2017 [Section No. A.10.2.5.2.2]

Second Revision No. 520-NFPA 13-2017 [Section No. A.10.2.6.1.4.5]

A.10.2.6.1.4.5

See Figure A.10.2.6.1.4.5.

Figure A.10.2.6.1.4.5 Hip Roof Installations.



Submitter Information Verification

Submitter Full Name: AUT-SSI
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Fri Jul 14 15:18:13 EDT 2017

Committee Statement

Committee Statement: Add 6'-0" minimum or baffles required between the two sprinklers on opposing slopes.
Response Message:

Public Comment No. 45-NFPA 13-2017 [Section No. A.10.2.6.1.4.5]

Second Revision No. 464-NFPA 13-2017 [Section No. A.12.1.1]

A.12.1.1

The response and water distribution pattern of listed residential sprinklers have been shown by extensive fire testing to provide better control than spray sprinklers in residential occupancies. These sprinklers are intended to prevent flashover in the room of fire origin, thus improving the chance for occupants to escape or be evacuated.

The protection area for residential sprinklers is defined in the listing of the sprinkler as a maximum square or rectangular area. Listing information is presented in even ~~2 ft (600 mm)~~ increments from 12 ft to 20 ft (3.7 m to 6.1 m). When a sprinkler is selected for an application, its area of coverage must be equal to or greater than both the length and width of the hazard area. For example, if the hazard to be protected is a room 13 ft 6 in. (4.1 m) wide and 17 ft 6 in. (5.3 m) long, a sprinkler that is listed to protect a rectangular area of 14 ft × 18 ft (4.3 m × 5.5 m) or a square area of 18 ft × 18 ft (5.5 m × 5.5 m) must be selected. The flow used in the calculations is then selected as the flow required by the listing for the selected coverage.

Residential sprinklers can only be used in corridors that lead to dwelling units. However, the corridors that lead to dwelling units can also lead to other hazards that are not dwelling units and can still be protected with residential sprinklers.

Submitter Information Verification

Submitter Full Name: AUT-SSI
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Tue Jun 27 15:36:12 EDT 2017

Committee Statement

Committee Statement: A recent revision occurred in UL 1626 that allows a residential sprinkler to utilize a 15 x 15 spacing. Based on this, a small change is suggested for the second sentence in the second paragraph of A.12.1.1. Public Comment closed for NFPA 13 several days before the revised UL 1626 was published.

Response Message:

Second Revision No. 521-NFPA 13-2017 [New Section after A.16.9.12.3.1]

A.16.10.4.6

See Figure A.16.10.4.6(a) and Figure A.16.10.4.6(b) .

Figure A.16.10.4.6(a) Unacceptable Pressure Gauge Location.

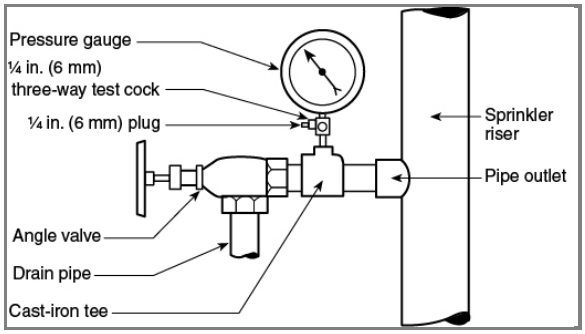
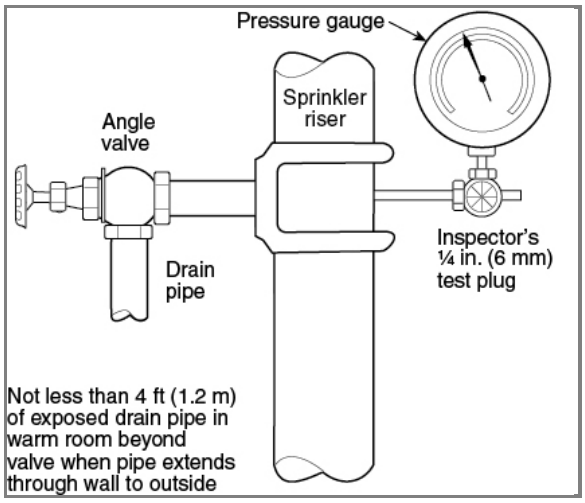


Figure A.16.10.4.6(b) Drain Connection for System Riser.



Submitter Information Verification

Submitter Full Name: AUT-SSI
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Fri Jul 14 15:29:19 EDT 2017

Committee Statement

Committee Statement: During the rewrite / editing Figure A.8.17.4.1 was deleted, with no substantiation or explanation. The illustration should be reinstated as Annex Section A.16.10.4.6. The missing figure has been part of NFPA 13 for a great many years (at least 45 to my knowledge). It has stood the test of time and provides extremely valuable information / guidance. It should not be lost as part of the editing process.

Response Message:

Public Comment No. 73-NFPA 13-2017 [New Section after A.16.9.12.3.1]

Public Comment No. 70-NFPA 13-2017 [New Section after A.16.9.12.3.1]

Second Revision No. 523-NFPA 13-2017 [Section No. F.1.2.6]

F.1.2.6 ASTM Publications.

ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959.

ASTM A126, *Standard Specification for Gray Iron ~~Casting~~ Castings for Valves, Flanges, and Pipe Fittings*, 2004, reapproved 2014.

ASTM A135/A135M, *Standard Specification for Electric-Resistance-Welded Steel Pipe*, 2009, reapproved 2014.

ASTM A197/A197M, *Standard Specification for Cupola Malleable Iron*, 2000, reapproved 2015.

ASTM A307, *Standard Specification for Carbon Steel Bolts, ~~and~~ Studs ~~and~~ , Threaded Rod 60,000 ~~PSI~~ psi Tensile Strength*, 2014.

ASTM A1023/A1023M, *Standard Specification for Stranded Carbon Steel Wire Ropes for General Purposes* , 2015.

ASTM A603, *Standard Specification for Zinc-Coated Steel Structural Wire Rope*, reapproved 2014.

ASTM B31, *Standards of Pressure Piping*, collection with various dates.

ASTM ~~C296/C296M~~ C136/C136M , *Standard ~~Specification for Asbestos-Cement Pressure Pipe~~ Test Method for Sieve Analysis of Fine and Coarse Aggregates* , ~~2000, reapproved 2015~~ 2014 .

ASTM C635/C635M, *Standard Specification for the Manufacture, Performance, and Testing of Metal Suspension Systems of Acoustical Tile and Lay-In Panel Ceilings*, 2013a.

ASTM C636/C636M, *Standard Practice for Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-In Panels*, 2013.

ASTM D2487, *Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)* , 2011.

ASTM E8/E8M, *Structural Test Method for Tension Testing of Metallic Materials*, 2015a.

ASTM E84, *Standard Test Method of Surface Burning Characteristics of Building Materials*, ~~2015b~~ 2016 .

ASTM E119, *Standard Test Methods for Fire Tests of Building Construction and Materials*, ~~2016~~ 2016a .

ASTM E580/E580M, *Standard Practice for Installation of Ceiling Suspension Systems for Acoustical Tile and Lay-in Panels in Areas Subject to Earthquake Ground Motions*, 2014.

ASTM F437, *Standard Specification for Threaded Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80*, 2015.

ASTM F438, *Standard Specification for Socket-Type Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 40*, 2015.

ASTM F439, *Standard Specification for Socket-Type Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80*, 2013.

ASTM F442/F442M, *Standard Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe (SDR-PR)*, 2013.

ASTM F2164, *Standard Practice for Field Leak Testing of Polyethylene (PE) and Crosslinked Polyethylene (PEX) Pressure Piping Systems Using Hydrostatic Pressure* , 2013.

Submitter Information Verification

Submitter Full Name: AUT-SSI
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Fri Jul 14 15:36:08 EDT 2017

Committee Statement

Committee Statement: date updates
Response Message:

Public Comment No. 57-NFPA 13-2017 [Section No. F.1.2.6]

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National Fire Protection Association

1 Batterymarch Park, Quincy, MA 02169-7471
Phone: 617-770-3000 • Fax: 617-770-0700 • www.nfpa.org

M E M O R A N D U M

TO: Technical Committee on Residential Sprinkler Systems

FROM: Elena Carroll, *Project Administrator*

DATE: November 1, 2017

SUBJECT: NFPA 13D Second Draft Technical Committee FINAL Ballot Results (A2018)

According to the final ballot results, all ballot items received the necessary affirmative votes to pass ballot.

31 **Members Eligible to Vote**
4 **Members Not Returned** (Cronin, O'Brian, Paez, Puchovsky)

Supplemental Ballot Results:

31 **Members Eligible to Vote**
4 **Members Not Returned** (Deegan, Ketner, Paez, Puchovsky)

The attached report shows the number of affirmative, negative, and abstaining votes as well as the explanation of the vote for **each** revision**.**

To pass ballot, **each** revision requires: (1) a simple majority of those eligible to vote and (2) an affirmative vote of $^{2}/_{3}$ of ballots returned. See Sections 3.3.4.3.(c) and 4.3.10.1 of the ***Regulations Governing the Development of NFPA Standards***.

Second Revision No. 17-NFPA 13D-2017 [Global Comment]

Update metric conversions in NFPA 13D to match that as shown on the attached list and pdf of NFPA 13D.

Supplemental Information

File Name	Description	Approved
Metric_values_used_in_NFPA_13..docx	Metric values used in NFPA 13, 13D & 13R	
NFPA_13D_Metric.pdf	NFPA 13D Metric	
NFPA_13D_Table_10.4.9.2_a_.xlsx	Metric values for Table 10.4.9.2(a)	
Table_10.4.9.2_c_.xlsx	Metric values for Table 10.4.9.2(c)	
Table_10.4.9.2_d_.xlsx	Metric values for Table 10.4.9.2(d)	
Table_10.4.9.2_e_.xlsx	Metric values for Table 10.4.9.2(e)	
Table_10.4.9.2_f_.xlsx	Metric values for Table 10.4.9.2(f)	
Table_10.4.9.2_g_.xlsx	Metric values for Table 10.4.9.2(g)	
Table_10.4.9.2_h_.xlsx	Metric values for Table 10.4.9.2(h)	
Table_A.10.4.4_a_.xlsx	Metric values for Table A.10.4.4(a)	
Table_A.10.4.4_b_.xlsx	Metric values for Table A.10.4.4(b)	
Table_A.10.4.4_c_.xlsx	Metric values for Table A.10.4.4(c)	
Table_A.10.4.4_d_.xlsx	Metric values for Table A.10.4.4(d)	

Submitter Information Verification

Submitter Full Name: David Hague
Organization: National Fire Protection Assoc
Street Address:
City:
State:
Zip:
Submittal Date: Thu Oct 12 10:30:08 EDT 2017

Committee Statement

Committee Statement: The metric conversions in the attached list are considered to be “soft” or approximate conversions and are intended to consider trade sizes for pipe and other materials and have been appropriately rounded with the number of significant digits taken into account. The intent of this list is to provide for consistent use of metric conversions throughout the standard with the understanding that it is acceptable for an engineer, authority having

jurisdiction, designer or, installer to use an exact conversion rather than an approximate conversion as used in the standard when necessary.

The attached list has been reviewed by the NFPA 13 Metric Task Group.

Response Message:

Ballot Results

✔ **This item has passed ballot**

31 Eligible Voters
4 Not Returned
24 Affirmative All
0 Affirmative with Comments
3 Negative with Comments
0 Abstention

Not Returned

Deegan, Thomas G.
Ketner, Charles W.
Paez, Ernie
Puchovsky, Milosh T.

Affirmative All

Bell, Kerry M.
Benn, Fred
Bradley, Frederick C.
Browning, Chase A.
Buuck, Daniel
Cronin, Bradford T.
Dannaway, Samuel S.
Feid, Jeffrey
Isman, Kenneth E.
Lugar, James R.
Nickelson, David A.
Noble, Thomas William
O'Brian, Michael
Pilette, Maurice M.
Schultz, Bruce
Schwab, Peter T.
Skare, Eric J.
Stanley, George W.
Towler, Michael

Townley, Donald R.

Van Walraven, Ed

Viola, John F.

Webb, Ronald N.

Yu, Hong-Zeng

Negative with Comment

Asp, Roland A.

I am voting negative on SR-17 for the reasons outlined in Terry Victors's Negative ballot. The limits outlined in the NFPA standards need to maintained and be consistent whether the metric or SI units are being used. It makes no sense to relax the requirements (using "soft conversions") when metric units are being applied. As stated in Terry Victors negative ballot, if using SI units, sprinklers are required under all obstructions 48 inches or more, it should not be permitted to reduce this requirement to 47 1/4 inches when using metric units. I agree that soft conversions makes sense in certain situations but I believe the committee needs to revisit the conditions when soft conversions are permissible and when hard conversions need to be required.

Nickson, Ronald G.

Support of comments by Terry Vector

Victor, Terry L.

The soft conversions shown in the ballot are problematic. Hard conversions will better serve the users of NFPA documents. We test sprinklers in the US and put limits on their use with maximum spacing, minimum pressure, area limitations, etc. Then we try to convert to metric and all rules are ignored. Instead of a hard conversion using decimals we offer a soft conversion by rounding off to the nearest unit or tenth or hundredth of a unit. When changing to a soft conversion the requirements are either relaxed slightly or are slightly more stringent. Example: Obstructions OVER 48” wide require sprinklers under the obstruction. When using the conversions offered by the NFPA, 48” becomes 1200 mm which is really 47 ¼”. In this case the conversion make the requirement more restrictive, and believe me I’ve seen many ducts that are exactly 48” wide and therefore shouldn’t require sprinklers under them. However with this conversion they will require sprinklers below them when installed outside the US. I reached out to our R&D office in Canada and Tyco Fire Protection Products contacted our colleagues in Europe and Asia. Everyone questioned responded that hard conversions using decimals are preferred. I will provide the NFPA with an Excel spreadsheet showing the inaccuracies created by using a soft conversion. Most dimensional conversions are off by 2%. This is unacceptable. In the same spreadsheet, conversions in UL1971 are included that show a very minimal variance when using a hard conversion with a one decimal conversion factor. The NFPA needs to go back to a more reasonable conversion scheme to minimize the variance in this SR.

Length					
.003”	.08 mm	7.5”	190 mm	26”	650 mm
.0315”	.8 mm	8”	200 mm	27.6”	690 mm
1/32”	0.8 mm	8.5”	215 mm	28”	700 mm
1/16”	1.6 mm	9”	225 mm	29”	725 mm
3/32”	2 mm	9.25”	230 mm	30”	750 mm
1/8”	3 mm	9.5”	240 mm	30.5”	765 mm
3/16”	5 mm	10”	250 mm	31”	775 mm
¼”	6 mm	11”	275 mm	32”	800 mm
5/16”	8 mm	11.5”	290 mm	33”	825 mm
3/8”	10 mm	12”	300 mm	35”	875 mm
½”	13 mm	12.25”	305 mm	35.4”	885 mm
17/32”	13 mm	12.5”	315 mm	36”	900 mm
9/16”	14 mm	12.75”	320 mm	37”	925 mm
5/8”	16 mm	14”	350 mm	38”	950 mm
¾”	19 mm	15”	375 mm	40”	1000 mm
7/8”	22 mm	15.5”	390 mm	42”	1050 mm
1”	25 mm	16”	400 mm	44”	1100 mm
1.5”	40 mm	16.25”	410 mm	47”	1175 mm
1.75”	45 mm	16.5”	415 mm	48”	1200 mm
2”	50 mm	17”	425 mm	54”	1350 mm
2.5”	65 mm	17.5”	440 mm	55”	1375 mm
2.75”	70 mm	18”	450 mm	57”	1425 mm
3”	75 mm	19”	475 mm	58”	1450 mm
3.5”	90 mm	20”	500 mm	66”	1650 mm
4”	100 mm	21”	525 mm	68”	1700 mm
4.5”	115 mm	22”	550 mm	72”	1800 mm
5”	125 mm	22.5”	565 mm	76”	1900 mm
5.5”	140 mm	23”	575 mm	78”	1950 mm
5.75”	145 mm	24”	600 mm	96”	2400 mm
6”	150 mm	25”	625 mm	102”	2550 mm
7”	175 mm	25.5”	640 mm	120”	3000 mm
				148”	3700 mm

Length					
3.5ft	1.1 m	10’-10”	3.3 m	22’-6”	6.9 m
3’-8”	1.1 m	11’-0”	3.4 m	24ft	7.3 m
4ft	1.2 m	11’-3”	3.4 m	25ft	7.6 m
4’-2”	1.3 m	11’-5”	3.5 m	25’-3”	7.7 m
4.5ft	1.4 m	11’-6”	3.5 m	26ft	7.9 m
4’-7”	1.4 m	11’-611/16”	3.5 m	27ft	8.2 m
4’-9”	1.4 m	11’-8”	3.6 m	28ft	8.5 m
5ft	1.5 m	12ft	3.7 m	28’-8”	8.7 m
5’-2”	1.6 m	12’-4”	3.8 m	29’-8”	9 m
5.5ft	1.7 m	13ft	4.0 m	30ft	9.1 m
5’-8”	1.7 m	13’-6”	4.1 m	32ft	10 m
5’-9 5/16”	1.8 m	13’-71/2”	4.2 m	33ft	10 m
6ft	1.8 m	13’-11”	4.2 m	35ft	11 m
6’-3”	1.9 m	14ft	4.3 m	36ft	11 m
6’-4”	1.9 m	14’-6”	4.4 m	40ft	12 m
6.5ft	2 m	15ft	4.6 m	41’-3”	13 m
6’-10”	2.1 m	15’-4”	4.7 m	45ft	14 m
7ft	2.1 m	16ft	4.9 m	50ft	15 m
7.5ft	2.3 m	16’-6”	5.0 m	51’-6”	16 m
7’-7”	2.3 m	16’-8”	5.1 m	55ft	17 m
7’-9”	2.4 m	17ft	5.2 m	60ft	18 m
8ft	2.4 m	18ft	5.5 m	65ft	20 m
8’-2”	2.5 m	18’-6”	5.6 m	70ft	21 m
8’-4”	2.5 m	19’-2”	5.8 m	75ft	23 m
8’-77/8”	2.6 m	19’-10”	6 m	76ft	23 m
9ft	2.7 m	19’-11”	6.1 m	80ft	24 m
9’-5”	2.9 m	20ft	6.1 m	100ft	30 m
9’-6”	2.9 m	20’-8”	6.3 m	200ft	61 m
10ft	3 m	21’-6”	6.6 m	250ft	76 m
10.5ft	3.2 m	21’-10”	6.7 m	300ft	91 m
10’-9”	3.3 m	22 ft	6.7 m	400ft	120 m

Area					
3.5 ft2	0.3 m2	256 ft2	24 m2	2,700 ft2	250 m2
6 ft2	0.6 m2	300 ft2	28 m2	2,734 ft2	255 m2
10 ft2	0.9 m2	306 ft2	28 m2	2,800 ft2	260 m2
12 ft2	1.1 m2	324 ft2	30 m2	3,000 ft2	280 m2
16 ft2	1.5 m2	395 ft2	37 m2	3,250 ft2	300 m2
18 ft2	1.7m2	400 ft2	37 m2	3,300 ft2	305 m2
20 ft2	1.9m2	450 ft2	42 m2	3,450 ft2	320 m2
24 ft2	2.2m2	504 ft2	47 m2	3,500 ft2	325 m2
25 ft2	2.3 m2	585 ft2	54 m2	3,600 ft2	335 m2
32 ft2	3.0 m2	600 ft2	56 m2	3,750 ft2	350 m2
50 ft2	4.6 m2	648 ft2	60 m2	3,900 ft2	360 m2
55 ft2	5.1 m2	700 ft2	65 m2	4,000 ft2	370 m2
64 ft2	5.9 m2	756 ft2	70 m2	4,100 ft2	380 m2
70 ft2	6.5 m2	768 ft2	71 m2	4,500 ft2	420 m2
80 ft2	7.4 m2	800 ft2	74 m2	4,800 ft2	445 m2
90 ft2	8.4 m2	1,000 ft2	93 m2	5,000 ft2	465 m2
100 ft2	9 m2	1,200ft2	112 m2	6,000 ft2	555 m2
110 ft2	10 m2	1,300 ft2	120 m2	6,400 ft2	595 m2
120 ft2	11 m2	1,365 ft2	125 m2	8,000 ft2	740 m2
124 ft2	12 m2	1,400 ft2	130 m2	8,800 ft2	820 m2
130 ft2	12 m2	1,500 ft2	140 m2	10,000 ft2	930 m2
144 ft2	13 m2	1,700 ft2	160 m2	13,100 ft2	1 215 m2
150 ft2	14 m2	1,800 ft2	165 m2	25,000 ft2	2 320 m2
168 ft2	16 m2	1,950 ft2	180 m2	40,000 ft2	3 720 m2
175 ft2	16 m2	2,000 ft2	185 m2	50,000 ft2	4 650 m2
196 ft2	18 m2	2,300 ft2	215 m2	52,000 ft2	4 830 m2
200 ft2	18 m2	2,500 ft2	230m2	100,000 ft2	9 230 m2
225 ft2	20 m2	2,535 ft2	235 m2		
250 ft2	23 m2	2,600 ft2	240 m2		

Volume			
1.76 cuin	28 ml	160 ft3	4.5 m3
15.5 ft3	0.5 m3	400 ft3	11 m3
17.4 ft3	0.5 m3	1,000 ft3	28 m3
17.6 ft3	0.5 m3	1,800 ft3	51 m3
20.7 ft3	0.6 m3	2,100 ft3	59 m3
21.1 ft3	0.6 m3	2,300 ft3	65 m3
22 ft3	0.6 m3	6,500 ft3	184 m3
100 ft3	2.8 m3	2.25M ft3	63,720 m3

Capacity	
16 oz.	0.5 l
32 oz.	1 l
1 gal	4 l
5 gal	20 l
40 gal	150 l
100 gal	380 l
150 gal	570 l
250 gal	950 l
500 gal	1900 l
750 gal	2850 l
300,000 gal	1,135,500 l

Drill Size	
3/32”	2,3 mm
1/8”	3,2 mm
3/8”	10 mm

Density of Cotton Bales	
22.0 lb/ft^3	350 kg/m^3
22.7 lb/ft^3	365 kg/m^3
24.2 lb/ft^3	390 kg/m^3
28.4 lb/ft^3	455 kg/m^3
28.7 lb/ft^3	460 kg/m^3
32.2 lb/ft^3	515 kg/m^3

Flow					
30 gpm	115 lpm	300 gpm	1150 lpm	1000 gpm	3800 lpm
15 gpm	57 lpm	400 gpm	1500 lpm	1500 gpm	5700 lpm
20 gpm	75 lpm	500 gpm	1900 lpm	1992 gpm	7540 lpm
50 gpm	190 lpm	600 gpm	2250 lpm	1993 gpm	7543 lpm
60 gpm	230 lpm	700 gpm	2650 lpm	2156 gpm	8160 lpm
100 gpm	380 lpm	750 gpm	2850 lpm	2575 gpm	9750 lpm
102.8 gpm	390 lpm	800 gpm	3050 lpm	4907 gpm	18,572 lpm
200 gpm	760 lpm	850 gpm	3200 lpm		
215.8 gpm	815 lpm	900 gpm	3400 lpm		
250 gpm	950 lpm				

Pressure			
5 psi	0.3 bar	75	5.2 bar
7	0.5 bar	90	6.2 bar
10	0.7 bar	100	6.9 bar
11	.8 bar	150	10 bar
15	1.0 bar	165	11 bar
20	1.4 bar	175	12 bar
22	15 bar	189	13 bar
25	1.7 bar	200	14 bar
30	2.1 bar	259	17 bar
35	2.4 bar	300	21 bar
50	3.4 bar	400	28 bar
63	4.3 bar		

Gauge	
12	2.8 mm
14	1.98 mm
16	1.57 mm
22	.78 mm
24	.63mm

Weight			
6 lb	2.7 kg	350 lb	160 kg
10 lb	4.5 kg	440 lb	200 kg
20 lb	9.1 kg	520 lb	235 kg
40 lb	18 kg	750 lb	340 kg
61 lb	27 kg	787 lb	355 kg
91 lb	41 kg	1200 lb	544 kg
131 lb	59 kg	1634 lb	740 kg
200 lb	91 kg	2000 lb	907 kg
250 lb	115 kg	2300 lb	1043 kg
		4000 lb	1815 kg

Velocity	
30 mph	49 km/h

Discharge Density			
gpm/ft2	mm/min	gpm/ft2	mm/min
.005	.2	.425	17.3
.05	2.04	.426	17.4
.1	4.1	.44	17.9
.15	6.1	.45	18.3
.16	6.5	.46	18.7
.17	7.0	.49	20
.18	7.3	.5	20.4
.19	7.7	.55	22.4
.2	8.2	.56	22.8
.21	8.6	.57	23.2
.225	9.2	.6	24.5
.24	9.8	.61	24.9
.25	10.2	.65	26.5
.26	10.6	.68	27.7
.28	11.4	.7	28.5
.29	11.8	.74	30.2
.3	12.2	.75	30.6
.31	12.6	.77	31.4
.32	13.0	.8	32.6
.33	13.4	.85	34.6
.34	13.9	.9	36.7
.35	14.3	.92	37.5
.37	15.1	.96	39.1
.375	15.3	1.1	44.8
.39	15.9	1.2	48.9
.4	16.3	6.0	245
.42	17.1	7.5	306

Table 10.4.9.2(a) Water Service Pressure Loss (PL_{svc})

	20 mm pipe				25 mm Pipe				32 mm Pipe			
Rate* (lpm)	12 m or less	13 m to 23 m	23 m to 30 m	31 m to 49 m	12 m or less	13 m to 23 m	23 m to 30 m	31 m to 49 m	12 m or less	13 m to 23 m	23 m to 30 m	31 m to 49 m
30	0.4	0.6	0.8	1.2	0.1	0.2	0.2	0.4	0.0	0.1	0.1	0.1
38	0.5	0.9	1.2	1.8	0.2	0.3	0.4	0.5	0.1	0.1	0.1	0.2
45	0.7	1.3	1.7	NP	0.2	0.4	0.5	0.7	0.1	0.1	0.2	0.3
53	1.0	1.7	NP	NP	0.3	0.5	0.7	1.0	0.1	0.2	0.2	0.4
61	1.3	NP	NP	NP	0.4	0.6	0.9	1.3	0.1	0.2	0.3	0.5
68	1.6	NP	NP	NP	0.5	0.8	1.1	1.6	0.2	0.3	0.4	0.6
76	1.9	NP	NP	NP	0.6	1.0	1.3	1.9	0.2	0.4	0.5	0.7
83	NP	NP	NP	NP	0.7	1.1	1.5	NP	0.3	0.4	0.6	0.9
91	NP	NP	NP	NP	0.8	1.3	1.8	NP	0.3	0.5	0.7	1.0
98	NP	NP	NP	NP	0.9	1.5	NP	NP	0.3	0.6	0.8	1.2
106	NP	NP	NP	NP	1.0	1.8	NP	NP	0.4	0.7	0.9	1.3
114	NP	NP	NP	NP	1.2	NP	NP	NP	0.4	0.8	1.0	1.5
121	NP	NP	NP	NP	1.3	NP	NP	NP	0.5	0.9	1.2	1.7
129	NP	NP	NP	NP	1.5	NP	NP	NP	0.6	1.0	1.3	NP
136	NP	NP	NP	NP	1.7	NP	NP	NP	0.6	1.1	1.4	NP
8	5.1	8.7	11.8	17.4	1.5	2.5	3.4	5.1	0.6	1	1.3	1.9
10	7.7	13.1	17.8	26.3	2.3	3.8	5.2	7.7	0.8	1.4	2	2.9
12	10.8	18.4	24.9	NP	3.2	5.4	7.3	10.7	1.2	2	2.7	4
14	14.4	24.5	NP	NP	4.2	7.1	9.6	14.3	1.6	2.7	3.6	5.4
16	18.4	NP	NP	NP	5.4	9.1	12.4	18.3	2	3.4	4.7	6.9
18	22.9	NP	NP	NP	6.7	11.4	15.4	22.7	2.5	4.3	5.8	8.6
20	27.8	NP	NP	NP	8.1	13.8	18.7	27.6	3.1	5.2	7	10.4
22	NP	NP	NP	NP	9.7	16.5	22.3	NP	3.7	6.2	8.4	12.4
24	NP	NP	NP	NP	11.4	19.3	26.2	NP	4.3	7.3	9.9	14.6
26	NP	NP	NP	NP	13.2	22.4	NP	NP	5	8.5	11.4	16.9
28	NP	NP	NP	NP	15.1	25.7	NP	NP	5.7	9.7	13.1	19.4
30	NP	NP	NP	NP	17.2	NP	NP	NP	6.5	11	14.9	22
32	NP	NP	NP	NP	19.4	NP	NP	NP	7.3	12.4	16.8	24.8
34	NP	NP	NP	NP	21.7	NP	NP	NP	8.2	13.9	18.8	NP
36	NP	NP	NP	NP	24.1	NP	NP	NP	9.1	15.4	20.9	NP

essure loss exceeds reasonable limits.

Notes:

local plumbing code and are based on an SDR of 11 and a Hazen- Williams*C* factor of 150.

or actual lengths up to 100 ft (30.5 m) and 15 percent length increase for actual lengths over 100 ft (30.5 m)

te required by 10.4.9.2, Step 4, where the water service pipe supplies more than one dwelling

Table 10.4.9.2(c) Allowable Pipe Length for 20 mm Type M Copper Water Tubing										
Sprinkler Flow Rate (lpm)	Available Pressure *Pt* (bar)									
	15	20	25	30	35	40	45	50	55	60
	Allowable Length of pipe from Service Valve to Farthest Sprinkler (m)									
30	66	88	110	132	154	176	198	220	242	264
34	53	71	89	106	124	142	159	177	195	212
38	44	58	73	87	102	117	131	146	160	175
42	37	49	61	73	86	98	110	122	134	147
45	31	42	52	62	73	83	94	104	114	125
49	27	36	45	54	63	72	81	90	99	108
53	23	31	39	47	55	62	70	78	86	94
57	21	27	34	41	48	55	62	69	76	83
61	18	24	30	37	43	49	55	61	67	73
64	16	22	27	33	38	44	49	55	60	66
68	15	20	25	30	34	39	44	49	54	59
72	13	18	22	27	31	36	40	45	49	53
76	12	16	20	24	28	32	36	41	45	48
79	11	15	19	22	26	30	33	37	41	44
83	10	13	17	20	24	27	30	34	37	41
87	9.4	12	16	19	22	25	28	31	34	37
91	8.5	12	14	17	20	23	26	29	32	35
95	7.9	11	13	16	19	21	24	27	30	32
98	7.3	10	12	15	17	20	22	25	27	30
102	7.0	9.1	12	14	16	19	21	23	26	28
106	6.4	8.5	11	13	15	17	20	22	24	26
110	6.1	8.2	10	12	14	16	18	20	22	24
114	5.8	7.6	9.4	12	13	15	17	19	21	23
117	5.5	7.3	8.8	11	12	14	16	18	20	22
121	5.2	6.7	8.5	10	12	13	15	17	19	20
125	4.9	6.4	7.9	9.8	11	13	14	16	18	19
129	NP	6.1	7.6	9.1	11	12	14	15	17	18
132	NP	5.8	7.3	8.5	10	12	13	14	16	17
136	NP	5.5	6.7	8.2	9.4	11	12	14	15	16
140	NP	5.2	6.4	7.9	9.1	10	12	13	14	16
144	NP	4.9	6.1	7.3	8.5	9.8	11	12	14	15
148	NP	4.6	5.8	7.0	8.2	9.4	11	12	13	14
151	NP	NP	5.5	6.7	7.9	8.8	10	11	12	13

8	¼	217	289	361	434	506	578	650	723	795	867
9	¼	174	232	291	349	407	465	523	581	639	697
##########	¼	143	191	239	287	335	383	430	478	526	574
##########	¼	120	160	200	241	281	321	361	401	441	481
##########	¼	102	137	171	205	239	273	307	341	375	410
##########	¼	88	118	147	177	206	235	265	294	324	353
##########	¼	77	103	128	154	180	205	231	257	282	308
##########	¼	68	90	113	136	158	181	203	226	248	271
##########	¼	60	80	100	120	140	160	180	200	220	241
##########	¼	54	72	90	108	125	143	161	179	197	215
##########	¼	48	64	81	97	113	129	145	161	177	193
##########	¼	44	58	73	88	102	117	131	146	160	175
##########	¼	40	53	66	80	93	106	119	133	146	159
##########	¼	36	48	61	73	85	97	109	121	133	145
##########	¼	33	44	56	67	78	89	100	111	122	133
##########	¼	31	41	51	61	72	82	92	102	113	123
##########	¼	28	38	47	57	66	76	85	95	104	114
##########	¼	26	35	44	53	61	70	79	88	97	105
##########	¼	24	33	41	49	57	65	73	82	90	98
##########	¼	23	30	38	46	53	61	69	76	84	91
##########	¼	21	28	36	43	50	57	64	71	78	85
##########	¼	20	27	33	40	47	53	60	67	73	80
##########	¼	19	25	31	38	44	50	56	63	69	75
##########	¼	18	24	29	35	41	47	53	59	65	71
##########	¼	17	22	28	33	39	44	50	56	61	67
##########	¼	16	21	26	32	37	42	47	53	58	63
##########	¼	NP	20	25	30	35	40	45	50	55	60
##########	¼	NP	19	24	28	33	38	42	47	52	57
##########	¼	NP	18	22	27	31	36	40	45	49	54
##########	¼	NP	17	21	26	30	34	38	43	47	51
##########	¼	NP	16	20	24	28	32	36	40	45	49
##########	¼	NP	15	19	23	27	31	35	39	42	46
##########	¼	NP	NP	18	22	26	29	33	37	40	44

Table 10.4.9.2(d) Allowable Pipe Length for 25 mm Type M Copper Water Tubing

Sprinkler Flow Rate (lpm)	Available Pressure *Pt* (bar)									
	15	20	25	30	35	40	45	50	55	60
	Allowable Length of pipe from Service Valve to Farthest Sprinkler (m)									
30	246	328	409	491	573	655	737	819	901	983
34	198	263	329	395	461	527	593	659	725	790
38	162	217	271	325	379	433	488	542	596	650
42	136	182	227	272	318	363	409	454	500	545
45	116	155	193	232	271	309	348	387	426	464
49	100	134	167	200	233	267	300	333	367	400
53	87	116	145	174	204	233	262	291	320	349
57	77	102	128	154	179	205	230	256	282	307
61	68	91	114	136	159	182	205	227	250	272
64	61	81	101	122	142	162	183	203	223	244
68	55	73	91	110	128	146	164	183	201	219
72	50	66	83	99	116	132	149	165	182	198
76	45	60	75	90	105	120	135	150	166	180
79	41	55	69	82	96	110	124	137	151	165
83	38	50	63	76	88	101	113	126	139	151
87	35	46	58	69	81	93	105	116	128	139
91	32	43	54	64	75	86	97	107	118	129
95	30	40	50	60	69	80	90	99	109	119
98	28	37	46	55	65	74	83	93	102	111
102	26	34	43	52	60	69	78	86	95	104
106	24	32	40	48	56	65	73	81	89	97
110	23	30	38	45	53	60	68	76	83	91
114	21	28	35	43	50	57	64	71	78	85
117	20	27	34	40	47	53	60	67	73	80
121	19	25	31	38	44	50	57	63	69	76
125	18	24	30	36	42	48	54	59	66	71
129	17	23	28	34	39	45	51	56	62	68
132	16	21	27	32	37	43	48	53	59	64
136	15	20	25	30	35	41	46	51	56	61
140	14	19	24	29	34	38	43	48	53	58
144	14	18	23	27	32	37	41	46	50	55
148	13	17	22	26	30	35	39	44	48	52
151	12	17	21	25	29	33	37	42	46	50

8	806	1075	1343	1612	1881	2149	2418	2687	2955	3224
9	648	864	1080	1296	1512	1728	1945	2161	2377	2593
10	533	711	889	1067	1245	1422	1600	1778	1956	2134
11	447	596	745	894	1043	1192	1341	1491	1640	1789
12	381	508	634	761	888	1015	1142	1269	1396	1523
13	328	438	547	657	766	875	985	1094	1204	1313
14	286	382	477	572	668	763	859	954	1049	1145
15	252	336	420	504	588	672	756	840	924	1008
16	224	298	373	447	522	596	671	745	820	894
17	200	266	333	400	466	533	600	666	733	799
18	180	240	300	360	420	479	539	599	659	719
19	163	217	271	325	380	434	488	542	597	651
20	148	197	247	296	345	395	444	493	543	592
21	135	180	225	270	315	360	406	451	496	541
22	124	165	207	248	289	331	372	413	455	496
23	114	152	190	228	267	305	343	381	419	457
24	106	141	176	211	246	282	317	352	387	422
25	98	131	163	196	228	261	294	326	359	392
26	91	121	152	182	212	243	273	304	334	364
27	85	113	142	170	198	226	255	283	311	340
28	79	106	132	159	185	212	238	265	291	318
29	74	99	124	149	174	198	223	248	273	298
30	70	93	116	140	163	186	210	233	256	280
31	66	88	110	132	153	175	197	219	241	263
32	62	83	103	124	145	165	186	207	227	248
33	59	78	98	117	137	156	176	195	215	234
34	55	74	92	111	129	148	166	185	203	222
35	53	70	88	105	123	140	158	175	193	210
36	50	66	83	100	116	133	150	166	183	199
37	47	63	79	95	111	126	142	158	174	190
38	45	60	75	90	105	120	135	150	165	181
39	43	57	72	86	100	115	129	143	158	172
40	41	55	68	82	96	109	123	137	150	164

Table 10.4.9.2(e) Allowable Pipe Length for 20 mm CPVC (IPS) Pipe

Sprinkler Flow Rate (lpm)	Available Pressure *Pt* (bar)									
	15	20	25	30	35	40	45	50	55	60
	Allowable Length of pipe from Service Valve to Farthest Sprinkler (m)									
30	106	142	177	212	248	283	319	354	390	425
34	85	114	142	171	199	228	256	285	313	342
38	70	94	117	141	164	187	211	234	258	281
42	59	79	98	118	137	157	177	196	216	236
45	50	67	84	100	117	134	151	167	184	201
49	43	58	72	87	101	115	130	144	158	173
53	38	50	63	75	88	101	113	126	138	151
57	33	44	55	66	77	88	100	111	122	133
61	30	39	49	59	69	79	88	98	108	118
64	26	35	44	53	62	70	79	88	97	105
68	24	32	40	47	55	63	71	79	87	95
72	21	29	36	43	50	57	64	71	79	86
76	20	26	33	39	45	52	59	65	72	78
79	18	24	30	36	41	48	53	59	65	71
83	16	22	27	33	38	44	49	55	60	65
87	15	20	25	30	35	40	45	50	55	60
91	14	19	23	28	33	37	42	46	51	56
95	13	17	22	26	30	34	39	43	47	52
98	12	16	20	24	28	32	36	40	44	48
102	11	15	19	22	26	30	34	37	41	45
106	10	14	17	21	24	28	31	35	38	42
110	10	13	16	20	23	26	29	33	36	39
114	9.1	12	15	18	21	25	28	31	34	37
117	8.5	12	14	17	20	23	26	29	32	35
121	8.2	11	14	16	19	22	24	27	30	33
125	7.6	10	13	16	18	21	23	26	28	31
129	7.3	10	12	15	17	20	22	24	27	29
132	7.0	9.1	12	14	16	19	21	23	25	28
136	6.7	8.8	11	13	15	17	20	22	24	26
140	6.1	8.2	10	12	15	17	19	21	23	25
144	6.1	7.9	10	12	14	16	18	20	22	24
148	5.8	7.6	9.4	11	13	15	17	19	21	23
151	5.5	7.3	9.1	11	12	14	16	18	20	22

8	348	465	581	697	813	929	1045	1161	1278	1394
9	280	374	467	560	654	747	841	934	1027	1121
10	231	307	384	461	538	615	692	769	845	922
11	193	258	322	387	451	515	580	644	709	773
12	165	219	274	329	384	439	494	549	603	658
13	142	189	237	284	331	378	426	473	520	568
14	124	165	206	247	289	330	371	412	454	495
15	109	145	182	218	254	290	327	363	399	436
16	97	129	161	193	226	258	290	322	354	387
17	86	115	144	173	202	230	259	288	317	346
18	78	104	130	155	181	207	233	259	285	311
19	70	94	117	141	164	188	211	234	258	281
20	64	85	107	128	149	171	192	213	235	256
21	58	78	97	117	136	156	175	195	214	234
22	54	71	89	107	125	143	161	179	197	214
23	49	66	82	99	115	132	148	165	181	198
24	46	61	76	91	107	122	137	152	167	183
25	42	56	71	85	99	113	127	141	155	169
26	39	52	66	79	92	105	118	131	144	157
27	37	49	61	73	86	98	110	122	135	147
28	34	46	57	69	80	92	103	114	126	137
29	32	43	54	64	75	86	96	107	118	129
30	30	40	50	60	70	81	91	101	111	121
31	28	38	47	57	66	76	85	95	104	114
32	27	36	45	54	63	71	80	89	98	107
33	25	34	42	51	59	68	76	84	93	101
34	24	32	40	48	56	64	72	80	88	96
35	23	30	38	45	53	61	68	76	83	91
36	22	29	36	43	50	57	65	72	79	86
37	20	27	34	41	48	55	61	68	75	82
38	20	26	33	39	46	52	59	65	72	78
39	19	25	31	37	43	50	56	62	68	74
40	18	24	30	35	41	47	53	59	65	71

Table 10.4.9.2(f) Allowable Pipe Length for 25 mm CPVC (IPS) Pipe										
Sprinkler Flow Rate (lpm)	Available Pressure *Pt* (bar)									
	15	20	25	30	35	40	45	50	55	60
	Allowable Length of pipe from Service Valve to Farthest Sprinkler (m)									
30	320	426	533	639	746	853	959	1066	1172	1279
34	257	343	429	514	600	685	771	857	943	1028
38	212	282	353	423	493	564	635	705	776	846
42	177	237	296	355	414	473	532	591	650	709
45	151	201	252	302	352	403	453	503	554	604
49	130	174	217	260	304	347	390	434	477	521
53	113	151	189	227	265	303	340	378	416	454
57	100	133	166	200	233	266	300	333	366	400
61	89	118	148	177	207	237	266	296	325	355
64	79	106	132	158	185	211	238	264	291	317
68	71	95	119	143	166	190	214	238	262	285
72	65	86	108	129	151	172	194	215	237	258
76	59	78	98	117	137	156	176	196	215	235
79	54	72	89	107	125	143	161	179	197	215
83	49	66	82	98	115	131	148	164	180	197
87	45	60	76	91	106	121	136	151	166	181
91	42	56	70	84	98	112	126	140	154	168
95	39	52	65	78	91	104	116	130	142	155
98	36	48	60	72	84	96	108	120	132	144
102	34	45	56	67	79	90	101	112	123	135
106	31	42	52	63	73	84	94	105	116	126
110	30	39	49	59	69	79	88	98	108	118
114	28	37	46	55	65	74	83	92	101	111
117	26	35	44	52	61	69	78	87	96	104
121	25	33	41	49	57	66	74	82	90	98
125	23	31	39	46	54	62	70	77	85	93
129	22	29	37	44	51	59	66	73	81	88
132	21	28	35	42	49	55	62	69	77	83
136	20	27	33	40	46	53	59	66	73	79
140	19	25	31	37	44	50	56	63	69	75
144	18	24	30	36	42	48	54	60	66	72
148	17	23	28	34	40	45	51	57	62	68
151	16	22	27	33	38	43	49	54	60	65

8	#	1398	1748	2098	2447	2797	3146	3496	3845	4195
9	#	1125	1406	1687	1968	2249	2530	2811	3093	3374
10	#	925	1157	1388	1619	1851	2082	2314	2545	2776
11	#	776	970	1164	1358	1552	1746	1940	2133	2327
12	#	660	826	991	1156	1321	1486	1651	1816	1981
13	#	570	712	854	997	1139	1281	1424	1566	1709
14	#	497	621	745	869	993	1117	1241	1366	1490
15	#	437	546	656	765	874	983	1093	1202	1311
16	#	388	485	582	679	776	873	970	1067	1164
17	#	347	433	520	607	693	780	867	954	1040
18	#	312	390	468	546	624	702	780	858	936
19	#	282	353	423	494	565	635	706	776	847
20	#	257	321	385	449	513	578	642	706	770
21	#	235	293	352	410	469	528	586	645	704
22	#	215	269	323	377	430	484	538	592	646
23	#	198	248	297	347	396	446	496	545	595
24	#	183	229	275	321	366	412	458	504	550
25	#	170	212	255	297	340	382	425	467	510
26	#	158	197	237	276	316	355	395	434	474
27	#	147	184	221	258	295	332	368	405	442
28	#	138	172	207	241	275	310	344	379	413
29	#	129	161	194	226	258	290	323	355	387
30	#	121	152	182	212	242	273	303	333	364
31	#	114	143	171	200	228	257	285	314	342
32	#	108	134	161	188	215	242	269	296	323
33	#	102	127	152	178	203	229	254	280	305
34	#	96	120	144	168	192	216	240	265	289
35	#	91	114	137	160	182	205	228	251	273
36	#	87	108	130	151	173	195	216	238	260
37	#	82	103	123	144	165	185	206	226	247
38	#	78	98	117	137	157	176	196	215	235
39	#	75	93	112	131	149	168	187	205	224
40	#	71	89	107	125	142	160	178	196	214

Table 10.4.9.2(g) Allowable Pipe Length for 20 mm PEX Tubing

Sprinkler Flow Rate (lpm)	Available Pressure *Pt* (bar)									
	15	20	25	30	35	40	45	50	55	60
	Allowable Length of pipe from Service Valve to Farthest Sprinkler (m)									
30	28	37	47	56	66	75	85	94	103	113
34	23	30	38	45	53	61	68	76	83	91
38	19	25	31	37	44	50	56	62	69	75
42	16	21	26	31	37	42	47	52	57	62
45	13	18	22	27	31	36	40	45	49	53
49	12	15	19	23	27	31	34	38	42	46
53	10	13	17	20	23	27	30	34	37	40
57	9	12	15	18	21	23	27	29	32	35
61	8	10	13	16	18	21	23	26	29	31
64	7	9	12	14	16	19	21	23	26	28
68	6	9	10	12	15	17	19	21	23	25
72	6	8	9	11	13	15	17	19	21	23
76	5	7	9	10	12	14	16	17	19	21
79	5	6	8	9	11	12	14	16	17	19
83	NP	6	7	9	10	12	13	14	16	17
87	NP	5	7	8	9	11	12	13	15	16
91	NP	5	6	7	9	10	11	12	13	15
95	NP	NP	6	7	8	9	10	11	12	14
98	NP	NP	5	6	7	9	9	11	12	13
102	NP	NP	5	6	7	8	9	10	11	12
106	NP	NP	5	5	6	7	8	9	10	11
110	NP	NP	NP	5	6	7	8	9	9	10
114	NP	NP	NP	5	6	6	7	8	9	10
117	NP	NP	NP	5	5	6	7	8	9	9
121	NP	NP	NP	NP	5	6	6	7	8	9
125	NP	NP	NP	NP	5	5	6	7	8	8
129	NP	NP	NP	NP	NP	5	6	6	7	8
132	NP	NP	NP	NP	NP	5	5	6	7	7
136	NP	NP	NP	NP	NP	5	5	6	6	7
140	NP	NP	NP	NP	NP	NP	5	5	6	7
144	NP	NP	NP	NP	NP	NP	5	5	6	6
148	NP	NP	NP	NP	NP	NP	NP	5	5	6
151	NP	NP	NP	NP	NP	NP	NP	5	5	6

8	93	123	154	185	216	247	278	309	339	370
9	74	99	124	149	174	199	223	248	273	298
10	61	82	102	123	143	163	184	204	225	245
11	51	68	86	103	120	137	154	171	188	205
12	44	58	73	87	102	117	131	146	160	175
13	38	50	63	75	88	101	113	126	138	151
14	33	44	55	66	77	88	99	110	121	132
15	29	39	48	58	68	77	87	96	106	116
16	26	34	43	51	60	68	77	86	94	103
17	23	31	38	46	54	61	69	77	84	92
18	21	28	34	41	48	55	62	69	76	83
19	19	25	31	37	44	50	56	62	69	75
20	17	23	28	34	40	45	51	57	62	68
21	16	21	26	31	36	41	47	52	57	62
22	NP	19	24	28	33	38	43	47	52	57
23	NP	17	22	26	31	35	39	44	48	52
24	NP	16	20	24	28	32	36	40	44	49
25	NP	NP	19	22	26	30	34	37	41	45
26	NP	NP	17	21	24	28	31	35	38	42
27	NP	NP	16	20	23	26	29	33	36	39
28	NP	NP	15	18	21	24	27	30	33	36
29	NP	NP	NP	17	20	23	26	28	31	34
30	NP	NP	NP	16	19	21	24	27	29	32
31	NP	NP	NP	15	18	20	23	25	28	30
32	NP	NP	NP	NP	17	19	21	24	26	28
33	NP	NP	NP	NP	16	18	20	22	25	27
34	NP	NP	NP	NP	NP	17	19	21	23	25
35	NP	NP	NP	NP	NP	16	18	20	22	24
36	NP	NP	NP	NP	NP	15	17	19	21	23
37	NP	NP	NP	NP	NP	NP	16	18	20	22
38	NP	NP	NP	NP	NP	NP	16	17	19	21
39	NP	NP	NP	NP	NP	NP	NP	16	18	20
40	NP	NP	NP	NP	NP	NP	NP	16	17	19

Table 10.4.9.2(h) Allowable Pipe Length for 25 mm PEX Tubing

Sprinkler Flow Rate (lpm)	Available Pressure *Pt* (bar)									
	15	20	25	30	35	40	45	50	55	60
	Allowable Length of pipe from Service Valve to Farthest Sprinkler (m)									
30	96	127	159	191	223	255	287	319	351	383
34	77	102	128	154	180	205	231	256	282	308
38	63	84	105	126	148	169	190	211	232	253
42	53	71	88	106	124	141	159	177	194	212
45	45	60	75	90	105	120	136	151	166	181
49	39	52	65	78	91	104	117	130	143	156
53	34	45	57	68	79	91	102	113	125	136
57	30	40	50	60	70	80	90	100	110	119
61	27	35	44	53	62	71	80	88	97	106
64	24	32	40	48	55	63	71	79	87	95
68	21	28	36	43	50	57	64	71	78	85
72	19	26	32	39	45	52	58	64	71	77
76	18	23	29	35	41	47	53	59	64	70
79	16	21	27	32	37	43	48	53	59	64
83	15	20	24	30	34	39	44	49	54	59
87	13	18	23	27	32	36	41	45	50	54
91	12	17	21	25	29	34	37	42	46	50
95	12	16	20	23	27	31	35	39	43	46
98	11	14	18	22	25	29	32	36	40	43
102	10	13	17	20	23	27	30	34	37	40
106	9.4	12	16	19	22	25	28	31	34	38
110	8.8	12	15	18	21	23	27	30	32	35
114	8.2	11	14	16	19	22	25	28	30	33
117	7.9	10	13	16	18	21	23	26	29	31
121	7.3	10	12	15	17	20	22	24	27	30
125	7.0	9.1	12	14	16	19	21	23	26	28
129	6.7	8.8	11	13	15	18	20	22	24	26
132	6.1	8.2	10	12	15	17	19	21	23	25
136	5.8	7.9	10	12	14	16	18	20	22	24
140	5.5	7.6	9.4	11	13	15	17	19	21	23
144	5.5	7.0	8.8	11	12	14	16	18	20	21
148	5.2	6.7	8.5	10	12	14	15	17	19	20
151	4.9	6.4	8.2	10	11	13	15	16	18	20

8	#########	#########	#########	#########	#########	#########	#########	#########	#########	#########
9	#########	#########	#########	#########	#########	#########	#########	#########	#########	#########
10	#########	#########	#########	#########	#########	#########	#########	#########	#########	#########
11	#########	#########	#########	#########	#########	#########	#########	#########	#########	#########
12	#########	#########	#########	#########	#########	#########	#########	#########	#########	#########
13	#########	#########	#########	#########	#########	#########	#########	#########	#########	#########
14	#########	#########	#########	#########	#########	#########	#########	#########	#########	#########
15	#########	#########	#########	#########	#########	#########	#########	#########	#########	#########
16	#########	#########	#########	#########	#########	#########	#########	#########	#########	#########
17	#########	#########	#########	#########	#########	#########	#########	#########	#########	#########
18	#########	#########	#########	#########	#########	#########	#########	#########	#########	#########
19	#########	#########	#########	#########	#########	#########	#########	#########	#########	#########
20	#########	#########	#########	#########	#########	#########	#########	#########	#########	#########
21	#########	#########	#########	#########	#########	#########	#########	#########	#########	#########
22	#########	#########	#########	#########	#########	#########	#########	#########	#########	#########
23	#########	#########	#########	#########	#########	#########	#########	#########	#########	#########
24	#########	#########	#########	#########	#########	#########	#########	#########	#########	#########
25	#########	#########	#########	#########	#########	#########	#########	#########	#########	#########
26	#########	#########	#########	#########	#########	#########	#########	#########	#########	#########
27	#########	#########	#########	#########	#########	#########	#########	#########	#########	#########
28	#########	#########	#########	#########	#########	#########	#########	#########	#########	#########
29	#########	#########	#########	#########	#########	#########	#########	#########	#########	#########
30	#########	#########	#########	#########	#########	#########	#########	#########	#########	#########
31	#########	#########	#########	#########	#########	#########	#########	#########	#########	#########
32	#########	#########	#########	#########	#########	#########	#########	#########	#########	#########
33	#########	#########	#########	#########	#########	#########	#########	#########	#########	#########
34	#########	#########	#########	#########	#########	#########	#########	#########	#########	#########
35	#########	#########	#########	#########	#########	#########	#########	#########	#########	#########
36	#########	#########	#########	#########	#########	#########	#########	#########	#########	#########
37	#########	#########	#########	#########	#########	#########	#########	#########	#########	#########
38	#########	#########	#########	#########	#########	#########	#########	#########	#########	#########
39	#########	#########	#########	#########	#########	#########	#########	#########	#########	#########
40	#########	#########	#########	#########	#########	#########	#########	#########	#########	#########

Table A.10.4.4(a) Pressure Loss in bar/m for Schedule 40 Steel Pipe C=120												
Pipe Size (mm)	Flow Rate (lpm)											
	38	45	53	61	68	75	95	115	130	150	170	190
25	0.0090	0.0113	0.0158	0.0204	0.0249	0.0294	0.0452	0.0633	0.0837	0.1063	0.1312	0.1606
32	0.0023	0.0023	0.0045	0.0045	0.0068	0.0068	0.0113	0.0158	0.0226	0.0271	0.0339	0.0430
40	0.0023	0.0023	0.0023	0.0023	0.0023	0.0045	0.0045	0.0068	0.0113	0.0136	0.0158	0.0204
50						0.0023	0.0023	0.0023	0.0023	0.0045	0.0045	0.0068

10	12	14	16	18	20	25	30	35	40	45	50
0.04	0.05	0.07	0.09	0.11	0.13	0.2	0.28	0.37	0.47	0.58	0.71
0.01	0.01	0.02	0.02	0.03	0.03	0.05	0.07	0.1	0.12	0.15	0.19
0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.03	0.05	0.06	0.07	0.09
—	—	—	—	—	0.01	0.01	0.01	0.01	0.02	0.02	0.03

Table A.10.4.4(b) Pressure Loss in bar/m for Copper Tubing - Types K, L & M C=150													
Tubing Size (mm)	Type	Flow Rate (lpm)											
		38	45	53	61	68	75	95	115	130	150	170	190
20	M	0.0181	0.0271	0.0362	0.0452	0.0566	0.0679	0.1041	0.1448	0.1923			
20	L	0.0226	0.0317	0.0407	0.0520	0.0656	0.0792	0.1199	0.1697	0.2262			
20	K	0.0294	0.0407	0.0543	0.0679	0.0860	0.1041	0.1561	0.2194	0.2896			
25	M	0.0045	0.0068	0.0090	0.0136	0.0158	0.0181	0.0294	0.0407	0.0543	0.0679	0.0860	0.1041
25	L	0.0068	0.0090	0.0113	0.0136	0.0181	0.0226	0.0339	0.0452	0.0611	0.0792	0.0973	0.1199
25	K	0.0068	0.0090	0.0136	0.0158	0.0204	0.0249	0.0385	0.0543	0.0701	0.0905	0.1131	0.1380
32	M	0.0023	0.0023	0.0045	0.0045	0.0068	0.0068	0.0113	0.0158	0.0204	0.0249	0.0339	0.0385
32	L	0.0023	0.0023	0.0045	0.0045	0.0068	0.0068	0.0113	0.0158	0.0226	0.0271	0.0362	0.0430
32	K	0.0023	0.0023	0.0045	0.0045	0.0068	0.0090	0.0136	0.0181	0.0249	0.0294	0.0385	0.0452
40	M		0.0023	0.0023	0.0023	0.0023	0.0023	0.0045	0.0068	0.0090	0.0113	0.0136	0.0181
40	L		0.0023	0.0023	0.0023	0.0023	0.0023	0.0045	0.0068	0.0090	0.0113	0.0158	0.0181
40	K		0.0023	0.0023	0.0023	0.0023	0.0045	0.0045	0.0068	0.0113	0.0136	0.0158	0.0204
50	M							0.0023	0.0023	0.0023	0.0023	0.0045	0.0045
50	L							0.0023	0.0023	0.0023	0.0023	0.0045	0.0045
50	K							0.0023	0.0023	0.0023	0.0023	0.0045	0.0045

10	12	14	16	18	20	25	30	35	40	45	50
0.08	0.12	0.16	0.2	0.25	0.3	0.46	0.64	0.85	—	—	—
0.1	0.14	0.18	0.23	0.29	0.35	0.53	0.75	1	—	—	—
0.13	0.18	0.24	0.3	0.38	0.46	0.69	0.97	1.28	—	—	—
0.02	0.03	0.04	0.06	0.07	0.08	0.13	0.18	0.24	0.3	0.38	0.46
0.03	0.04	0.05	0.06	0.08	0.1	0.15	0.2	0.27	0.35	0.43	0.53
0.03	0.04	0.06	0.07	0.09	0.11	0.17	0.24	0.31	0.4	0.5	0.61
0.01	0.01	0.02	0.02	0.03	0.03	0.05	0.07	0.09	0.11	0.15	0.17
0.01	0.01	0.02	0.02	0.03	0.03	0.05	0.07	0.1	0.12	0.16	0.19
0.01	0.01	0.02	0.02	0.03	0.04	0.06	0.08	0.11	0.13	0.17	0.2
—	0.01	0.01	0.01	0.01	0.01	0.02	0.03	0.04	0.05	0.06	0.08
—	0.01	0.01	0.01	0.01	0.01	0.02	0.03	0.04	0.05	0.07	0.08
—	0.01	0.01	0.01	0.01	0.02	0.02	0.03	0.05	0.06	0.07	0.09
—	—	—	—	—	—	0.01	0.01	0.01	0.01	0.02	0.02
—	—	—	—	—	—	0.01	0.01	0.01	0.01	0.02	0.02
—	—	—	—	—	—	0.01	0.01	0.01	0.01	0.02	0.02

Table A.10.4.4(c) Pressure Loss in bar/m for CPVC Pipe C=150

Nominal Pipe Size (mm)	Actual Pipe Size (mm)	Flow Rate (lpm)											
		38	45	53	61	68	75	95	115	130	150	170	190
20	22.2	0.0113	0.0158	0.0226	0.0294	0.0362	0.0430	0.0656	0.0905	0.1199	0.1538	0.1923	0.2330
25	28.0	0.0045	0.0045	0.0068	0.0090	0.0113	0.0136	0.0204	0.0294	0.0385	0.0498	0.0633	0.0769
32	35.4	0.0023	0.0023	0.0023	0.0023	0.0045	0.0045	0.0068	0.0090	0.0113	0.0158	0.0204	0.0249
40	40.6			0.0023	0.0023	0.0023	0.0023	0.0045	0.0045	0.0068	0.0090	0.0090	0.0113
50	50.9							0.0023	0.0023	0.0023	0.0023	0.0023	0.0045

	10	12	14	16	18	20	25	30	35	40	45	50
0.874	0.05	0.07	0.1	0.13	0.16	0.19	0.29	0.4	0.53	0.68	0.85	1.03
"	"	0.02	0.03	0.04	0.05	0.06	0.09	0.13	0.17	0.22	0.28	0.34
#	#	0.01	0.01	0.01	0.02	0.02	0.03	0.04	0.05	0.07	0.09	0.11
#	#	0	0.01	0.01	0.01	0.01	0.02	0.02	0.03	0.04	0.04	0.05
#	#	0	0	0	0	0	0.01	0.01	0.01	0.01	0.01	0.02

Table A.10.4.4(d) Pressure Loss in bar/m for PEX Pipe C=150													
Nominal Pipe Size (mm)	Actual Pipe Size (mm)	Flow Rate (lpm)											
		38	45	53	61	68	75	95	115	130	150	170	190
20	17.3	0.0407	0.0566	0.0747	0.0973	0.1199	0.1448	0.2194	0.3077	0.4095	0.5248	0.6515	0.7918
25	22.2	0.0113	0.0158	0.0226	0.0271	0.0362	0.0430	0.0633	0.0905	0.1199	0.1538	0.1900	0.2330
32	27.2	0.0045	0.0068	0.0090	0.0113	0.0136	0.0158	0.0249	0.0339	0.0452	0.0588	0.0724	0.0882
40	32.1	0.0023	0.0023	0.0045	0.0045	0.0068	0.0068	0.0113	0.0158	0.0204	0.0249	0.0317	0.0385
50	42.0				0.0023	0.0023	0.0023	0.0023	0.0045	0.0045	0.0068	0.0090	0.0113

	10	12	14	16	18	20	25	30	35	40	45	#
##########	##########	##########	##########	##########	##########	##########	##########	##########	##########	#########	#########	#########
#	0.05	0.07	0.1	0.12	0.16	0.19	0.28	0.4	0.53	0.68	0.84	1.03
#	0.02	0.03	0.04	0.05	0.06	0.07	0.11	0.15	0.2	0.26	0.32	0.39
#	0.01	0.01	0.02	0.02	0.03	0.03	0.05	0.07	0.09	0.11	0.14	0.17
#	0	0	0	0.01	0.01	0.01	0.01	0.02	0.02	0.03	0.04	0.05

Second Revision No. 15-NFPA 13D-2017 [Chapter 2]

Chapter 2 Referenced Publications

2.1 General.

The documents or portions thereof listed in this chapter are referenced within this standard and shall be considered part of the requirements of this document.

2.2 NFPA Publications.

National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA 13, *Standard for the Installation of Sprinkler Systems,* 2019 edition.

NFPA 70®, *National Electrical Code®*, 2017 edition.

NFPA 72®, *National Fire Alarm and Signaling Code,* 2019 edition.

NFPA 220, *Standard on Types of Building Construction,* 2018 edition.

NFPA 750, *Standard on Water Mist Fire Protection Systems,* 2019 edition.

2.3 Other Publications.

2.3.1 ASME Publications.

American Society of Mechanical Engineers, Two Park Avenue, New York, NY 10016-5990.

ASME B16.1, *Gray Iron Pipe Flanges and Flanged Fittings, Classes 25, 125, and 250*, 2015.

ASME B16.3, *Malleable Iron Threaded Fittings, Classes 150 and 300*, ~~2011~~ 2016 .

ASME B16.4, *Gray Iron Threaded Fittings*, Classes 125 and 250, ~~2011~~ 2016 .

ASME B16.5, *Pipe Flanges and Flanged Fittings, NPS 1/2 through NPS 24 Metric/Inch Standard*, 2013.

ASME B16.9, *Factory-Made Wrought Buttwelding Fittings*, 2012.

ASME B16.11, *Forged Fittings, Socket-Welding and Threaded*, ~~2011~~ 2016 .

ANSI/ASME B16.15, *Cast ~~Bronze~~ Copper Alloy Threaded Fittings: Classes 125 and 250* , 2013.

ASME B16.18, *Cast Copper Alloy Solder Joint Pressure Fittings*, 2012.

ASME B16.22, *Wrought Copper and Copper Alloy Solder Joint Pressure Fittings*, 2013.

ASME B16.25, *Buttwelding Ends*, 2012.

ASME B36.10M, *Welded and Seamless Wrought Steel Pipe*, 2015.

2.3.2 ASTM Publications.

ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959.

ASTM A53/A53M, *Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless*, 2012.

ASTM A135/A135M, *Standard Specification for Electric-Resistance-Welded Steel Pipe*, ~~2012~~ 2009 (2014) .

ASTM A234/A234M, *Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service*, ~~2013 e1.~~ 2016.

ASTM A795/A795M, *Standard Specification for Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless Steel Pipe for Fire Protection Use*, 2013.

ASTM B32, *Standard Specification for Solder Metal*, 2008 (2014) .

ASTM B43, *Standard Specification for Seamless Red Brass Pipe, Standard Sizes* , 2015.

ASTM B75/B75M, *Standard Specification for Seamless Copper Tube*, 2011.

ASTM B88, *Standard Specification for Seamless Copper Water Tube*, ~~2014~~ 2016 .

ASTM B251, *Standard Specification for General Requirements for Wrought Seamless Copper and Copper-Alloy Tube*, 2010.

ASTM B813, *Standard Specification for Liquid and Paste Fluxes for Soldering Applications of Copper and Copper-Alloy Tube*, 2016.

ASTM B828, *Standard Practice for Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings*, 2016.

ASTM F437, *Standard Specification for Threaded Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80*, 2015.

ASTM F438, *Standard Specification for Socket-Type Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 40*, 2015.

ASTM F439, *Standard Specification for Socket-Type Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80*, 2013.

ASTM F442/F442M, *Standard Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe (SDR-PR)*, 2013 e1.

ASTM F876, *Standard Specification for Crosslinked Polyethylene (PEX) Tubing*, ~~2015~~ 2015a .

2.3.3 AWS Publications.

American Welding Society, 8669 NW 36 Street, #130, Miami, FL 33166-6672.

AWS A5.8M/A5.8, *Specification for Filler Metals for Brazing and Braze Welding*, 2011.

2.3.4 Other Publications.

Merriam-Webster's Collegiate Dictionary, 11th edition, Merriam-Webster, Inc., Springfield, MA, 2003.

2.4 References for Extracts in Mandatory Sections.

NFPA 13R, *Standard for the Installation of Sprinkler Systems in Low-Rise Residential Occupancies,* 2019 edition.

NFPA 5000®, Building Construction and Safety Code®, 2018 edition.

Submitter Information Verification

Submitter Full Name: Chad
Organization: [Not Specified]
Street Address:
City:
State:

Zip:

Submittal Date: Sat Jun 24 21:42:46 EDT 2017

Committee Statement

Committee Statement: Editorial.

Response Message:

Ballot Results

This item has passed ballot

31 Eligible Voters
4 Not Returned
27 Affirmative All
0 Affirmative with Comments
0 Negative with Comments
0 Abstention

Not Returned

Cronin, Bradford T.
O'Brian, Michael
Paez, Ernie
Puchovsky, Milosh T.

Affirmative All

Asp, Roland A.
Bell, Kerry M.
Benn, Fred
Bradley, Frederick C.
Browning, Chase A.
Buuck, Daniel
Deegan, Thomas G.
Feid, Jeffrey
Isman, Kenneth E.
Lugar, James R.
Mathias, Daniel J.
Nickelson, David A.
Nickson, Ronald G.
Pilette, Maurice M.
Schultz, Bruce
Schwab, Peter T.
Skare, Eric J.
Skinner, Timothy J.

Stanley, George W.

Towler, Michael

Townley, Donald R.

Trim, Martin C. W.

Van Walraven, Ed

Victor, Terry L.

Viola, John F.

Webb, Ronald N.

Yu, Hong-Zeng

Second Revision No. 1-NFPA 13D-2017 [Section No. 7.4.5]

7.4.5*

Where sprinkler piping is exposed to the sprinkler protected area, it shall be supported with metal hangers or hangers ~~listed for this application~~ made of the same material as the structure .

A.7.4.5

Wood attached or fastened to the structure used as part of a trapeze hanger is considered an extension of the structure and is considered acceptable to hang sprinkler piping.

Submitter Information Verification

Submitter Full Name: Chad
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Wed Jun 21 08:31:21 EDT 2017

Committee Statement

Committee Statement: This proposal will clarify misconceptions about hanging pipe from a wooden structure. AHJ's have been disallowing this as they consider a wood trapeze to be a nonmetallic hanger.

This language will also address the concerns of the correlating committee (see CN-1)

Annex note submitted as separate PC

A.7.4.5

Wood used as part of a trapeze hanger is considered an extension of the structure and is considered acceptable to hang sprinkler piping.

Response Message:

Public Comment No. 15-NFPA 13D-2017 [Section No. 7.4.5]

Public Comment No. 16-NFPA 13D-2017 [New Section after A.7.4.4]

Public Comment No. 2-NFPA 13D-2017 [Global Input]

Public Comment No. 3-NFPA 13D-2017 [Global Input]

Ballot Results

✔ **This item has passed ballot**

31 Eligible Voters
4 Not Returned

27 Affirmative All
0 Affirmative with Comments
0 Negative with Comments
0 Abstention

Not Returned

Cronin, Bradford T.
O'Brian, Michael
Paez, Ernie
Puchovsky, Milosh T.

Affirmative All

Asp, Roland A.
Bell, Kerry M.
Benn, Fred
Bradley, Frederick C.
Browning, Chase A.
Buuck, Daniel
Deegan, Thomas G.
Feid, Jeffrey
Isman, Kenneth E.
Lugar, James R.
Mathias, Daniel J.
Nickelson, David A.
Nickson, Ronald G.
Pilette, Maurice M.
Schultz, Bruce
Schwab, Peter T.
Skare, Eric J.
Skinner, Timothy J.
Stanley, George W.
Towler, Michael
Townley, Donald R.
Trim, Martin C. W.
Van Walraven, Ed
Victor, Terry L.
Viola, John F.
Webb, Ronald N.
Yu, Hong-Zeng

Second Revision No. 2-NFPA 13D-2017 [Section No. 8.1.3.1.2]

8.1.3.1.2*

Where construction features or other special conditions exist that are outside the scope of sprinkler listings, listed sprinklers shall be permitted to be installed beyond their listing limitations.

A.8.1.3.1.2

See A.10.2.4.

For situations not meeting the conditions of 8.1.3.1.1 , sprinkler coverage should be determined in consultation with the manufacturer and the authority having jurisdiction as appropriate for the conditions.

Submitter Information Verification

Submitter Full Name: Chad
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Wed Jun 21 08:38:52 EDT 2017

Committee Statement

Committee Statement: For situations outside the listing of sprinklers, consultation with the manufacturer and the AHJ should be performed. Section 1.4.1 and 4.5 currently require that documentation be submitted to the AHJ to establish equivalency.

Response Message:

Public Comment No. 22-NFPA 13D-2017 [Section No. 8.1.3.1.2]

Ballot Results

✔ **This item has passed ballot**

31 Eligible Voters
4 Not Returned
27 Affirmative All
0 Affirmative with Comments
0 Negative with Comments
0 Abstention

Not Returned

Cronin, Bradford T.

O'Brian, Michael

Paez, Ernie

Puchovsky, Milosh T.

Affirmative All

Asp, Roland A.

Bell, Kerry M.

Benn, Fred

Bradley, Frederick C.

Browning, Chase A.

Buuck, Daniel

Deegan, Thomas G.

Feid, Jeffrey

Isman, Kenneth E.

Lugar, James R.

Mathias, Daniel J.

Nickelson, David A.

Nickson, Ronald G.

Pilette, Maurice M.

Schultz, Bruce

Schwab, Peter T.

Skare, Eric J.

Skinner, Timothy J.

Stanley, George W.

Towler, Michael

Townley, Donald R.

Trim, Martin C. W.

Van Walraven, Ed

Victor, Terry L.

Viola, John F.

Webb, Ronald N.

Yu, Hong-Zeng

Second Revision No. 13-NFPA 13D-2017 [New Section after 8.2.1.2]

8.2.1.3

Concealed sprinklers shall be permitted to be installed in beams up to 4 in. (100 mm) in depth.

Submitter Information Verification

Submitter Full Name: Chad
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Thu Jun 22 15:57:03 EDT 2017

Committee Statement

Committee Statement: Following discussions at the first draft meeting on the installation of residential pendent sprinklers below beams, the question was raised if this would also apply to concealed sprinklers. Upon review of existing test data, a recommendation was made to limit concealed sprinklers installed under beams to no greater than 4 inches in depth. This language would clarify that the previous section would not apply to concealed sprinklers.

Response Message:

Ballot Results

✔ **This item has passed ballot**

31 Eligible Voters
4 Not Returned
25 Affirmative All
0 Affirmative with Comments
2 Negative with Comments
0 Abstention

Not Returned

Cronin, Bradford T.
O'Brian, Michael
Paez, Ernie
Puchovsky, Milosh T.

Affirmative All

Asp, Roland A.
Bell, Kerry M.

Benn, Fred

Bradley, Frederick C.

Browning, Chase A.

Buuck, Daniel

Deegan, Thomas G.

Feid, Jeffrey

Isman, Kenneth E.

Lugar, James R.

Mathias, Daniel J.

Nickelson, David A.

Nickson, Ronald G.

Pilette, Maurice M.

Schultz, Bruce

Skare, Eric J.

Skinner, Timothy J.

Stanley, George W.

Towler, Michael

Townley, Donald R.

Trim, Martin C. W.

Van Walraven, Ed

Viola, John F.

Webb, Ronald N.

Yu, Hong-Zeng

Negative with Comment

Schwab, Peter T.

I am in agreement with Mr. Victor

Victor, Terry L.

Although testing was discussed during the second draft meeting, no test results were provided to committee members for review and comment. Concealed sprinklers have been installed under horizontal & sloping beamed ceilings since residential concealed sprinklers were first introduced with no known failures.

Second Revision No. 14-NFPA 13D-2017 [Section No. 8.2.1.2]

8.2.1.2*

Pendent-type residential sprinklers located under or adjacent to beams in accordance with 10.2.1 shall be installed in accordance with one of the following:

(1) Pendent, recessed pendent, and flush-type pendent sprinklers shall be permitted to be installed directly under a beam having a maximum depth of 14 in. (350 mm) with the sprinkler deflector 1 in. to 2 in. (25 mm to 50 mm) below the beam, or in accordance with the manufacturer's instructions for recessed or flush sprinklers if the deflector is less than 1 in. (25 mm) below the beam, as shown in Figure 8.2.1.2(a) .

(2) Pendent sprinklers~~, including flush-type pendent sprinklers,~~ shall be permitted to be installed adjacent to beams where the vertical centerline of the sprinkler is no greater than 2 in. (50 mm) from the edge of the beam and with the sprinkler deflector 1 in. to 2 in. (25 mm to 50 mm) below the beam, or in accordance with the manufacturer's instructions for flush sprinklers if the deflector is less than 1 in. (25 mm) below the beam, as shown in Figure 8.2.1.2(b) .

Figure 8.2.1.2(a) Position of Sprinkler Under a Beam.

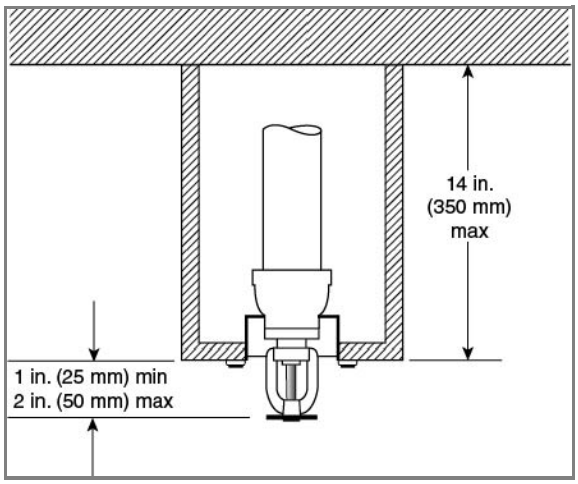
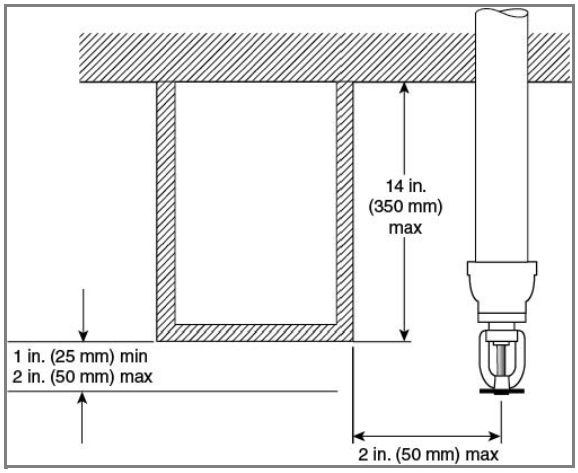


Figure 8.2.1.2(b) Position of Sprinkler Adjacent to a Beam.



A.8.2.1.2

Concealed sprinklers should not be considered flush-type sprinklers.

Supplemental Information

File Name	Description	Approved
Figures_8.2.1.2.pdf	New Figure 8.2.1.2(1) and Figure 8.2.1.2(2)--for staff use	

Submitter Information Verification

Submitter Full Name: Chad
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Thu Jun 22 15:59:52 EDT 2017

Committee Statement

Committee Statement: This comment is in support of FR 32 and seeks to add two figures to illustrate the requirements for installing sprinklers under and adjacent to beams,

Note this section and new figures have also been to submitted to NFPA 13 and the figures submitted to NFPA 13R. See attached figures, Figure 8.2.1.2(1) and Figure 8.2.1.2(2).

Response Message:

Public Comment No. 18-NFPA 13D-2017 [Section No. 8.2.1.2]

Ballot Results

✔ **This item has passed ballot**

31 Eligible Voters
4 Not Returned
25 Affirmative All
1 Affirmative with Comments
1 Negative with Comments
0 Abstention

Not Returned

Cronin, Bradford T.
O'Brian, Michael
Paez, Ernie
Puchovsky, Milosh T.

Affirmative All

Asp, Roland A.
Bell, Kerry M.
Benn, Fred
Bradley, Frederick C.
Browning, Chase A.
Deegan, Thomas G.
Feid, Jeffrey
Isman, Kenneth E.

Lugar, James R.

Mathias, Daniel J.

Nickelson, David A.

Nickson, Ronald G.

Pilette, Maurice M.

Schultz, Bruce

Schwab, Peter T.

Skare, Eric J.

Skinner, Timothy J.

Stanley, George W.

Towler, Michael

Townley, Donald R.

Van Walraven, Ed

Victor, Terry L.

Viola, John F.

Webb, Ronald N.

Yu, Hong-Zeng

Affirmative with Comment

Buuck, Daniel

I support the intent of this revision, but I do want to point out that it introduces the term "flush-type" sprinklers to the standard for the first time. Secondly, "concealed sprinklers" (also called "concealed pendent style" and "concealed-type" sprinklers in the standard) are not defined. This makes the proposed annex statement "Concealed sprinklers should not be considered flush-type sprinklers" confusing without prior knowledge of what they are.

Negative with Comment

Trim, Martin C. W.

Concealed sprinklers should not be limited to a 14" beam depth.

Second Revision No. 16-NFPA 13D-2017 [Section No. 8.2.5.5.3]

8.2.5.5.3

Where sidewall sprinklers are more than 3 ft (0.91 m) above the top of cabinets, the sprinkler shall be permitted to be installed on the wall above the cabinets where the cabinets are no greater than 12 in. (~~900 mm~~ 300 mm) from the wall.

Submitter Information Verification

Submitter Full Name: Chad Duffy
Organization: National Fire Protection Assoc
Street Address:
City:
State:
Zip:
Submittal Date: Mon Jul 24 14:24:01 EDT 2017

Committee Statement

Committee Statement: Editorial revision.
Response Message:

Ballot Results

This item has passed ballot

31 Eligible Voters
4 Not Returned
27 Affirmative All
0 Affirmative with Comments
0 Negative with Comments
0 Abstention

Not Returned

Cronin, Bradford T.
O'Brian, Michael
Paez, Ernie
Puchovsky, Milosh T.

Affirmative All

Asp, Roland A.
Bell, Kerry M.
Benn, Fred
Bradley, Frederick C.

Browning, Chase A.

Buuck, Daniel

Deegan, Thomas G.

Feid, Jeffrey

Isman, Kenneth E.

Lugar, James R.

Mathias, Daniel J.

Nickelson, David A.

Nickson, Ronald G.

Pilette, Maurice M.

Schultz, Bruce

Schwab, Peter T.

Skare, Eric J.

Skinner, Timothy J.

Stanley, George W.

Towler, Michael

Townley, Donald R.

Trim, Martin C. W.

Van Walraven, Ed

Victor, Terry L.

Viola, John F.

Webb, Ronald N.

Yu, Hong-Zeng

Second Revision No. 8-NFPA 13D-2017 [Section No. 8.3.1]

8.3.1

Sprinklers shall be installed in all areas except where omission is permitted by 8.3.2 through ~~8.3.8~~ 8.3.9 .

Submitter Information Verification

Submitter Full Name: Chad
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Thu Jun 22 09:54:28 EDT 2017

Committee Statement

Committee Statement: 8.3.1 has been revised due to the addition of new section 8.3.5 and renumbering of subsequent text.
Response Message:

Ballot Results

This item has passed ballot

31 Eligible Voters
4 Not Returned
27 Affirmative All
0 Affirmative with Comments
0 Negative with Comments
0 Abstention

Not Returned

Cronin, Bradford T.
O'Brian, Michael
Paez, Ernie
Puchovsky, Milosh T.

Affirmative All

Asp, Roland A.
Bell, Kerry M.
Benn, Fred
Bradley, Frederick C.
Browning, Chase A.

Buuck, Daniel

Deegan, Thomas G.

Feid, Jeffrey

Isman, Kenneth E.

Lugar, James R.

Mathias, Daniel J.

Nickelson, David A.

Nickson, Ronald G.

Pilette, Maurice M.

Schultz, Bruce

Schwab, Peter T.

Skare, Eric J.

Skinner, Timothy J.

Stanley, George W.

Towler, Michael

Townley, Donald R.

Trim, Martin C. W.

Van Walraven, Ed

Victor, Terry L.

Viola, John F.

Webb, Ronald N.

Yu, Hong-Zeng

Second Revision No. 7-NFPA 13D-2017 [New Section after 8.3.4]

8.3.5

Sprinklers shall not be required within an attached enclosed swimming pool or tennis court rooms where provided with a minimum of one exit door exiting directly to the exterior.

Submitter Information Verification

Submitter Full Name: Chad
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Thu Jun 22 09:52:01 EDT 2017

Committee Statement

Committee Statement: Limited fuel loading if any. Ceiling configurations generally unique, to include high ceilings, peaks, slopes, skylights ,etc. making it difficult to position and space sprinklers in accordance with listing requirements. Not listed (data) as areas of origin within annex table A.1.2.(a). Pool water and or tennis court floors usually not associated as source of ignition, ref: Annex table A.1.2 (c). These room areas are not anticipated to be used for sleeping purposes. Other sections of 8.3 permit sprinkler omissions with greater fuel loadings than what would be anticipated within these areas. Renumber the following sections accordingly.

Response Message:

Ballot Results

✔ **This item has passed ballot**

31 Eligible Voters
4 Not Returned
23 Affirmative All
1 Affirmative with Comments
3 Negative with Comments
0 Abstention

Not Returned

Cronin, Bradford T.

O'Brian, Michael

Paez, Ernie

Puchovsky, Milosh T.

Affirmative All

Asp, Roland A.

Bell, Kerry M.

Benn, Fred

Bradley, Frederick C.

Browning, Chase A.

Buuck, Daniel

Feid, Jeffrey

Lugar, James R.

Mathias, Daniel J.

Nickelson, David A.

Nickson, Ronald G.

Pilette, Maurice M.

Schultz, Bruce

Skare, Eric J.

Skinner, Timothy J.

Stanley, George W.

Towler, Michael

Townley, Donald R.

Trim, Martin C. W.

Van Walraven, Ed

Viola, John F.

Webb, Ronald N.

Yu, Hong-Zeng

Affirmative with Comment

Deegan, Thomas G.

The use of such areas, especially as it evolves over time, is not easily controlled. It is not uncommon for the use of such areas to ultimately include a degree of storage. Facilities included for entertainment purposes can provide sources of ignition. The difficulty in providing coverage for such areas is a legitimate concern when considering cost. If there is adequate separation between these areas and attached living areas, and if the use of the areas can be limited with regard to fuel loadings beyond "normal" as well as the use of entertainment facilities which introduce a greater potential for ignition, elimination of protection may make sense.

Negative with Comment

Isman, Kenneth E.

Pools can be covered with suitable flooring and the space can be used as an assembly occupancy. Even with a single exit to the exterior, there may be insufficient exits for the occupant load. A blanket exemption of sprinklers is not a good idea. Some sort of performance-based option that insures adequate egress before conditions become untenable would be better.

Schwab, Peter T.

There is nothing in this section that prohibits living space over the pool or tennis court.

Victor, Terry L.

I agree with Mr. Deegan and Mr. Isman. Sprinkler protection should be provided for these enclosures under most circumstances. While there may be attached pool enclosures and tennis courts that don’t warrant sprinkler protection, to provide a blanket exemption is not advisable. Instead the committee should provide a list of

conditions that would allow for the omission of sprinklers such as no storage of combustibles including furniture, no fueled fired appliances (grills and cooktops) or heaters, no means to cover the pool and use the space for other uses, etc.

Second Revision No. 4-NFPA 13D-2017 [Section No. 12.3.6.1]

12.3.6.1*

In a detached dwelling or a manufactured home the sprinkler system shall be permitted to be put in an inactive state for any of the following reasons:

(1) After a manufactured home has been installed and tested in the factory and is being prepared for shipment

(2) When a manufactured home is being stored for future occupancy

(3) When the detached dwelling is unoccupied during renovation work, with notification and approval of the AHJ

(4) When the detached dwelling is unoccupied for an extended period of time, with notification and approval of the AHJ

A.12.3.6.1

The primary purpose of this standard is protection against injury and life loss. There are many instances when an installed system needs to be taken out of service such as for shipping or storage of a manufactured home, when extensive renovation or remodeling work is going on in the home, or when the home will be unoccupied for an extended period of time such as when a summer home is closed up for winter. This section provides guidance for taking an installed system out of service when there is little or no risk of injury or life loss. This guidance is especially needed when the detached dwelling or manufactured home is subject to freezing temperatures. Once the home is to be occupied again, the system should be tested for leaks and the system and components inspected and tested before being restored to service.

Submitter Information Verification

Submitter Full Name: Chad
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Wed Jun 21 10:21:26 EDT 2017

Committee Statement

Committee Statement: This note clarifies that it is acceptable to turn the system off when there will not be occupants for extended periods of time.

Response Message:

Public Comment No. 12-NFPA 13D-2017 [Section No. 12.3.6.1]

Ballot Results

✔ **This item has passed ballot**

31 Eligible Voters
4 Not Returned
27 Affirmative All
0 Affirmative with Comments
0 Negative with Comments
0 Abstention

Not Returned

Cronin, Bradford T.
O'Brian, Michael
Paez, Ernie
Puchovsky, Milosh T.

Affirmative All

Asp, Roland A.
Bell, Kerry M.
Benn, Fred
Bradley, Frederick C.
Browning, Chase A.
Buuck, Daniel
Deegan, Thomas G.
Feid, Jeffrey
Isman, Kenneth E.
Lugar, James R.
Mathias, Daniel J.
Nickelson, David A.
Nickson, Ronald G.
Pilette, Maurice M.
Schultz, Bruce
Schwab, Peter T.
Skare, Eric J.
Skinner, Timothy J.
Stanley, George W.
Towler, Michael
Townley, Donald R.
Trim, Martin C. W.
Van Walraven, Ed
Victor, Terry L.
Viola, John F.
Webb, Ronald N.
Yu, Hong-Zeng

Second Revision No. 9-NFPA 13D-2017 [Section No. A.6.2]

A.6.2

The connection to city mains for fire protection is often subject to local regulation of metering and backflow prevention requirements. Preferred and acceptable water supply arrangements are shown in Figure A.6.2(a) through Figure A.6.2(e). Where it is necessary to use a meter between the city water main and the sprinkler system supply, an acceptable arrangement as shown in Figure A.6.2(c) and Figure A.6.2(d) can be used. Under these circumstances, the flow characteristics of the meter are to be included in the hydraulic calculation of the system *[see Table 10.4.4(a)]*. Where a tank is used for both domestic and fire protection purposes, a low water alarm that actuates when the water level falls below 110 percent of the minimum quantity specified in 6.1.2 should be provided.

The effect of pressure-reducing valves on the system should be considered in the hydraulic calculation procedures.

Figure A.6.2(a), Figure A.6.2(c), or Figure A.6.2(d) are acceptable methods for getting the water supply into the unit for a stand-alone sprinkler system (one that does not also provide direct connections to the cold water fixtures) because the common supply pipe for the domestic system and the sprinkler system between the water supply and the dwelling unit has a single control valve that shuts the sprinkler system, which helps to ensure that people who have running water to their domestic fixtures also have fire protection. This serves as a form of supervision for the control valve and can be used to make sure that the valve stays open in place of other, more expensive options such as tamper switches with a monitoring service.

Some water utilities ~~insist on~~ choose to install separate taps and supply pipes from the water supply to the dwelling unit for fire sprinkler systems as shown in Figure A.6.2(d), due to ~~concerns about shutting off the water supply for nonpayment of bills and the desire not to shut off fire protection if this ever occurs~~ the preference to not shut off water to piping that includes fire supply as well as domestic water supply. While these types of arrangements are acceptable, they might not be cost efficient and should be ~~discouraged~~ evaluated due to the extra cost burden this places on the building owner. ~~It is extremely rare that the water utilities would actually shut off water for nonpayment , and even if they do they are creating a situation in which the dwelling would be unfit for occupation.~~

Single services should be acceptable as NFPA 13D is a life safety standard. This means that the purpose of the standard is to protect human life and not to necessarily protect property. In the event that the domestic water supply is shut off, plumbing code dictates that the home is uninhabitable and thus should be vacated. If there are no occupants within the home then there are no life safety concerns.

Additionally, having a single service connection provides some assurance that the water supply to the sprinkler system is operational.

Figure A.6.2(a) Minimum Requirements for a Stand-Alone System.

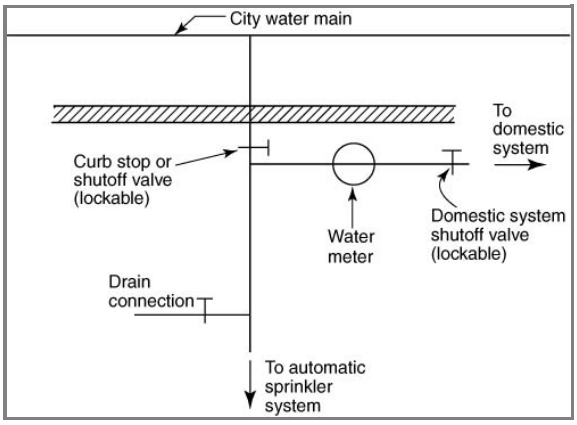


Figure A.6.2(b) Acceptable Arrangement for Stand-Alone Piping Systems — Option 1.

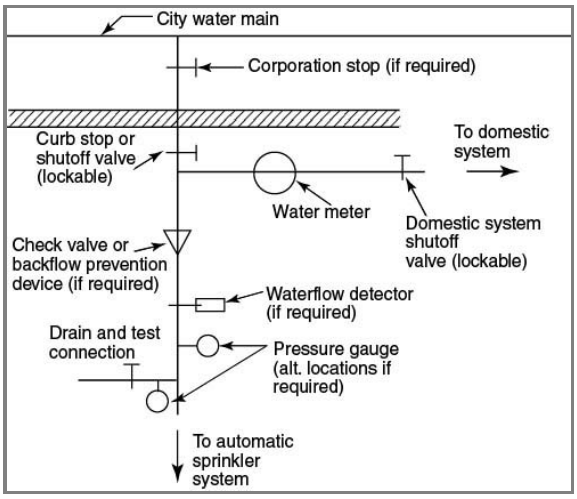


Figure A.6.2(c) Acceptable Arrangement for Stand-Alone Piping System — Option 2.

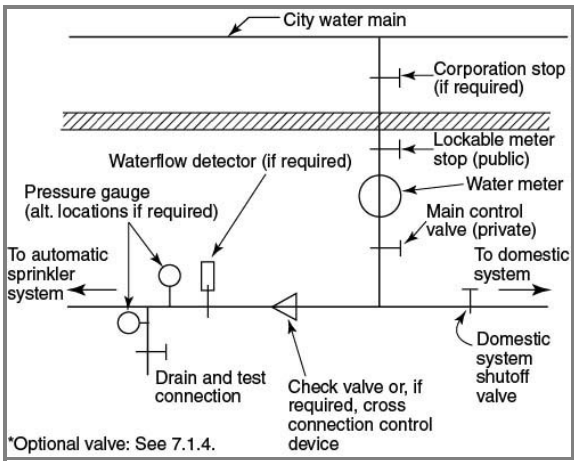


Figure A.6.2(d) Acceptable Arrangement for Stand-Alone Piping Systems — Option 3.

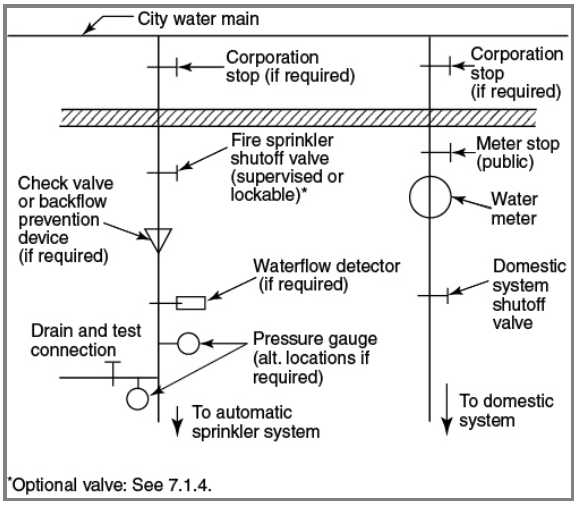
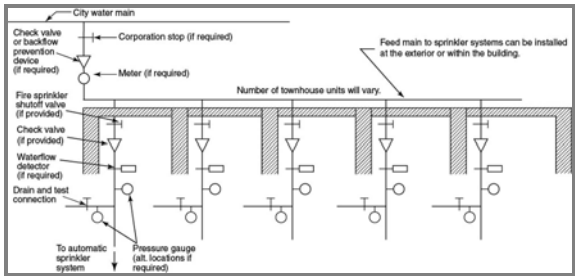


Figure A.6.2(e) Acceptable Arrangement for Townhouse Stand-Alone Piping Systems.



Supplemental Information

File Name	Description	Approved
NFPA_13D_Fig_A_6_2_e_Model_1_.pdf	Revised Figure A.6.2(e)--for staff use	

Submitter Information Verification

Submitter Full Name: Chad
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Thu Jun 22 10:29:27 EDT 2017

Committee Statement

Committee Statement: Figure has been modified to remove the connection line shown on the inside and a note has been added to clarify that the supply can be either inside or outside of the structure. See revised attached Figure. The text has been modified to take into account concerns raised by the water utility industry.

Response Message:

Public Comment No. 14-NFPA 13D-2017 [Section No. A.6.2]

Ballot Results

✔ **This item has passed ballot**

31 Eligible Voters
4 Not Returned
27 Affirmative All
0 Affirmative with Comments
0 Negative with Comments

0 Abstention

Not Returned

Cronin, Bradford T.

O'Brian, Michael

Paez, Ernie

Puchovsky, Milosh T.

Affirmative All

Asp, Roland A.

Bell, Kerry M.

Benn, Fred

Bradley, Frederick C.

Browning, Chase A.

Buuck, Daniel

Deegan, Thomas G.

Feid, Jeffrey

Isman, Kenneth E.

Lugar, James R.

Mathias, Daniel J.

Nickelson, David A.

Nickson, Ronald G.

Pilette, Maurice M.

Schultz, Bruce

Schwab, Peter T.

Skare, Eric J.

Skinner, Timothy J.

Stanley, George W.

Towler, Michael

Townley, Donald R.

Trim, Martin C. W.

Van Walraven, Ed

Victor, Terry L.

Viola, John F.

Webb, Ronald N.

Yu, Hong-Zeng

Second Revision No. 10-NFPA 13D-2017 [Section No. A.6.2.3]

A.6.2.3

~~The best method for getting the water supply into the unit for a stand-alone sprinkler system (one that does not also provide direct connections to the cold water fixtures) is to have a common pipe for the domestic system and the sprinkler system between the water supply and the dwelling unit. Once inside the dwelling unit, the pipes can be split to provide the individual domestic and sprinkler systems. In this arrangement, a single control valve on the combined pipe (prior to the split) as shown in Figure A.6.2(a) being the only control valve that shuts the sprinkler system is preferred because it ensures that people who have running water to their domestic fixtures also have fire protection. This serves as a form of supervision for the control valve and can be used to make sure that the valve stays open in place of other, more expensive options such as tamper switches with monitoring service.~~

~~Some water utilities insist on separate taps and supply pipes from the water supply to the dwelling unit for fire sprinkler systems due to concerns about shutting off the water supply for nonpayment of bills and the desire not to shut off fire protection if this ever occurs. While this type of arrangement is acceptable *[see Figure A.6.2(b)]* , it is not cost efficient and should be discouraged due to the extra burden this places on the building owner. The concern over shutting off the water for nonpayment of bills is a nonissue for a number of reasons. First, the water utilities rarely actually shut off water for nonpayment. Second, if they do shut off water for nonpayment, they are creating violations of all sorts of health and safety codes, allowing people to live in a home without running water. Concern over the fire protection for those individuals when they are violating all kinds of other health codes is disingenuous. More likely, the water utility will not shut off the water and will follow other legal avenues to collect on unpaid bills such as liens on property. Millions of people should not have to pay hundreds of millions of dollars to install separate water taps and lines for the few services that might get shut off.~~ In a situation where a two-family dwelling or townhouse has a common water supply, there must be a way to isolate the sprinkler system in one unit without having to enter another unit. Where each unit has its own shutoff valve and one unit suffers a fire event and cannot be occupied, the damaged unit can be isolated and other units can remain occupied because they have functioning sprinkler systems.

Submitter Information Verification

Submitter Full Name: Chad
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Thu Jun 22 10:48:09 EDT 2017

Committee Statement

Committee Statement: Currently this section is an almost word-for-word copy of the previous section. It doesn't seem as though the language needs to be repeated. The language on page 64 of the 13D/13R handbook in the handbook (Ask the AHJ) would be more appropriate to clarify this section.

Response Message:

Ballot Results

✔ **This item has passed ballot**

31 Eligible Voters
4 Not Returned
27 Affirmative All
0 Affirmative with Comments
0 Negative with Comments
0 Abstention

Not Returned

Cronin, Bradford T.
O'Brian, Michael
Paez, Ernie
Puchovsky, Milosh T.

Affirmative All

Asp, Roland A.
Bell, Kerry M.
Benn, Fred
Bradley, Frederick C.
Browning, Chase A.
Buuck, Daniel
Deegan, Thomas G.
Feid, Jeffrey
Isman, Kenneth E.
Lugar, James R.
Mathias, Daniel J.
Nickelson, David A.
Nickson, Ronald G.
Pilette, Maurice M.
Schultz, Bruce
Schwab, Peter T.
Skare, Eric J.
Skinner, Timothy J.
Stanley, George W.
Towler, Michael
Townley, Donald R.
Trim, Martin C. W.
Van Walraven, Ed
Victor, Terry L.
Viola, John F.
Webb, Ronald N.
Yu, Hong-Zeng

Second Revision No. 5-NFPA 13D-2017 [Section No. A.7.5.6.3(3)]

A.7.5.6.3(3)

See Figure A.7.5.6.3(3)(a), ~~and~~ Figure A.7.5.6.3(3)(b), Figure A.7.5.6.3(3)(c) , and Figure A.7.5.6.3(3)(d) .

Figure A.7.5.6.3(3)(a) Recessed Fireplace — Ordinary Temperature Sprinkler Location .

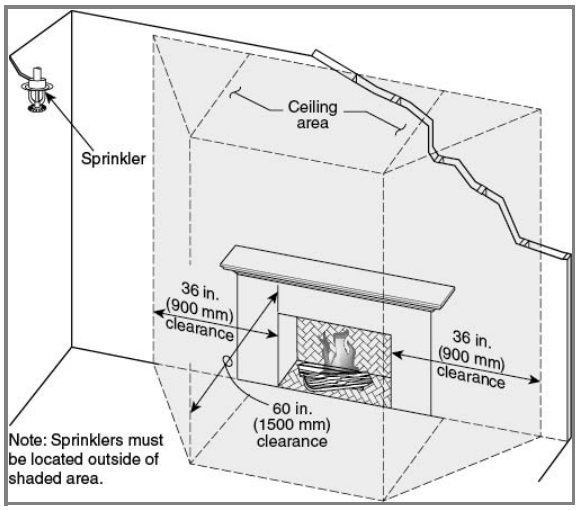


Figure A.7.5.6.3(3)(b) ~~Open Fireplace~~ Recessed Fireplace — Intermediate Temperature Sprinkler Location .

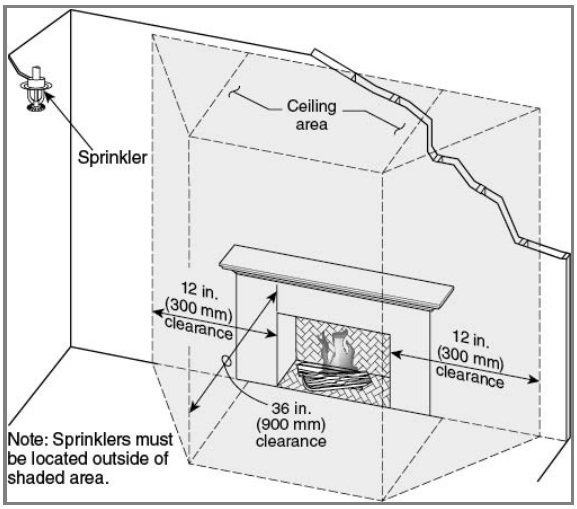


Figure A.7.5.6.3(3)(c) Open Fireplace — Ordinary Temperature Sprinkler Location.

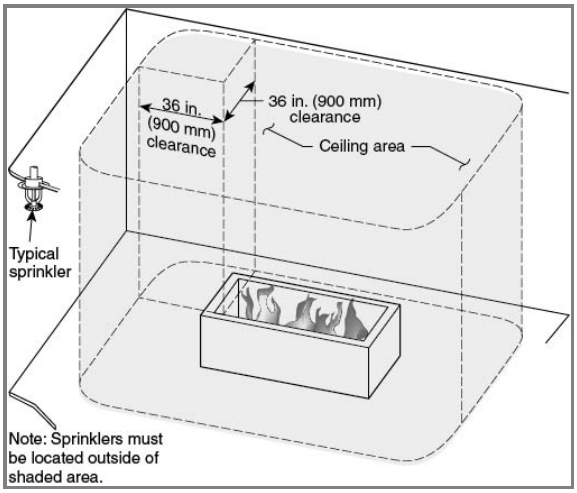
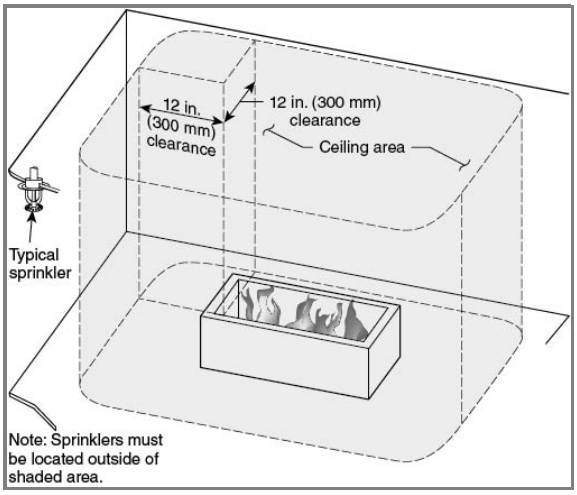


Figure A.7.5.6.3(3)(d) Open Fireplace — Intermediate Temperature Sprinkler Location.



Supplemental Information

File Name	Description	Approved
Figure_A.7.5.6.3_3_a_Recessed_Fireplace_Ordinary_Temperature_Sprinkler_Location.pdf	New Figures A.7.5.6.3(3)(a) through A.7.5.6.3(3)	

	(d)--for staff use
Figure_A.7.5.6.3_3_b_Recessed_Fireplace_Intermediate_Temperature_Sprinkler_Location.pdf	New Figures A.7.5.6.3(3)(a) through A.7.5.6.3(3) (d)--for staff use
Figure_A.7.5.6.3_3_c_Open_Fireplace_Ordinary_Temperature_Sprinkler_Location.png	New Figures A.7.5.6.3(3)(a) through A.7.5.6.3(3) (d)--for staff use
Figure_A.7.5.6.3_3_d_Open_Fireplace_Intermediate_Temperature_Sprinkler_Location.png	New Figures A.7.5.6.3(3)(a) through A.7.5.6.3(3) (d)--for staff use

Submitter Information Verification

Submitter Full Name: Chad
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Wed Jun 21 10:50:43 EDT 2017

Committee Statement

Committee Statement: Improved drawings have been submitted to illustrate the concept accepted in the First Revision. This should be correlated across NFPA 13 and NFPA 13R. See attached figures.

Response Message:

Public Comment No. 13-NFPA 13D-2017 [Section No. A.7.5.6.3(3)]

Ballot Results

✔ **This item has passed ballot**

31 Eligible Voters
4 Not Returned
25 Affirmative All
2 Affirmative with Comments
0 Negative with Comments
0 Abstention

Not Returned

Cronin, Bradford T.

O'Brian, Michael

Paez, Ernie

Puchovsky, Milosh T.

Affirmative All

Bell, Kerry M.

Benn, Fred

Bradley, Frederick C.

Browning, Chase A.

Deegan, Thomas G.

Feid, Jeffrey

Isman, Kenneth E.

Lugar, James R.

Mathias, Daniel J.

Nickelson, David A.

Nickson, Ronald G.

Pilette, Maurice M.

Schultz, Bruce

Schwab, Peter T.

Skare, Eric J.

Skinner, Timothy J.

Stanley, George W.

Towler, Michael

Townley, Donald R.

Trim, Martin C. W.

Van Walraven, Ed

Victor, Terry L.

Viola, John F.

Webb, Ronald N.

Yu, Hong-Zeng

Affirmative with Comment

Asp, Roland A.

I am in support of this revision but I agree with Daniel Buuck's comment that the dotted line extending perpendicular from the wall should start at corner of the recessed fireplace.

Buuck, Daniel

The new figures are a great improvement over the old ones. However, upon review for the ballot, the dashed lines extending perpendicular from the wall appear to be placed incorrectly. Table 7.5.6.3 gives the dimension of 60 inches from the "front of recessed fireplace." Since that's the case, the lines should originate at the corner of the recessed fireplace (with the herringbone pattern floor) and extend 60 inches out from there.

Second Revision No. 11-NFPA 13D-2017 [Section No. A.10.2]

A.10.2

All residential sprinklers have been investigated under a flat, smooth, 8 ft (2.4 m) high horizontal ceiling. Some residential sprinklers have been investigated and listed for use under specific ceiling configurations such as a horizontal beamed ceiling. The performance of residential sprinklers under flat, smooth, horizontal ceilings has been well documented throughout the life of NFPA 13D. Prior to 2010, several manufacturers of residential sprinklers had performed testing and received listings for residential sprinklers under certain slopes and in certain beam conditions. In 2010, the Fire Protection Research Foundation (FPRF) conducted a research project consisting of 76 FDS simulations and 12 full-scale fire tests. The results have been used to develop system design criteria in a generic manner to simplify the use of residential sprinklers. Some residential sprinkler listings still exist for situations beyond the scope of the generic design. See the FPRF report, "Analysis of the Performance of Residential Sprinkler Systems with Sloped or Sloped and Beamed Ceilings," dated July 2010, for more information.

Questions are frequently asked regarding the minimum two sprinkler design when certain sprinkler performance statistics have indicated that in a majority of the cases (with residential sprinklers) the fire is controlled or suppressed with a single sprinkler. While these statistics might or might not be accurate, the water supplies for the fire sprinkler systems under which these statistics were generated were designed for two or more sprinklers in the first place. When the fires occurred, the first sprinkler operated in excess of its individual design flow and pressure because the sprinkler system's water supply was strong enough to handle multiple sprinklers and only a single sprinkler opened. At these higher flows and pressures, the discharge from a single sprinkler was sufficient to limit or suppress the heat generated from the fire. This concept is called "hydraulic increase." Hydraulic increase can also occur when a water supply's capabilities during the fire event exceeded that required by the minimum design requirements of the standard. Since none of the data used to generate the previously mentioned statistics captured the capabilities of the water supply in relation to the design requirements, the impact of the hydraulic increase on the number of single sprinkler activations cannot be determined.

But if the minimum water supply requirement of the standard is reduced to only be capable of handling a single sprinkler, then there could be no hydraulic increase safety factor. When the first sprinkler opens, it will only get the flow and pressure that were originally designed for it, and the potential is significant for that to be insufficient to control the fire, given any obstructions and the layout of the space where the fire starts.

The National Institute for Standards and Technology (NIST), under a grant from the United States Fire Administration, studied this concept several years ago in the hopes of being able to propose a single-sprinkler flow for the 2007 edition of NFPA 13D (see NIST Report NIST GCR 05-875 prepared by Underwriters Laboratories with a publication date of February 2004). Unfortunately, the research did not support the design of a sprinkler system with only the flow for a single sprinkler, even under conditions of small rooms with flat, smooth ceilings. Without the hydraulic increase associated with the two-sprinkler design, the fire scenarios were too many where the first sprinkler to open would have insufficient flow to control the fire and then multiple sprinklers would open, causing the room to reach untenable conditions and the water supply to be overrun. These same fire scenarios were easily controlled by a sprinkler system designed for a two-sprinkler water supply from the start.

In addition to the NIST tests, the National Fire Sprinkler Association conducted a series of full-scale fire tests in simulated bedrooms that were 14 ft × 14 ft (4.2 m × 4.2 m) with an adjoining hallway, each with flat, smooth, 8 ft (2.4 m) high ceilings. The tests were performed to determine better rules for keeping sprinklers clear of obstructions like ceiling fans, but baseline tests were also performed without any obstructions at the ceiling. In nine out of the twelve tests, including the two baseline tests without obstructions at the ceiling, a sprinkler in the hall outside the room of fire origin opened first, followed by the sprinkler in the room of origin. Even though the room of origin met all of the rules of NFPA 13D as a compartment, a sprinkler outside of this room was opening first. All of these fires were controlled by the sprinklers, but if the water supply had only been sufficient for a single sprinkler, the sprinklers might not have been able to provide fire control.

For examples of selecting a compartment for consideration, see Figure A.10.2(a), ~~and~~ Figure A.10.2(b), and Figure A.10.2(c), which show examples of design configurations for compartments based on the presence of lintels to stop the flow of heat. In all three figures, the area under consideration for determining the number of design sprinklers is the living room. In Figure A.10.2(a), the living room is considered a compartment since the opening to the hall has an 8 in. (200 mm) lintel, the opening to the dining room has an 8 in. (200 mm) lintel, and all openings on that wall are limited to 8 ft (2.4 m). In Figure A.10.2(b), the living room and dining room are considered one compartment due to the lack of a lintel between the two spaces. The hall is a separate compartment since there is still an 8 in. (200 mm) lintel between the living room and hall. In Figure A.10.2(c), the living room, dining room, and hall are considered one compartment since there are no lintels separating those spaces.

Figure A.10.2(a) Sprinkler Design Areas for Typical Residential Occupancy — ~~Without Lintel~~ With Lintel Between Adjoining Spaces: Dining Room and Hall .

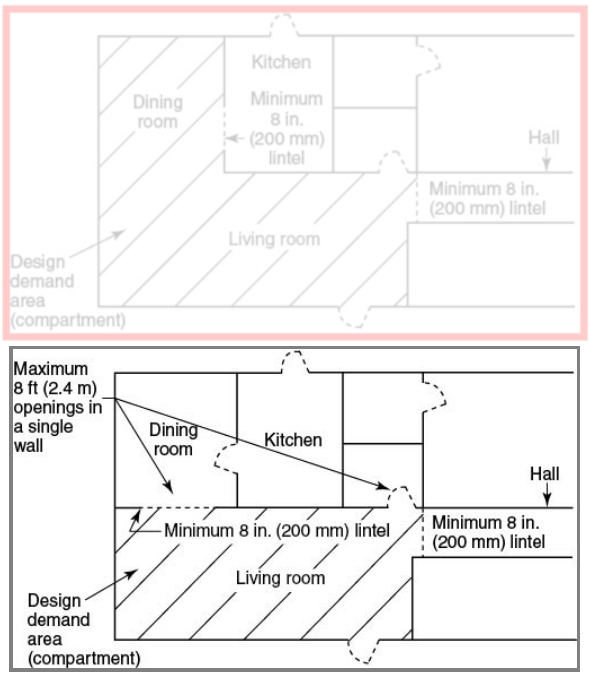


Figure A.10.2(b) Sprinkler Design Areas for Typical Residential Occupancy — Without Lintel Between Dining Room, With Lintel Between Hall .

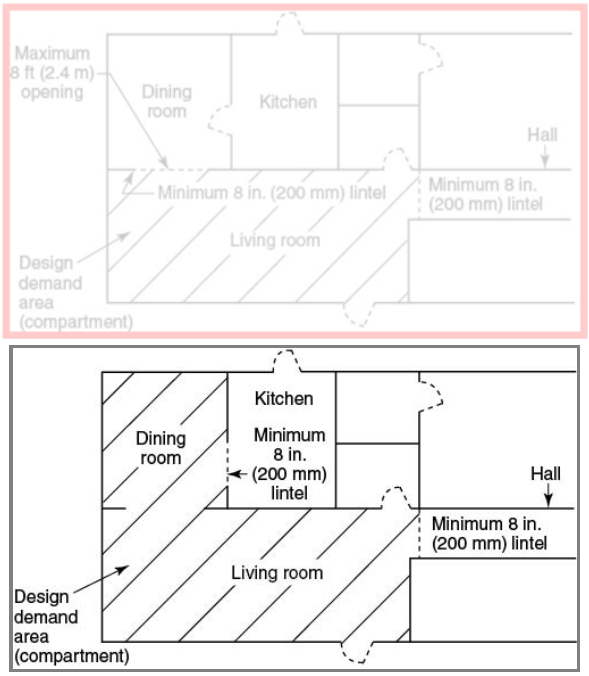
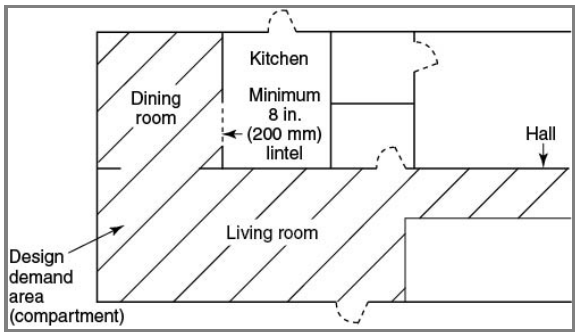


Figure A.10.2(c) Sprinkler Design Areas for Typical Residential Occupancy — Without Lintel Between Adjoining Spaces: Dining Room and Hall.



Supplemental Information

File Name	Description	Approved
NFPA_13D_Figure_A.10.2.pdf	New Figures A.10.2(a), A.10.2(b), and A.10.2(c)--for staff use	

Submitter Information Verification

Submitter Full Name: Chad
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Thu Jun 22 11:12:35 EDT 2017

Committee Statement

Committee Statement: The annex text has been modified to clarify the application of the rules regarding the definition of compartment. The existing figures have been modified and a new figure has been added. See attached figures.

Response Message:

Ballot Results

✔ **This item has passed ballot**

31 Eligible Voters
4 Not Returned
27 Affirmative All
0 Affirmative with Comments
0 Negative with Comments
0 Abstention

Not Returned

Cronin, Bradford T.
O'Brian, Michael
Paez, Ernie
Puchovsky, Milosh T.

Affirmative All

Asp, Roland A.

Bell, Kerry M.

Benn, Fred

Bradley, Frederick C.

Browning, Chase A.

Buuck, Daniel

Deegan, Thomas G.

Feid, Jeffrey

Isman, Kenneth E.

Lugar, James R.

Mathias, Daniel J.

Nickelson, David A.

Nickson, Ronald G.

Pilette, Maurice M.

Schultz, Bruce

Schwab, Peter T.

Skare, Eric J.

Skinner, Timothy J.

Stanley, George W.

Towler, Michael

Townley, Donald R.

Trim, Martin C. W.

Van Walraven, Ed

Victor, Terry L.

Viola, John F.

Webb, Ronald N.

Yu, Hong-Zeng

Second Revision No. 12-NFPA 13D-2017 [Section No. A.12.3.6.2.1]

A.12.3.6.2.1

For drops less than 4 in. (100 mm) long, the branch line piping and the drops can both be installed in areas subject to freezing. Tests prove that if the branch line is empty of water and water is in a drop, when ice forms it will expand into the branch piping without harming the sprinkler or the system piping.

For horizontal sidewall sprinklers, the testing manifolds were comprised of 1 in. (25 mm) CPVC pipe and fittings, and the sprinklers were installed into 1 in. × ½ in. (25 mm × 15 mm) sprinkler adapter reducing elbows that were located 4 in. (100 mm) from the centerline of the branch line. For pendent sprinklers, the testing manifolds were comprised of 1 in. (25 mm) CPVC pipe and fittings, and the sprinklers were installed into a 1 in. × ½ in. (25 mm × 15 mm) sprinkler adapter fitting with a 4 in. (100 mm) long pipe nipple.

Submitter Information Verification

Submitter Full Name: Chad
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Thu Jun 22 11:40:02 EDT 2017

Committee Statement

Committee Statement: The 4 inch dimension in the standard could be misunderstood and needs to be clarified. Adding the dimensions provided by the test will give the user more information. Also, CPVC is not mentioned in either 12.3.6.2.1 or its Annex, and since the testing used CPVC, this should be noted.

Response Message:

Ballot Results

✔ **This item has passed ballot**

31 Eligible Voters
4 Not Returned
27 Affirmative All
0 Affirmative with Comments
0 Negative with Comments
0 Abstention

Not Returned

Cronin, Bradford T.
O'Brian, Michael
Paez, Ernie
Puchovsky, Milosh T.

Affirmative All

Asp, Roland A.

Bell, Kerry M.

Benn, Fred

Bradley, Frederick C.

Browning, Chase A.

Buuck, Daniel

Deegan, Thomas G.

Feid, Jeffrey

Isman, Kenneth E.

Lugar, James R.

Mathias, Daniel J.

Nickelson, David A.

Nickson, Ronald G.

Pilette, Maurice M.

Schultz, Bruce

Schwab, Peter T.

Skare, Eric J.

Skinner, Timothy J.

Stanley, George W.

Towler, Michael

Townley, Donald R.

Trim, Martin C. W.

Van Walraven, Ed

Victor, Terry L.

Viola, John F.

Webb, Ronald N.

Yu, Hong-Zeng

Second Revision No. 6-NFPA 13D-2017 [Section No. B.1.2.1]

B.1.2.1 ASTM Publications.

ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959.

ASTM A135, *Standard Specification for Electric-Resistance-Welded Steel Pipe*, 2006.

ASTM E84, *Standard Test Method for Surface Burning Characteristics of Building Materials*, ~~2009~~ 2016 .

ASTM F437, *Standard Specification for Threaded Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80*, 1996.

ASTM F438, *Standard Specification for Socket-Type Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 40*, 1997.

ASTM F439, *Standard Specification for Socket-Type Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80*, 1997.

ASTM F442, *Standard Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe (SDR-PR)*, 1997.

ASTM F876, *Standard Specification for Crosslinked Polyethylene (PEX) Tubing*, 2008.

IEEE/ASTM SI 10, *Standard for Use of the International System of Units (SI): The Modern Metric System*, 1997.

Submitter Information Verification

Submitter Full Name: Chad
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Wed Jun 21 10:51:56 EDT 2017

Committee Statement

Committee Statement: date update
Response Message:

Public Comment No. 11-NFPA 13D-2017 [Section No. B.1.2.1]

Ballot Results

✔ **This item has passed ballot**

31 Eligible Voters
4 Not Returned
27 Affirmative All
0 Affirmative with Comments
0 Negative with Comments
0 Abstention

Not Returned

Cronin, Bradford T.

O'Brian, Michael

Paez, Ernie

Puchovsky, Milosh T.

Affirmative All

Asp, Roland A.

Bell, Kerry M.

Benn, Fred

Bradley, Frederick C.

Browning, Chase A.

Buuck, Daniel

Deegan, Thomas G.

Feid, Jeffrey

Isman, Kenneth E.

Lugar, James R.

Mathias, Daniel J.

Nickelson, David A.

Nickson, Ronald G.

Pilette, Maurice M.

Schultz, Bruce

Schwab, Peter T.

Skare, Eric J.

Skinner, Timothy J.

Stanley, George W.

Towler, Michael

Townley, Donald R.

Trim, Martin C. W.

Van Walraven, Ed

Victor, Terry L.

Viola, John F.

Webb, Ronald N.

Yu, Hong-Zeng

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National Fire Protection Association

1 Batterymarch Park, Quincy, MA 02169-7471
Phone: 617-770-3000 • Fax: 617-770-0700 • www.nfpa.org

M E M O R A N D U M

TO: Technical Committee on Residential Sprinkler Systems

FROM: Elena Carroll, *Project Administrator*

DATE: November 1, 2017

SUBJECT: NFPA 13R Second Draft Technical Committee FINAL Ballot Results (A2018)

According to the final ballot results, all ballot items received the necessary affirmative votes to pass ballot.

31 **Members Eligible to Vote**
5 **Members Not Returned** (Cronin, O'Brian, Paez, Puchovsky, Yu)

Supplemental Ballot Results:

31 **Members Eligible to Vote**
7 **Members Not Returned** (Deegan, Ketner, Paez, Puchovsky, Stanley, O'Brian, Van Walraven)

The attached report shows the number of affirmative, negative, and abstaining votes as well as the explanation of the vote for **each** revision**.**

To pass ballot, **each** revision requires: (1) a simple majority of those eligible to vote and (2) an affirmative vote of $^{2}/_{3}$ of ballots returned. See Sections 3.3.4.3.(c) and 4.3.10.1 of the ***Regulations Governing the Development of NFPA Standards***.

Second Revision No. 26-NFPA 13R-2017 [Global Comment]

Update metric conversions in NFPA 13R to match that as shown on the attached list and pdf of NFPA 13R.

Supplemental Information

File Name	Description	Approved
13R_Metric.pdf	NFPA 13R Metric	
Metric_values_used_in_NFPA_13..docx	Metric values used in NFPA 13, 13D & 13R	
Table_6.4.6.3.6.2.xlsx	Reformatted Table showing metric	
Table_6.4.6.3.7.2_a_.xlsx	Reformatted table showing metric	
Table_6.4.6.3.7.2_b_.xlsx	Reformatted table showing metric	

Submitter Information Verification

Submitter Full Name: David Hague
Organization: National Fire Protection Assoc
Street Address:
City:
State:
Zip:
Submittal Date: Thu Oct 12 10:41:08 EDT 2017

Committee Statement

Committee Statement: The metric conversions in the attached list are considered to be “soft” or approximate conversions and are intended to consider trade sizes for pipe and other materials and have been appropriately rounded with the number of significant digits taken into account. The intent of this list is to provide for consistent use of metric conversions throughout the standard with the understanding that it is acceptable for an engineer, authority having jurisdiction, designer or, installer to use an exact conversion rather than an approximate conversion as used in the standard when necessary.

The attached list has been reviewed by the NFPA 13 Metric Task Group.

Response Message:

Ballot Results

This item has passed ballot

31 Eligible Voters
7 Not Returned
21 Affirmative All
0 Affirmative with Comments
3 Negative with Comments
0 Abstention

Not Returned

Deegan, Thomas G.
Ketner, Charles W.
O'Brian, Michael
Paez, Ernie
Puchovsky, Milosh T.
Stanley, George W.
Van Walraven, Ed

Affirmative All

Bell, Kerry M.
Benn, Fred
Bradley, Frederick C.
Browning, Chase A.
Buuck, Daniel
Cronin, Bradford T.
Dannaway, Samuel S.
Feid, Jeffrey
Isman, Kenneth E.
Lugar, James R.
Nickelson, David A.
Noble, Thomas William
Pilette, Maurice M.
Schultz, Bruce
Schwab, Peter T.
Skare, Eric J.
Towler, Michael
Townley, Donald R.
Viola, John F.
Webb, Ronald N.
Yu, Hong-Zeng

Negative with Comment

Asp, Roland A.

I am voting negative on SR-17 for the reasons outlined in Terry Victors's Negative ballot. The limits outlined in the NFPA standards need to maintained and be consistent whether the metric or SI units are being used. It makes no sense to relax the requirements (using "soft conversions") when metric units are being applied. As stated in Terry Victors negative ballot, if using SI units, sprinklers are required under all obstructions 48 inches or more, it should not be permitted to reduce this requirement to 47 1/4 inches when using metric units. I agree that soft conversions makes sense in certain situations but I believe the committee needs to revisit the conditions when soft conversions are permissible and when hard conversions need to be required.

Nickson, Ronald G.

Support of comment by Terry Vector.

Victor, Terry L.

The soft conversions shown in the ballot are problematic. Hard conversions will better serve the users of NFPA documents. We test sprinklers in the US and put limits on their use with maximum spacing, minimum pressure, area limitations, etc. Then we try to convert to metric and all rules are ignored. Instead of a hard conversion using decimals we offer a soft conversion by rounding off to the nearest unit or tenth or hundredth of a unit. When changing to a soft conversion the requirements are either relaxed slightly or are slightly more stringent. Example: Obstructions OVER 48” wide require sprinklers under the obstruction. When using the conversions offered by the NFPA, 48” becomes 1200 mm which is really 47 ¼”. In this case the conversion make the requirement more restrictive, and believe me I’ve seen many ducts that are exactly 48” wide and therefore shouldn’t require sprinklers under them. However with this conversion they will require sprinklers below them when installed outside the US. I reached out to our R&D office in Canada and Tyco Fire Protection Products contacted our colleagues in Europe and Asia. Everyone questioned responded that hard conversions using decimals are preferred. I will provide the NFPA with an Excel spreadsheet showing the inaccuracies created by using a soft conversion. Most dimensional conversions are off by 2%. This is unacceptable. In the same spreadsheet, conversions in UL1971 are included that show a very minimal variance when using a hard conversion with a one decimal conversion factor. The NFPA needs to go back to a more reasonable conversion scheme to minimize the variance in this SR.

Length					
.003”	.08 mm	7.5”	190 mm	26”	650 mm
.0315”	.8 mm	8”	200 mm	27.6”	690 mm
1/32”	0.8 mm	8.5”	215 mm	28”	700 mm
1/16”	1.6 mm	9”	225 mm	29”	725 mm
3/32”	2 mm	9.25”	230 mm	30”	750 mm
1/8”	3 mm	9.5”	240 mm	30.5”	765 mm
3/16”	5 mm	10”	250 mm	31”	775 mm
¼”	6 mm	11”	275 mm	32”	800 mm
5/16”	8 mm	11.5”	290 mm	33”	825 mm
3/8”	10 mm	12”	300 mm	35”	875 mm
½”	13 mm	12.25”	305 mm	35.4”	885 mm
17/32”	13 mm	12.5”	315 mm	36”	900 mm
9/16”	14 mm	12.75”	320 mm	37”	925 mm
5/8”	16 mm	14”	350 mm	38”	950 mm
¾”	19 mm	15”	375 mm	40”	1000 mm
7/8”	22 mm	15.5”	390 mm	42”	1050 mm
1”	25 mm	16”	400 mm	44”	1100 mm
1.5”	40 mm	16.25”	410 mm	47”	1175 mm
1.75”	45 mm	16.5”	415 mm	48”	1200 mm
2”	50 mm	17”	425 mm	54”	1350 mm
2.5”	65 mm	17.5”	440 mm	55”	1375 mm
2.75”	70 mm	18”	450 mm	57”	1425 mm
3”	75 mm	19”	475 mm	58”	1450 mm
3.5”	90 mm	20”	500 mm	66”	1650 mm
4”	100 mm	21”	525 mm	68”	1700 mm
4.5”	115 mm	22”	550 mm	72”	1800 mm
5”	125 mm	22.5”	565 mm	76”	1900 mm
5.5”	140 mm	23”	575 mm	78”	1950 mm
5.75”	145 mm	24”	600 mm	96”	2400 mm
6”	150 mm	25”	625 mm	102”	2550 mm
7”	175 mm	25.5”	640 mm	120”	3000 mm
				148”	3700 mm

Length					
3.5ft	1.1 m	10’-10”	3.3 m	22’-6”	6.9 m
3’-8”	1.1 m	11’-0”	3.4 m	24ft	7.3 m
4ft	1.2 m	11’-3”	3.4 m	25ft	7.6 m
4’-2”	1.3 m	11’-5”	3.5 m	25’-3”	7.7 m
4.5ft	1.4 m	11’-6”	3.5 m	26ft	7.9 m
4’-7”	1.4 m	11’-611/16”	3.5 m	27ft	8.2 m
4’-9”	1.4 m	11’-8”	3.6 m	28ft	8.5 m
5ft	1.5 m	12ft	3.7 m	28’-8”	8.7 m
5’-2”	1.6 m	12’-4”	3.8 m	29’-8”	9 m
5.5ft	1.7 m	13ft	4.0 m	30ft	9.1 m
5’-8”	1.7 m	13’-6”	4.1 m	32ft	10 m
5’-9 5/16”	1.8 m	13’-71/2”	4.2 m	33ft	10 m
6ft	1.8 m	13’-11”	4.2 m	35ft	11 m
6’-3”	1.9 m	14ft	4.3 m	36ft	11 m
6’-4”	1.9 m	14’-6”	4.4 m	40ft	12 m
6.5ft	2 m	15ft	4.6 m	41’-3”	13 m
6’-10”	2.1 m	15’-4”	4.7 m	45ft	14 m
7ft	2.1 m	16ft	4.9 m	50ft	15 m
7.5ft	2.3 m	16’-6”	5.0 m	51’-6”	16 m
7’-7”	2.3 m	16’-8”	5.1 m	55ft	17 m
7’-9”	2.4 m	17ft	5.2 m	60ft	18 m
8ft	2.4 m	18ft	5.5 m	65ft	20 m
8’-2”	2.5 m	18’-6”	5.6 m	70ft	21 m
8’-4”	2.5 m	19’-2”	5.8 m	75ft	23 m
8’-77/8”	2.6 m	19’-10”	6 m	76ft	23 m
9ft	2.7 m	19’-11”	6.1 m	80ft	24 m
9’-5”	2.9 m	20ft	6.1 m	100ft	30 m
9’-6”	2.9 m	20’-8”	6.3 m	200ft	61 m
10ft	3 m	21’-6”	6.6 m	250ft	76 m
10.5ft	3.2 m	21’-10”	6.7 m	300ft	91 m
10’-9”	3.3 m	22 ft	6.7 m	400ft	120 m

Area					
3.5 ft2	0.3 m2	256 ft2	24 m2	2,700 ft2	250 m2
6 ft2	0.6 m2	300 ft2	28 m2	2,734 ft2	255 m2
10 ft2	0.9 m2	306 ft2	28 m2	2,800 ft2	260 m2
12 ft2	1.1 m2	324 ft2	30 m2	3,000 ft2	280 m2
16 ft2	1.5 m2	395 ft2	37 m2	3,250 ft2	300 m2
18 ft2	1.7m2	400 ft2	37 m2	3,300 ft2	305 m2
20 ft2	1.9m2	450 ft2	42 m2	3,450 ft2	320 m2
24 ft2	2.2m2	504 ft2	47 m2	3,500 ft2	325 m2
25 ft2	2.3 m2	585 ft2	54 m2	3,600 ft2	335 m2
32 ft2	3.0 m2	600 ft2	56 m2	3,750 ft2	350 m2
50 ft2	4.6 m2	648 ft2	60 m2	3,900 ft2	360 m2
55 ft2	5.1 m2	700 ft2	65 m2	4,000 ft2	370 m2
64 ft2	5.9 m2	756 ft2	70 m2	4,100 ft2	380 m2
70 ft2	6.5 m2	768 ft2	71 m2	4,500 ft2	420 m2
80 ft2	7.4 m2	800 ft2	74 m2	4,800 ft2	445 m2
90 ft2	8.4 m2	1,000 ft2	93 m2	5,000 ft2	465 m2
100 ft2	9 m2	1,200ft2	112 m2	6,000 ft2	555 m2
110 ft2	10 m2	1,300 ft2	120 m2	6,400 ft2	595 m2
120 ft2	11 m2	1,365 ft2	125 m2	8,000 ft2	740 m2
124 ft2	12 m2	1,400 ft2	130 m2	8,800 ft2	820 m2
130 ft2	12 m2	1,500 ft2	140 m2	10,000 ft2	930 m2
144 ft2	13 m2	1,700 ft2	160 m2	13,100 ft2	1 215 m2
150 ft2	14 m2	1,800 ft2	165 m2	25,000 ft2	2 320 m2
168 ft2	16 m2	1,950 ft2	180 m2	40,000 ft2	3 720 m2
175 ft2	16 m2	2,000 ft2	185 m2	50,000 ft2	4 650 m2
196 ft2	18 m2	2,300 ft2	215 m2	52,000 ft2	4 830 m2
200 ft2	18 m2	2,500 ft2	230m2	100,000 ft2	9 230 m2
225 ft2	20 m2	2,535 ft2	235 m2		
250 ft2	23 m2	2,600 ft2	240 m2		

Volume			
1.76 cuin	28 ml	160 ft3	4.5 m3
15.5 ft3	0.5 m3	400 ft3	11 m3
17.4 ft3	0.5 m3	1,000 ft3	28 m3
17.6 ft3	0.5 m3	1,800 ft3	51 m3
20.7 ft3	0.6 m3	2,100 ft3	59 m3
21.1 ft3	0.6 m3	2,300 ft3	65 m3
22 ft3	0.6 m3	6,500 ft3	184 m3
100 ft3	2.8 m3	2.25M ft3	63,720 m3

Capacity	
16 oz.	0.5 l
32 oz.	1 l
1 gal	4 l
5 gal	20 l
40 gal	150 l
100 gal	380 l
150 gal	570 l
250 gal	950 l
500 gal	1900 l
750 gal	2850 l
300,000 gal	1,135,500 l

Drill Size	
3/32”	2,3 mm
1/8”	3,2 mm
3/8”	10 mm

Density of Cotton Bales	
22.0 lb/ft^3	350 kg/m^3
22.7 lb/ft^3	365 kg/m^3
24.2 lb/ft^3	390 kg/m^3
28.4 lb/ft^3	455 kg/m^3
28.7 lb/ft^3	460 kg/m^3
32.2 lb/ft^3	515 kg/m^3

Flow					
30 gpm	115 lpm	300 gpm	1150 lpm	1000 gpm	3800 lpm
15 gpm	57 lpm	400 gpm	1500 lpm	1500 gpm	5700 lpm
20 gpm	75 lpm	500 gpm	1900 lpm	1992 gpm	7540 lpm
50 gpm	190 lpm	600 gpm	2250 lpm	1993 gpm	7543 lpm
60 gpm	230 lpm	700 gpm	2650 lpm	2156 gpm	8160 lpm
100 gpm	380 lpm	750 gpm	2850 lpm	2575 gpm	9750 lpm
102.8 gpm	390 lpm	800 gpm	3050 lpm	4907 gpm	18,572 lpm
200 gpm	760 lpm	850 gpm	3200 lpm		
215.8 gpm	815 lpm	900 gpm	3400 lpm		
250 gpm	950 lpm				

Pressure			
5 psi	0.3 bar	75	5.2 bar
7	0.5 bar	90	6.2 bar
10	0.7 bar	100	6.9 bar
11	.8 bar	150	10 bar
15	1.0 bar	165	11 bar
20	1.4 bar	175	12 bar
22	15 bar	189	13 bar
25	1.7 bar	200	14 bar
30	2.1 bar	259	17 bar
35	2.4 bar	300	21 bar
50	3.4 bar	400	28 bar
63	4.3 bar		

Gauge	
12	2.8 mm
14	1.98 mm
16	1.57 mm
22	.78 mm
24	.63mm

Weight			
6 lb	2.7 kg	350 lb	160 kg
10 lb	4.5 kg	440 lb	200 kg
20 lb	9.1 kg	520 lb	235 kg
40 lb	18 kg	750 lb	340 kg
61 lb	27 kg	787 lb	355 kg
91 lb	41 kg	1200 lb	544 kg
131 lb	59 kg	1634 lb	740 kg
200 lb	91 kg	2000 lb	907 kg
250 lb	115 kg	2300 lb	1043 kg
		4000 lb	1815 kg

Velocity	
30 mph	49 km/h

Discharge Density			
gpm/ft2	mm/min	gpm/ft2	mm/min
.005	.2	.425	17.3
.05	2.04	.426	17.4
.1	4.1	.44	17.9
.15	6.1	.45	18.3
.16	6.5	.46	18.7
.17	7.0	.49	20
.18	7.3	.5	20.4
.19	7.7	.55	22.4
.2	8.2	.56	22.8
.21	8.6	.57	23.2
.225	9.2	.6	24.5
.24	9.8	.61	24.9
.25	10.2	.65	26.5
.26	10.6	.68	27.7
.28	11.4	.7	28.5
.29	11.8	.74	30.2
.3	12.2	.75	30.6
.31	12.6	.77	31.4
.32	13.0	.8	32.6
.33	13.4	.85	34.6
.34	13.9	.9	36.7
.35	14.3	.92	37.5
.37	15.1	.96	39.1
.375	15.3	1.1	44.8
.39	15.9	1.2	48.9
.4	16.3	6.0	245
.42	17.1	7.5	306

Table 6.4.6.3.6.2 Positioning of Sprinklers to Avoid Obstructions to Discharge (Residential Upright and Pendent Spray Sprinklers)			
Distance from Sprinkler to side of Obstruction (A)		Maximum Allowable Distance of Deflector Above Bottom of Obstruction (B)	
ft	mm	in	mm
Less than 1 ft	300	0	0
1 ft to less than 1 ft 6 in.	300 to less than 450	0	0
1 ft 6 in. to less than 2 ft	300 to less than 600	1	25
2 ft to less than 2 ft 6 in.	600 to less than 750	1	25
2 ft 6 in. to less than 3 ft	750 to less than 900	1	25
3 ft to less than 3 ft 6 in.	900 to less than 1050	3	75
3 ft 6 in. to less than 4 ft	1050 to less than 1200	3	75
4 ft to less than 4 ft 6 in	1200 to less than 1350	5	125
4 ft 6 in. to less than 5 ft	1350 to less than 1500	7	175
5 ft to less than 5 ft 6 in	1500 to less than 1650	7	175
5 ft 6 in. to less than 6 ft	1650 to less than 1800	7	175
6 ft to less than 6 ft 6 in	1800 to less than 1950	9	225
6 ft 6 in. to less than 7 ft	1950 to less than 2100	11	275
7 ft and greater	2100 and greater	14	350

Table 6.4.6.3.7.2(a) Positioning of Sprinklers to Avoid Obstructions (Residentail Sidewall Sprinklers)			
Distance from Sidewall Sprinkler to Side of Obstruction (A)	**Distance from Sidewall Sprinkler to Side of Obstruction (A)**	**Maximum Allowable Distance of Dseflector Above Bottom of Obstruction (B)**	**Maximum Allowable Distance of Dseflector Above Bottom of Obstruction (B)**
ft	**m**	**ft**	**mm**
Less than 8 ft	2.4	Not allowed	Not allowed
8 ft to less than 10 ft	2.4 to less than 3	1	25
10 ft to less than 11 ft	3 to less than 3.4	2	50
11 ft to less than 12 ft	3.4 to less than 3.7	3	75
12 ft to less than 13 ft	3.7 to less than 4.0	4	100
13 ft to less than 14 ft	4.0 to less than 4.3	6	150
14 ft to less than 15 ft	4.3 to less than 4.6	7	175
15 ft to less than 16 ft	4.6 to less than 4.9	9	225
16 ft to less than 17 ft	4.9 to less than 5.2	11	275
17 ft or greater	5.4 or greater	14	350

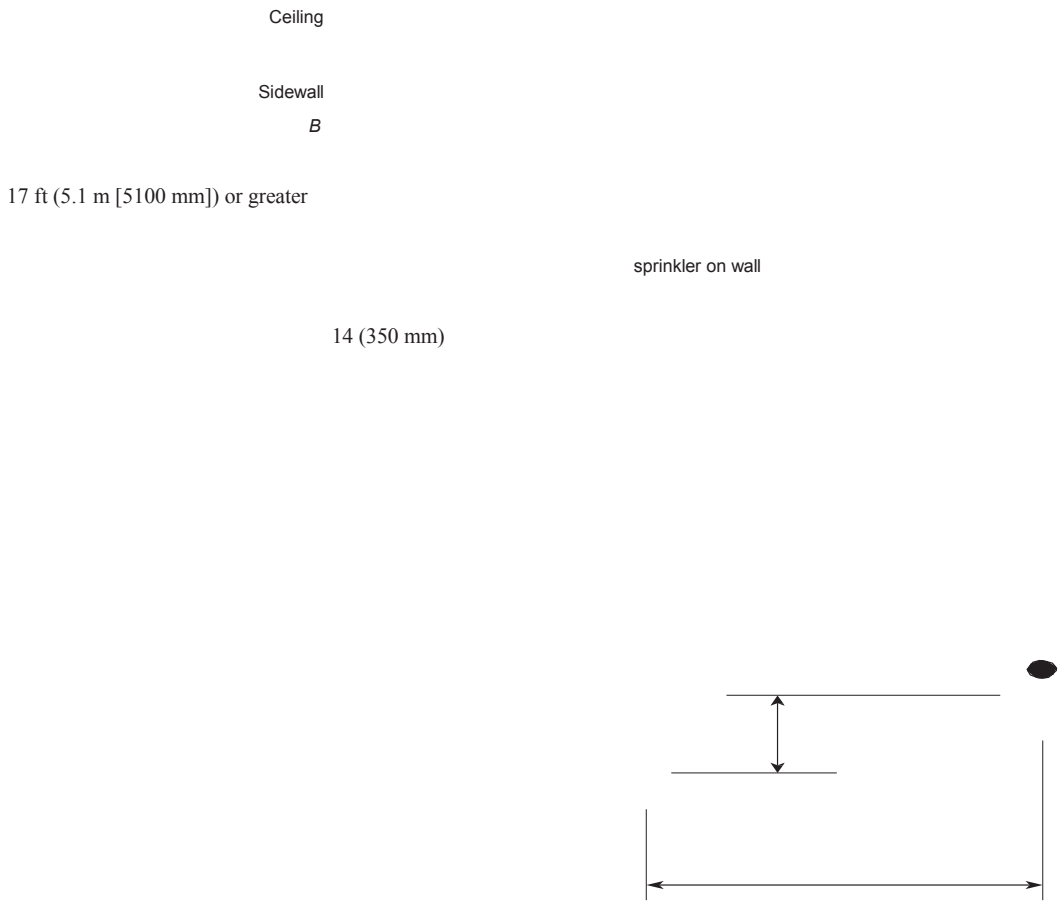


Table 6.4.6.3.7.2(b) Positioning of Sprinklers to Avoid Obstruction Along Wall (Residential Sidewall Sprinklers)			
Distance from Sidewall Sprinkler to Side of Obstruction (a)		**Maximum Allowable Distance of Deflector Above Bottom of Obstruction (B)**	
ft	**mm**	**in**	**mm**
Less than 1 ft 6 in.	Less than 450	0	0
1 ft 6 in. to less than 3 ft	450 to less than 900	1	25
3 ft to less than 4 ft	900 to less than 1200	3	75
4 ft to less than 4 ft 6 in.	1200 to less than 1350	5	125
4 ft 6 in. to less than 6 ft	1350 to less than 1800	7	175
6 ft to less than 6 ft 6 in.	1800 to less than 1950	9	225
6 ft 6 in. to less than 7 ft	1950 to less than 2100	11	275
7 ft to less than 7ft 6 in.	2100 to less than 2250	14	350

Second Revision No. 20-NFPA 13R-2017 [Section No. 1.4]

1.4* Equivalency.

Nothing in this standard is intended to prevent the use of systems, methods, or devices of equivalent or superior quality, strength, fire resistance, effectiveness, durability, and safety over those prescribed by this standard.

A.1.4

It is the intent of the committee to recognize that future editions of this standard are a further refinement of this edition and earlier editions. The changes in future editions will reflect the continuing input of the fire protection community in its attempt to meet the purpose stated in this standard. Compliance with all requirements of a future edition could be considered as providing an equivalent level of system integrity and performance of the system.

1.4.1

Technical documentation shall be submitted to the authority having jurisdiction to demonstrate equivalency.

1.4.2

The system, method, or device shall be approved for the intended purpose by the authority having jurisdiction.

Submitter Information Verification

Submitter Full Name: Chad
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Thu Jun 22 09:37:16 EDT 2017

Committee Statement

Committee Statement: The added annex language maintains consistency with NFPA 13D.
Response Message:

Ballot Results

✔ **This item has passed ballot**

31 Eligible Voters
5 Not Returned
25 Affirmative All
0 Affirmative with Comments
1 Negative with Comments
0 Abstention

Not Returned

Cronin, Bradford T.

O'Brian, Michael

Paez, Ernie

Puchovsky, Milosh T.

Yu, Hong-Zeng

Affirmative All

Asp, Roland A.

Benn, Fred

Bradley, Frederick C.

Browning, Chase A.

Buuck, Daniel

Deegan, Thomas G.

Feid, Jeffrey

Isman, Kenneth E.

Lugar, James R.

Mathias, Daniel J.

Nickelson, David A.

Nickson, Ronald G.

Pilette, Maurice M.

Schultz, Bruce

Schwab, Peter T.

Skare, Eric J.

Skinner, Timothy J.

Stanley, George W.

Towler, Michael

Townley, Donald R.

Trim, Martin C. W.

Van Walraven, Ed

Victor, Terry L.

Viola, John F.

Webb, Ronald N.

Negative with Comment

Bell, Kerry M.

NFPA has developed language addressing the application of different editions of NFPA standards that will be included in the front matter of all NFPA standards going forward. With this in mind, it is appropriate for this Annex text to be deleted. See agenda item 17-8-57 for the August 2017 Standards Council meeting.

Second Revision No. 25-NFPA 13R-2017 [Chapter 2]

Chapter 2 Referenced Publications

2.1 General.

The documents or portions thereof listed in this chapter are referenced within this standard and shall be considered part of the requirements of this document.

2.2 NFPA Publications.

National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA 13, *Standard for the Installation of Sprinkler Systems,* 2019 edition.

NFPA 20, *Standard for the Installation of Stationary Pumps for Fire Protection,* 2019 edition.

NFPA 22, *Standard for Water Tanks for Private Fire Protection,* 2018 edition.

NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems,* 2017 edition.

NFPA 82, *Standard on Incinerators and Waste and Linen Handling Systems and Equipment,* 2014 edition.

NFPA *101*®, *Life Safety Code*®, 2018 edition.

NFPA 220, *Standard on Types of Building Construction,* 2018 edition.

NFPA 750, *Standard on Water Mist Fire Protection Systems,* 2019 edition.

NFPA 5000®, *Building Construction and Safety Code*®, 2018 edition.

2.3 Other Publications.

2.3.1 ASME Publications.

ASME International, Two Park Avenue, New York, NY 10016-5990.

ASME A17.1/CSA B44 , *Safety Code for Elevators and Escalators*, ~~2013~~ 2016 .

ASME B16.1, *Gray Iron Pipe Flanges and Flanged Fittings, Classes 25, 125, and 250,* 2015.

ASME B16.3, *Malleable Iron Threaded Fittings, Classes 150 and 300,*~~2011~~ 2016 .

ASME B16.4, *Gray Iron Threaded Fittings, Classes 125 and 250,*~~2011~~ 2016 .

ASME B16.5, *Pipe Flanges and Flanged Fittings, NPS 1/2 through NPS 24 Metric/Inch Standard,* 2013.

ASME B16.9, *Factory-Made Wrought Buttwelding Fittings*, 2012.

ASME B16.11, *Forged Fittings, Socket-Welding and Threaded*, ~~2011~~ 2016 .

ASME B16.15, *Cast Copper Alloy Threaded Fittings, Classes 125 and 250*, 2013.

ASME B16.18, *Cast Copper Alloy Solder Joint Pressure Fittings*, 2012.

ASME B16.22, *Wrought Copper and Copper Alloy Solder Joint Pressure Fittings*, 2013.

ASME B16.25, *Buttwelding Ends*, 2012.

ASME B36.10M, *Welded and Seamless Wrought Steel Pipe*, 2015.

ASME *Boiler and Pressure Vessel Code* , 2017 edition.

2.3.2 ASTM Publications.

ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959.

ASTM A53/A53M, *Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless*, 2012.

ASTM A135/A135M, *Standard Specification for Electric-Resistance-Welded Steel Pipe*, 2009, reapproved 2014.

ASTM A234/A234M, *Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperatures*, ~~2015~~ 2016 .

ASTM A795/A795M, *Standard Specification for Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless Steel Pipe for Fire Protection Use*, 2013.

ASTM B32, *Standard Specification for Solder Metal*, 2008, reapproved 2014.

ASTM ~~B43~~ B43 , *Standard Specification for Seamless Red Brass Pipe, Standard Sizes*, 2015.

ASTM B88, *Standard Specification for Seamless Copper Water Tube*, ~~2014~~ 2016 .

ASTM B251, *Standard Specification for General Requirements for Wrought Seamless Copper and Copper-Alloy Tube*, 2010.

ASTM B813, *Standard Specification for Liquid and Paste Fluxes for Soldering Applications of Copper and Copper-Alloy Tube*, 2016.

ASTM F437, *Standard Specification for Threaded Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80*, 2015.

ASTM F438, *Standard Specification for Socket-Type Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 40*, 2015.

ASTM F439, *Standard Specification for Socket-Type Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80*, 2013.

ASTM F442/F442M, *Standard Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe (SDR-PR)*, 2015a.

2.3.3 AWS Publications.

American Welding Society, ~~8869~~ 8669 NW 36 Street, #130, Miami, FL 33166-6672.

AWS A5.8/A5.8M, *Specification for Filler Metals for Brazing and Braze Welding*, 2011, Amendment 1, 2012.

AWS B2.1/B2.1M, *Specification for Welding Procedure and Performance Qualification,*2014, Amendment 1, 2015.

2.3.4 Other Publications.

Merriam-Webster's Collegiate Dictionary, 11th edition, Merriam-Webster, Inc., Springfield, MA, 2003.

2.4 References for Extracts in Mandatory Sections.

NFPA 13, *Standard for the Installation of Sprinkler Systems,* 2019 edition.

NFPA 5000®, Building Construction and Safety Code®, 2018 edition.

Submitter Information Verification

Submitter Full Name: Chad
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Sat Jun 24 22:22:31 EDT 2017

Committee Statement

Committee Statement: Editorial.

Response Message:

Ballot Results

✔ **This item has passed ballot**

31 Eligible Voters
5 Not Returned
26 Affirmative All
0 Affirmative with Comments
0 Negative with Comments
0 Abstention

Not Returned

Cronin, Bradford T.
O'Brian, Michael
Paez, Ernie
Puchovsky, Milosh T.
Yu, Hong-Zeng

Affirmative All

Asp, Roland A.
Bell, Kerry M.
Benn, Fred
Bradley, Frederick C.
Browning, Chase A.
Buuck, Daniel
Deegan, Thomas G.
Feid, Jeffrey
Isman, Kenneth E.
Lugar, James R.
Mathias, Daniel J.
Nickelson, David A.
Nickson, Ronald G.
Pilette, Maurice M.
Schultz, Bruce
Schwab, Peter T.
Skare, Eric J.
Skinner, Timothy J.
Stanley, George W.
Towler, Michael

Townley, Donald R.

Trim, Martin C. W.

Van Walraven, Ed

Victor, Terry L.

Viola, John F.

Webb, Ronald N.

Second Revision No. 2-NFPA 13R-2017 [Section No. 5.2.2.3]

5.2.2.3

Pipe or tube listed for light-hazard occupancies shall be permitted to be installed ~~in concealed spaces~~ above ordinary-hazard rooms~~.~~ under the following conditions:

(1) In rooms 400 ft^2 (37 m^2) or less, piping shall be permitted to be installed either exposed in accordance with its listing or installed concealed behind a minimum of one layer of ⅜ in. (10 mm) thick gypsum wallboard or ½ in. (13 mm) thick plywood.

(2) In rooms over 400 ft^2 (37 m^2) piping shall be permitted to be installed concealed behind a minimum of one layer of ⅜ in. (10 mm) thick gypsum wallboard or ½ in. (13 mm) thick plywood.

Submitter Information Verification

Submitter Full Name: Chad
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Wed Jun 21 13:19:55 EDT 2017

Committee Statement

Committee Statement: Thermoplastic piping systems have been listed for use in 13R Garages since the 1990's. This listing established that the minimum required protection criteria for this hazard was a one layer of 3/8 inch thick gypsum wallboard or 1/2 inch thick plywood. There is no appreciable difference between a garage and other ordinary hazard areas found in a 13R occupancy.

Response Message:

Public Comment No. 32-NFPA 13R-2017 [Section No. 5.2.2.3]

Public Comment No. 28-NFPA 13R-2017 [Section No. 5.2.2.3]

Ballot Results

✔ **This item has passed ballot**

31 Eligible Voters
5 Not Returned
24 Affirmative All
0 Affirmative with Comments
1 Negative with Comments
1 Abstention

Not Returned

Cronin, Bradford T.

O'Brian, Michael

Paez, Ernie

Puchovsky, Milosh T.

Yu, Hong-Zeng

Affirmative All

Asp, Roland A.

Benn, Fred

Bradley, Frederick C.

Browning, Chase A.

Buuck, Daniel

Deegan, Thomas G.

Feid, Jeffrey

Lugar, James R.

Mathias, Daniel J.

Nickelson, David A.

Nickson, Ronald G.

Pilette, Maurice M.

Schultz, Bruce

Schwab, Peter T.

Skare, Eric J.

Skinner, Timothy J.

Stanley, George W.

Towler, Michael

Townley, Donald R.

Trim, Martin C. W.

Van Walraven, Ed

Victor, Terry L.

Viola, John F.

Webb, Ronald N.

Negative with Comment

Isman, Kenneth E.

We should not be allowing pipe that failed to get a listing for ordinary hazard to be used to protect ordinary hazard spaces. If the barrier would have been sufficient to get the listing, don't you think it would have been listed that way?

Abstention

Bell, Kerry M.

I am abstaining since this revision impacts the UL listing of plastic piping products.

Second Revision No. 3-NFPA 13R-2017 [Section No. 5.4.4]

5.4.4*

Water-filled piping shall be permitted to be installed in areas ~~where the temperature is less than 40°F (4°C)~~ subject to freezing when heat loss calculations performed by a professional engineer verify that the system will not freeze.

A.5.4.4

There are some geographic regions where the temperature will get below 40°F (4°C) for brief periods of time. However, the water in the pipe has sufficient thermal mass to keep it from freezing and thus additional freeze protection is not required.

Submitter Information Verification

Submitter Full Name: Chad
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Wed Jun 21 13:54:17 EDT 2017

Committee Statement

Committee Statement: Adding annex language that mirrors the committee statement from the first draft. Less than 40 degrees F was changed to "subject to freezing" making it easier to address sprinkler systems installed in geographic regions that experience short periods of temperature exposures not long enough to freeze the water in the pipe.

Response Message:

Public Comment No. 7-NFPA 13R-2017 [Section No. 5.4.4]

Ballot Results

✔ **This item has passed ballot**

31 Eligible Voters
5 Not Returned
26 Affirmative All
0 Affirmative with Comments
0 Negative with Comments
0 Abstention

Not Returned

Cronin, Bradford T.

O'Brian, Michael

Paez, Ernie

Puchovsky, Milosh T.

Yu, Hong-Zeng

Affirmative All

Asp, Roland A.

Bell, Kerry M.

Benn, Fred

Bradley, Frederick C.

Browning, Chase A.

Buuck, Daniel

Deegan, Thomas G.

Feid, Jeffrey

Isman, Kenneth E.

Lugar, James R.

Mathias, Daniel J.

Nickelson, David A.

Nickson, Ronald G.

Pilette, Maurice M.

Schultz, Bruce

Schwab, Peter T.

Skare, Eric J.

Skinner, Timothy J.

Stanley, George W.

Towler, Michael

Townley, Donald R.

Trim, Martin C. W.

Van Walraven, Ed

Victor, Terry L.

Viola, John F.

Webb, Ronald N.

Second Revision No. 4-NFPA 13R-2017 [Section No. 6.2.2.2]

6.2.2.2

The following types of spaces shall be permitted to be protected by residential sprinklers in accordance with Section 7.1:

(1) Lobbies not in hotels and motels

(2) Foyers

(3) Corridors

(4) Halls

(5) Lounges

(6) Ordinary-hazard areas in accordance with 7.2.4.1

(7) Garages in accordance in accordance with 7.3.4 and 7.3.4.1(1)

(8) Porches, balconies, lanais, and similar areas

(9) Other areas with fire loads similar to residential fire loads

Submitter Information Verification

Submitter Full Name: Chad
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Wed Jun 21 14:04:08 EDT 2017

Committee Statement

Committee Statement: Some AHJ's consider these areas "outside" the dwelling unit since they are exterior. Residential sprinklers should be allowed when these areas are required to be protected (Type 5 construction).

Response Message:

Public Comment No. 43-NFPA 13R-2017 [Section No. 6.2.2.2]

Ballot Results

✔ **This item has passed ballot**

31 Eligible Voters
5 Not Returned
26 Affirmative All
0 Affirmative with Comments
0 Negative with Comments
0 Abstention

Not Returned

Cronin, Bradford T.

O'Brian, Michael

Paez, Ernie

Puchovsky, Milosh T.

Yu, Hong-Zeng

Affirmative All

Asp, Roland A.

Bell, Kerry M.

Benn, Fred

Bradley, Frederick C.

Browning, Chase A.

Buuck, Daniel

Deegan, Thomas G.

Feid, Jeffrey

Isman, Kenneth E.

Lugar, James R.

Mathias, Daniel J.

Nickelson, David A.

Nickson, Ronald G.

Pilette, Maurice M.

Schultz, Bruce

Schwab, Peter T.

Skare, Eric J.

Skinner, Timothy J.

Stanley, George W.

Towler, Michael

Townley, Donald R.

Trim, Martin C. W.

Van Walraven, Ed

Victor, Terry L.

Viola, John F.

Webb, Ronald N.

Second Revision No. 1-NFPA 13R-2017 [Section No. 6.2.3.3]

6.2.3.3*

The practices of 6.2.3.3.1 through ~~6.2.3.3.3~~ 6.2.3.3.5 shall be observed when installing residential sprinklers unless higher expected ambient temperatures require a higher temperature rating.

6.2.3.3.1

Sprinklers under glass or plastic skylights exposed to direct rays of the sun shall be of intermediate temperature classification.

6.2.3.3.2

Sprinklers in an unventilated concealed space under uninsulated roof or in an unventilated attic shall be of intermediate temperature classification.

6.2.3.3.3*

Sprinklers ~~in closets containing ventless clothes dryers~~ installed near specific heat sources that are identified in Table 6.2.3.3.3 shall be of the ~~intermediate-temperature classification or higher~~ temperature rating indicated in Table 6.2.3.3.3 unless sprinklers are listed for positioning closer to the heat source .

Table 6.2.3.3.3 Minimum Distances for Ordinary and Intermediate Temperature Residential Sprinklers

	From Edge of Source to Ordinary Temperature Sprinkler		From Edge of Source to Intermediate Temperature Sprinkler	
Heat Source	in.	mm	in.	mm
Side of open or recessed fireplace	36	900	12	300
Front of recessed fireplace	60	1500	36	900
Coal- or wood- burning stove	42	1050	12	300
Kitchen range	18	450	9	225
Wall oven	18	450	9	225
Hot air flues	18	450	9	225
Uninsulated heat ducts	18	450	9	225
Uninsulated hot water pipes	12	300	6	150
Side of ceiling- or wall-mounted hot air diffusers	24	600	12	300
Front of wall-mounted hot air diffusers	36	900	18	450
Hot water heater or furnace	6	150	3	75
Light fixture:				
0 W–250 W	6	150	3	75
250 W–499 W	12	300	6	150

6.2.3.3.3.1

Sprinklers adjacent to diffusers shall not be required to meet 6.2.3.3.3 where the temperature from the diffuser does not exceed 100°F (38°C).

6.2.3.3.4

Sprinklers in closets containing ventless clothes dryers shall be of the intermediate-temperature classification or higher.

6.2.3.3.5

All sprinklers within a compartment shall have the same temperature classification except where required by 6.2.3.3 for a specific location.

Supplemental Information

File Name	Description	Approved
Table_6.2.3.3.3.docx	Table 6.2.3.3.3--for staff use	

Submitter Information Verification

Submitter Full Name: Chad
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Wed Jun 21 11:23:33 EDT 2017

Committee Statement

Committee Statement: During the first draft, sections 6.2.3.3.3 and 6.2.3.4 and Table 6.2.3.3.3 were inadvertently deleted. This comment simply adds back the text and table. It also renumbers the remainder of the section into a more logical progression. See attached Table 6.2.3.3.3.

Response Message:

Public Comment No. 25-NFPA 13R-2017 [New Section after 6.2.3.3.3.1]

Public Comment No. 8-NFPA 13R-2017 [Section No. 6.2.3.3]

Public Comment No. 44-NFPA 13R-2017 [Section No. 6.2.3.3.3]

Public Comment No. 26-NFPA 13R-2017 [Section No. 6.2.3.3.3.1]

Public Comment No. 4-NFPA 13R-2017 [Global Input]

Public Comment No. 33-NFPA 13R-2017 [Section No. 6.2.3.3.3.1]

Public Comment No. 27-NFPA 13R-2017 [Section No. 6.2.3.3 [Excluding any Sub-Sections]]

Ballot Results

✔ **This item has passed ballot**

31 Eligible Voters
5 Not Returned
26 Affirmative All
0 Affirmative with Comments
0 Negative with Comments
0 Abstention

Not Returned

Cronin, Bradford T.

O'Brian, Michael

Paez, Ernie

Puchovsky, Milosh T.

Yu, Hong-Zeng

Affirmative All

Asp, Roland A.

Bell, Kerry M.

Benn, Fred

Bradley, Frederick C.

Browning, Chase A.

Buuck, Daniel

Deegan, Thomas G.

Feid, Jeffrey

Isman, Kenneth E.

Lugar, James R.

Mathias, Daniel J.

Nickelson, David A.

Nickson, Ronald G.

Pilette, Maurice M.

Schultz, Bruce

Schwab, Peter T.

Skare, Eric J.

Skinner, Timothy J.

Stanley, George W.

Towler, Michael

Townley, Donald R.

Trim, Martin C. W.

Van Walraven, Ed

Victor, Terry L.

Viola, John F.

Webb, Ronald N.

Second Revision No. 22-NFPA 13R-2017 [New Section after 6.4.6.1.1.1]

6.4.6.1.2

Concealed sprinklers shall be permitted to be installed in beams up to 4 in. (100 mm) in depth.

Submitter Information Verification

Submitter Full Name: Chad
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Fri Jun 23 13:50:08 EDT 2017

Committee Statement

Committee Statement: Following discussions at the first draft meeting on the installation of residential pendent sprinklers below beams, the question was raised if this would also apply to concealed sprinklers. Upon review of existing test data, a recommendation was made to limit concealed sprinklers installed under beams to no greater than 4 inches in depth. This language would clarify that the previous section would not apply to concealed sprinklers.

Response Message:

Ballot Results

✔ **This item has passed ballot**

31 Eligible Voters
5 Not Returned
24 Affirmative All
0 Affirmative with Comments
2 Negative with Comments
0 Abstention

Not Returned

Cronin, Bradford T.
O'Brian, Michael
Paez, Ernie
Puchovsky, Milosh T.
Yu, Hong-Zeng

Affirmative All

Asp, Roland A.

Bell, Kerry M.

Benn, Fred

Bradley, Frederick C.

Browning, Chase A.

Buuck, Daniel

Deegan, Thomas G.

Feid, Jeffrey

Isman, Kenneth E.

Lugar, James R.

Mathias, Daniel J.

Nickelson, David A.

Nickson, Ronald G.

Pilette, Maurice M.

Schultz, Bruce

Skare, Eric J.

Skinner, Timothy J.

Stanley, George W.

Towler, Michael

Townley, Donald R.

Trim, Martin C. W.

Van Walraven, Ed

Viola, John F.

Webb, Ronald N.

Negative with Comment

Schwab, Peter T.

I agree with Mr. Victor.

Victor, Terry L.

Although testing was discussed during the second draft meeting, no test results were provided to committee members for review and comment. Concealed sprinklers have been installed under horizontal & sloping beamed ceilings since residential concealed sprinklers were first introduced with no known failures.

Second Revision No. 23-NFPA 13R-2017 [Section No. 6.4.6.1.1.1]

6.4.6.1.1.1*

Pendent-type residential sprinklers located under or adjacent to beams in accordance with 7.1.1.3.1 shall be installed in accordance with one of the following:

(1) Pendent, recessed pendent and flush-type pendent sprinklers shall be permitted to be installed directly under a beam having a maximum depth of 14 in. (350 mm) with the sprinkler deflector 1 in. to 2 in. (25 mm to 50 mm) below the beam, or in accordance with the manufacturer's instructions for recessed or flush sprinklers if the deflector is less than 1 in. (25 mm) below the beam. , as shown in Figure 6.4.6.1.1.1(a) .

(2) Pendent sprinklers ~~including flush-type pendent sprinklers,~~ shall be permitted to be installed adjacent to beams when the vertical centerline of the sprinkler is no greater than 2 in. (50 mm) from the edge of the beam and with the sprinkler deflector 1 in. to 2 in. (25 mm to 50 mm) below the beam, or in accordance with the manufacturer's instructions for flush sprinklers if the deflector is less than 1 in. (25 mm) below the beam. , as shown in Figure 6.4.6.1.1.1(b) .

Figure 6.4.6.1.1.1(a) Position of Sprinkler Under a Beam.

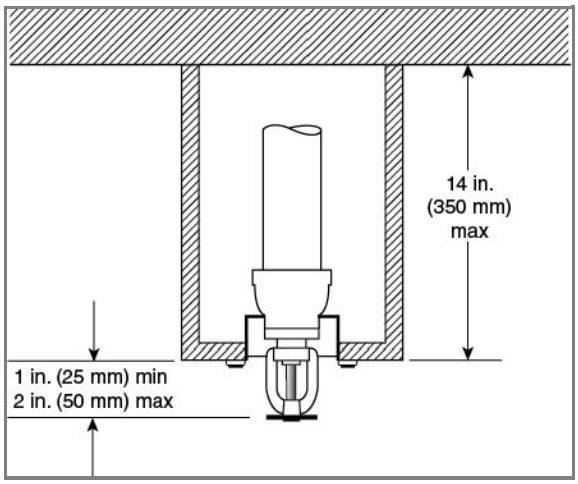
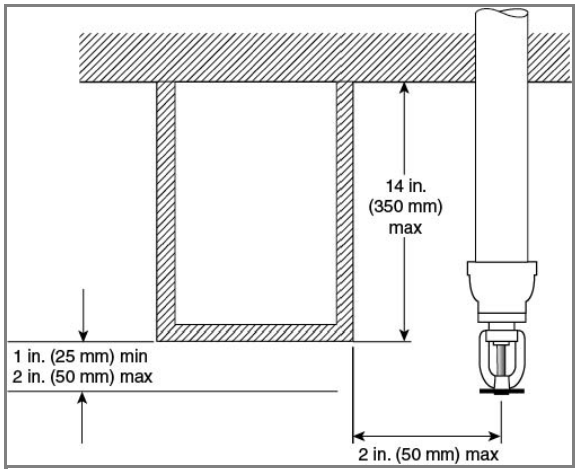


Figure 6.4.6.1.1.1(b) Position of Sprinkler Adjacent to a Beam.



A.6.4.6.1.1.1

Concealed sprinklers should not be considered flush-type sprinklers.

Supplemental Information

File Name	Description	Approved
Figures_6.4.6.1.1.1.pdf	New figures 6.4.6.1.1.1(1) and 6.4.6.1.1.1(2)--for staff use	

Submitter Information Verification

Submitter Full Name: Chad
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Fri Jun 23 13:53:44 EDT 2017

Committee Statement

Committee Statement: This comment is in support of this new language and seeks to add two new figures to illustrate these requirements.Note these figures have also been submitted to NFPA 13. See attached figures, Figure 6.4.6.1.1.1(1) and Figure 6.4.6.1.1.1(2).

Response Message:

Public Comment No. 47-NFPA 13R-2017 [Section No. 6.4.6.1.1.1]

Ballot Results

✔ **This item has passed ballot**

31 Eligible Voters
5 Not Returned
24 Affirmative All
1 Affirmative with Comments
1 Negative with Comments
0 Abstention

Not Returned

Cronin, Bradford T.
O'Brian, Michael
Paez, Ernie
Puchovsky, Milosh T.
Yu, Hong-Zeng

Affirmative All

Asp, Roland A.
Bell, Kerry M.
Benn, Fred
Bradley, Frederick C.
Browning, Chase A.
Deegan, Thomas G.
Feid, Jeffrey
Isman, Kenneth E.

Lugar, James R.

Mathias, Daniel J.

Nickelson, David A.

Nickson, Ronald G.

Pilette, Maurice M.

Schultz, Bruce

Schwab, Peter T.

Skare, Eric J.

Skinner, Timothy J.

Stanley, George W.

Towler, Michael

Townley, Donald R.

Van Walraven, Ed

Victor, Terry L.

Viola, John F.

Webb, Ronald N.

Affirmative with Comment

Buuck, Daniel

I support the intent of this revision, but I do want to point out that the term "flush-type" sprinklers (also called "flush" sprinklers in the standard) and "concealed sprinklers" are not defined. This makes the proposed annex statement "Concealed sprinklers should not be considered flush-type sprinklers" confusing without prior knowledge of what they are.

Negative with Comment

Trim, Martin C. W.

Concealed sprinklers should not be limited to a 14" beam depth.

Second Revision No. 7-NFPA 13R-2017 [Section No. 6.4.6.3.4.1]

6.4.6.3.4.1

Pendent sprinklers shall be located at least 3 ft (914 mm) from obstructions such as ceiling fans and light fixtures unless the requirements of 6.4.6.3.4.5 or 6.4.6.3.6 are met.

Submitter Information Verification

Submitter Full Name: Chad
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Wed Jun 21 14:39:43 EDT 2017

Committee Statement

Committee Statement: This revision is necessary to coordinate with added section 6.4.6.3.4.5.
Response Message:

Ballot Results

✔ **This item has passed ballot**

31 Eligible Voters
5 Not Returned
26 Affirmative All
0 Affirmative with Comments
0 Negative with Comments
0 Abstention

Not Returned

Cronin, Bradford T.
O'Brian, Michael
Paez, Ernie
Puchovsky, Milosh T.
Yu, Hong-Zeng

Affirmative All

Asp, Roland A.
Bell, Kerry M.
Benn, Fred
Bradley, Frederick C.

Browning, Chase A.

Buuck, Daniel

Deegan, Thomas G.

Feid, Jeffrey

Isman, Kenneth E.

Lugar, James R.

Mathias, Daniel J.

Nickelson, David A.

Nickson, Ronald G.

Pilette, Maurice M.

Schultz, Bruce

Schwab, Peter T.

Skare, Eric J.

Skinner, Timothy J.

Stanley, George W.

Towler, Michael

Townley, Donald R.

Trim, Martin C. W.

Van Walraven, Ed

Victor, Terry L.

Viola, John F.

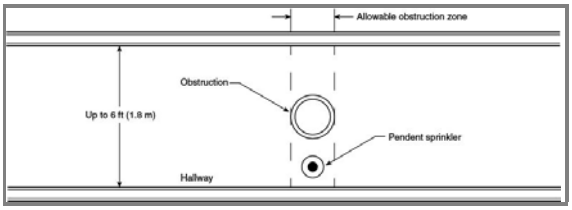
Webb, Ronald N.

Second Revision No. 6-NFPA 13R-2017 [New Section after 6.4.6.3.4.4]

6.4.6.3.4.5*

In hallways up to 6 ft (1.8 m) in width, sprinklers shall be permitted to be located adjacent to obstructions where the sprinkler is installed in the allowable obstruction zone as shown in Figure 6.4.6.3.4.5 .

Figure 6.4.6.3.4.5 Obstruction in Hallway — Pendent Sprinkler.



A.6.4.6.3.4.5

Surface-mounted obstructions can include, but are not limited to, light fixtures, exit signage, and smoke detectors.

Supplemental Information

File Name	Description	Approved
PC45_pendent_hallway_obstruction.pdf	New Figure 6.4.6.3.4.5. For staff use	

Submitter Information Verification

Submitter Full Name: Chad
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Wed Jun 21 14:23:50 EDT 2017

Committee Statement

Committee Statement: In a hallway, an obstruction is not a problem when the sprinkler is installed adjacent to the light on the width of the hallway. Attach revised figure changing "light" to "obstruction."

Response Message:

Public Comment No. 45-NFPA 13R-2017 [New Section after 6.4.6.3.4.4]

Ballot Results

✔ **This item has passed ballot**

31 Eligible Voters
5 Not Returned

26 Affirmative All
0 Affirmative with Comments
0 Negative with Comments
0 Abstention

Not Returned

Cronin, Bradford T.
O'Brian, Michael
Paez, Ernie
Puchovsky, Milosh T.
Yu, Hong-Zeng

Affirmative All

Asp, Roland A.
Bell, Kerry M.
Benn, Fred
Bradley, Frederick C.
Browning, Chase A.
Buuck, Daniel
Deegan, Thomas G.
Feid, Jeffrey
Isman, Kenneth E.
Lugar, James R.
Mathias, Daniel J.
Nickelson, David A.
Nickson, Ronald G.
Pilette, Maurice M.
Schultz, Bruce
Schwab, Peter T.
Skare, Eric J.
Skinner, Timothy J.
Stanley, George W.
Towler, Michael
Townley, Donald R.
Trim, Martin C. W.
Van Walraven, Ed
Victor, Terry L.
Viola, John F.
Webb, Ronald N.

Second Revision No. 9-NFPA 13R-2017 [Section No. 6.4.6.3.5.1]

6.4.6.3.5.1

Sidewall sprinklers shall be located at least 5 ft (1.52 m) from obstructions such as ceiling fans and light fixtures unless the requirements of 6.4.6.3.5.5 or 6.4.6.3.7 are met.

Submitter Information Verification

Submitter Full Name: Chad
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Wed Jun 21 14:47:54 EDT 2017

Committee Statement

Committee Statement: This revision is necessary to coordinate with the added section 6.4.6.3.4.5.
Response Message:

Ballot Results

✔ **This item has passed ballot**

31 Eligible Voters
5 Not Returned
26 Affirmative All
0 Affirmative with Comments
0 Negative with Comments
0 Abstention

Not Returned

Cronin, Bradford T.
O'Brian, Michael
Paez, Ernie
Puchovsky, Milosh T.
Yu, Hong-Zeng

Affirmative All

Asp, Roland A.
Bell, Kerry M.
Benn, Fred
Bradley, Frederick C.

Browning, Chase A.

Buuck, Daniel

Deegan, Thomas G.

Feid, Jeffrey

Isman, Kenneth E.

Lugar, James R.

Mathias, Daniel J.

Nickelson, David A.

Nickson, Ronald G.

Pilette, Maurice M.

Schultz, Bruce

Schwab, Peter T.

Skare, Eric J.

Skinner, Timothy J.

Stanley, George W.

Towler, Michael

Townley, Donald R.

Trim, Martin C. W.

Van Walraven, Ed

Victor, Terry L.

Viola, John F.

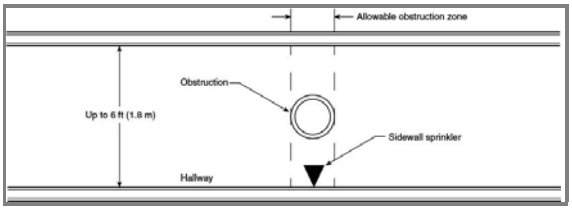
Webb, Ronald N.

Second Revision No. 8-NFPA 13R-2017 [New Section after 6.4.6.3.5.4]

6.4.6.3.5* Obstruction in Hallway — Sidewall Sprinkler.

In hallways up to 6 ft (1.8 m) in width, sprinklers shall be permitted to be located adjacent to obstructions where the sprinkler is installed in the allowable obstruction zone as shown in Figure 6.4.6.3.5.5 .

Figure 6.4.6.3.5.5 Obstruction in Hallway — Sidewall Sprinkler.



A.6.4.6.3.5.5

Surface-mounted obstructions can include, but are not limited to, light fixtures, exit signage, and smoke detectors.

Supplemental Information

File Name	Description	Approved
PC45_sidewall_hallway_obstruction.pdf	New Figure 6.4.6.3.5.5. For staff use	

Submitter Information Verification

Submitter Full Name: Chad
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Wed Jun 21 14:43:41 EDT 2017

Committee Statement

Committee Statement: In a hallway, an obstruction is not a problem when the sprinkler is installed adjacent to the light on the width of the hallway. See attached Figure 6.4.6.3.5.5
Response Message:

Ballot Results

✔ **This item has passed ballot**

31 Eligible Voters
5 Not Returned
26 Affirmative All

0 Affirmative with Comments

0 Negative with Comments

0 Abstention

Not Returned

Cronin, Bradford T.

O'Brian, Michael

Paez, Ernie

Puchovsky, Milosh T.

Yu, Hong-Zeng

Affirmative All

Asp, Roland A.

Bell, Kerry M.

Benn, Fred

Bradley, Frederick C.

Browning, Chase A.

Buuck, Daniel

Deegan, Thomas G.

Feid, Jeffrey

Isman, Kenneth E.

Lugar, James R.

Mathias, Daniel J.

Nickelson, David A.

Nickson, Ronald G.

Pilette, Maurice M.

Schultz, Bruce

Schwab, Peter T.

Skare, Eric J.

Skinner, Timothy J.

Stanley, George W.

Towler, Michael

Townley, Donald R.

Trim, Martin C. W.

Van Walraven, Ed

Victor, Terry L.

Viola, John F.

Webb, Ronald N.

Second Revision No. 10-NFPA 13R-2017 [Section No. 6.6.5]

6.6.5*

Except as provided for in 6.6.5.1, sprinklers shall not be required in any ~~lanais, porches, balconies, corridors, carports, porte cocheres, and stairs~~ of the following features that are open and attached~~.~~ :

(1) Lanais

(2) Porches

(3) Balconies

(4) Carports

(5) Porte cocheres

(6) Stairs

(7) Corridors that are open to the outside atmosphere and are separated from the exit stairwell

(8) Other similar features

6.6.5.1

Where a roof or deck is provided above, sprinklers shall be installed to protect attached exterior balconies, attached exterior decks, and ground floor patios serving dwelling units in buildings of Construction Type V.

6.6.5.1.1

Where sidewall sprinklers are installed beneath decks or balconies constructed with open wood joists, sprinklers shall be permitted to be installed with deflectors not less than 1 in. (25 mm) or more than 6 in. (152 mm) below the structural members, provided that the deflector is not more than 14 in. (356 mm) below the underside surface of the deck.

Submitter Information Verification

Submitter Full Name: Chad
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Wed Jun 21 15:23:44 EDT 2017

Committee Statement

Committee Statement: Corridors that are open to the outside but not separated from the exit stairwell need sprinkler protection. The phrase "other similar features" was added to allow sprinklers to be omitted regardless of what the architect called the space.

Response Message:

Public Comment No. 19-NFPA 13R-2017 [Section No. 6.6.5]

Public Comment No. 34-NFPA 13R-2017 [Section No. 6.6.5 [Excluding any Sub-Sections]]

Public Comment No. 1-NFPA 13R-2017 [New Section after 6.6.9.4]

Ballot Results

This item has passed ballot

31 Eligible Voters
5 Not Returned
26 Affirmative All
0 Affirmative with Comments
0 Negative with Comments
0 Abstention

Not Returned

Cronin, Bradford T.
O'Brian, Michael
Paez, Ernie
Puchovsky, Milosh T.
Yu, Hong-Zeng

Affirmative All

Asp, Roland A.
Bell, Kerry M.
Benn, Fred
Bradley, Frederick C.
Browning, Chase A.
Buuck, Daniel
Deegan, Thomas G.
Feid, Jeffrey
Isman, Kenneth E.
Lugar, James R.
Mathias, Daniel J.
Nickelson, David A.
Nickson, Ronald G.
Pilette, Maurice M.
Schultz, Bruce
Schwab, Peter T.
Skare, Eric J.
Skinner, Timothy J.
Stanley, George W.
Towler, Michael
Townley, Donald R.
Trim, Martin C. W.
Van Walraven, Ed
Victor, Terry L.
Viola, John F.

Webb, Ronald N.

Second Revision No. 11-NFPA 13R-2017 [Section No. 7.4.3 [Excluding any Sub-Sections]]

Attics that are not required by 7.4.1 to have sprinklers shall be permitted to have protection in accordance with one of the following.

(1) Protection complying with NFPA 13

(2) Protection using sprinklers specifically listed to provide attic protection in residential occupancies using a discharge density of not less than 0.05 gpm/ft^2 (2.04 mm/min) and a design area of not less than four sprinklers

Submitter Information Verification

Submitter Full Name: Chad
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Wed Jun 21 16:17:44 EDT 2017

Committee Statement

Committee Statement: Reference to 4.5.1 is incorrect.
Response Message:

Public Comment No. 41-NFPA 13R-2017 [Section No. 7.4.3 [Excluding any Sub-Sections]]

Public Comment No. 58-NFPA 13R-2017 [Section No. 7.4.3 [Excluding any Sub-Sections]]

Ballot Results

✔ **This item has passed ballot**

31 Eligible Voters
5 Not Returned
25 Affirmative All
0 Affirmative with Comments
1 Negative with Comments
0 Abstention

Not Returned

Cronin, Bradford T.

O'Brian, Michael

Paez, Ernie

Puchovsky, Milosh T.

Yu, Hong-Zeng

Affirmative All

Asp, Roland A.

Bell, Kerry M.

Benn, Fred

Bradley, Frederick C.

Browning, Chase A.

Buuck, Daniel

Feid, Jeffrey

Isman, Kenneth E.

Lugar, James R.

Mathias, Daniel J.

Nickelson, David A.

Nickson, Ronald G.

Pilette, Maurice M.

Schultz, Bruce

Schwab, Peter T.

Skare, Eric J.

Skinner, Timothy J.

Stanley, George W.

Towler, Michael

Townley, Donald R.

Trim, Martin C. W.

Van Walraven, Ed

Victor, Terry L.

Viola, John F.

Webb, Ronald N.

Negative with Comment

Deegan, Thomas G.

The need to provide more cost effective fire protection for attic spaces is apparent. However, there is not a listed product on the market that is consistent with 7.4.3(2). If a listed product is to be developed that provides a more efficient means of protecting certain attics, it shouldn't be limited by the criteria included in 7.4.3(2). I believe that the wording after "occupancies" should be eliminated even though the limiting phrase "shall be permitted to have" is included above.

Second Revision No. 12-NFPA 13R-2017 [Sections 9.3.1, 9.3.2, 9.3.3, 9.3.4]

9.3.1

For systems with common domestic/fire mains serving more than one dwelling unit, domestic demand for the building being calculated shall be included as part of the overall system demand unless provisions are made to prevent the domestic waterflow ~~upon~~ on sprinkler system activation.

9.3.2

Domestic demand shall be based ~~upon~~ on one of the following:

(1) Table 9.3.2(a) and Table 9.3.2(b)

(2) The locally adopted plumbing code

(3) Specifications or values from a registered design professional

.

Table 9.3.2(a) Fixture Load Values

Facility Type	Unit
Private Facilities (those within individual dwelling units)	
Bathroom group with flush tank (including lavatory, water closet, and bathtub with shower)	~~6~~ 3.6
Bathroom group with flush valve	8
Bathtub	~~2~~ 1.4
Dishwasher	~~1~~ 1.4
Kitchen sink	~~2~~ 1.4
Laundry trays (1 to 3)	~~3~~ 1.4
Lavatory	~~1~~ 0.7
Shower ~~stall~~ head	~~2~~ 1.4
Washing machine	~~2~~ 1.4
Water closet with flush valve	6
Water closet with flush tank	~~3~~ 2.2
Public Facilities	
Bathtub	4
Drinking fountain	0
Kitchen sink	4
Lavatory	2
Service sink	3
Shower head	4
Urinal with 1 in. (25 mm) flush valve	10
Urinal with ¾ in. (20 mm) flush valve	5
Urinal with flush tank	3
Washing machine [8 lb (3.63 kg)]	3
Washing machine [16 lb (7.26 kg)]	4
Water closet with flush valve	10
Water closet with flush tank	5

Table 9.3.2(b) Total Estimated Domestic Demand

Total Fixture Load Units [from Table 9.3.3(a)]	Total Demand			
	For Systems with Predominately Flush Tanks		For Systems with Predominately Load Units	
	gpm	L/min	gpm	L/min
1	3	11.5	—	—
2	5	19	—	—
5	10	38	15	57
10	15	57	25	95
20	20	76	35	130
35	25	95	45	170
50	30	115	50	190

70	35	130	60	225
100	45	170	70	265
150	55	210	80	305
200	65	245	90	340
250	75	285	100	380
350	100	380	125	475
500	125	475	150	570
750	175	660	175	660
1000	200	755	200	755
1500	275	1040	275	1040
2000	325	1230	325	1230
3500	500	1900	500	1900

9.3.2.1

Interpolation of Table 9.3.2(b) shall be allowed when calculating domestic demand.

~~9.3.3~~

~~Where more demanding domestic demands are specified, they shall be used.~~

9.3.3

Domestic demand shall be added to the hydraulic calculations at the point the piping becomes combined or common.

Supplemental Information

File Name	Description	Approved
Table_9.3.2_a_and_Table_9.3.2_b_.docx	Table 9.3.2(a) and Table 9.3.2(b)--for staff use	

Submitter Information Verification

Submitter Full Name: Chad
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Wed Jun 21 16:55:26 EDT 2017

Committee Statement

Committee Statement: Options have been added for the determination of domestic demand and the fixture loads have been reduced recognizing new technology for plumbing fixtures. See attached revised Tables 9.3.2(a) and 9.3.2(b) and delete Annex A.9.3 including Tables A.9.3(a) and A.9.3(b).

Response Message:

Public Comment No. 23-NFPA 13R-2017 [Section No. A.9.3]

Public Comment No. 22-NFPA 13R-2017 [Section No. 9.3.3]

Public Comment No. 35-NFPA 13R-2017 [Section No. 9.3.2 [Excluding any Sub-Sections]]

Public Comment No. 21-NFPA 13R-2017 [Section No. 9.3.2.1]

Public Comment No. 11-NFPA 13R-2017 [Section No. 9.3.2 [Excluding any Sub-Sections]]

Public Comment No. 20-NFPA 13R-2017 [Section No. 9.3.2 [Excluding any Sub-Sections]]

Public Comment No. 24-NFPA 13R-2017 [Sections 9.3.2, 9.3.3]

Ballot Results

✔ **This item has passed ballot**

31 Eligible Voters
5 Not Returned
26 Affirmative All
0 Affirmative with Comments
0 Negative with Comments
0 Abstention

Not Returned

Cronin, Bradford T.
O'Brian, Michael
Paez, Ernie
Puchovsky, Milosh T.
Yu, Hong-Zeng

Affirmative All

Asp, Roland A.
Bell, Kerry M.
Benn, Fred
Bradley, Frederick C.
Browning, Chase A.
Buuck, Daniel
Deegan, Thomas G.
Feid, Jeffrey
Isman, Kenneth E.
Lugar, James R.
Mathias, Daniel J.
Nickelson, David A.
Nickson, Ronald G.
Pilette, Maurice M.
Schultz, Bruce
Schwab, Peter T.
Skare, Eric J.
Skinner, Timothy J.
Stanley, George W.
Towler, Michael
Townley, Donald R.
Trim, Martin C. W.

Van Walraven, Ed

Victor, Terry L.

Viola, John F.

Webb, Ronald N.

Second Revision No. 13-NFPA 13R-2017 [Section No. 9.7]

9.7 Fire Pump.

9.7.1*

A single automatically controlled fire pump ~~in accordance with~~ ~~NFPA 20~~ unit shall be an acceptable water supply source.

A.9.7.1

A separate fire pump is not required for every building. It is a common and acceptable practice to provide a single fire pump for multiple buildings where the buildings are under the control of the same owner or management firm or where the multiple owners of the buildings have entered into a cooperative agreement for the maintenance and care of the fire pump system. In the case where a fire pump serves multiple buildings, it must be sized so that it can meet the demand of the largest single fire that might occur in any of the buildings, but it is not required to meet the demand of multiple fires simultaneously.

9.7.2

Fire pump units shall be designed and installed in accordance with NFPA 20 .

Submitter Information Verification

Submitter Full Name: Chad
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Thu Jun 22 08:49:17 EDT 2017

Committee Statement

Committee Statement: There are two separate and distinct ideas being provided in section 9.7. It is better to separate them so that there is no confusion. If section 9.7 is left as it was in the first draft, it implies that a fire pump that does not meet NFPA 20 might be acceptable, which has not been the position of the committee. Also, clarification of the single fire pump for multiple buildings is important to the concept of having a single fire pump as proposed in the first draft.

Response Message:

Public Comment No. 29-NFPA 13R-2017 [Section No. 9.7]

Ballot Results

✔ **This item has passed ballot**

31 Eligible Voters
5 Not Returned
26 Affirmative All

0 Affirmative with Comments
0 Negative with Comments
0 Abstention

Not Returned

Cronin, Bradford T.
O'Brian, Michael
Paez, Ernie
Puchovsky, Milosh T.
Yu, Hong-Zeng

Affirmative All

Asp, Roland A.
Bell, Kerry M.
Benn, Fred
Bradley, Frederick C.
Browning, Chase A.
Buuck, Daniel
Deegan, Thomas G.
Feid, Jeffrey
Isman, Kenneth E.
Lugar, James R.
Mathias, Daniel J.
Nickelson, David A.
Nickson, Ronald G.
Pilette, Maurice M.
Schultz, Bruce
Schwab, Peter T.
Skare, Eric J.
Skinner, Timothy J.
Stanley, George W.
Towler, Michael
Townley, Donald R.
Trim, Martin C. W.
Van Walraven, Ed
Victor, Terry L.
Viola, John F.
Webb, Ronald N.

Second Revision No. 14-NFPA 13R-2017 [Section No. A.1.1]

A.1.1

NFPA 13R is appropriate for use as an alternative to NFPA 13 only in those residential occupancies, as defined in this standard, up to and including four aboveground stories in height. It should be noted that model building codes contain special allowances for pedestal or podium-style buildings, which permit the story height for structures above the pedestal to be measured from the top surface of the pedestal, rather than from grade plane, and it is the intent of NFPA 13R to follow this model building code method for determining the number of stories. Accordingly, it is possible for a four-story residential structure to be within the scope of NFPA 13R even when that structure is constructed on top of a one-story pedestal. However, where this is allowed, model building codes will require the pedestal portion to be constructed using Type I construction, and the pedestal portion will be required to be protected by an NFPA 13–compliant sprinkler system.

Regardless of whether a building does or does not involve a pedestal, NFPA 13R systems are always limited to structures that do not exceed 60 ft (18 m) in height above grade plane. Note that model building codes do not allow building height to be measured from the top of a pedestal. That allowance only applies to determining the number of stories. The ~~60-foot~~ 60 ft (18 m) overall height limit is consistent with limits established by model building codes for buildings of Type V construction. The height of a structure above grade plane is determined by model building codes, which base the height on the average height of the highest roof surface above grade plane. For further information on the building height story limits, see model building codes.

Buildings that contain multiple occupancies (either separated or nonseparated), accessory occupancies, or incidental uses are often subject to special rules that might restrict the use of NFPA 13R. In buildings containing a residential occupancy properly separated from other occupancies, the use of NFPA 13R in the residential occupancy and NFPA 13 in the nonresidential occupancy(s) is appropriate. Refer to the adopted building code to determine whether such restrictions are applicable.

The criteria in this standard are based on full-scale fire tests of rooms containing typical furnishings found in residential living rooms, kitchens, and bedrooms. The furnishings were arranged as typically found in dwelling units in a manner similar to that shown in Figure A.1.1(a), Figure A.1.1(b), and Figure A.1.1(c). Sixty full-scale fire tests were conducted in a two-story dwelling in Los Angeles, California, and 16 tests were conducted in a 14 ft (4.3 m) wide mobile home in Charlotte, North Carolina. Sprinkler systems designed and installed according to this standard are expected to prevent flashover within the compartment of origin where sprinklers are installed in the compartment. A sprinkler system designed and installed according to this standard cannot, however, be expected to completely control a fire involving fuel loads that are significantly higher than average for dwelling units [10 lb/ft^2 (49 kg/m^2)], configurations of fuels other than those with typical residential occupancies, or conditions where the interior finish has an unusually high flame spread index (i.e., greater than 225).

To be effective, sprinkler systems installed in accordance with this standard need to open the sprinklers closest to the fire before the fire exceeds the ability of the sprinkler discharge to extinguish or control the fire. Conditions that allow the fire to grow beyond that point before sprinkler activation or that interfere with the quality of water distribution can produce conditions beyond the capabilities of the sprinkler system described in this standard. Unusually high ceilings or ceiling configurations that tend to divert the rising hot gases from sprinkler locations or change the sprinkler discharge pattern from its standard pattern can produce fire conditions that cannot be extinguished or controlled by the systems described in this standard.

NFPA 13R references NFPA 13 in many aspects (i.e., hanging and bracing, design densities and spacing outside of dwelling unit, painting and finish of sprinklers, welding, and so on). If this standard does not specifically address a situation, NFPA 13 is a good resource that can be utilized by the installer and the authority having jurisdiction for a solution. It is not the intent of this standard to require compliance with NFPA 13 when NFPA 13R is silent on a subject. Only AHJ approval should be required.

Figure A.1.1(a) Bedroom.

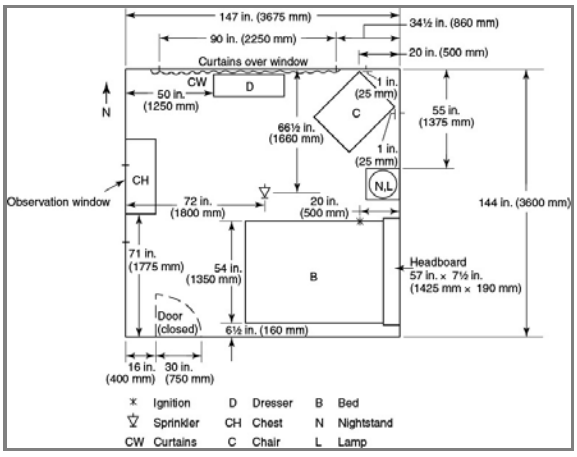


Figure A.1.1(b) Manufactured Home Bedroom.

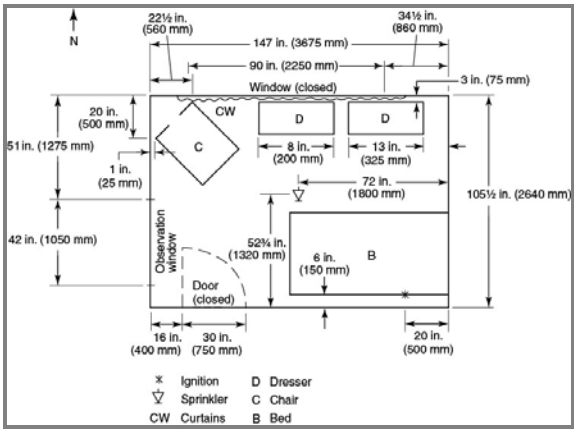
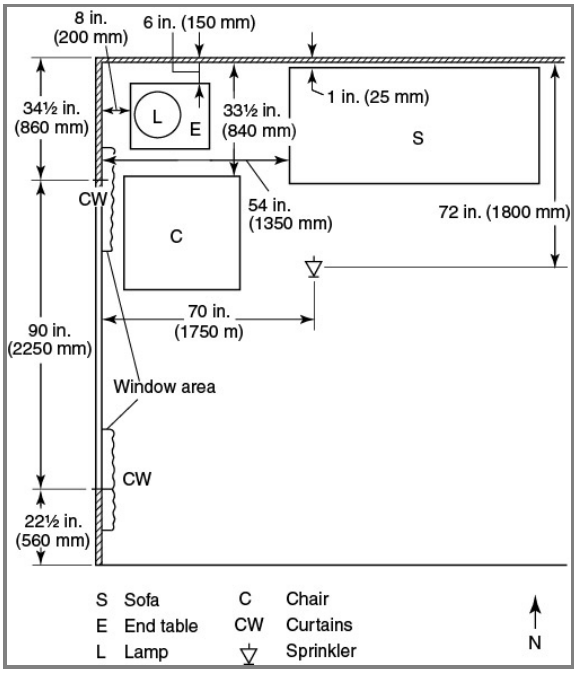


Figure A.1.1(c) Living Room.



Submitter Information Verification

Submitter Full Name: Chad

Organization: [Not Specified]

Street Address:
City:
State:
Zip:
Submittal Date: Thu Jun 22 08:52:18 EDT 2017

Committee Statement

Committee Statement: Further clarifies that NFPA 13 and NFPA 13R systems can be located in the same building if properly separated.

Response Message:

Public Comment No. 42-NFPA 13R-2017 [Section No. A.1.1]

Ballot Results

✔ **This item has passed ballot**

31 Eligible Voters
5 Not Returned
26 Affirmative All
0 Affirmative with Comments
0 Negative with Comments
0 Abstention

Not Returned

Cronin, Bradford T.
O'Brian, Michael
Paez, Ernie
Puchovsky, Milosh T.
Yu, Hong-Zeng

Affirmative All

Asp, Roland A.
Bell, Kerry M.
Benn, Fred
Bradley, Frederick C.
Browning, Chase A.
Buuck, Daniel
Deegan, Thomas G.
Feid, Jeffrey
Isman, Kenneth E.
Lugar, James R.
Mathias, Daniel J.
Nickelson, David A.

Nickson, Ronald G.

Pilette, Maurice M.

Schultz, Bruce

Schwab, Peter T.

Skare, Eric J.

Skinner, Timothy J.

Stanley, George W.

Towler, Michael

Townley, Donald R.

Trim, Martin C. W.

Van Walraven, Ed

Victor, Terry L.

Viola, John F.

Webb, Ronald N.

Second Revision No. 15-NFPA 13R-2017 [Section No. A.3.3.10]

A.3.3.10 Residential Occupancies.

Buildings that contain multiple occupancies, either separated or nonseparated; accessory occupancies; or incidental uses are often subject to special rules that could restrict the use of NFPA 13R. Refer to the adopted building code to determine whether such restrictions are applicable. NFPA 13R is appropriate for use in a residential occupancy. In the list of building types included in this definition, there are situations where there will be mixed occupancies, and NFPA 13R might not be the appropriate sprinkler system standard for the nonresidential occupancies.

Submitter Information Verification

Submitter Full Name: Chad
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Thu Jun 22 08:53:14 EDT 2017

Committee Statement

Committee Statement: Adding additional explanatory language that mirrors the committee statement from the first draft.
Response Message:

Public Comment No. 6-NFPA 13R-2017 [Section No. A.3.3.10]

Ballot Results

✔ **This item has passed ballot**

31 Eligible Voters
5 Not Returned
26 Affirmative All
0 Affirmative with Comments
0 Negative with Comments
0 Abstention

Not Returned

Cronin, Bradford T.
O'Brian, Michael
Paez, Ernie
Puchovsky, Milosh T.
Yu, Hong-Zeng

Affirmative All

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Schultz, Bruce

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Skinner, Timothy J.

Stanley, George W.

Towler, Michael

Townley, Donald R.

Trim, Martin C. W.

Van Walraven, Ed

Victor, Terry L.

Viola, John F.

Webb, Ronald N.

Second Revision No. 16-NFPA 13R-2017 [Section No. A.6.2.3.3.3]

A.6.2.3.3.3

See Figure A.6.2.3.3.3(a) ~~and~~ , Figure A.6.2.3.3.3(b), Figure A.6.2.3.3.3(c) , and Figure A.6.2.3.3.3(d) .

Figure A.6.2.3.3.3(a) ~~Clearance Around Recessed Fireplace.~~ Recessed Fireplace — Ordinary Temperature Sprinkler Location.

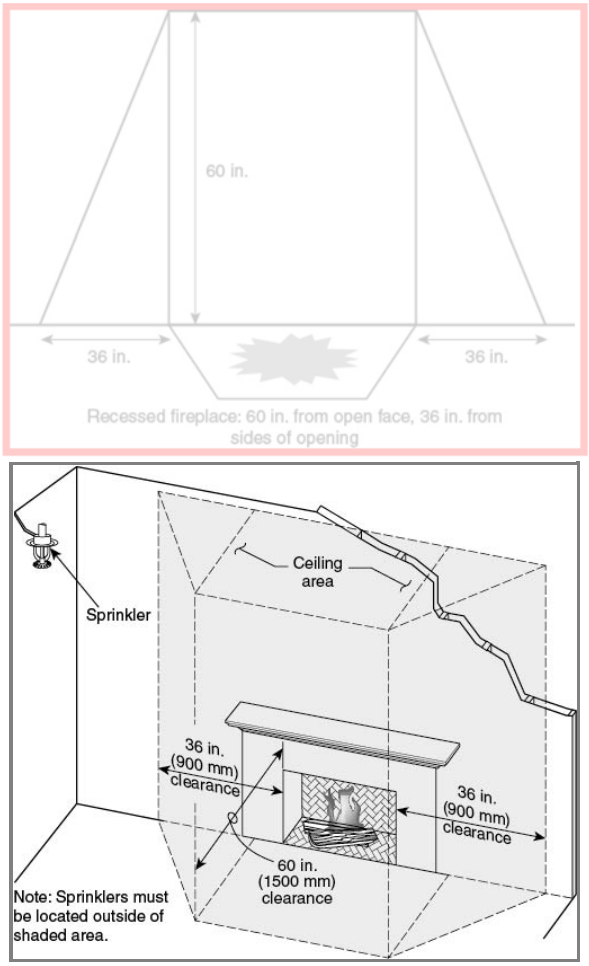


Figure A.6.2.3.3.3(b) ~~Clearance Around Open Fireplace.~~ Recessed Fireplace — Intermediate Temperature Sprinkler Location.

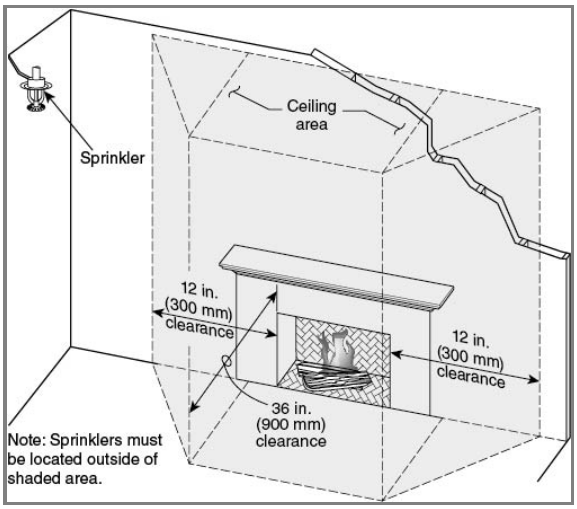


Figure A.6.2.3.3.3(c) Open Fireplace — Ordinary Temperature Sprinkler Location.

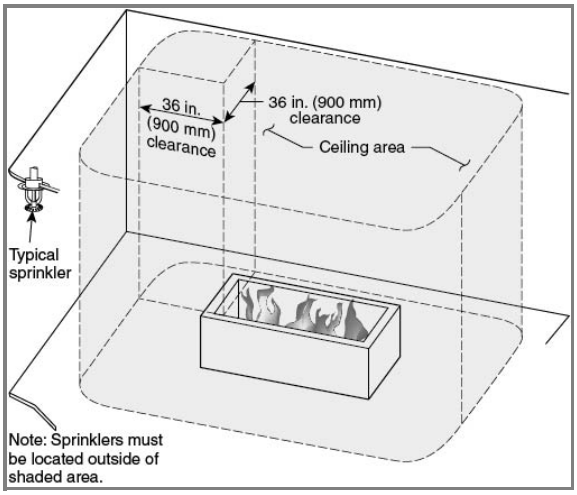
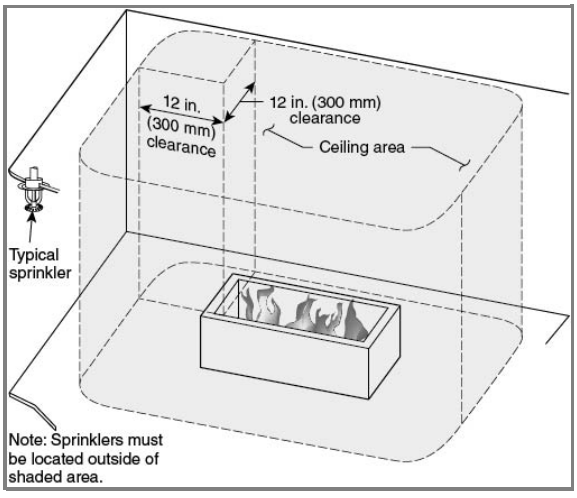


Figure A.6.2.3.3.3(d) Open Fireplace — Intermediate Temperature Sprinkler Location.



Supplemental Information

File Name	Description	Approved
Figure_A.6.2.3.3.3_a_Recessed_Fireplace_Ordinary_Temperature_Sprinkler_Location.pdf	New Figure A.6.2.3.3.3(a) through A.6.2.3.3.3(b)--	

	for staff use
Figure_A.6.2.3.3.3_b_Recessed_Fireplace_Intermediate_Temperature_Sprinkler_Location.pdf	New Figure A.6.2.3.3.3(a) through A.6.2.3.3.3(b)--for staff use
Figure_A.6.2.3.3.3_c_Open_Fireplace_Ordinary_Temperature_Sprinkler_Location.png	New Figure A.6.2.3.3.3(a) through A.6.2.3.3.3(b)--for staff use
Figure_A.6.2.3.3.3_d_Open_Fireplace_Intermediate_Temperature_Sprinkler_Location.png	New Figure A.6.2.3.3.3(a) through A.6.2.3.3.3(b)--for staff use

Submitter Information Verification

Submitter Full Name: Chad
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Thu Jun 22 09:00:40 EDT 2017

Committee Statement

Committee Statement: Improved drawings have been submitted to illustrate the concept accepted in the First Revision. This should be correlated across NFPA 13 and NFPA 13D. See attached figures.

Response Message:

Public Comment No. 39-NFPA 13R-2017 [Section No. A.6.2.3.3.3]

Ballot Results

✔ **This item has passed ballot**

31 Eligible Voters
5 Not Returned
24 Affirmative All
2 Affirmative with Comments
0 Negative with Comments
0 Abstention

Not Returned

Cronin, Bradford T.
O'Brian, Michael
Paez, Ernie
Puchovsky, Milosh T.

Yu, Hong-Zeng

Affirmative All

Bell, Kerry M.

Benn, Fred

Bradley, Frederick C.

Browning, Chase A.

Deegan, Thomas G.

Feid, Jeffrey

Isman, Kenneth E.

Lugar, James R.

Mathias, Daniel J.

Nickelson, David A.

Nickson, Ronald G.

Pilette, Maurice M.

Schultz, Bruce

Schwab, Peter T.

Skare, Eric J.

Skinner, Timothy J.

Stanley, George W.

Towler, Michael

Townley, Donald R.

Trim, Martin C. W.

Van Walraven, Ed

Victor, Terry L.

Viola, John F.

Webb, Ronald N.

Affirmative with Comment

Asp, Roland A.

I am in support of this revision but I agree with Daniel Buuck's comment that the dotted line extending perpendicular from the wall should start at corner of the recessed fireplace.

Buuck, Daniel

The new figures are a great improvement over the old ones. However, upon review for the ballot, the dashed lines extending perpendicular from the wall appear to be placed incorrectly. Table 6.2.3.3.3 gives the dimension of 60 inches from the "front of recessed fireplace." Since that's the case, the lines should originate at the corner of the recessed fireplace (with the herringbone pattern floor) and extend 60 inches out from there.

Second Revision No. 17-NFPA 13R-2017 [Section No. A.6.6.5]

A.6.6.5

An example of an open or exterior corridor, stair, or breezeway is one that is exposed to the outside atmosphere (temperature). Another example is an exterior wraparound corridor that is typical in a two- to three-story motel.

~~Note that although NFPA 13R does not require sprinklers in corridors that are open and attached, the adopted building code might require sprinkler protection in certain open-ended corridors.~~

~~The 2015 IBC has added section 903.3.1.2.2, which requires sprinklers in open-ended corridors and associated stairways that are not separated. This requirement has been included in 1027.6, but the ICC felt it needed to flag the requirement in NFPA 13R. As this committee did with the sprinklers on porches in buildings of Type 5 construction, it should align with what is found in the IBC.~~

Submitter Information Verification

Submitter Full Name: Chad
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Thu Jun 22 09:04:19 EDT 2017

Committee Statement

Committee Statement: This appears to have been substantiation text and not annex material. Based on the changes made by PC#19 SR#10 these statements are no longer accurate.

Response Message:

Public Comment No. 30-NFPA 13R-2017 [Section No. A.6.6.5]

Ballot Results

✔ **This item has passed ballot**

31 Eligible Voters
5 Not Returned
26 Affirmative All
0 Affirmative with Comments
0 Negative with Comments
0 Abstention

Not Returned

Cronin, Bradford T.

O'Brian, Michael

Paez, Ernie

Puchovsky, Milosh T.

Yu, Hong-Zeng

Affirmative All

Asp, Roland A.

Bell, Kerry M.

Benn, Fred

Bradley, Frederick C.

Browning, Chase A.

Buuck, Daniel

Deegan, Thomas G.

Feid, Jeffrey

Isman, Kenneth E.

Lugar, James R.

Mathias, Daniel J.

Nickelson, David A.

Nickson, Ronald G.

Pilette, Maurice M.

Schultz, Bruce

Schwab, Peter T.

Skare, Eric J.

Skinner, Timothy J.

Stanley, George W.

Towler, Michael

Townley, Donald R.

Trim, Martin C. W.

Van Walraven, Ed

Victor, Terry L.

Viola, John F.

Webb, Ronald N.

Second Revision No. 18-NFPA 13R-2017 [Section No. A.6.6.6]

A.6.6.6

Concealed spaces are permitted to have small openings such as grilles for return air when the space is being used as a plenum. Such small openings do not disqualify the space from being considered as a concealed space, and sprinklers are still permitted to be omitted. *(See Section 7.4 for additional information on attic sprinklers.)*

Submitter Information Verification

Submitter Full Name: Chad
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Thu Jun 22 09:08:36 EDT 2017

Committee Statement

Committee Statement: Editorial to match FR approved by the committee and the original submittal
Response Message:

Public Comment No. 59-NFPA 13R-2017 [Section No. A.6.6.6]

Ballot Results

✔ **This item has passed ballot**

31 Eligible Voters
5 Not Returned
26 Affirmative All
0 Affirmative with Comments
0 Negative with Comments
0 Abstention

Not Returned

Cronin, Bradford T.
O'Brian, Michael
Paez, Ernie
Puchovsky, Milosh T.
Yu, Hong-Zeng

Affirmative All

Asp, Roland A.

Bell, Kerry M.

Benn, Fred

Bradley, Frederick C.

Browning, Chase A.

Buuck, Daniel

Deegan, Thomas G.

Feid, Jeffrey

Isman, Kenneth E.

Lugar, James R.

Mathias, Daniel J.

Nickelson, David A.

Nickson, Ronald G.

Pilette, Maurice M.

Schultz, Bruce

Schwab, Peter T.

Skare, Eric J.

Skinner, Timothy J.

Stanley, George W.

Towler, Michael

Townley, Donald R.

Trim, Martin C. W.

Van Walraven, Ed

Victor, Terry L.

Viola, John F.

Webb, Ronald N.

Second Revision No. 21-NFPA 13R-2017 [Section No. A.7.1.1.3]

A.7.1.1.3

All residential sprinklers have been investigated under a flat, smooth, 8 ft ~~(2.44 m)~~ (2.4 m) high horizontal ceiling. Some residential sprinklers have been investigated and listed for use under specific ceiling configurations such as a horizontal beamed ceiling. The performance of residential sprinklers under flat, smooth, horizontal ceilings has been well documented throughout the life of NFPA 13R. Prior to 2010, several manufacturers of residential sprinklers had performed testing and received listings for residential sprinklers under certain slopes and in certain beam conditions. In 2010, the Fire Protection Research Foundation (FPRF) conducted a research project consisting of 76 FDS simulations and 12 full-scale fire tests. The results have been used to develop system design criteria in a generic manner to simplify the use of residential sprinklers. Some residential sprinkler listings still exist for situations beyond the scope of the generic design. *(See the FPRF report, "Analysis of the Performance of Residential Sprinkler Systems with Sloped or Sloped and Beamed Ceilings," dated July 2010, for more information.)*

For examples of selecting a compartment for consideration, see Figure A.7.1.1.3(a), ~~and~~ Figure A.7.1.1.3(b), and Figure A.7.1.1.3(c) , which show examples of design configurations for compartments based on the presence of lintels to stop the flow of heat. In all three figures, the area under consideration for determining the number of design sprinklers is the living room. In Figure A.7.1.1.3(a) , the living room is considered a compartment since the opening to the hall has an 8 in. (200 mm) lintel, and the opening to the dining room has an 8 in. (200 mm) lintel, and all openings on that wall are limited to 8 ft (2.4 m). In Figure A.7.1.1.3(b) , the living room and dining room are considered one compartment due to the lack of a lintel between the two spaces. The hall is a separate compartment since there is still an 8 in. (200 mm) lintel between the living room and hall. In Figure A.7.1.1.3(c) , the living room, dining room, and hall are considered one compartment since there are no lintels separating those spaces.

Figure A.7.1.1.3(a) Sprinkler Design Areas for Typical Residential Occupancy — ~~Without Lintel~~ With Lintel Between Adjoining Spaces: Dining Room and Hall .

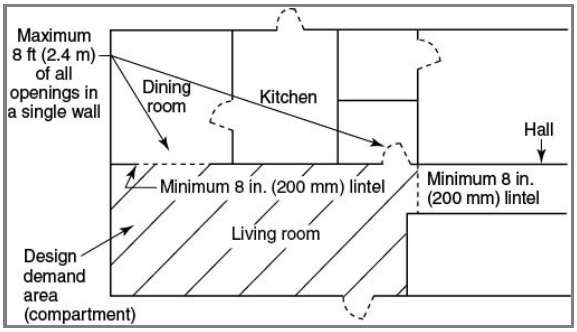


Figure A.7.1.1.3(b) Sprinkler Design Areas for Typical Residential Occupancy — ~~with Lintel~~ Without Lintel Between Dining Room; With Lintel Between Hall .

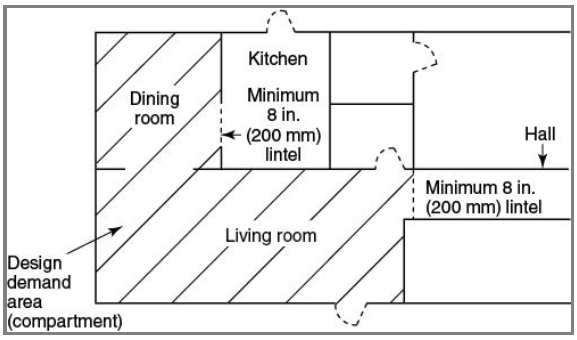
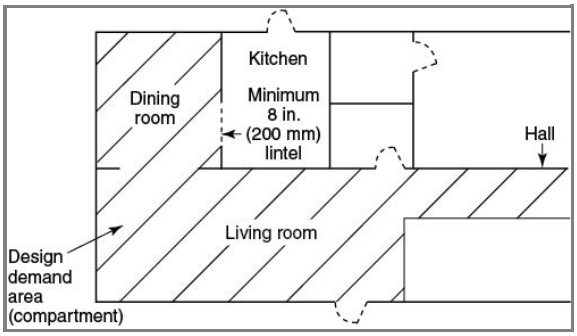


Figure A.7.1.1.3(c) Sprinkler Design Areas for Typical Residential Occupancy — Without Lintel Between Adjoining Spaces: Dining Room and Hall.



Supplemental Information

File Name	Description	Approved
Annex_Figures_NFPA_13R_and_D-_Brad.pdf	New Figures A.7.1.1.3(a), A.7.1.1.3(b). and A.7.1.1.3(c). For staff use	

Submitter Information Verification

Submitter Full Name: Chad
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Thu Jun 22 11:07:09 EDT 2017

Committee Statement

Committee Statement: The annex text has been modified to clarify the application of the rules regarding the definition of compartment. The existing figures have been modified and a new figure has been added. See attached figures.

Response Message:

Ballot Results

✔ **This item has passed ballot**

31 Eligible Voters
5 Not Returned

26 Affirmative All
0 Affirmative with Comments
0 Negative with Comments
0 Abstention

Not Returned

Cronin, Bradford T.
O'Brian, Michael
Paez, Ernie
Puchovsky, Milosh T.
Yu, Hong-Zeng

Affirmative All

Asp, Roland A.
Bell, Kerry M.
Benn, Fred
Bradley, Frederick C.
Browning, Chase A.
Buuck, Daniel
Deegan, Thomas G.
Feid, Jeffrey
Isman, Kenneth E.
Lugar, James R.
Mathias, Daniel J.
Nickelson, David A.
Nickson, Ronald G.
Pilette, Maurice M.
Schultz, Bruce
Schwab, Peter T.
Skare, Eric J.
Skinner, Timothy J.
Stanley, George W.
Towler, Michael
Townley, Donald R.
Trim, Martin C. W.
Van Walraven, Ed
Victor, Terry L.
Viola, John F.
Webb, Ronald N.

Second Revision No. 19-NFPA 13R-2017 [Section No. A.7.4.3]

A.7.4.3

NFPA 13R does not require installation of sprinklers in attics that are not intended for occupancy or storage. ~~However, model building~~ The presence of an attic access or scuttle hole does not determine that the attic is intended for storage.

Building codes sometimes require protection of attics in tall, combustible-framed residential occupancies that are otherwise allowed to follow NFPA 13R. Such protection is permitted to be provided by sprinklers or other means allowed by the ~~model~~ building code or NFPA 13, as specified for protection of combustible concealed spaces. Common methods of protection in lieu of sprinklers include filling the space with noncombustible insulation, using fire-retardant-treated wood, or using noncombustible materials. Even though sprinklers are not mandatory for attic protection under NFPA 13R, NFPA 13R offers appropriate design requirements for cases where sprinklers are provided and sets design benchmarks that parallel what is permitted for garages.

Submitter Information Verification

Submitter Full Name: Chad
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Thu Jun 22 09:09:33 EDT 2017

Committee Statement

Committee Statement: Clarification is needed that the presence of an attic access does not mean the attic will be used for occupancy or storage. Additional changes were made to be consistent with PC#3. The term "model" was removed referring to building codes in general.

Response Message:

Public Comment No. 9-NFPA 13R-2017 [Section No. A.7.4.3]

Ballot Results

✔ **This item has passed ballot**

31 Eligible Voters
5 Not Returned
26 Affirmative All
0 Affirmative with Comments
0 Negative with Comments
0 Abstention

Not Returned

Cronin, Bradford T.

O'Brian, Michael

Paez, Ernie

Puchovsky, Milosh T.

Yu, Hong-Zeng

Affirmative All

Asp, Roland A.

Bell, Kerry M.

Benn, Fred

Bradley, Frederick C.

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Van Walraven, Ed

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Viola, John F.

Webb, Ronald N.

Second Revision No. 24-NFPA 13R-2017 [Section No. A.9.3]

~~A.9.3~~

Table A.9.3(a) and Table A.9.3(b) can be used to determine a domestic design demand. Using Table A.9.3(a), the total number of water supply fixture units downstream of any point in the piping serving both sprinkler and domestic needs is determined. Using Table A.9.3(b), the appropriate total flow allowance is determined and added to the sprinkler demand at the total pressure required for the sprinkler system at that point.

Table A.9.3(a) Fixture Load Values

Facility Type	Unit
Private Facilities (those within individual dwelling units)	
Bathroom group with flush tank (including lavatory, water closet, and bathtub with shower)	6
Bathroom group with flush valve	8
Bathtub	2
Dishwasher	1
Kitchen sink	2
Laundry trays	3
Lavatory	1
Shower stall	2
Washing machine	2
Water closet with flush valve	6
Water closet with flush tank	3
Public Facilities	
Bathtub	4
Drinking fountain	0
Kitchen sink	4
Lavatory	2
Service sink	3
Shower head	4
Urinal with 1 in. (25 mm) flush valve	10
Urinal with ¾ in. (20 mm) flush valve	5
Urinal with flush tank	3
Washing machine [8 lb (3.63 kg)]	3
Washing machine [16 lb (7.26 kg)]	4
Water closet with flush valve	10
Water closet with flush tank	5

Table A.9.3(b) Total Estimated Domestic Demand

Total Fixture Load Units [from Table A.9.6(a)]	Total Demand			
	For Systems with Predominately Flush Tanks		For Systems with Predominately Flush Valves	
	gpm	L/min	gpm	L/min
1	3	11.5	—	—
2	5	19	—	—
5	10	38	15	57
10	15	57	25	95
20	20	76	35	130
35	25	95	45	170
50	30	115	50	190

~~Total Demand~~

~~Total Fixture Load Units [from Table A.9.6(a)]~~	~~For Systems with Predominately Flush Tanks~~		~~For Systems with Predominately Flush Valves~~	
	~~gpm~~	~~L/min~~	~~gpm~~	~~L/min~~
~~70~~	~~35~~	~~130~~	~~60~~	~~225~~
~~100~~	~~45~~	~~170~~	~~70~~	~~265~~
~~150~~	~~55~~	~~210~~	~~80~~	~~305~~
~~200~~	~~65~~	~~245~~	~~90~~	~~340~~
~~250~~	~~75~~	~~285~~	~~100~~	~~380~~
~~350~~	~~100~~	~~380~~	~~125~~	~~475~~
~~500~~	~~125~~	~~475~~	~~150~~	~~570~~
~~750~~	~~175~~	~~660~~	~~175~~	~~660~~
~~1000~~	~~200~~	~~755~~	~~200~~	~~755~~
~~1500~~	~~275~~	~~1040~~	~~275~~	~~1040~~
~~2000~~	~~325~~	~~1230~~	~~325~~	~~1230~~
~~3500~~	~~500~~	~~1900~~	~~500~~	~~1900~~

Submitter Information Verification

Submitter Full Name: Chad
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Fri Jun 23 16:19:55 EDT 2017

Committee Statement

Committee Statement: See committee action on SR#12.
Response Message:

Ballot Results

This item has passed ballot

31 Eligible Voters
5 Not Returned
26 Affirmative All
0 Affirmative with Comments
0 Negative with Comments
0 Abstention

Not Returned

Cronin, Bradford T.

O'Brian, Michael

Paez, Ernie

Puchovsky, Milosh T.

Yu, Hong-Zeng

Affirmative All

Asp, Roland A.

Bell, Kerry M.

Benn, Fred

Bradley, Frederick C.

Browning, Chase A.

Buuck, Daniel

Deegan, Thomas G.

Feid, Jeffrey

Isman, Kenneth E.

Lugar, James R.

Mathias, Daniel J.

Nickelson, David A.

Nickson, Ronald G.

Pilette, Maurice M.

Schultz, Bruce

Schwab, Peter T.

Skare, Eric J.

Skinner, Timothy J.

Stanley, George W.

Towler, Michael

Townley, Donald R.

Trim, Martin C. W.

Van Walraven, Ed

Victor, Terry L.

Viola, John F.

Webb, Ronald N.