

Report of the Committee on

General Storage

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Nonvoting

Martin M. Brown, Laguna Hills, CA
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Sultan M. Javeri, AXA - AGR, France

Staff Liaison: Milosh T. Puchovsky

This list represents the membership at the time the Committee was balloted on the text of this edition. Since that time, changes in the membership may have occurred. A key to classifications is found at the back of this document.

Committee Scope: This Committee shall have primary responsibility for documents on safeguarding general warehousing and commodities stored indoors or outdoors against fire. This committee does not cover storage specifically covered by other NFPA standards.

The Report of the Technical Committee on **General Storage** is presented for adoption.

This Report was prepared by the **Technical Committee on General Storage**, and proposes for adoption amendments to NFPA 231-1995, **Standard for General Storage**. NFPA 231-1995 is published in Volume 5 of the 1997 National Fire Codes and in separate pamphlet form.

This Report has been submitted to letter ballot of the **Technical Committee on General Storage**, which consists of 28 voting members. The results of the balloting, after circulation of any negative votes, can be found in the report.

NFPA 231 — A98 ROP

(Log #CP6)

231- 1 - (Entire Document): Accept

SUBMITTER: Technical Committee on General Storage

RECOMMENDATION: 1. Throughout the document where the terms "Standard Orifice", "Large Orifice", and "Extra Large Orifice Sprinklers" exist, replace them with "1/2 in. (12.7 mm) orifice", "17/32 in. (13.5 mm) orifice" and "5/8 in. (15.9 mm) orifice" respectively.

2. Throughout the document where 165°F, 212°F, and 286°F describe the temperature rating of a sprinkler, replace this description with "Ordinary Temperature", "Intermediate Temperature", and "High Temperature".

SUBSTANTIATION: 1. According to NFPA 13, which is referenced by this standard, sprinklers sizes are now identified according to their nominal orifice size and are not identified according to a generic description of their orifice size.

2. According to NFPA 13, which is referenced by this standard, sprinkler temperature ratings are identified according to the operating temperature range they fall into rather than to a specific temperature value.

COMMITTEE ACTION: Accept.

NUMBER OF COMMITTEE MEMBERS ELIGIBLE TO VOTE: 28

VOTE ON COMMITTEE ACTION:

AFFIRMATIVE: 28

COMMENT ON AFFIRMATIVE:

SCHUMANN: Item #1 is OK. In item #2, ordinary temperature classification ranges from 135°F to 170°F. In standards that were developed from tests using 165°F sprinklers, do we want to allow 135°F sprinklers to be used which could have an adverse effect on the number of operating sprinklers?

(Log #11)

231- 2 - (1-1.1): Reject

SUBMITTER: Kenneth E. Isman, Nat'l Fire Sprinkler Assn.

RECOMMENDATION: Add the word "warehouse" to Section 1-1.1 so that it reads:

"This standard shall apply to the warehouse storage of materials representing..."

SUBSTANTIATION: To try and clarify that this document is for warehouses, not retail occupancies.

COMMITTEE ACTION: Reject.

COMMITTEE STATEMENT: The term "warehouse" is too limiting with regard to the scope of the standard. The standard is intended to cover storage areas in all types of occupancies such as in mercantile and manufacturing. The standard is not limited to warehouse applications only.

NUMBER OF COMMITTEE MEMBERS ELIGIBLE TO VOTE: 28

VOTE ON COMMITTEE ACTION:

AFFIRMATIVE: 28

(Log #12)

231- 3 - (1-1.3(d)): Accept in Principle

SUBMITTER: Kenneth E. Isman, Nat'l Fire Sprinkler Assn.

RECOMMENDATION: Revise 1-1.3(d) to include more examples and refer to specific NFPA standards.

SUBSTANTIATION: There is some confusion over the scope of NFPA 231 with relation to other NFPA standards such as NFPA 30. Specific statements similar to Section 1-1 of NFPA 231C would be helpful.

COMMITTEE ACTION: Accept in Principle.

Add the following after the existing text in 1-1.3(d):

"Storage of high hazard materials such as tires, roll paper stored on end, and flammable liquids is outside the scope of this standard. Storage of such commodities shall be protected in accordance with the provisions of NFPA 30, NFPA 30B, NFPA 40, NFPA 58, NFPA 231C, NFPA 231D, NFPA 231F, NFPA 232, NFPA 490, and NFPA 430."

COMMITTEE STATEMENT: The Technical Committee agrees with the submitter's intent and has added specific reference standards.

NUMBER OF COMMITTEE MEMBERS ELIGIBLE TO VOTE: 28

VOTE ON COMMITTEE ACTION:

AFFIRMATIVE: 28

(Log #2)

231- 4 - (1-3 Shelf Storage): Reject

SUBMITTER: Brian M. Nixon, Naval Facilities Engr Command

RECOMMENDATION: Add a sentence at the end of the definition of "Shelf Storage" that reads:

"Two such structures located back-to-back also constitutes shelf storage."

SUBSTANTIATION: Back-to-back shelf storage configuration is a very common practice. It is unclear if back-to-back shelf storage falls within the scope of NFPA 231 or not.

COMMITTEE ACTION: Reject.

COMMITTEE STATEMENT: Placing two shelf units, as defined by the standard, in a back-to-back configuration could result in a shelf unit with a width in excess of 30 in. A shelf with a depth in excess of 30 in. is not considered shelf storage by the standard.

NUMBER OF COMMITTEE MEMBERS ELIGIBLE TO VOTE: 28

VOTE ON COMMITTEE ACTION:

AFFIRMATIVE: 28

(Log #CP3)

231- 5 - (Chapter 2): Accept

SUBMITTER: Technical Committee on General Storage

RECOMMENDATION: Replace Chapter 2 including all appendix items with the following text:

Chapter 2 Classification of Storage

2-1* Commodity Classification.

2-1.1 General.

2-1.1.1 Commodity classification and the corresponding protection requirements shall be determined based on the make up of individual storage units (i.e., unit load, pallet load).

Commodity classification is governed by the type and amounts of materials -e.g., metal, paper, wood, plastics - involved in a product and its primary packaging. However, in a storage or warehousing situation it is also affected by such factors as the material of the main storage or shipping container, the amount of air space and the location of the more hazardous materials within the container. For example, a Group A plastic product enclosed in a 5- or 6-sided metal container could be considered Class II; while a ceramic product heavily wrapped in tissue paper and placed in a corrugated carton could be Class III.

2-1.1.2 Mixed Commodities.

Protection requirements shall not be based on the overall commodity mix in a fire area. Mixed commodity storage shall be protected by the requirements for the highest classified commodity and storage arrangement.

Exception No. 1: Up to 10 pallet loads of a higher hazard commodity, within the scope of this standard, may be present in an area not exceeding 40,000 sq ft. The higher hazard commodity must be randomly dispersed with no adjacent loads in any direction (including diagonally). If the ceiling protection is based on Class I or II commodities, then the allowable number of pallet loads for Class IV or Group A Plastics shall be reduced to 5.

Exception No. 2: When the higher hazard material can be confined to a designated area and properly protected for that area.

2-1.2 Pallet Types.

When loads are palletized, the use of wooden or metal pallets is assumed in the classification of commodities. When plastic pallets are used, the classification of the commodity unit shall be increased one class (i.e., Class III will become class IV and Class IV will become Group A Plastics). No increase is required for Group A Plastic commodity.

Exception: When specific test data is available, the results of this data will take precedence in determining classification of commodities.

2-1.3* Commodity Classes.

2-1.3.1* Class I commodity is defined as noncombustible products that are:

(a) placed directly upon wooden pallets or,

(b) in single layer corrugated cartons, with or without single thickness cardboard dividers, with or without pallets or,

(c) shrink-wrapped or paper-wrapped as a unit load with or without pallets.

APPENDIX ITEMS

2-1.3.2* Class II commodity is defined as noncombustible products that are in slatted wooden crates, solid wood boxes, multiple-layered corrugated cartons or equivalent combustible packaging material, with or without pallets.

2-1.3.3* Class III commodity is defined as products fashioned from wood, paper, natural fibers or Group C plastics with or without cartons, boxes or crates and with or without pallets. Such products may contain a limited amount (5% by weight or volume) of Group A or B Plastics.

2-1.3.4* Class IV commodity is defined as products, with or without pallets that:

- (a) are constructed partially or totally of Group B plastics or,
- (b) consist of free-flowing Group A plastic materials or,
- (c) contain within themselves or their packaging an appreciable amount (5% to 15% by weight or 5% to 25% by volume) of Group A plastics. The remaining materials may be metal, wood, paper, natural or synthetic fibers, Group B or Group C plastics.

2-1.4 Classification of Plastics, Elastomers, and Rubber.

Plastics, elastomers, and rubber shall be classified as Group A, Group B, or Group C.

The following categories are based on unmodified plastic materials. The use of fire- or flame-retarding modifiers or the physical form of the material could change the classification.

2-1.4.1* Group A.

ABS (acrylonitrile-butadiene-styrene copolymer)
 Acetal (polyformaldehyde)
 Acrylic (polymethyl methacrylate)
 Butyl rubber
 EPDM (ethylene - propylene rubber)
 FRP (fiberglass reinforced polyester)
 Natural rubber (if expanded)
 Nitrile rubber (acrylonitrile-butadiene rubber)
 PET (thermoplastic polyester)
 Polybutadiene
 Polycarbonate
 Polyester elastomer
 Polyethylene
 Polypropylene
 Polystyrene
 Polyurethane
 PVC (polyvinyl chloride - highly plasticized, with plasticizer content greater than 20%) (rarely found)
 SAN (styrene acrylonitrile)
 SBR (styrene-butadiene rubber)

2-1.4.2 Group B.

Cellulosics (cellulose acetate, cellulose acetate butyrate, ethyl cellulose)
 Chloroprene rubber
 Fluoroplastics (ECTFE - ethylene-chlorotrifluoro-ethylene copolymer; ETFE - ethylene-tetrafluoroethylene-copolymer; FEP - fluorinated ethylene-propylene copolymer)
 Natural Rubber (not expanded)
 Nylon (nylon 6, nylon 6/6)
 Silicone rubber

2-1.4.3 Group C.

Fluoroplastics (PCTFE - polychlorotrifluoroethylene; PTFE - polytetrafluoroethylene)
 Melamine (melamine formaldehyde)
 Phenolic
 PVC (polyvinyl chloride - flexible - PVC's with plasticizer content up to 20%)
 PVDC (polyvinylidene chloride)
 PVDF (polyvinylidene fluoride)
 PVF (polyvinyl fluoride)
 Urea (urea formaldehyde)

A-2-1 Specifying 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 may be successfully controlled by the prescribed sprinkler protection for that commodity class. In real life, however, many storage arrays will not fit precisely into one of the fundamental classifications thus requiring the user to make judgments after comparing each classification to the storage conditions at hand. With the thousands of products possible in storage arrays, it becomes impossible to define in words all the possible variations that could be acceptable in any class. As an alternative, to help the user, the Committee has classified a variety of common products in Appendix A, based on judgment, loss experience and fire test results.

Appendix A-2-1.3 is an alphabetized listing of commodities with corresponding classifications.

Appendix A-2-1.3.1 through A-2-1.4.1 gives examples of commodities all within a given class.

A-2-1.3 Alphabetized Listing of Commodity Classes

Commodity	Commodity Class
AEROSOLS (cartoned or uncartoned): - Level 1	Class III
ALCOHOLIC BEVERAGES (cartoned or uncartoned): - up to 20% alcohol; in metal, glass or ceramic containers - up to 20% alcohol in wood containers	Class I Class II
AMMUNITION (small arms, shotgun): - packaged, cartoned	Class IV
APPLIANCES, Major (i.e., stoves, refrigerators): - not packaged, no appreciable plastic exterior trim - corrugated, cartoned, (no appreciable plastic trim)	Class I Class II
BAKED GOODS (cookies, cakes, pies) - frozen, packaged in cartons (Note 1) - packaged, in cartons	Class II Class III
BARLEY, RICE, OATS: - packaged, in cartons	Class III
BATTERIES: - packaged in cartons - in blister pack in cartons Automobile - filled (Note 2) Truck or Larger - empty or filled (Note 2)	Dry Cells Class I Class II Class I Group A Plastics
BEANS (dried): - packaged, cartoned	Class III
BOTTLES/JARS: Empty, cartoned - glass - plastic PET (polyethylene terephthalate) Filled noncomb. powders - glass, cartoned - plastic, cartoned (< 1 gallon) - plastic (other than PET) (any size) Filled noncomb. liquids - glass, cartoned - plastic, cartoned (less than 5 gallon) - plastic, open or solid plastic crates (Note 3) Plastics Filled noncomb. powders - plastic cartoned or uncartoned (>1 gallon) Plastics - plastic, solid plastic crates - plastic, open plastic crates	Class I Class IV Class I Class IV Group A Plastics Class I Class I Group A Plastics Group A Plastics Group A Plastics Group A Plastics Group A Plastics

NFPA 231 — A98 ROP

BOXES, CRATES:					
- empty, wood, solid walls	Class II			- cartoned	Class I
- empty, wood, slatted (Note 4)	Outside of Scope			FROZEN FOODS:- non-wax, non-plastic packaging	Class I
BREAD (wrapped cartoned)	Class III			- waxed-paper containers, cartoned	Class II
BUTTER:				- plastic trays	Class III
- whipped spread	Class III			FRUIT (fresh):	
CANDLES (packaged, cartoned):				- non-plastic trays or containers,	Class I
- treat as expanded plastic	Group A Plastics			- with wood spacers	Class I
CANDY (packaged, cartoned)	Class III			FURNITURE: Wood:	
CANNED FOODS (in ordinary cartons)	Class I			- no plastic coverings or foam plastic cushioning	Class III
CANS (metal)				- with plastic coverings	Class IV
- empty	Class I			- with foam plastic cushioning	Group A Plastics
CARPET TILES (cartoned)	Group A Plastics			ICE CREAM	Class I
CARTONS:				LEATHER GOODS:	Class III
Corrugated				LEATHER HIDES (baled)	Class II
- unassembled (neat piles)	Class III			LIGHT FIXTURES (non-plastic)	
- partially assembled	Class IV			- cartoned	Class II
Wax coated, single walled	Group A Plastics			LIGHTERS (butane):	
CEMENT (bagged)	Class I			- blister-packed, cartoned	Group A Plastics
CEREALS (packaged, cartoned)	Class III			- loose in large containers (Level 3 Aerosol)	Outside of Scope
CHARCOAL (bagged):				LIQUOR (100 proof or less, one gallon or less, cartoned):	
- standard	Class III			- glass (palletized) (Note 6)	Class IV
CHEESE:				- plastic bottles	Class IV
- packaged, cartoned	Class III			MARBLE (artificial sinks, countertops)	
- wheels, cartoned	Class III			- cartoned, crated	Class II
CHEWING GUM (packaged, cartoned)	Class III			MARGARINE:	
CHOCOLATE (packaged, cartoned)	Class III			- up to 50% oil (in paper or plastic containers)	Class III
CLOTH (cartoned or not):				- between 50% and 80% oil (in any packaging)	Group A Plastics
- natural fiber, viscose	Class III			MATCHES (packaged, cartoned):	
- synthetic (Note 5)	Class IV			- paper	Class IV
COCOA PRODUCTS (packaged, cartoned)	Class III			- wood	Group A Plastics
COFFEE:				MATTRESSES:	
- canned, cartoned	Class I			- standard (box spring)	Class III
- packaged, cartoned	Class III			- foam (in finished form)	Group A Plastics
COFFEE BEANS (bagged)	Class III			MEAT, MEAT PRODUCTS:	
COTTON:				- bulk	Class I
- packaged cartoned	Class III			- canned, cartoned	Class I
DIAPERS:				- frozen, non-waxed, non-plastic containers	Class I
- cotton, linen	Class III			- frozen, waxed-paper containers	Class II
- disposable with plastics & non woven fabric (in cartons)	Class IV			- frozen, expanded plastic trays	Class II
- disposable with plastics & non-woven fabric (uncartoned), plastic wrapped	Group A Plastics			METAL DESKS:	
DRIED FOODS (packaged, cartoned)	Class III			- with plastic tops and trim	Class I
FERTILIZERS (bagged):				MILK:	
- phosphates	Class I			- non-wax paper containers	Class I
- nitrates	Class II			- waxed paper containers	Class I
FIBERGLASS INSULATION:				- plastic containers	Class I
- paper-backed rolls (bagged or unbagged)	Class IV			- containers in plastic crates	Group A Plastics
FILE CABINETS (metal):				MOTORS:	
- cardboard box or shroud	Class I			- electrical	Class I
FISH OR FISH PRODUCTS:				NAIL POLISH:	
Frozen				- 1-2 oz glass cartoned	Class IV
- non-wax, non-plastic packaging	Class I			- 1-2 oz plastic bottles-cartoned	Group A Plastics
- waxed-paper containers, cartoned	Class II			NUTS:	
- boxed or barreled	Class II			- canned, cartoned	Class I
- plastic trays, cartoned	Class III			- packaged, cartoned	Class III
Canned				- bagged	Class III

NFPA 231 — A98 ROP

PAINTS (friction top cans, cartoned)		
- water-based (latex)	Class I	
- oil based	Class IV	
PAPER PRODUCTS:		
- books; magazines; stationery; plastic-coated paper food containers; newspapers, cardboard games or cartoned tissue products	Class III	
- tissue products, uncartoned & plastic wrapped	Group A Plastics	
PAPER, ROLLED		
In racks or on side	[INCLUDED IN NFPA 231C]	
ONLY]		
- medium or heavyweight	Class III	
In racks:	[INCLUDED IN NFPA 231C]	
ONLY]		
- lightweight	Class IV	
PAPER, WAXED (packaged in cartons)	Class IV	
PHARMACEUTICALS:		
Pills, powders:		
- glass bottles, cartoned	Class II	
- plastic bottles, cartoned	Class IV	
Non-flammable liquids:		
- glass bottles, cartoned	Class II	
PHOTOGRAPHIC: Film		
- motion picture or bulk rolls of film in polycarbonate, polyethylene or metal cans, polyethylene bagged in cardboard boxes	Class II	
- 35 MM in metal film cartridges in polyethylene cans in cardboard boxes	Class III	
- paper, in sheets, bagged in polyethylene, in cardboard boxes	Class III	
- roll film in polycarbonate plastic cassettes, bulk wrapped in cardboard boxes.	Class IV	
PLASTIC CONTAINERS:		
- non-combustible liquids or semi-liquids in plastic containers less than 5 gallon capacity.	Class I	
- non-combustible liquids or semi-liquids in plastic containers larger than 5 gallons	Class II	
- combustible or non-combustible solids in plastic containers and empty plastic containers	Group A Plastics	
POLYURETHANE:		
- cartoned or uncartoned expanded	Group A Plastics	
POULTRY PRODUCTS:		
- canned, cartoned	Class I	
- frozen, non-wax non-plastic containers	Class I	
- frozen, (on paper or expanded plastic trays)	Class II	
POWDERS (ordinary combustibles - free flowing):		
- in paper bags (i.e., flour, sugar, etc.)	Class II	
PVA (polyvinyl alcohol) resins:		
- bagged	Class IV	
PVC (polyvinyl chloride):		
- flexible (e.g., cable jackets, plasticized sheets)	Class III	
- rigid (e.g., pipe, pipe fittings)	Class III	
- bagged resins	Class III	
RAGS (baled):		
- natural fibers	Class III	
- synthetic fibers	Class IV	
RUBBER:		
- natural, blocks in cartons	Class IV	
- synthetic	Group A Plastics	
SALT:		
- bagged	Class I	
- packaged, cartoned	Class II	
SHINGLES:		
- asphalt coated fiberglass	Class III	
- asphalt impregnated felt	Class IV	
SHOCK ABSORBERS:		
- metal dust cover	Class II	
- plastic dust cover	Class III	
SIGNATURES (book, magazines):		
- solid array on pallet	Class II	
SKIS:		
- wood	Class III	
- foam core	Class IV	
STUFFED TOYS (foam or synthetic)		Group A Plastics
SYRUP:		
- drummed (metal containers)	Class I	
- barreled, wood	Class II	
TEXTILES:		
- natural fiber clothing or textile products	Class III	
Synthetics (except rayon and nylon):		
50/50 Blend or less		
- thread, yarn on wood or paper spools	Class III	
- fabrics	Class III	
- thread, yarn on plastic spools	Class IV	
- baled fiber	Group A Plastics	
Greater than 50/50 Blend		
- thread, yarn on wood or paper spools	Class IV	
- fabrics	Class IV	
- baled fiber	Group A Plastics	
- thread, yarn on plastic spools	Group A Plastics	
Rayon and Nylon		
- baled fiber	Class IV	
- thread, yarn on wood or paper spools	Class IV	
- fabrics	Class IV	
- thread, yarn on plastic spools	Group A Plastics	
TOBACCO PRODUCTS:		
- in paperboard cartons	Class III	
TRANSFORMERS (dry & oil filled)		Class I
VINYL COATED FABRIC:		
- cartoned	Group A Plastics	
VINYL FLOOR COVERINGS:		
- tiles in cartons	Class IV	
- rolled	Group A Plastics	
WAX COATED paper; cups, plates:		
- boxed or packaged inside cartons (emphasis is on packaging)	Class IV	
- loose inside large cartons	Group A Plastics	
WAX (paraffin, blocks, cartoned)		Group A Plastics
WIRE:		
- bare wire on metal spools on wood skids	Class I	
- bare wire on wood or cardboard spools on wood skids	Class II	
- bare wire on metal, wood or cardboard spools in cardboard boxes on wood skids	Class II	
- single or multiple PVC covered wire on metal spools on wood skids	Class II	
- insulated - (PVC) cable on large wood or metal spools on wood skids	Class II	
- bare wire on plastic spools in cardboard boxes on wood skids	Class IV	
- single or multiple (PVC) covered wire on plastic spools in cardboard boxes on wood skids	Class IV	
- single, multiple, or power cables (PVC) on large plastic spools	Class IV	
- bulk storage of empty plastic spools	Group A Plastics	

NFPA 231 — A98 ROP

WOOD PRODUCTS:

- solid piles; lumber, plywood, particle board, pressboard (smooth ends & edges) Class II
- spools (empty) Class III
- toothpicks, clothespins, hangars in cartons Class III
- doors, windows, wood cabinets & furniture Class III
- patterns Class IV

NOTES:

1. Presumes product is in a plastic-coated package in a corrugated carton. If packaged in a metal foil, it may be considered Class I.
2. Most batteries have a polypropylene case and, if stored empty, should be treated as a Group A plastic. Truck batteries, even when filled, should be considered a Group A plastic because of the thicker walls.
3. As the openings in plastic crates become larger, the commodity behaves more like Class III. Conversely, as the openings become smaller, the product makeup behaves more like a plastic.
4. Should be treated as idle pallets.
5. Tests conducted clearly indicated synthetics or synthetic blends are considered greater than Class III.
6. When liquor is stored in glass containers in racks, it should be considered a Class III Commodity: when it is palletized, it should be considered a Class IV Commodity.

A-2-1.3.1 Examples of Class I Commodities.

ALCOHOLIC BEVERAGES (cartoned or uncartoned):
- up to 20% alcohol; in metal, glass or ceramic containers

APPLIANCES, Major (i.e., - stoves, refrigerators):
- not packaged, no appreciable plastic exterior trim

BATTERIES:
Dry Cells - packaged in cartons
Automobile - filled (Note 1)

BOTTLES/JARS:
Empty, cartoned - glass:
Filled noncomb. liquids - glass, cartoned,
- plastic, cartoned (less than 5 gallon)
Filled noncomb. powders - glass, cartoned

CANNED FOODS (in ordinary cartons)

CANS (metal)
- empty

CEMENT (bagged)

COFFEE:
- canned, cartoned

FERTILIZERS (bagged):
- phosphates

FILE CABINETS (metal):
- cardboard box or shroud

FISH OR FISH PRODUCTS (frozen):
- non-wax, non-plastic packaging

FISH OR FISH PRODUCTS (canned):
- cartoned

FROZEN FOODS:
- non-wax, non-plastic packaging

FRUIT (fresh):
- non-plastic trays or containers,
- with wood spacers

ICE CREAM

MEAT, MEAT PRODUCTS:
- bulk
- canned, cartoned

- frozen, non-waxed, non-plastic containers

METAL DESKS: - with plastic tops and trim

MILK: - non-wax paper containers
- waxed paper containers
- plastic containers

MOTORS: - electrical

NUTS: - canned, cartoned

PAINTS (friction top cans, cartoned)
- water-based (latex)

PLASTIC CONTAINERS:
- non-combustible liquids or semi-liquids in plastic containers less than 5 gallon capacity.

POULTRY PRODUCTS:
- canned, cartoned
- frozen, non-wax non-plastic containers

SALT:
- bagged

SYRUP:
- drummed (metal containers)

TRANSFORMERS (dry & oil filled)

WIRE:
- bare wire on metal spools on wood skids

A-2-1.3.2 Examples of Class II Commodities

ALCOHOLIC BEVERAGES:
- up to 20% alcohol in wood containers

APPLIANCES (major, e.g., - stoves):
- corrugated, cartoned, (no appreciable plastic trim)

BAKED GOODS (cookies, cakes, pies)
- frozen, packaged in cartons (Note 2)

BATTERIES: Dry Cells - in blister pack in cartons

BOXES, CRATES:
- empty, wood, solid walls

FERTILIZERS (bagged):
- nitrates

FISH OR FISH PRODUCTS (frozen):
- waxed-paper containers, cartoned
- boxed or barreled

FROZEN FOODS:
- waxed-paper containers, cartoned

LEATHER HIDES (baled)

LIGHT FIXTURES (non-plastic)
- cartoned

MARBLE (artificial sinks, countertops)
- cartoned, crated

MEAT, MEAT PRODUCTS:
- frozen, waxed-paper containers
- frozen, expanded plastic trays

PHARMACEUTICALS :
Pills, powders:
- glass bottles, cartoned
Non-flammable liquids:
- glass bottles, cartoned

PHOTOGRAPHIC: Film
- motion picture or bulk rolls of film in polycarbonate, polyethylene or metal cans, polyethylene bagged in cardboard boxes.

PLASTIC CONTAINERS:

NFPA 231 — A98 ROP

- non-combustible liquids or semi-liquids in plastic containers larger than 5 gallons

POULTRY PRODUCTS:

- frozen, (on paper or expanded plastic trays)

POWDERS (ordinary combustibles - free flowing):

- in paper bags (i.e., flour, sugar, etc.)

SALT:

- packaged, cartoned

SHOCK ABSORBERS:

- metal dust cover

SIGNATURES (book, magazines):

- solid array on pallet

SYRUP:

- barreled, wood

WIRE:

- bare wire on wood or cardboard spools on wood skids
- bare wire on metal, wood or cardboard spools in cardboard boxes on wood skids
- single or multiple PVC covered wire on metal spools on wood skids
- insulated - (PVC) cable on large wood or metal spools on wood skids

WOOD PRODUCTS (solid piles):

- lumber, plywood, particle board, pressboard (smooth ends & edges)

A-2-1.3.3 Examples of Class III Commodities.

AEROSOLS (cartoned or uncartoned):

- Level I

BAKED GOODS (cookies, cakes, pies)

- packaged, in cartons

BARLEY, RICE, OATS:

- packaged, in cartons

BEANS (dried):

- packaged, cartoned

BREAD (wrapped cartoned)

BUTTER:

- whipped spread

CANDY (packaged, cartoned)

CARTONS (corrugated):

- unassembled (neat piles)

CEREALS (packaged, cartoned)

CHARCOAL (bagged):

- standard

CHEESE:

- packaged, cartoned
- wheels, cartoned

CHEWING GUM (packaged, cartoned)

CHOCOLATE (packaged, cartoned)

CLOTH (cartoned or not):

- natural fiber, viscose

COCOA PRODUCTS (packaged, cartoned)

COFFEE:

- packaged, cartoned

COFFEE BEANS (bagged)

COTTON:

- packaged cartoned

DIAPERS:

- cotton, linen

DRIED FOODS (packaged, cartoned)

FISH OR FISH PRODUCTS (frozen):

- plastic trays, cartoned

FROZEN FOODS:

- plastic trays

FURNITURE:

- wood (no plastic coverings or foam plastic cushioning)

LEATHER GOODS:

MARGARINE:

- up to 50% oil (in paper or plastic containers)

MATTRESSES:

- standard (box spring)

NUTS:

- packaged, cartoned
- bagged

PAPER PRODUCTS:

- books; magazines; stationery; plastic-coated paper food containers; newspapers, cardboard games or cartoned tissue products

PAPER, ROLLED (in racks or on side)

- medium or heavyweight [INCLUDED IN NFPA 231C ONLY]

PHOTOGRAPHIC: Film

- 35 MM in metal film cartridges in polyethylene cans in cardboard boxes
- paper, in sheets, bagged in polyethylene, in cardboard boxes

PVC (polyvinyl chloride):

- flexible (e.g., cable jackets, plasticized sheets)
- rigid (e.g., pipe, pipe fittings)
- bagged resins

RAGS (baled):

- natural fibers

SHINGLES:

- asphalt coated fiberglass

SHOCK ABSORBERS:

- plastic dust cover

SKIS:

- wood

TEXTILES:

- natural fiber clothing or textile products
Synthetics (except rayon and nylon):
50/50 Blend or less
- thread, yarn on wood or paper spools
- fabrics

TOBACCO PRODUCTS:

- in paperboard cartons

WOOD PRODUCTS:

- spools (empty)
- toothpicks, clothespins, hangars in cartons
- doors, windows, wood cabinets & furniture

A-2-1.3.4 Examples of Class IV Commodities.

AMMUNITION (small arms, shotgun):

- packaged, cartoned

BOTTLES/JARS: Empty, cartoned

- plastic PET (polyethylene terephthalate)
Filled noncomb. powders
- plastic, cartoned (< 1 gallon)

CARTONS (corrugated):

- partially assembled

NFPA 231 — A98 ROP

CLOTH (cartoned or not):
 - synthetic (Note 3)

DIAPERS:
 - disposable with plastics & non woven fabric (in cartons)

FIBERGLASS INSULATION:
 - paper backed rolls (bagged or unbagged)

FURNITURE - Wood:
 - with plastic coverings

LIQUOR (100 proof or less, one gallon or less, cartoned):
 - glass (palletized) (Note 4)
 - plastic bottles

MATCHES (packaged, cartoned):
 - paper

NAIL POLISH:
 - 1-2 oz glass cartoned

PAINTS (friction top cans, cartoned):
 - oil based

PAPER, ROLLED (in racks): [INCLUDED IN
 - lightweight NFPA 231C ONLY]

PAPER, WAXED (packaged in cartons)

PHARMACEUTICALS (pills, powders):
 - plastic bottles, cartoned

PHOTOGRAPHIC:
 - roll film in polycarbonate plastic cassettes, bulk wrapped in cardboard boxes.

PVA (polyvinyl alcohol) resins:
 - bagged

RAGS (baled):
 - synthetic fibers

RUBBER:
 - natural, blocks in cartons

SHINGLES:
 - asphalt impregnated felt

SKIS:
 - foam core

TEXTILES:
 Synthetics (except rayon and nylon):
 50/50 Blend or less
 - thread, yarn on plastic spools
 Greater than 50/50 Blend
 - thread, yarn on wood or paper spools
 - fabrics
 Rayon and Nylon
 - baled fiber
 - thread, yarn on wood or paper spools
 - fabrics

VINYL FLOOR COVERINGS:
 - tiles in cartons

WAX COATED paper; cups, plates:
 - boxed or packaged inside cartons (emphasis is on packaging)

WIRE:
 - bare wire on plastic spools in cardboard boxes on wood skids
 - single or multiple (PVC) covered wire on plastic spools in cardboard boxes on wood skids
 - single, multiple, or power cables (PVC) on large plastic spools

WOOD PRODUCTS:
 - patterns

A-2-1.4.1 Examples of Group A Plastic Commodities.

BATTERIES: Truck or Larger
 - empty or filled (Note 1)

BOTTLES/JARS: Empty, Cartoned
 - plastic (other than PET) (any size)
 Filled noncomb. liquids
 - plastic, open or solid plastic crates (Note 5)
 Filled noncomb. powders
 - plastic cartoned or uncartoned (>1 gallon)
 - plastic, solid plastic crates
 - plastic, open plastic crates

CANDLES (packaged, cartoned):
 - treat as expanded plastic

CARPET TILES (cartoned)

CARTONS (wax coated, single walled)

DIAPERS:
 - disposable with plastics & non-woven fabric (uncartoned), plastic wrapped

FURNITURE - Wood:
 - with foam plastic cushioning

LIGHTERS (butane):
 - blister-packed, cartoned

MARGARINE:
 - between 50% and 80% oil (in any packaging)

MATCHES (packaged, cartoned):
 - wood

MATTRESSES:
 - foam (in finished form)

MILK:
 - containers in plastic crates

NAIL POLISH:
 - 1-2 oz plastic bottles-cartoned

PAPER PRODUCTS:
 - tissue products, uncartoned & plastic wrapped

PLASTIC CONTAINERS:
 - combustible or non-combustible solids in plastic containers and empty plastic containers

POLYURETHANE:
 - cartoned or uncartoned expanded

RUBBER:
 - synthetic

STUFFED TOYS (foam or synthetic)

TEXTILES:
 Synthetics (except rayon and nylon):
 50/50 Blend or less
 - baled fiber
 Greater than 50/50 Blend
 - baled fiber
 - thread, yarn on plastic spools
 Rayon and Nylon
 - thread, yarn on plastic spools

VINYL COATED FABRIC:
 - cartoned

VINYL FLOOR COVERINGS:
 - rolled

WAX COATED paper; cups, plates
 - loose inside large cartons

WAX (paraffin, blocks, cartoned)

NFPA 231 — A98 ROP

WIRE:

- bulk storage of empty plastic spools

Examples of Commodities Outside the Scope of this Standard

BOXES, CRATES:

- empty, wood, slatted (Note 6)

LIGHTERS (butane):

- loose in large containers (Level 3 Aerosol)

NOTES:

1. Most batteries have a polypropylene case and, if stored empty, should be treated as a Group A plastic. Truck batteries, even when filled, should be considered a Group A plastic because of the thicker walls.
2. Presumes product is in a plastic-coated package in a corrugated carton. If packaged in a metal foil, it may be considered Class I.
3. Tests conducted clearly indicated synthetics or synthetic blends are considered greater than Class III.
4. When liquor is stored in glass containers in racks, it should be considered a Class III Commodity: when it is palletized, it should be considered a Class IV Commodity.
5. As the openings in plastic crates become larger, the commodity behaves more like Class III. Conversely, as the openings become smaller, the product makeup behaves more like a plastic.
6. Should be treated as idle pallets.

SUBSTANTIATION: Review of data over the past 2 years has prompted the Committee to expand upon the commodity classifications. Information has also been added regarding the protection of mixed commodities.

COMMITTEE ACTION: Accept.

NUMBER OF COMMITTEE MEMBERS ELIGIBLE TO VOTE: 28
VOTE ON COMMITTEE ACTION:

AFFIRMATIVE: 28

COMMENT ON AFFIRMATIVE:

SCHUMANN: Under batteries, the words "Dry cells" should be in the commodity column not the commodity class column.

Under barley, rice and oats should have their own entries.

Under bottles/jars, all items filled with noncombustible powders should be together.

Under candles, expanded Group A plastic should be in the commodity class column.

(Log #6)

231-6 - (3-2): Reject

SUBMITTER: Mark Chubb, Southeastern Assoc. of Fire Chiefs

RECOMMENDATION: Revise text as follows:

3-2* Emergency Smoke and Heat Venting. Protection outlined in this standard shall apply to buildings with or without roof vents and draft curtains. Where roof vents and draft curtains or mechanical smoke exhaust are installed, the effect of smoke and heat venting on automatic sprinkler operation shall be taken into account. Designs using these fire protection features in combination with one another shall be based on engineering judgment and recognized good practice.

3-2.1 Smoke And Heat Vent Operation. Smoke and heat vents, where required by the authority having jurisdiction, shall be operated automatically and manually.

Exception: Automatic operation is not required when remote manual activation is provided in buildings protected throughout by ESFR sprinkler systems when approved by the authority having jurisdiction.

3-2.1.1 Where installed, smoke and heat vents shall not operate prior to activation of the automatic sprinkler system. Heat responsive devices used to open smoke and heat vents shall have a temperature rating not less than 45°F (25°C) higher than the temperature rating of sprinkler heat sensitive elements, and a response time index (RTI) at least equal to, but not more than 3 times greater than the sprinkler RTI.

3-2.1.2 Manual releases shall permit the smoke and heat vents to be operated remotely. Manual release devices shall be installed in a location acceptable to the authority having jurisdiction.

3-2.2 Smoke and Heat Vent Location. Smoke and heat vents shall be located so that no portion of the vent opening is directly above or within 8 in. (203mm) of sprinklers.

3-2.3 Mechanical Smoke Exhaust. Engineered mechanical smoke exhaust shall be an acceptable alternate to smoke and heat vents.

3-2.3.1 Mechanical smoke exhaust fans shall be automatically activated by the automatic sprinkler system or by heat detectors having operating characteristics equivalent to those described in 3-2.1.1. Individual manual controls of each fan unit shall also be provided.

3-2.3.2 Wiring for operation and control of smoke exhaust fans shall be connected ahead of the main disconnect and protected against exposure to temperatures in excess of 1000°F (538°C) for a period of not less than 15 minutes.

3-2.3.3 Controls shall be located so as to be immediately accessible to the fire service from the exterior of the building and protected against interior fire exposure by separation assemblies having a fire resistance rating not less than 1-hour when tested in accordance with NFPA 251.

3-2.4 Draft Curtains Not Required. Draft curtains need not be installed in buildings protected by ESFR sprinkler systems.

SUBSTANTIATION: The provisions of NFPA 231 are referenced throughout the United States as minimum requirements for the design of automatic sprinkler systems to high-piled combustible stock. Two of the three model building codes referencing this standard also require smoke and heat vents or mechanical smoke exhaust (see 411.1 of the Standard Building Code® and Chapter 36 of the Standard Fire Prevention Code® and Article 81 of the Uniform Fire Code™). Continuing controversy surrounding the combined use of these fire protection features has prompted significant debate and ongoing research activities here and abroad to identify technical concerns, quantify the interaction between these systems, and develop technical tools to aid designers in employing these technologies. In the interim, however, additional guidance is needed to ensure the confidence of users and the safety of buildings built under these code requirements and NFPA 231.

The proposed requirements were originally developed by private industry and have been successfully processed through the Southern Building Code Congress International Southeastern Association of Fire Chiefs code development system. They constitute minimal design guidance for situations where the two fire protection systems are used in conjunction with one another for protection of life or property.

The proposed requirements (3-2) complement the existing text by advising users of the need to consider the possible interactions between the systems and consult sources of engineering guidance and good practice in developing designs using these technologies. Nothing in the proposed requirements would make the installation of smoke and heat vents or mechanical smoke exhaust mandatory where they are not already required by model building and fire codes.

Automatic operating capability (proposed 3-2.1 and 3-2.3.1) is required to mitigate the need for firefighters to attempt vertical ventilation of the fire by placing firefighters at-risk on the roof above a fire in a rack storage facility. Manual operation (proposed 3-2.1 and 3-2.3.1) ensures that vents remain under the control of the fire service without placing firefighters at-risk. Automatic and manual venting also affords an opportunity to mitigate fire damage in the event the fire overwhelms the capabilities of the automatic sprinkler system.

The exception to automatic operation requirements for buildings protected with ESFR sprinkler systems does not currently appear in the model codes (proposed 3-2.1, Exception). However, this approach is commonly used and accepted by code officials enforcing these requirements. (At the time the current smoke and heat venting requirements were developed, ESFR technology was not available.)

The proposed new provisions (3-2.1.1) regarding automatic operation and location are intended to prevent the operation of vents prior to sprinklers, possibly compromising the effectiveness of sprinkler protection. The temperature rating and RTI values specified have been evaluated by the Southeastern Association of Fire Chiefs' Ad Hoc Committee on Smoke and Heat Venting using the computer programs LAVENT and DETACT-T2 to ensure that sprinklers will operate later than sprinklers but not too late to ensure vents provide life safety or property protection benefits.

The location of vents with respect to sprinklers (proposed 3-2.1) is intended to ensure that sprinkler spray does not obstruct vents.

Testing conducted by Factory Mutual Research Corporation has indicated that draft curtains may significantly affect the operation of sprinklers where storage arrays transect draft curtain boundaries (see Troup, J.M.A. "Large-Scale Fire Tests of Rack

NFPA 231 — A98 ROP

Stored Plastics in Retail Operation Scenarios Protected by ELO Sprinklers: A Study of the Effects of Draft Curtains," FMRC J.I. 0X1R0.RR, Norwood Mass: Factory Mutual Research Corp., June 1994). If the rising fire plume is located very near or directly beneath draft curtains, the resulting division of the ceiling jet could cause a significant increase in the resulting number of sprinklers activated. In an ESFR system, this could quickly overwhelm the available water supply. Waiving the requirement for draft curtains (3-2.4) enables users to avoid this situation when storage arrays cannot be modified to support sprinkler system design.

COMMITTEE ACTION: Reject.

COMMITTEE STATEMENT: No data exists which clearly allows evaluation of the interaction between heat/smoke vents and automatic sprinklers for the protection of storage occupancies. A test program being conducted by the National Fire Protection Research Foundation is currently underway and should provide additional data on this subject.

NUMBER OF COMMITTEE MEMBERS ELIGIBLE TO VOTE: 28

VOTE ON COMMITTEE ACTION:

AFFIRMATIVE: 28

(Log #13)

231- 7 - (3-2 Exception (New) and A-3-2): Accept in Principle in Part

SUBMITTER: Kenneth E. Isman, Nat'l Fire Sprinkler Assn.

RECOMMENDATION: Add a new exception to 3-2 and replace A-3-2 as follows:

3-2 <no change>

Exception: Where buildings are protected with ESFR sprinklers, the draft curtains and automatic smoke vents shall be permitted to be omitted.

A-3-2 Most of the fire tests performed to develop this standard were conducted without smoke and heat venting or draft curtains. Those fire tests which have been performed with these features have caused greater fire damage and have opened additional sprinklers. Consideration should be given to adding additional sprinklers to the design area when draft curtains and automatic vents are installed.

Smoke removal is important to manual fire fighting and overhaul. Where automatic smoke vents are not installed, consideration should be given to manual smoke vents which can be operated by fire fighters after control of the fire is achieved. Such manual venting can be achieved with roof mounted vents, eavline windows, doors, or mechanical exhaust systems. See NFPA 204M.

SUBSTANTIATION: More accurately reflects the state-of-the-art in terms of smoke vents and draft curtains. Recent fire tests, combined with the knowledge of past history shows that these devices can cause failure of sprinkler systems if not accounted for properly in the design.

COMMITTEE ACTION: Accept in Principle in Part.

1. Revise the proposed Exception to Section 3-2 to read as follows:

Exception: Where local codes require heat and smoke vents in buildings protected by ESFR sprinklers, the vents shall be manually operated, or have an operating mechanism with a standard response fusible element rated no less than 286°F. Drop out vents shall not be permitted.

2. Reject the proposed appendix material to A-3-2.

COMMITTEE STATEMENT:

1. Data indicates that smoke/heat vents which operate prior to the activation of ESFR sprinklers can have a negative impact on the performance of the ESFR sprinklers.

2. This material is not specific to ESFR sprinklers.

NUMBER OF COMMITTEE MEMBERS ELIGIBLE TO VOTE: 28

VOTE ON COMMITTEE ACTION:

AFFIRMATIVE: 27

NEGATIVE: 1

EXPLANATION OF NEGATIVE:

KROMAN: I could accept the use of 360°F auto vents in the exception, but I cannot support the use of 286° links.

Committee Statement #1 (correctly) states that auto smoke/heat vents which operate before ESFR heads can have a negative impact on performance. Joe Hankins mentioned that no full scale ESFR tests were done with auto vents, but small and intermediate testing showed that auto venting will indeed interfere with ESFR effectiveness.

FM modeling evidently showed that 360° links would be acceptable, and FMDS 2-2 states that if local codes require auto vents, use 360°F links; but it also states if local codes don't permit 360°F links, the use of 286°F links is "acceptable". Certainly, FM is free to determine protection criteria for their own needs. But

should this Committee accept this when the empirical evidence seems to indicate this could result in a negative impact on ESFR performance.

The wording in FMDS implies that the use of 286°F rated links is acceptable solely because some authorities having jurisdiction require it. This is a legitimate concern on the part of end users and needs to be addressed, perhaps by adding additional explanatory material in the Appendix about the known relationship between ESFR and auto vents. However, by allowing the use of 286°F links in the Exception to 3-2, this Committee has formally sanctioned their use. This is a peculiar stance on the part of the Committee, which usually insists on complete test data before changing protection criteria.

Furthermore, what if intermediate temperature ESFR heads are provided due to ambient temperatures above 100°F? With 212° ESFR heads and 286°F auto vents, is the Committee confident that ESFR effectiveness is not negatively impacted?

It seems to me the prudent course is to wait until the NFPRF's project on auto venting is complete. The actual test results from that project will offer more definitive data on the use of auto vents, including their interaction with ESFR sprinklers.

(Log #CP4)

231- 8 - (Table 4-4.1.2): Accept

SUBMITTER: Technical Committee on General Storage

RECOMMENDATION: Delete the words "or Nonexpanded Polyethylene Solid Deck Idle Pallets" from the title of the table.

SUBSTANTIATION: This Table is to apply only to wood pallets with exceptions referenced in other sections.

COMMITTEE ACTION: Accept.

NUMBER OF COMMITTEE MEMBERS ELIGIBLE TO VOTE: 28

VOTE ON COMMITTEE ACTION:

AFFIRMATIVE: 28

(Log #CP7)

231- 9 - (4-4.1.2, 4-4.2.1 Exception No. 3): Accept

SUBMITTER: Technical Committee on General Storage

RECOMMENDATION: 1. In the first paragraph of 4-4.1.2 add the words "Table 8-1, or Table 9-1" in between the words "Table 4-4.1.2" and "unless", so it reads:

"Pallets, where stored indoors, shall be protected as indicated in Table 4-4.1.2, Table 8-1 or Table 9-1, unless the following conditions are met:"

2. Add an Exception No. 3 to 4-4.2.1 as follows:

Exception No. 3: Indoor storage of plastic pallets shall be permitted to be protected in accordance with Table 9-1.

SUBSTANTIATION: Data indicates that ESFR sprinklers are effective for the protection of certain indoor storage arrangements of idle wood and plastic pallets. Other data indicates that large drop sprinklers are effective for the protection of certain indoor storage arrangements of idle wood pallets.

COMMITTEE ACTION: Accept.

NUMBER OF COMMITTEE MEMBERS ELIGIBLE TO VOTE: 28

VOTE ON COMMITTEE ACTION:

AFFIRMATIVE: 27

ABSTENTION: 1

EXPLANATION OF ABSTENTION:

McPHEE: The reference to Table 9-1 in 4-4.1.2 and the new Exception No. 3 to 4-4.2.1 is questioned.

From my notes of the March meeting I have no record of any proposal or discussion that Table 9-1 on ESFR be expanded to cover storage of idle wood or plastic pallets. Table 8-1 already had a reference to this type of storage so the reference to Table 8-1 here is appropriate.

I have to presume that this was justified through the Committee comment/discussion based simply on comparisons of existing density/storage height provisions already in the standard for idle pallet storage protected by standard or large drop sprinklers, e.g., Table 4-4.1.2; Section 4-4.2.2; and Table 8-1.

(Log #9)

231- 10 - (Table 4-4.1.2 and 4-4.2.1 Exception No. 3): Accept in Principle in Part

SUBMITTER: Jesse Beitel/Joseph Scheffey, Hughes Assoc., Inc.

RECOMMENDATION: (a) Edit the title of Table 4-4.1.2 as follows:

"Protection for Indoor Storage of Wood ~~Idle or~~, Nonexpanded Polyethylene Solid Deck ~~Idle Pallets, or Equivalent Plastic Idle Pallets.~~"

(b) Add the following new exception to Section 4-4.2.1:

Exception No. 3: Indoor storage of plastic pallets having a demonstrated fire hazard which is equal to or less than idle wood

NFPA 231 — A98 ROP

pallets shall be permitted to be protected in accordance with Section 4.4.1.2.

SUBSTANTIATION: Open deck plastic pallets are now available which have ignition, fire growth, and fire spread characteristics which represent an equivalent or lower fire hazard compared to idle wood pallets. Likewise, the sprinkler protection required to control/suppress a fire in idle pallet storage for these new materials is equivalent or less than that specified in Section 4.4.1.2.

Because idle wood pallets are considered as a special type of hazard, specific protection criteria has been established in Section 4.4.1.2 and Table 4.4.1.2. It follows that if pallets of other construction materials have a demonstrated equivalent or lesser hazard, these newer technology materials should be recognized. To be consistent with the current NFPA and Model Code emphasis on performance based approaches, the proposal uses performance-based language instead of specifying particular materials.

Results of fire testing (currently underway) which demonstrate this equivalence will be submitted to the Committee. This testing is consistent with the methodologies used to establish the baseline of performance represented by idle wood pallets. The required protection for this baseline hazard is established in Section 4.4.1.2 and Table 4.4.1.2.

COMMITTEE ACTION: Accept in Principle in Part.

1. Reject part (a) of the submitter's Proposal.
2. Add a new Exception No. 4 as indicated by part b of the submitter's Proposal with the following changes:

- (a) Change "plastic" to "non-wood."
- (b) Add the words "and is listed for such equivalency" between the words "idle wood pallets" and "shall be permitted".

The Exception should read:

Exception No. 4: Indoor storage of non-wood pallets having a demonstrated fire hazard which is equal to or less than idle wood pallets and is listed for such equivalency shall be permitted to be protected in accordance with Section 4.4.1.2.

COMMITTEE STATEMENT: Although pallets are not currently listed, the Technical Committee believes that there is a need to reference an evaluation methodology which can identify those non-wood pallets which when stored idle do not present a more severe hazard than do the storage of idle wood pallets. The change to the proposed Exception No. 3 does not make it necessary to accept part a of the submitter's Proposal.

NUMBER OF COMMITTEE MEMBERS ELIGIBLE TO VOTE: 28

VOTE ON COMMITTEE ACTION:

AFFIRMATIVE: 28

(Log #CP5)

231- 11 - (4.4.2, A-4.4.2.1): Accept

SUBMITTER: Technical Committee on General Storage

RECOMMENDATION: 1. In Exception No. 2 to 4.4.2.1 add the words "storage of" between the words "indoor" and "nonexpanded polyethylene", so it reads:

Exception No. 2: Indoor storage of nonexpanded polyethylene solid deck pallets shall be permitted to be protected in accordance with 4.4.1.2.

2. Relocate the text of A-4.4.2 as the second paragraph of A-4.4. Remove * from 4.4.2.

3. In existing A-4.4.2, in the first line replace the word "and" with "or" so it reads:

"A fire in stocks of idle plastic or wooden pallets."

SUBSTANTIATION: These changes are editorial.

COMMITTEE ACTION: Accept.

NUMBER OF COMMITTEE MEMBERS ELIGIBLE TO VOTE: 28

VOTE ON COMMITTEE ACTION:

AFFIRMATIVE: 28

(Log #14)

231- 12 - (4.4.2.2(a).5 Exception): Accept

SUBMITTER: Kenneth E. Isman, Nat'l Fire Sprinkler Assn.

RECOMMENDATION: In Section 4.4.2.2(a)(5), add an additional sentence to read:

"Flow from these sprinklers shall be permitted to be omitted from the sprinkler system demand for hydraulic calculations."

SUBSTANTIATION: Confusion exists as to how to treat these sprinklers. In the Report on Proposals for the 1995 edition, a proposal to require 30 gpm was rejected. Without any other information, we have been telling people to treat these sprinklers similar to those under obstructions. Clear information in NFPA 231 would be helpful.

COMMITTEE ACTION: Accept.

NUMBER OF COMMITTEE MEMBERS ELIGIBLE TO VOTE: 28

VOTE ON COMMITTEE ACTION:

AFFIRMATIVE: 28

(Log #15)

231- 13 - (4-5): Reject

SUBMITTER: Kenneth E. Isman, Natal Fire Sprinkler Assign.

RECOMMENDATION: Replace Section 4-5 (including the note) as follows:

4-5 Flammable and Combustible Liquids. General storage warehouses shall be permitted to store a limited quantity of flammable and combustible liquids in accordance with Section 4-5 of NFPA 30.

SUBSTANTIATION: NFPA 30 has been dramatically revised and handles the storage of flammable and combustible liquids quite well. Another alternative to this paragraph would be to lift sections of NFPA 30 using the NFPA extract policy.

COMMITTEE ACTION: Reject.

COMMITTEE STATEMENT: Data indicates that the sprinkler protection required by this standard would be inadequate for the protection of flammable liquids.

NUMBER OF COMMITTEE MEMBERS ELIGIBLE TO VOTE: 28

VOTE ON COMMITTEE ACTION:

AFFIRMATIVE: 28

(Log #5)

231- 14 - (5-1.5): Reject

SUBMITTER: Samuel Vanover, New Orleans, LA

RECOMMENDATION: Sprinklers shall only be recognized when installed to a maximum height to which they have been tested and listed.

SUBSTANTIATION: Most sprinklers have only been tested by UL for a ceiling height of 18 ft. Most sprinklers have only been tested by FM for a ceiling height of 30 ft. There is no scientific data to support sprinkler effectiveness above the tested height. To not recognize sprinkler limitations is to mislead the public.

COMMITTEE ACTION: Reject.

COMMITTEE STATEMENT: Testing at UL, FM and other testing laboratories has not been limited to ceiling heights of 18 ft and 30 ft. There is data which demonstrates that sprinklers perform adequately beyond the ceiling heights indicated in the submitter's substantiation.

NUMBER OF COMMITTEE MEMBERS ELIGIBLE TO VOTE: 28

VOTE ON COMMITTEE ACTION:

AFFIRMATIVE: 28

(Log #10)

231- 15 - (5-1.5 Exception No. 3 (New)): Reject

SUBMITTER: James Golinveaux, Central Sprinkler Co.

RECOMMENDATION: Add an Exception No. 3 to read as follows:

"The use of orifices sizes larger than extra-large orifice (ELO) shall be permitted where listed for such use."

SUBSTANTIATION: The limitation of orifice size in this section restricts the use of sprinklers that are equal in performance and recognized by NFPA 13, 1996.

COMMITTEE ACTION: Reject.

COMMITTEE STATEMENT: The Technical Committee does not wish to relinquish its prerogative of reviewing and evaluating data for new sprinkler devices intended for the protection of storage occupancies. However, the Technical Committee recognizes the need to establish specific criteria for the evaluation of new sprinkler devices. A task group has been established and has been assigned this issue. Additionally, 1-1.4 allows for the development and use of new technologies.

NUMBER OF COMMITTEE MEMBERS ELIGIBLE TO VOTE: 28

VOTE ON COMMITTEE ACTION:

AFFIRMATIVE: 28

NFPA 231 — A98 ROP

(Log #32)

231- 16 - (5-1.5 Exception No. 3 (New)): Accept in Principle
SUBMITTER: Gary W. Ponte, The Reliable Automatic Sprinkler Co., Inc.

RECOMMENDATION: Add new text as follows:

Exception No. 3: The use of very extra large (VELO) sprinklers [3/4 in. (19.0mm)] shall be permitted where listed for such use and where installed at a minimum design pressure of 7 psi (0.5 bar).

SUBSTANTIATION: A VELO Sprinkler can control fires at lower operating pressures than existing sprinklers allowed under this standard; which is an improved method of fire protection. Attached is a copy of UL Listing Report 96 NK25107 which details extensive successful testing this sprinkler has had in full scale fire testing.

COMMITTEE ACTION: Accept in Principle.

Revise the Exception to read:

Exception No. 3: The use of 3/4 in. (19.0 mm) orifice sprinklers shall be permitted where listed for such use.

COMMITTEE STATEMENT: 1. NFPA 13, which is referenced by this standard, identifies sprinklers according to their nominal orifice size and not according to a generic description of the sprinkler's orifice size.

2. Identifying the minimum 7 psi pressure is not necessary because NFPA 13, which is referenced by this standard, requires sprinklers to operate at a minimum operating pressure of 7 psi unless a higher operating pressure is otherwise noted.

NUMBER OF COMMITTEE MEMBERS ELIGIBLE TO VOTE: 28

VOTE ON COMMITTEE ACTION:

AFFIRMATIVE: 28

(Log #16)

231- 17 - (5-1.6 Exception (New) and 5-1.7 (New)): Accept in Principle

SUBMITTER: Kenneth E. Isman, Nat'l Fire Sprinkler Assn.

RECOMMENDATION: Add an exception to 5-1.6 and a new 5-1.7 as follows:

5-1.6 <no change>

Exception: When separated by at least one-hour rated fire resistive construction which is continuous from floor to ceiling of the storage area.

5-1.7 Where non-storage spaces have lower ceilings than the storage portion of the building, the space above this drop ceiling shall be sprinklered unless it complies with the rules of NFPA 13 for allowable unsprinklered concealed spaces. Where the area above a drop ceiling is sprinklered, the sprinkler system shall conform to the rules of Section 5-1.6 or its exception.

SUBSTANTIATION: A Formal Interpretation request in September of 1995 showed the need for these new sections. It was difficult to answer the questions "yes" or "no" since the effect of the answers was to write new code text through an F.I.

COMMITTEE ACTION: Accept in Principle.

Accept the submitters Proposal with the following change:

In the proposed Exception to 5-1.6 change "ceiling" to "roof/ceiling" so it reads:

Exception: When separated by at least one-hour rated fire resistive construction which is continuous from floor to roof/ceiling of the storage area.

COMMITTEE STATEMENT: To be consistent with the language used throughout the document.

NUMBER OF COMMITTEE MEMBERS ELIGIBLE TO VOTE: 28

VOTE ON COMMITTEE ACTION:

AFFIRMATIVE: 26

NEGATIVE: 2

EXPLANATION OF NEGATIVE:

OLISZEWICZ: In my opinion, the need for separation by fire resistive construction was not demonstrated by the substantiation for this change. In addition, the proposal did not provide any substantiation for the 1 hr duration.

VICTOR: The Exception should read:

Exception: When separated by a non-combustible partition which has non-combustible self-closing doors, and which is continuous from floor to ceiling of the storage area.

I agree that there should be a separation between the two areas in order to allow for the omission of the 15 ft requirement. However, I don't feel that a 1-hr rated partition, with the protected openings and all other construction features that go along with such a rating, is necessary. NFPA 13 does not require rated separations between different occupancy classifications. Also, in accordance with NFPA 13, to omit sprinklers in a non-combustible concealed space, the space does not require a rated wall or ceiling.

(Log #34)

231- 18 - (5-1.7 (New)): Reject

SUBMITTER: Douglas Rice, Central Sprinkler Co.

RECOMMENDATION: Add a new 5-1.7 as follows:

5-1.7 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:

- (a) Fire tests related to the intended hazard
- (b) Distribution of the spray pattern with respect to wetting of floors and walls
- (c) Distribution of the spray pattern with respect to obstruction
- (d) Evaluation of the thermal sensitivity of the sprinkler
- (e) Performance under horizontal or sloped ceilings
- (f) Area of design.

These sprinklers shall be limited to orifice size and temperature ratings per NFPA 13 and the protection area shall not exceed 196 ft² (17m²).

SUBSTANTIATION: New technology in fire sprinklers for high piled storage occupancies is progressing rapidly. The standard as it exists restricts new technology unless specifically approved by each and every authority having jurisdiction in accordance with 1-1.4. this restricts the use of new technology which could increase the level of protection and reduce the cost of the installed system. This proposal would allow new technology to progress while providing guidance similar to NFPA 13.

COMMITTEE ACTION: Reject.

COMMITTEE STATEMENT: The Committee agrees that specific criteria is necessary to evaluate new sprinkler devices, however the Technical Committee does not specifically agree with the criteria offered by the proposal. A task group has been established to study this issue and propose language. Also see Committee Statement on Proposal 231-15 (Log #10).

NUMBER OF COMMITTEE MEMBERS ELIGIBLE TO VOTE: 28

VOTE ON COMMITTEE ACTION:

AFFIRMATIVE: 28

(Log #1)

231- 19 - (6-1.2): Reject

SUBMITTER: Brian M. Nixon, Naval Facilities Engr Command

RECOMMENDATION: Revise first sentence to:

"Bin box storage of nonencapsulated commodities over 12 ft (3.7 m) up to 30 ft (9.1 m), bin box storage of encapsulated commodities over 12 ft (3.7 m) up to 15 ft (4.6 m) and shelf storage over 12 ft (3.7 m) up to 15 ft (4.6 m) and provided with walkways..." (remainder of sentence remains as is)

SUBSTANTIATION: The current sentence wording is unclear and can easily be incorrectly interpreted to allow bin box storage of encapsulated commodities and shelf storage up to the maximum 30 ft shown on Figure 6-2.2.4 - in violation of the 15 ft limitations for these types of storage stated in paragraphs 6-1.1(b) and 6-1.1(c).

COMMITTEE ACTION: Reject.

COMMITTEE STATEMENT: The Committee agrees that more clarification is needed with regard to certain arrangements of bin box and shelf storage. However, the committee does not agree with the specific language offered by the proposal. Since holding a Proposal for further study is not an appropriate action, the Technical Committee has rejected this Proposal and established a task group to review these issues and provide revised language to be submitted as a comment during the public comment period.

NUMBER OF COMMITTEE MEMBERS ELIGIBLE TO VOTE: 28

VOTE ON COMMITTEE ACTION:

AFFIRMATIVE: 28

(Log #3)

231- 20 - (6-1.2): Reject

SUBMITTER: Brian M. Nixon, Naval Facilities Engr Command

RECOMMENDATION: Add sentences at the end of the current paragraph:

"To adjust the design density for walkway sprinklers, the storage height in Figure 6-2.2.4 shall be the approximate height of the sprinkler deflectors, water demand of sprinklers installed under the walkways need not be added to ceiling demand."

SUBSTANTIATION: The current wording does not provide guidance on how to calculate the special case where walkways are present.

NFPA 231 — A98 ROP

COMMITTEE ACTION: Reject.
COMMITTEE STATEMENT: See Committee Action and Statement on Proposal 231-19 (Log #1).
NUMBER OF COMMITTEE MEMBERS ELIGIBLE TO VOTE: 28
VOTE ON COMMITTEE ACTION:
AFFIRMATIVE: 28

(Log #17)

231- 21 - (6-1.2): Reject
SUBMITTER: Kenneth E. Isman, Nat'l Fire Sprinkler Assn.
RECOMMENDATION: Make 6-1.2 an exception to 6-1.1(c), clarify the maximum height limitation, clarify which storage height to use for the 6-2.2.4 adjustment and put a picture in the appendix.
SUBSTANTIATION: Section 6-1.2 appears to contradict Section 6-1.1(c). The only way that this makes sense is to make it an exception to the height limitation. It would also appear from the current text that storage can go up indefinitely as long as there is a walkway every 12 ft vertically. It is also not clear if the designer is to take the storage height adjustment for 12 ft or for the total storage height.
COMMITTEE ACTION: Reject.
COMMITTEE STATEMENT: See Committee Statement on Proposal 231-19 (Log #1).
NUMBER OF COMMITTEE MEMBERS ELIGIBLE TO VOTE: 28
VOTE ON COMMITTEE ACTION:
AFFIRMATIVE: 28

(Log #18)

231- 22 - (6-2): Accept
SUBMITTER: Kenneth E. Isman, Nat'l Fire Sprinkler Assn.
RECOMMENDATION: Revise the title from "Water Supplies" to "Protection Criteria".
SUBSTANTIATION: The title water supplies has caused some confusion. Even though the end result of Section 6-2 is to calculate a water supply demand (which is compared to the available supply), no-one seems to get the connection for this title.
COMMITTEE ACTION: Accept.
NUMBER OF COMMITTEE MEMBERS ELIGIBLE TO VOTE: 28
VOTE ON COMMITTEE ACTION:
AFFIRMATIVE: 28

(Log #19)

231- 23 - (6-2.2.1 and Table 6-2.2.1): Accept
SUBMITTER: Kenneth E. Isman, Nat'l Fire Sprinkler Assn.
RECOMMENDATION: Replace Section 6-2.2.1 with the following section and Table.
6-2.2.1 Sprinkler demand criteria for storage 12 ft or less in height shall be in accordance with Table 6-2.2.1. All other requirements of this standard shall apply to such storage.

Commodity	Storage Height	Sprinkler Protection Criteria
Class I	Up to 12 ft	NFPA 13 - Ordinary Hazard Group 1
Class II	Up to 8 ft	NFPA 13 - Ordinary Hazard Group 1
Class II	Over 8 to 12 ft	NFPA 13 - Ordinary Hazard Group 2
Class III	Up to 12 ft.	NFPA 13 - Ordinary Hazard Group 2
Class IV	Up to 12 ft	NFPA 13 - Ordinary Hazard Group 2

SUBSTANTIATION: To be consistent with the Section 5-2.3.2.2 of NFPA 13 which was changed due to specific fire tests.
COMMITTEE ACTION: Accept.

Make the following editorial changes:

1. Add a title to the proposed Table 6-2.2.1 to read as follows:
"Table 6-2.2.1 Sprinkler Protection of Class I through IV Commodities Stored 12 ft or less in Height"
2. In the proposed language to section 6-2.2.1, change the term "demand criteria" to "protection criteria". Section 6-2.2.1 will now read:
6-2.2.1 Sprinkler protection for storage 12 ft or less in height shall be in accordance with Table 6-2.2.1. All other requirements of this standard shall apply to such storage.

NUMBER OF COMMITTEE MEMBERS ELIGIBLE TO VOTE: 28
VOTE ON COMMITTEE ACTION:
AFFIRMATIVE: 28
COMMENT ON AFFIRMATIVE:
McPHEE: In the Committee Action it would appear that the wording of the new section should read in part:
"6-2.2.1 Sprinkler protection criteria for storage..."
Also, the Table included has no Title on it.

(Log #20)

231- 24 - (Figure 6-2.2.2 Note): Accept
SUBMITTER: Kenneth E. Isman, Nat'l Fire Sprinkler Assn.
RECOMMENDATION: Delete the notes under Figure 6-2.2.2.
SUBSTANTIATION: The first note incorrectly references Figure 6-2.2.3 and both notes are unnecessary given the figure titles.
COMMITTEE ACTION: Accept.
NUMBER OF COMMITTEE MEMBERS ELIGIBLE TO VOTE: 28
VOTE ON COMMITTEE ACTION:
AFFIRMATIVE: 28

(Log #22)

231- 25 - (7-1.3 and 7-1.4): Accept
SUBMITTER: Kenneth E. Isman, Nat'l Fire Sprinkler Assn.
RECOMMENDATION: Replace the last sentence of Sections 7-1.3 and 7-1.4 with the sentence:
"See Chapter 6 for protection of these storage commodities with spray sprinklers."
SUBSTANTIATION: Protection criteria for Class III and IV commodities belongs in Chapter 6, not Chapter 7.
COMMITTEE ACTION: Accept.
NUMBER OF COMMITTEE MEMBERS ELIGIBLE TO VOTE: 28
VOTE ON COMMITTEE ACTION:
AFFIRMATIVE: 28

(Log #23)

231- 26 - (7-2): Accept
SUBMITTER: Kenneth E. Isman, Nat'l Fire Sprinkler Assn.
RECOMMENDATION: Revise the title of 7-2 from "Water Supplies" to "Protection Criteria".
SUBSTANTIATION: The title water supplies has caused some confusion. Even though the end result of Section 7-2 is to calculate a water supply demand (which is compared to the available supply), no-one seems to get the connection for this title.
COMMITTEE ACTION: Accept.
NUMBER OF COMMITTEE MEMBERS ELIGIBLE TO VOTE: 28
VOTE ON COMMITTEE ACTION:
AFFIRMATIVE: 28

(Log #24)

231- 27 - (7-2.2): Accept in Principle in Part
SUBMITTER: Kenneth E. Isman, Nat'l Fire Sprinkler Assn.
RECOMMENDATION: Delete all of the notes to Table 7-2.2 and revise 7-2.2 as follows:
7-2.2 Design areas and densities shall be selected for the appropriate storage configuration from Table 7-2.2. The columns A, B, C, D and E correspond to the protection required by the Decision Tree (Figure 7-1.1).
7-2.2.1 OH-2 in Table 7-2.2 refers to area/density selection from NFPA 13 - Ordinary Hazard Group 2.
7-2.2.2 EH-1 in Table 7-2.2 refers to area/density selection from NFPA 13 - Extra Hazard Group 1.
7-2.2.3 EH-2 in Table 7-2.2 refers to area/density selection from NFPA 13 - Extra Hazard Group 2.
7-2.2.4 NA in Table 7-2.2 indicates that storage configuration is not allowed.
7-2.2.5 For Table 7-2.2, the design areas are a minimum of 2500 sq ft.
Exception No. 1: Where Table 7-2.2 allows densities and areas to be selected in accordance with NFPA 13 - Ordinary Hazard Group 2, any area/density from that curve shall be acceptable.
Exception No. 2: For closed arrays, the area shall be permitted to be reduced to 2000 sq ft.

NFPA 231 — A98 ROP

7-2.2.6 Interpolation of densities between storage heights shall be permitted. Interpolation of roof/ceiling heights shall not be permitted.

7-2.2.7 Where Table 7-2.2 requires densities of 0.4 gpm/sq ft or greater, 17/32 or 5/8 in. orifice spray sprinklers shall be used.

7-2.2.8 High temperature spray sprinklers shall be used.

Exception: Where Table 7-2.2 allows densities and areas to be selected in accordance with NFPA 13 - Ordinary Hazard Group 2, Extra Hazard Group 1 or Extra Hazard Group 2, ordinary temperature sprinklers shall be permitted.

Also replace "N/A" in Table 7-2.2 with "NA".

SUBSTANTIATION: A number of changes and clarifications were made with this proposal. The first is to satisfy the NFPA style manual that requirements not be in notes.

The terms large orifice and extra large orifice have been eliminated because NFPA 13 eliminated them as descriptions of sprinklers.

The remaining changes are for clarity, but should not effect the requirements of Chapter 7.

COMMITTEE ACTION: Accept in Principle in Part.

Make the following changes to the submitter's Proposal:

1. Do not add proposed 7-2.2.1, 7-2.2.2, 7-2.2.3 as indicated by the Proposal, but instead maintain as Note 2 as proposed by item 5 of Committee Proposal 231-29 (Log #CP1).

2. Do not add 7-2.2.4 as indicated by the Proposal.

3. For proposed 7-2.2.5 see item 6 of Committee Proposal 231-29 (Log #CP1).

4. For proposed 7-2.2.6 see item 7 of Committee Proposal 231-29 (Log #CP1).

5. For proposed 7-2.2.7 see item 8 of Committee Proposal 231-29 (Log #CP1).

6. Do not add proposed 7-2.2.8.

7. Add the following as the last paragraph to existing A-7.2.2:
A-7.2.2 The Table is based on tests that were conducted primarily with high temperature rated 17/32 in. orifice sprinklers. Other tests have demonstrated that where sprinklers are used with orifices greater than 17/32 in., ordinary temperature sprinklers are acceptable.

COMMITTEE STATEMENT: 1. Existing Notes 1 through 3 are aids in applying Table 7-2.2. They are not requirements and should not be located in the body of the standard.

2. The designation N/A will no longer be used in Table 7-2.2. See item 1 of Committee Proposal 231-29 (Log #CP1).

3. See Committee Proposal 231-29 (Log #CP1).

4. See Committee Proposal 231-29 (Log #CP1).

5. See Committee Proposal 231-29 (Log #CP1).

6 and 7. The revised wording more accurately conveys testing results.

NUMBER OF COMMITTEE MEMBERS ELIGIBLE TO VOTE: 28

VOTE ON COMMITTEE ACTION:

AFFIRMATIVE: 28

(Log #25)

231-28 - (Table 7-2.2): Accept in Principle

SUBMITTER: Kenneth E. Isman, Nat'l Fire Sprinkler Assn.

RECOMMENDATION: Put the metric equivalents in the same type of brackets as the (L/s)/m² at the top of the table.

SUBSTANTIATION: A number of people have been confused because of the different types of brackets and parenthesis used in this table. Some have tried to use the number in parenthesis as alternate gpm/sq ft densities due to the difference.

COMMITTEE ACTION: Accept in Principle.

In addition to making this change to Table 7-2.2, make this designation consistent throughout the document.

COMMITTEE STATEMENT: Editorial change for consistency throughout the document.

NUMBER OF COMMITTEE MEMBERS ELIGIBLE TO VOTE: 28

VOTE ON COMMITTEE ACTION:

AFFIRMATIVE: 28

(Log #CP1)

231-29 - (Table 7-2.2): Accept

SUBMITTER: Technical Committee on General Storage

RECOMMENDATION: 1. Revise Table 7-2.2 as follows:

(table shown below)

2. Add a new Note 1 to read as follows:

Note 1: Minimum clearance between sprinkler deflector and top of storage shall be maintained as required.

3. Delete existing Notes 1 through 5.

4. Renumber existing Note 6 as Note 2.

5. Renumber existing Note 7 as Note 3.

6. Add a new Section 7-2.2.1 to read as follows:

7-2.2.1 For Table 7-2.2, the design areas are a minimum of 2500 sq ft.

Exception No. 1: Where Table 7-2.2 allows densities and areas to be selected in accordance with NFPA 13, Ordinary Hazard Group 2, any area/density from that curve shall be acceptable.

Exception No. 2: For closed arrays, the area shall be permitted to be reduced to 2000 sq ft.

7. Add a new Section 7-2.2.2 to read as follows:

7-2.2.2 Interpolation of densities between storage heights shall be permitted. Densities shall be based upon the 2500 sq ft design area except as permitted for closed arrays. The 'up to' in the table is intended to aid in the interpolation of densities between storage heights. Interpolation of ceiling/roof heights shall not be permitted.

8. Add a new Section 7-2.2.3 to read as follows:

7-2.2.3 Where Table 7-2.2 requires densities of 0.4 gpm/sq ft or greater, 1/2 in. (12.7 mm) orifice sprinklers shall not be permitted.

9. Add a second sentence to Section 7-2.1 after item (d) as follows:

"Where the distance between roof/ceiling height and top of storage exceeds 20 feet, provide protection needed for the storage height which would result in a 20 ft distance between the roof/ceiling height and top of storage."

SUBSTANTIATION: A major difficulty in applying 7-2.2 is that interpolation of densities/areas between storage heights is permitted but interpolation of ceiling/roof heights is not. As a result there are certain storage arrangements in which a density cannot be properly obtained from the table. An example includes 17 ft high storage in a 20 ft high building. While Table 7-2.2 offers criteria for 15 ft storage in a 20 ft building no criteria exists for 20 ft high storage in a 20 ft high building. In order to obtain a second point for interpolation, criteria for 20 ft storage in a 25 ft high building would need to be used. However, Note 3 of the table does not allow for interpolation between these two points.

The task group proposes the table be revised as indicated. By adding the phrase "up to" in the roof/ceiling column, the second interpolation value can be obtained. Using the 17 ft high storage in a 20 ft high building example, the criteria for 20 ft storage in a building with a roof/ceiling up to 25 ft can now be used as the second data point. Additionally, the task group proposes that the table include criteria for larger clearances for arrangements where storage heights are relatively low when compared to building height. Upon reviewing existing information about sprinkler performance, storage heights and roof/ceiling heights, the task group believes that with relatively low storage heights (up to 15 ft high) the existing densities are adequate. With these

Density (gpm/sq ft)

Storage Hght	Roof/Ceiling Ht	A	B	C	D	E
5	up to 25	OH-2	OH-2	OH-2	OH-2	OH-2
12	up to 15	0.2	EH-2	0.3	EH-1	EH-2
	>15 to 20	0.3	0.6	0.5	EH-2	EH-2
	>20 to 32	0.4	0.8	0.6	0.45	0.7
15	up to 20	0.25	0.5	0/4	0.3	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	0.3	0.6	0.45	0.35	0.55
	>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	0.4	0.75	0.55	0.45	0.7
	>30 to 35	0.6	1.2	0.85	0.7	1.1

NFPA 231 — A98 ROP

lower storage heights, fire loads are reduced. The higher ceilings limit plume momentum from the developing fire. Additionally, where required sprinkler densities exceed 0.4 gpm per sq ft, large orifice or extra large orifice sprinklers must still be used. These sprinklers produce larger water droplets which have sufficient momentum to penetrate the fire plume.

Existing Notes to Table 7-2.2 were removed as requirements should be located in the body of the standard.

With regard to item 8, any sprinkler with an orifice size larger than 1/2 in. and which has been accepted for use by this Committee for storage applications is to be used where discharge densities of 0.4 gpm/sq ft or greater are used. This requirement was previously limited to 5/8 in. orifice sprinklers.

COMMITTEE ACTION: Accept.

NUMBER OF COMMITTEE MEMBERS ELIGIBLE TO VOTE: 28
VOTE ON COMMITTEE ACTION:

AFFIRMATIVE: 28

COMMENT ON AFFIRMATIVE:

SCHUMANN: Revisions to table are OK. The protection for 12 ft storage in a 20 ft building in Column E seems inadequate. From an analysis of the protection given in Table 7-2.2, it seems that stable arrays require more protection than unstable arrays. Also exposed requires more than cartoned. The "*" items below do not seem to follow that thought process.

Column B Expanded, Exposed, Stable

.6/2500

Column C Expanded, Exposed, Unstable

.5/2500

Column D Expanded, Cartoned, Unstable

.4/2500 (EH2)

*Column E Expanded, Cartoned, Stable

.4/2500 (EH2)

Column A Nonexpanded, Exposed or Cartoned, Unstable

.3/2500

Column C Nonexpanded, Cartoned, Stable

.5/2500

*Column E Nonexpanded, Exposed, Stable

.4/2500 (EH 2)

(Log #33)

231- 30 - (Table 7-2.2, Note 4): Accept in Principle

SUBMITTER: Gary W. Ponte, The Reliable Automatic Sprinkler Co., Inc.

RECOMMENDATION: Revise text as follows:

Note 4: Fore density demands of 0.4 gpm/ft² or greater, large orifice, extra-large orifice (ELO), or very extra large orifice (VELO) sprinklers shall be used.

SUBSTANTIATION: A VELO Sprinkler can control fires at lower operating pressures than existing sprinklers allowed under this standard; which is an improved method of fire protection.

Note: Supporting material is available for review at NFPA Headquarters.

COMMITTEE ACTION: Accept in Principle.

See item 8 of Committee Proposal 231-29 (Log #CP1).

COMMITTEE STATEMENT: See Committee Proposal 231-29 (Log #CP1).

NUMBER OF COMMITTEE MEMBERS ELIGIBLE TO VOTE: 28

VOTE ON COMMITTEE ACTION:

AFFIRMATIVE: 28

(Log #26)

231- 31 - (7-2.4): Accept

SUBMITTER: Kenneth E. Isman, Nat'l Fire Sprinkler Assn.

RECOMMENDATION: Revise 7-2.4 to read as follows:

7-2.4 Water supply duration (sprinkler demand plus hose streams) shall be 2-hour duration where storage heights are 5 to 20 ft and 2.5-hr duration where storage heights are over 20 ft up to 25 ft.

SUBSTANTIATION: To clarify that the "ft" applied to storage heights and to clarify which number to use for 20 ft high storage.

COMMITTEE ACTION: Accept.

Editorially add "ft" after the dimension "5" so it reads:

7-2.4 Water supply duration (sprinkler demand plus hose streams) shall be 2-hour duration where storage heights are 5 ft to 20 ft and 2.5-hr duration where storage heights are over 20 ft up to 25 ft.

NUMBER OF COMMITTEE MEMBERS ELIGIBLE TO VOTE: 28
VOTE ON COMMITTEE ACTION:

AFFIRMATIVE: 28

(Log #4)

231- 32 - (Table 8-1): Reject

SUBMITTER: Forrest Weir, Arlington, VA

RECOMMENDATION: Revise Table 8-1 of NFPA 231 to include coverage of any on all of the additional commodity hazards shown in related Table A-5-3.4 of NFPA 13, Installation of Sprinkler Systems.

SUBSTANTIATION: The purpose of this proposal is to lift the hazard criteria shown in Table A-5-3.4 above the level of merely asterisk or explanatory materials. The record protection criteria, for instance, is based on 1980 Factory Mutual records fire tests using large-drop sprinklers.

COMMITTEE ACTION: Reject.

COMMITTEE STATEMENT: The Table currently addresses the application of large drop sprinklers for the protection of general storage. It is not appropriate to include information which is outside the scope of NFPA 231.

NUMBER OF COMMITTEE MEMBERS ELIGIBLE TO VOTE: 28

VOTE ON COMMITTEE ACTION:

AFFIRMATIVE: 28

(Log #27)

231- 33 - (Table 8-1): Accept

SUBMITTER: Kenneth E. Isman, Nat'l Fire Sprinkler Assn.

RECOMMENDATION: Delete Note 2 and all references in the Table. Replace the references to note 2 with the actual number of sprinklers which would be required if this pressure were selected.

SUBSTANTIATION: The purpose of the Table is to tell people how many sprinklers to calculate.

It would be much easier if people could get that information directly from the table without having to go to a confusing note and guess what it means.

COMMITTEE ACTION: Accept.

NUMBER OF COMMITTEE MEMBERS ELIGIBLE TO VOTE: 28

VOTE ON COMMITTEE ACTION:

AFFIRMATIVE: 28

(Log #28)

231- 34 - (Table 8-1): Accept in Principle

SUBMITTER: Kenneth E. Isman, Nat'l Fire Sprinkler Assn.

RECOMMENDATION: Revise Table as follows:

SUBSTANTIATION: Clarifies how to deal with multiple hazards which are currently in the same row. For instance, there are people who interpret the 1995 edition as saying that solid piled Class IV commodities are unlimited in height while only unexpanded plastics are limited to 20 ft.

Also clarifies the clearance issue. Currently, if someone stores up to 20 ft in a 30 ft building, they are okay. But if they remove 5 ft of storage, they are protecting 15 ft with 15 ft clearance which violates the standard.

231-34 (Log #28) Recommendation:

Configuration	Commodity	Maximum Storage Height	Maximum Building Height
Palletized	Class I, II or III	25 ft	35 ft
Palletized	Class IV	20 ft	30 ft
Palletized	Unexpanded Plastics	20 ft	30 ft
Palletized	Idle Wood Pallets	20 ft	30 ft
Solid Piled	Class I, II, III	20 ft	30 ft
Solid Piled	Class IV	20 ft	30 ft
Solid Piled	Unexpanded Plastics	20 ft	30 ft

NFPA 231 — A98 ROP

COMMITTEE ACTION: Accept in Principle.

Accept the Proposal with the following change:

Split the existing first column entitled "Hazard" into four columns as indicated by the Proposal and reinstate existing information on 18 ft high storage of expanded plastics:

Configuration	Commodity	Maximum Storage Height	Maximum Building Height
Palletized	Class I, II or III	25 ft	35 ft
Palletized	Class IV	20 ft	30 ft
Palletized	Unexpanded Plastics	20 ft	30 ft
Palletized	Expanded Plastics	18 ft	26 ft
Palletized	Idle Wood Pallets	20 ft	30 ft
Solid Piled	Class I, II, III	20 ft	30 ft
Solid Piled	Class IV	20 ft	30 ft
Solid Piled	Unexpanded Plastics	20 ft	30 ft

COMMITTEE STATEMENT: Data indicates that large drop sprinklers are effective for palletized storage of expanded plastics stored up to 18 ft high in a 26 ft building.

NUMBER OF COMMITTEE MEMBERS ELIGIBLE TO VOTE: 28

VOTE ON COMMITTEE ACTION:

AFFIRMATIVE: 28

COMMENT ON AFFIRMATIVE:

SCHUMANN: The plastic commodities should be indicated as cartoned or exposed.

(Log #29)

231- 35 - (Table 8-1): Accept

SUBMITTER: Kenneth E. Isman, Nat'l Fire Sprinkler Assn.

RECOMMENDATION: Change "N/A: Not Applicable" to "NA:

Not Allowed"

SUBSTANTIATION: More specific to the intent of the table.

COMMITTEE ACTION: Accept.

NUMBER OF COMMITTEE MEMBERS ELIGIBLE TO VOTE: 28

VOTE ON COMMITTEE ACTION:

AFFIRMATIVE: 28

(Log #30)

231- 36 - (8-2): Accept in Principle in Part

SUBMITTER: Kenneth E. Isman, Nat'l Fire Sprinkler Assn.

RECOMMENDATION: 1. Change the title of 8-2 from "Water Supplies" to "Protection Criteria".

2. Move Note 1 of Table 8-1 to new Section 8-2.4 and revise to read:

"For large drop sprinkler installed under open wood joist construction, the minimum operating pressure shall be 50 psi."

3. Eliminate the title to 8-3.

4. Move 8-3.1 and its exception to new Section 8-2.5 without change.

5. Add a new Section 8-2.6 and exception as follows:

"For the purpose of using Table 8-1, preaction systems shall meet the requirements of wet pipe systems.

Exception: Double interlock preaction systems shall meet the requirements of dry-pipe systems.

SUBSTANTIATION: 1. Change of title is consistent with previous paragraphs:

2. The existing note is contradictory in two ways. First it requires fire stopping and then it gives provisions for doing without fire stopping. The provisions themselves are contradictory in that they both refer to intervals under 20 ft. This proposal is in line with the revision to the FM Data Sheet 2-7 (1994 edition) which is based on the FM tests. Information of the FM requirement and the justification can be found in Data Sheet 2-7 Sections 2.1.1(5) Note 1 and 3.2.2.5.

3. and 4. The reference to NFPA 13 belongs with the other protection criteria.

5. Guidance is needed on how to handle preaction systems of all kinds.

COMMITTEE ACTION: Accept in Principle in Part.

Accept the Proposal with the following changes:

1. Revise item 5 of the submitter's Proposal to read:

8-2.6. For the purpose of using Table 8-1, preaction systems shall be classified as dry pipe systems.

Do not add the proposed Exception.

2. Add a new 8-2.7 to read as follows:

8-2.7 For wet pipe systems, ordinary, intermediate or high temperature sprinklers shall be used. For dry pipe systems, high temperature sprinklers shall be used.

COMMITTEE STATEMENT: 1. Data has shown that the time delays associated with water traveling from the sprinkler valve to the open sprinklers in preaction systems will have a substantial negative impact on the sprinkler systems ability to control the fire.

2. The standard has been silent on this issue but the Committee is of the opinion that higher rated temperature sprinklers are preferred to limit the number of sprinklers which will open before water is delivered to them.

NUMBER OF COMMITTEE MEMBERS ELIGIBLE TO VOTE: 28

VOTE ON COMMITTEE ACTION:

AFFIRMATIVE: 27

NEGATIVE: 1

EXPLANATION OF NEGATIVE:

VICTOR: I disagree with committee action on item #5 of the submitter's recommendation. A preaction system installed in accordance with NFPA 13 for any other occupancy is treated as a wet system for hydraulic calculation purposes. If the 231 committee wants to address their concern about water delivery time to the calculated area, then address the detection/actuation system. I recommend the following new language be added: "The detection system shall be designed to ensure actuation of the deluge valve before any sprinklers are opened."

(Log #31)

231- 37 - (9-1): Accept in Principle

SUBMITTER: Kenneth E. Isman, Nat'l Fire Sprinkler Assn.

RECOMMENDATION: Move notes 1 and 2 to Table 9-1 to new Sections 9-1.1.1 and 9-1.1.2 respectively.

SUBSTANTIATION: In line with the NFPA Manual of Style which does not allow requirements in notes.

COMMITTEE ACTION: Accept in Principle.

See items 1 and 2 of the Committee Action on Proposal 231-38 (Log #7).

COMMITTEE STATEMENT: See Committee Action and Statement on Proposal 231-38 (Log #7).

NUMBER OF COMMITTEE MEMBERS ELIGIBLE TO VOTE: 28

VOTE ON COMMITTEE ACTION:

AFFIRMATIVE: 28

NFPA 231 — A98 ROP

(Log #7)

231-38 - (Table 9-1): Accept in Principle in Part
SUBMITTER: James Golinveaux, Metal Building Manufacturers
RECOMMENDATION: Revise table as follows:

(table shown below)

SUBSTANTIATION: For 35 ft of storage, many buildings 3 exceed to 40 ft ceiling limitation of ESFR sprinklers.

Note: Supporting material is available for review at NFPA Headquarters.

COMMITTEE ACTION: Accept in Principle in Part.

Accept proposed Table 9-1 with the following changes as shown below.

1. Remove the last column entitled "commodity limitation" and delete proposed Note 2.

2. Move Note 1 into a new Section 9-1.1.1.

3. Add "idle wood and plastic pallets" in two locations as indicated on the revised figure.

4. Revise the column heading entitled "Maximum Height of Building" to read "Maximum Roof/Ceiling Height of Building" and delete the reference to Note 1.

COMMITTEE STATEMENT:

1. The "Commodity Limitation" column and Note 2 are being removed because the limitations they address are contained in the table.

2. Note 1 is being moved as requirements should be located in the body of the standard. See Proposal 231-37 (Log #31).

3. Data indicates that ESFR sprinklers are effective for certain arrangements of idle pallet storage.

4. This provides consistency with the remainder of the document.

NUMBER OF COMMITTEE MEMBERS ELIGIBLE TO VOTE: 28
VOTE ON COMMITTEE ACTION:

AFFIRMATIVE: 26

NEGATIVE: 1

ABSTENTION: 1

EXPLANATION OF NEGATIVE:

SCHUMANN: No test data presented to include idle wood or plastic pallets.

No test data presented to include exposed (uncartoned) plastics.

Test data for 35 ft high storage in a 45 ft high building is incomplete. No chronology given for Test #4 (9-18-96). Test #5 chronology indicates flame persisting at 2 min 40 sec. No further comment on presence or absence of fire and test was terminated at 15 min. No conclusions can be made.

231-38 (Log #7) Recommendation:

Table 9-1 ESFR Sprinkler Data

Type of Storage	Commodity	Maximum Height of Storage (ft) (m)	Maximum Height of Building (See Note 1.) (ft) (m)	Nominal K factor	Sprinkler Design Pressure (psi) (bars)	Commodity Limitation
Palletized and solid pile storage (no open-top containers or solid shelves)	Cartoned unexpanded plastic; cartoned expanded plastic; uncartoned unexpanded plastic; and Class I, II, III, or IV commodities encapsulated or unencapsulated	25 (7.6)	30 (9.1)	13.5-14.5	50 (3.4)	
	Cartoned or <u>or uncartoned</u> , unexpanded plastic; and Class I, II, III, or IV commodities, encapsulated or unencapsulated	35 (10.7)	40 (12.2)	13.5-14.5	75 (5.2)	(See Note 2.)
	<u>Cartoned or uncartoned, unexpanded plastic; and Class I, II, III, or IV commodities, encapsulated or unencapsulated</u>	<u>35 (10.7)</u>	<u>45 (xx)</u>	<u>13.5-14.5</u>	<u>90 (xx)</u>	<u>(see Note 2.)</u>

NOTE 1: Maximum building height shall be measured to the underside of the roof deck or ceiling.

NOTE 2: Only ESFR sprinklers specifically listed for 45-ft (xx m) high buildings shall be used in buildings higher than 30 ft (9.1 m) up to 45 ft (xx m).

231-38 (Log #7) Committee Action:

Table 9-1 ESFR Sprinkler Data

Type of Storage	Commodity	Maximum Height of Storage (ft) (m)	Maximum Roof/Ceiling Height of Building (ft) (m)	Nominal K factor	Sprinkler Design Pressure (psi) (bars)
Palletized and solid pile storage (no open-top containers or solid shelves)	Cartoned unexpanded plastic; cartoned expanded plastic; uncartoned unexpanded plastic; and Class I, II, III, or IV commodities encapsulated or unencapsulated; idle wood or plastic pallets	25 (7.6)	30 (9.1)	13.5-14.5	50 (3.4)
	Cartoned or <u>or uncartoned</u> , unexpanded plastic; and Class I, II, III, or IV commodities, encapsulated or unencapsulated; idle wood or plastic pallets	35 (10.7)	40 (12.2)	13.5-14.5	75 (5.2)
	<u>Cartoned or uncartoned, unexpanded plastic; and Class I, II, III, or IV commodities, encapsulated or unencapsulated</u>	<u>35 (10.7)</u>	<u>45 (xx)</u>	<u>13.5-14.5</u>	<u>90 (xx)</u>

NFPA 231 — A98 ROP

EXPLANATION OF ABSTENTION:

McPHEE: The reference to "idle wood and plastic pallets" in Table 9-1 is questioned.

From my notes of the March meeting I have no record of any proposal or discussion that Table 9-1 on ESFR be expanded to cover storage of idle wood or plastic pallets. Table 8-1 already had a reference to this type of storage so the continued reference in Table 8-1 is still appropriate.

I have to presume that this was justified through the Committee comment/discussion based simply on comparisons of existing density/storage height provisions already in the standard for idle pallet storage protected by standard or large drop sprinklers, e.g., Table 4-4.1.2; Section 4-4.2.2; and Table 8-1.

(Log #8)

231- 39 - (9-2.5 (New)): Reject

SUBMITTER: John K. Gillette, III, Denton, TX, Fire Dept.

RECOMMENDATION: Add new text as follows:

Section 9-2.5 E.S.F.R. sprinklers shall be ordinary temperature rated sprinklers.

Exception No. 1: E.S.F.R. sprinklers located in proximity to heat sources.

Exception No. 2: E.S.F.R. sprinklers located under skylights.

Exception No. 3: When ambient temperatures (ceiling) is continuously or intermittently greater than 100°F, intermediate temperature heads will be installed.

SUBSTANTIATION: Per NFPA 231C, Section 10-2.5 addresses temperature ratings for E.S.F.R. Currently this section does not address temperature ratings. The temperature ratings will be consistent with NFPA 231C. The new proposal would add a third exception addressing ambient temperatures exceeding 100°F. Non air conditioned buildings have ambient temperatures exceeding 100°F. Factory Mutual Standard 2-2, Guideline for E.S.F.R. sprinklers, allows intermediate temperature sprinkler heads when ceiling temperatures exceeds 100°F. This addition will allow the use of intermediate rated E.S.F.R. sprinkler heads within structures.

COMMITTEE ACTION: Reject.

SUBMITTEE STATEMENT: The information proposed by the submitter is adequately addressed by section 4-4.6.4 of NFPA 13 which is referenced by NFPA 231. The rules for temperature ratings of ESFR sprinklers are not modified by NFPA 231.

NUMBER OF COMMITTEE MEMBERS ELIGIBLE TO VOTE: 28

VOTE ON COMMITTEE ACTION:

AFFIRMATIVE: 28

(Log #21)

231- 40 - (A-6-2.2.6 (New)): Accept in Principle

SUBMITTER: Kenneth E. Isman, Nat'l Fire Sprinkler Assn.

RECOMMENDATION: Insert a new appendix note as follows:

A-6-2.2.6 The metal construction and face area limitations apply to bin-box storage as well as shelf storage.

SUBSTANTIATION: Existing text is ambiguous. It could be read that these requirements only apply to shelf storage.

COMMITTEE ACTION: Accept in Principle.

Do not accept the proposed appendix but instead revise 6-2.2.6 as follows:

A-6-2.2.6 The area of application shall be permitted to be reduced by 50 percent, provided the minimum requirements of Chapter 5 are met.

COMMITTEE STATEMENT: The Committee agrees that the existing text is ambiguous but believes that revising the body of the standard is more appropriate.

NUMBER OF COMMITTEE MEMBERS ELIGIBLE TO VOTE: 28

VOTE ON COMMITTEE ACTION:

AFFIRMATIVE: 26

NEGATIVE: 2

EXPLANATION OF NEGATIVE:

KROMAN: The proposed new text appears to be typo error. My notes showed the Committee chose to reword 6-2.2.6 to "For bin boxes constructed of metal with a face not exceeding 16 sq ft, and for closed shelves..." (remainder of section to remain as is).

SCHUMANN: If 6-2.2.6 were revised as shown (improperly identified as A-6-2.2.6) the context of the existing 6-2.2.6 would be lost. Revise 6-2.2.6 as follows:

"For metal bin boxes and metal closed shelves with a face area not exceeding 16 ft² (1.5 m²), the area of sprinkler density application shall be permitted to be reduced by 50 percent, provided the minimum requirements of Chapter 5 are met."

(Log #CP2)

231- 41 - (Appendix B): Accept

SUBMITTER: Technical Committee on General Storage

RECOMMENDATION: Replace the text of Appendix B as follows:

Example 1: Storage is Expanded-Cartoned-Stable, 15 ft high in a 20 ft building.

Answer 1: Column E - Design Density = 0.45 gpm/sq ft.

Example 2: Storage is Nonexpanded-Unstable, 15 ft high in a 20 ft building.

Answer 2: Column A - Design Density is listed as 0.25, however, it is also possible that the storage may be 12 ft in this 20 ft building which would require 0.3. Unless the owner can guarantee that the storage will always be 15 ft, the Design Density = 0.3 gpm/sq ft.

Example 3: Storage is a Nonexpanded-Stable 15 ft fixed height unit load, one high, in an 18 ft building.

Answer 3: Column A - Design Density is 0.25 gpm/sq ft. Note that this does not go up to 0.3 like the previous example because of the use of a fixed height unit load. It will never be 12 ft. It will always be 15 ft or nothing.

Example 4: Storage is Expanded-Exposed-Unstable, 20 ft high in a 27 ft building.

Answer 4: Column C - Design Density = 0.7. Note that other lower storage heights should also be checked, but they reveal the same, or lower, densities (0.7 and 0.6) so the Design Density remains at 0.7 gpm/sq ft.

Example 5: Expanded-Cartoned-Unstable, 17 ft high in 32 ft building.

Answer 5: Column D - 15 ft storage in a 32 ft building would be 0.55

20 ft storage in a 32 ft building would be 0.70

Interpolation for 17 ft storage is as follows:

$0.7 - 0.55 = 0.15$

$0.15 / (20 - 15) = 0.03$

$0.03 \times (17 - 15) = 0.06$

$0.55 + 0.06 = 0.61$

Design Density = 0.61 gpm/sq ft

Example 6: Storage is Expanded-Exposed-Stable, 22 ft storage in 23.5 ft building.

Answer 6: Column B - Could interpolate between 0.6 and 0.75, however, this would be a moot point since the density for 15 ft storage in this 23.5 ft building would be 0.8. Unless the owner can guarantee 22 ft storage, the Design Density = 0.8 gpm/sq ft. If the owner can, in some way acceptable to the authority having jurisdiction guarantee 22 ft storage, the interpolation would yield a Design Density of 0.66 gpm/sq ft.

Example 7: Storage is Nonexpanded-Stable-Exposed, 13.5 ft high in 15 ft building.

Answer 7: Column E - 12 ft storage in a 15 building would be EH-2 (0.4 over 2500)

15 ft storage in a 15 ft building would be 0.45

Interpolation for 13.5 ft storage is as follows:

$0.45 - 0.4 = 0.05$

$0.05 / (15 - 12) = 0.017$

$0.017 \times (13.5 - 12) = 0.026$

$0.4 + 0.026 = 0.426$

Design Density = 0.426 gpm/sq ft

SUBSTANTIATION: As Table 7-2.2 was revised, the current example is no longer valid. The committee wished to provide other examples in applying table 7-2.2.

COMMITTEE ACTION: Accept.

NUMBER OF COMMITTEE MEMBERS ELIGIBLE TO VOTE: 28

VOTE ON COMMITTEE ACTION:

AFFIRMATIVE: 28

NFPA 231 — A98 ROP

The following draft of NFPA 231, *Standard for General Storage*, 1998, incorporates the Committee Actions on the Public and Committee Proposals which make up the Report on Proposals and which appear on the preceding pages. The draft is presented only as an aid to the reviewer.

NFPA 231

Standard for General Storage

1998 Edition

NOTICE: An asterisk (*) following the number or letter designating a paragraph indicates explanatory material on that paragraph in Appendix A.

Information on referenced publications can be found in Chapter 11 and Appendix D.

Chapter 1 Introduction

1-1 Scope.

1-1.1 This standard shall apply to the storage of materials representing the broad range of combustibles, including plastics that are stored palletized, solid-piled, in bin boxes, or on shelves.

Exception: Miscellaneous storage shall be permitted to be protected in accordance with NFPA 13, *Standard for the Installation of Sprinkler Systems*.

1-1.2 Outdoor Storage of a Broad Range of Combustibles. See Appendix C.

1-1.3 This standard shall not apply to the following:

- (a) Unsprinklered buildings.
- (b) Storage of commodities that, with their packaging and storage aids, would be classified as noncombustible.
- (c) Unpackaged bulk materials such as grain, coal, or similar commodities.
- (d) Inside or outside storage of commodities covered by other NFPA standards, except where specifically mentioned herein (e.g., pyroxylin plastics). Storage of high hazard materials such as tires, roll paper stored on end, and flammable liquids is outside the scope of this standard. Storage of such commodities shall be protected in accordance with the provisions of NFPA 30, *Flammable and Combustible Liquids Code*; NFPA 30B, *Code for the Manufacture and Storage of Aerosol Products*; NFPA 40, *Standard for the Storage and Handling of Cellulose Nitrate Motion Picture Film*; NFPA 58, *Standard for the Storage and Handling of Liquefied Petroleum Gases*; NFPA 231C, *Standard for Rack Storage of Materials*; NFPA 231D, *Standard for Storage of Rubber Tires*; NFPA 231E, *Standard for the Storage of Roll Paper*; NFPA 232, *Standard for the Protection of Records*; NFPA 430, *Code for the Storage of Liquid and Solid Oxidizers*; and NFPA 490, *Code for the Storage of Ammonium Nitrate*. (ROP 231-3)
- (e) Storage on racks.

1-1.4 Nothing in this standard intends to restrict new technologies or alternate arrangements, provided the level of safety prescribed by the standard is not reduced.

1-2 **Retroactivity Clause.** The provisions of this document shall be considered necessary to provide a reasonable level of protection from loss of life and property from fire. They reflect situations and the state of the art at the time the standard was issued.

Unless otherwise noted, it is not intended that the provisions of this document be applied to facilities, equipment, structures, or installations that were existing or approved for construction or installation prior to the effective date of this document.

Exception: In those cases where it is determined by the authority having jurisdiction that the existing situation involves a distinct hazard to life or property, this standard shall apply.

13 **Definitions.** Unless expressly stated elsewhere, for the purpose of this standard, the terms in this section shall be defined as follows:

Array.

Closed Array. A storage arrangement where air movement through the pile is restricted because of 6 in. (152 mm) or less vertical flues.

Open Array.* A storage arrangement where air movement through the pile is enhanced because of vertical flues larger than 6 in. (152 mm).

Available Height for Storage.* The maximum height at which commodities can be stored above the floor and still maintain adequate clearance from structural members and the required clearance below sprinklers.

Bin Box Storage. Storage in five-sided wood, metal, or cardboard boxes with open face on the aisles. Boxes are self-supporting or supported by a structure so designed that little or no horizontal or vertical space exists around boxes.

Ceiling Height. The distance between the floor and the underside of the ceiling above (or roof deck) within the storage area.

Clearance. The distance from the top of storage to the ceiling sprinkler deflectors.

Commodity. Combinations of products, packing material, and container.

Compartmented.* The rigid separation of the products in a container by dividers that form a stable unit under fire conditions.

Container (shipping, master, or outer container).* A receptacle strong enough, by reason of material, design, and construction, to be shipped safely without further packaging.

Early Suppression Fast Response (ESFR) Sprinklers. A listed ESFR sprinkler is a thermosensitive device designed to react at a predetermined temperature by automatically releasing a stream of water and distributing it in a specified pattern and quantity over a designated area so as to provide early suppression of a fire where installed on the appropriate sprinkler piping.

Encapsulated.* A method of packing consisting of a plastic sheet completely enclosing the sides and top of a pallet load containing a combustible commodity or combustible packages.

Expanded (foamed or cellular) Plastics. Those plastics, the density of which is reduced by the presence of numerous small cavities (cells), interconnecting or not, dispersed throughout their mass.

Exposed Group A Plastic Commodities. Those plastics not in packaging or coverings that absorb water or otherwise appreciably retard the burning hazard of the commodity (paper wrapped or encapsulated, or both, should be considered exposed).

Free-Flowing Plastic Materials. Those plastics that fall out of their containers during a fire, fill flue spaces, and create a smothering effect on the fire. Examples: powder, pellets, flakes, or random-packed small objects [e.g., razor blade dispensers, 1-oz to 2-oz (28-g to 57-g) bottles].

Large Drop Sprinkler. A listed large drop sprinkler is characterized by a K factor between 11.0 and 11.5 and a proven ability to meet prescribed penetration, cooling, and distribution criteria prescribed in the large drop sprinkler examination requirements. The deflector/discharge characteristics of the large drop sprinkler generate large drops of such size and velocity as to enable effective penetration of the high-velocity fire plume.

Miscellaneous Storage. Storage that does not exceed 12 ft (3.7 m) in height and is incidental to another occupancy use group as defined in NFPA 13, *Standard for the Installation of Sprinkler Systems*. Such storage shall not constitute more than 10 percent of the building area or 4000 ft² (372 m²) of the sprinklered area, whichever is greater. Such storage shall not exceed 1000 ft² (93 m²) in one pile or area, and each such pile or area shall be separated from other storage areas by at least 25 ft (7.6 m).

Noncombustible. Commodities, packaging, or storage aids that do not ignite, burn, or liberate flammable gases when heated to a temperature of 1380°F (749°C) for 5 minutes.

Packaging. A commodity wrapping, cushioning, or container.

Palletized Storage. Storage of commodities on pallets or other storage aids that form horizontal spaces between tiers of storage.

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.

Unstable Piles.* Those arrays where collapse, spillage of contents, or leaning of stacks across flue spaces occurs soon after initial fire development.

Roof Height. The distance between the floor and the underside of the roof deck within the storage area.

Shall. Indicates a mandatory requirement.

Shelf Storage. Storage on structures less than 30 in. (76.2 cm) deep with shelves usually 2 ft (0.6 m) apart vertically and separated by approximately 30-in. (76.2-cm) aisles.

Should. Indicates a recommendation or that which is advised but not required.

Solid Unit Load of a Nonexpanded 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; water from sprinklers might reach most surfaces available to burn.

Spray Sprinkler. A type of sprinkler listed for its capability to provide fire control for a wide range of fire hazards.

Sprinkler Temperature Rating.

(a) Ordinary-temperature-rated sprinklers include temperature ratings between 135°F and 170°F (57°C and 77°C).

(b) High-temperature-rated sprinklers include temperature ratings between 250°F and 300°F (121°C and 149°C).

Storage Aids. Commodity storage devices, such as pallets, dunnage, separators, and skids.

Unit Load. A pallet load or module held together in some manner and normally transported by material-handling equipment.

Chapter 2 Classification of Storage

2-1* Commodity Classification.

2-1.1 General.

2-1.1.1* Commodity classification and the corresponding protection requirements shall be determined based on the makeup of individual storage units (i.e., unit load, pallet load).

2-1.1.2 Mixed Commodities. Protection requirements shall not be based on the overall commodity mix in a fire area. Mixed commodity storage shall be protected by the requirements for the highest classified commodity and storage arrangement.

Exception No. 1: Up to 10 pallet loads of a higher hazard commodity, within the scope of this standard, shall be permitted to be present in an area not exceeding 40,000 ft² (3716 m²). The higher hazard commodity must be randomly dispersed with no adjacent loads in any direction (including diagonally). If the ceiling protection is based on Class I or II commodities, then the allowable number of pallet loads for Class IV or Group A plastics shall be reduced to five.

Exception No. 2: When the higher hazard material can be confined to a designated area and properly protected for that area.

2-1.2 Pallet Types. When loads are palletized, the use of wooden or metal pallets shall be assumed in the classification of commodities. When plastic pallets are used, the classification of the commodity unit shall be increased one class (i.e., Class III will become Class IV and Class IV will become Group A plastics). No increase shall be required for Group A plastic commodity.

Exception: When specific test data is available, the results of this data will take precedence in determining classification of commodities.

2-1.3* Commodity Classes.

2-1.3.1* Class I commodity shall be defined as noncombustible products that meet one of the following criteria:

- (a) Placed directly on wooden pallets
- (b) In single layer corrugated cartons, with or without single thickness cardboard dividers, with or without pallets
- (c) Shrink-wrapped or paper-wrapped as a unit load with or without pallets

2-1.3.2* Class II commodity shall be defined as noncombustible products that are in slatted wooden crates, solid wood boxes, multiple-layered corrugated cartons, or equivalent combustible packaging material, with or without pallets.

2-1.3.3* Class III commodity shall be defined as products fashioned from wood, paper, natural fibers, or Group C plastics with or without cartons, boxes, or crates and with or without pallets. Such products shall be permitted to contain a limited amount (5 percent by weight or volume) of Group A or B plastics.

2-1.3.4* Class IV commodity shall be defined as products, with or without pallets, that meet one of the following criteria:

- (a) Constructed partially or totally of Group B plastics.
- (b) Consist of free-flowing Group A plastic materials.
- (c) Contain within themselves or their packaging an appreciable amount (5 percent to 15 percent by weight or 5 percent to 25 percent by volume) of Group A plastics. The remaining materials shall be permitted to be metal, wood, paper, natural or synthetic fibers, or Group B or Group C plastics.

2-1.4 Classification of Plastics, Elastomers, and Rubber. Plastics, elastomers, and rubber shall be classified as Group A, Group B, or Group C.

The following categories are based on unmodified plastic materials. The use of fire- or flame-retarding modifiers or the physical form of the material could change the classification.

2-1.4.1* Group A.

ABS (acrylonitrile-butadiene-styrene copolymer)
Acetal (polyformaldehyde)
Acrylic (polymethyl methacrylate)
Butyl rubber
EPDM (ethylene-propylene rubber)
FRP (fiberglass reinforced polyester)
Natural rubber (if expanded)
Nitrile rubber (acrylonitrile-butadiene rubber)
PET (thermoplastic polyester)
Polybutadiene
Polycarbonate
Polyester elastomer
Polyethylene
Polypropylene
Polystyrene
Polyurethane
PVC (polyvinyl chloride — highly plasticized, with plasticizer content greater than 20 percent) (rarely found)
SAN (styrene acrylonitrile)
SBR (styrene-butadiene rubber)

2-1.4.2 Group B.

Cellulosics (cellulose acetate, cellulose acetate butyrate, ethyl cellulose)
Chloroprene rubber
Fluoroplastics (ECTFE — ethylene-chlorotrifluoro-ethylene copolymer; ETFE — ethylene-tetrafluoroethylene copolymer; FEP — fluorinated ethylene-propylene copolymer)
Natural rubber (not expanded)
Nylon (nylon 6, nylon 6/6)
Silicone rubber

NFPA 231 — A98 ROP

2-1.4.3 Group C.

Fluoroplastics (PCTFE — polychlorotrifluoroethylene; PTFE — polytetrafluoroethylene)
 Melamine (melamine formaldehyde)
 Phenolic
 PVC (polyvinyl chloride — flexible — PVCs with plasticizer content up to 20 percent)
 PVDC (polyvinylidene chloride)
 PVDF (polyvinylidene fluoride)
 PVF (polyvinyl fluoride)
 Urea (urea formaldehyde)
 (ROP 231-5)

Chapter 3 Building Construction

3-1 Construction.

3-1.1* Buildings used for storage of materials that are stored and protected in accordance with this standard shall be of any of the types described in NFPA 220, *Standard on Types of Building Construction*.

3-1.2 Adequate access shall be provided to all portions of the premises for fire-fighting purposes.

3-2* Emergency Smoke and Heat Venting. Protection outlined in this standard shall apply to buildings with or without roof vents and draft curtains.

Exception: Where local codes require heat and smoke vents in buildings protected by ESFR sprinklers, the vents shall be manually operated or have an operating mechanism with a standard response fusible element rated no less than 286°F (141°C). Drop out vents shall not be permitted. (ROP 231-7)

Chapter 4 Storage Arrangement

4-1 Piling Procedures and Precautions.

4-1.1 Any commodities that are hazardous in combination with each other shall be stored so they cannot come into contact with each other.

4-1.2* Safe floor loads shall not be exceeded. For water-absorbent commodities, normal floor loads shall be reduced to take into account the added weight of water that can be absorbed during fire-fighting operations.

4-2 Commodity Clearance.

4-2.1 The clearance between top of storage and sprinkler deflectors shall conform to NFPA 13, *Standard for the Installation of Sprinkler Systems*, except as modified by this standard.

4-2.2* If the commodity is stored above the lower chord of roof trusses, at least 1 ft (30.5 cm) of clear space shall be maintained to permit wetting of the truss unless the truss is protected with 1-hr fireproofing.

4-2.3 Storage clearance from ducts shall be maintained in accordance with NFPA 91, *Standard for Exhaust Systems for Air Conveying of Materials*, Section 2-18.

4-2.4 The clearance between stored materials and unit heaters, radiant space heaters, duct furnaces, and flues shall not be less than 3 ft (0.9 m) in all directions or shall be in accordance with the clearances shown on the approval agency label.

4-2.5* Clearance shall be maintained to lights or light fixtures to prevent possible ignition.

4-2.6 Sufficient clearance shall be maintained around the path of fire door travel to ensure proper operation and inspection.

4-3 Aisles.

4-3.1 Wall aisles shall be at least 24 in. (61 cm) wide in warehouses used for the storage of commodities that expand with the absorption of water.

4-3.2* Aisles shall be maintained to retard the transfer of fire from one pile to another and to permit convenient access for fire fighting, salvage, and removal of storage.

4-4* Storage of Idle Pallets.

4-4.1 Wood Pallets.

4-4.1.1* Pallets shall be stored outside or in a detached structure.

Exception: Indoor pallet storage shall be permitted in accordance with 4-4.1.2.

4-4.1.2* Pallets, where stored indoors, shall be protected as indicated in Table 4-4.1.2, Table 8-4.1.2, Table 9-1 unless the following conditions are met: (ROP 231-9)

(a) Pallets shall be stored no higher than 6 ft (1.8 m).

(b) Each pallet pile of no more than four stacks shall be separated from other pallet piles by at least 6 ft (1.4 m) of clear space or 25 ft (7.6 m) of commodity.

4-4.2 Plastic Pallets. (ROP 231-11)

4-4.2.1 Plastic pallets shall be stored outside or in a detached structure.

Exception No. 1: Indoor plastic pallet storage shall be permitted in accordance with 4-4.2.2.

Exception No. 2: Indoor storage of nonexpanded polyethylene solid deck pallets shall be permitted to be protected in accordance with 4-4.1.2. (ROP 231-11)

Exception No. 3: Indoor storage of plastic pallets shall be permitted to be protected in accordance with Table 9-1. (ROP 231-9)

Exception No. 4: Indoor storage of non-wood 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 4-4.1.2. (ROP 231-10)

4-4.2.2 Plastic pallets where stored indoors shall be protected as follows:

(a) Where 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-hr-rated fire walls.

(3) The storage shall be protected by sprinklers designed to deliver 0.60 gpm/ft² [0.41 (L/s)/m²] for the entire room or by high-expansion foam and sprinklers as indicated in Section 5-2.

(4) The storage shall be piled no higher than 12 ft (3.7 m).

(5) Any steel columns shall be protected by 1-hr 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. (ROP 231-12)

Table 4-4.1.2 Protection for Indoor Storage of Wood Idle Pallets (ROP 231-8)

Height of Pallet Storage ft [m]	Sprinkler Density Requirements gpm/ft ² [(L/s)/m ²]		Area of Sprinkler Demand ft ² [m ²]	
			Temperature Rating	
			High Temperature	Ordinary Temperature
Up to 6 [1.8]	.20	[.14]	2000 [186]	3000 [279]
6 to 8 [1.8 to 2.4]	.30	[.20]	2500 [232]	4000 [372]
8 to 12 [2.4 to 3.7]	.60	[.41]	3500 [325]	6000 [557]
12 to 20 [3.7 to 6.1]	.60	[.41]	4500 [418]	—

(ROP 231-1)

NFPA 231 — A98 ROP

(b) Where stored without cutoffs from other storage the following shall apply:

(1) Plastic pallet 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.

45* Flammable and Combustible Liquids. Only limited quantities of flammable and combustible liquids shall be permitted in general storage warehouses. Any such storage shall be segregated from other stored combustible material.

Chapter 5 Fire Protection — General

5-1 Automatic Sprinkler Systems.

5-1.1 Sprinkler systems installed in buildings used for solid pile, bin box, shelf, or palletized storage shall be in accordance with NFPA 13, *Standard for the Installation of Sprinkler Systems*.

Exception: Where modified by this standard.

5-1.2 The design density shall not be less than 0.15 gpm/ft² [0.10 (L/s)/m²], and the design area shall not be less than 2000 ft² (186 m²) for wet systems or 2600 ft² (242 m²) for dry systems for any commodity, class, or group.

5-1.2.1 The sprinkler design density for any given area of operation for a Class III or Class IV commodity, calculated in accordance with Chapter 6, shall not be less than the density for the corresponding area of operation for Ordinary Hazard Group 2 in NFPA 13, *Standard for the Installation of Sprinkler Systems*.

5-1.2.2 The water supply requirements for sprinklers only shall be based on the actual calculated demand for the hazard in accordance with Chapter 6, Chapter 7, Chapter 8, or Chapter 9, depending on the type of sprinkler selected and the commodity being protected.

5-1.3 Where palletized or solid pile storage is placed on top of racks, the provisions of NFPA 231C, *Standard for Rack Storage of Materials*, shall apply to the entire height of storage with regard to sprinkler requirements and water supplies for ceiling and rack sprinklers.

5-1.4 In warehouses with areas containing rack storage and other areas containing palletized, solid pile, bin box, or shelf storage, the standard applicable to the storage configuration shall apply.

5-1.5 Standard response $\frac{1}{2}$ -in. (12.7-mm) orifice for standard response $\frac{7}{32}$ -in. (13.5-mm) orifice sprinklers shall be used in applying the curves and tables in Chapters 6 and 7. (ROP 231-1)

Exception No. 1: Use of these curves and tables with quick response sprinklers shall be permitted at the discretion of the authority having jurisdiction.

Exception No. 2: The use of $\frac{3}{8}$ -in. (9.5-mm) orifice sprinklers shall be permitted where listed for such use and where installed at a minimum design pressure of 10 psi (69 kPa).

Exception No. 3: The use of $\frac{3}{4}$ -in. (19.0-mm) orifice sprinklers shall be permitted where listed for such use. (ROP 231-16)

5-1.6 In buildings occupied in part for storage, within the scope of this standard, the required sprinkler protection shall extend 15 ft (4.6 m) beyond the perimeter of the storage area.

Exception: When separated by at least 1-hr rated fire-resistive construction that is continuous from floor to roof/ceiling of the storage area. (ROP 231-17)

5-1.7 Where non-storage spaces have lower ceilings than the storage portion of the building, the space above this drop ceiling shall be sprinklered unless it complies with the rules of NFPA 13, *Standard for the Installation of Sprinkler Systems*, for allowable unsprinklered, concealed spaces. Where the area above a drop ceiling is sprinklered, the sprinkler system shall conform to the rules of 5-1.6 or its exception. (ROP 231-17)

5-2 High-Expansion Foam.

5-2.1 High-expansion foam systems installed in addition to automatic sprinklers shall be installed in accordance with NFPA 11A, *Standard for Medium- and High-Expansion Foam Systems*.

Exception: Where modified by this standard.

5-2.2 High-expansion foam used to protect the idle pallets shall have a maximum fill time of 4 minutes.

5-2.3 High-expansion foam systems shall be automatic in operation.

5-2.4 Detectors for high-expansion foam systems shall be listed and shall be installed at no more than one-half listed spacing.

5-2.5 Detection systems, concentrate pumps, generators, and other system components essential to the operation of the system shall have an approved standby power source.

5-2.6 A reduction in ceiling density to one-half that required for Class I through Class IV commodities, idle pallets, or plastics (using the secondary demand point) shall be permitted without revising the design area, but shall be not less than 0.15 gpm/ft² [0.10 (L/s)/m²].

5-3 Manual Inside Protection.

5-3.1 Small Hose Systems. Small hose lines [$1\frac{1}{2}$ in. (38 mm)] shall be available to reach all portions of the storage area, giving due consideration to accessible configuration with maximum anticipated storage in place. Each small hose shall be supplied from one of the following:

- Outside hydrants
- A separate system for small hose stations
- Valid hose connections on sprinkler risers where such connections are made downstream of sprinkler control valves
- * Adjacent sprinkler systems

5-3.2 Portable Fire Extinguishers. Portable fire extinguishers shall be provided in accordance with NFPA 10, *Standard for Portable Fire Extinguishers*. Up to one-half of the required complement of portable fire extinguishers for Class A fires shall be permitted to be omitted in storage areas where fixed small hose lines [$1\frac{1}{2}$ in. (38 mm)] are available to reach all portions of the storage area.

5-4* Hydrants. At locations without public hydrants, or where hydrants are not within 250 ft (76.2 m), private hydrants shall be installed in accordance with NFPA 24, *Standard for the Installation of Private Fire Service Mains and Their Appurtenances*.

5-5* Fire Organization.

5-5.1 Arrangements shall be made to permit rapid entry into the premises by the municipal fire department, police department, or other authorized personnel in case of fire or other emergency.

5-5.2 Plant emergency organizations, where provided, shall be instructed and trained in the following procedures:

- Maintenance of the security of the premises
- Means of summoning outside aid immediately in an emergency
- Use of hand extinguishers and hose lines on small fires and mop-up operations
- Operation of the sprinkler system and water supply equipment
- Use of material-handling equipment while sprinklers are operating to effect final extinguishment
- Supervision of sprinkler valves after system is turned off so that system can be reactivated if rekindling occurs
- Need for breathing apparatus
- Proper operation of emergency smoke and heat venting systems where these have been provided

5-5.3 A fire watch shall be maintained when the sprinkler system is not in service.

5-6* Alarm Service. A central station, auxiliary, remote station, or proprietary sprinkler waterflow alarm shall be provided. A local waterflow alarm shall be permitted where recorded guard service is provided.

NFPA 231 — A98 ROP

Chapter 6* Fire Protection for Commodity Classes I through IV — Spray Sprinklers

6-1 General.

6-1.1 Class I through Class IV commodities of the following configurations protected by spray sprinklers shall be in accordance with this chapter:

- (a) Nonencapsulated commodities that are solid pile, palletized, or bin box storage up to 30 ft (9.1 m) in height
- (b) Nonencapsulated commodities on shelf storage up to 15 ft (4.6 m) in height
- (c)* Encapsulated commodities that are solid pile, palletized, bin box, or shelf storage up to 15 ft (4.6 m) in height

6-1.2 Bin box and shelf storage over 12 ft (3.7 m) and provided with walkways at not over 12-ft (3.7-m) vertical intervals shall be provided with automatic sprinklers under the walkways as well as at the ceiling. The design density for ceiling and walkway sprinklers shall be permitted to be in accordance with the height adjustment of Figure 6-2.2.4.

6-2 Protection Criteria. (ROP 231-22)

6-2.1 The water supply shall be capable of providing the sprinkler system demand determined in accordance with 6-2.3, including the hose stream demand of 6-2.4 for the duration requirements of 6-2.5.

6-2.2 The area and density for the hydraulically remote area shall be determined as specified in 6-2.2.1 through 6-2.2.7.

6-2.2.1 Sprinkler protection criteria for storage 12 ft (3.66 m) or less in height shall be in accordance with Table 6-2.2.1. All other requirements of this standard shall apply to such storage. (ROP 231-23)

Table 6-2.2.1 Sprinkler Protection of Class I through IV Commodities Stored 12 ft (3.66 m) or less in Height

Commodity	Storage Height	Sprinkler Protection Criteria
Class I	Up to 12 ft	NFPA 13 — Ordinary Hazard Group 1
Class II	Up to 8 ft	NFPA 13 — Ordinary Hazard Group 1
Class II	Over 8 ft to 12 ft	NFPA 13 — Ordinary Hazard Group 2
Class III	Up to 12 ft	NFPA 13 — Ordinary Hazard Group 2
Class IV	Up to 12 ft	NFPA 13 — Ordinary Hazard Group 2

(ROP 231-23)

6-2.2.2 Where using ordinary temperature-rated sprinklers, a single point shall be selected from the appropriate commodity curve on Figure 6-2.2.2.

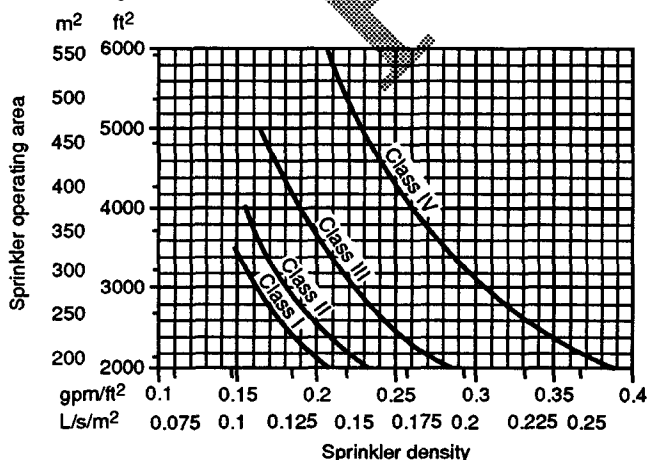


Figure 6-2.2.2 Sprinkler system design curves, 20-ft (6.1-m) high storage — ordinary temperature-rated sprinklers.

(ROP 231-24)

6-2.2.3 Where using high temperature-rated sprinklers, a single point shall be selected from the appropriate commodity curve on Figure 6-2.2.3.

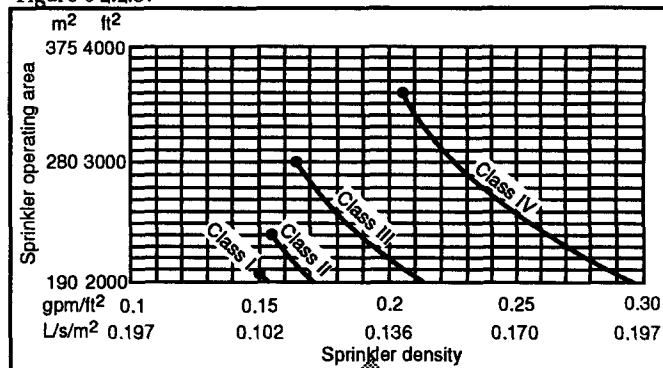


Figure 6-2.2.3 Sprinkler system design curves, 20-ft (6.1-m) high storage — high temperature-rated sprinklers.

6-2.2.4 The densities selected in accordance with 6-2.2.2 or 6-2.2.3 shall be modified in accordance with Figure 6-2.2.4 without revising the design area.

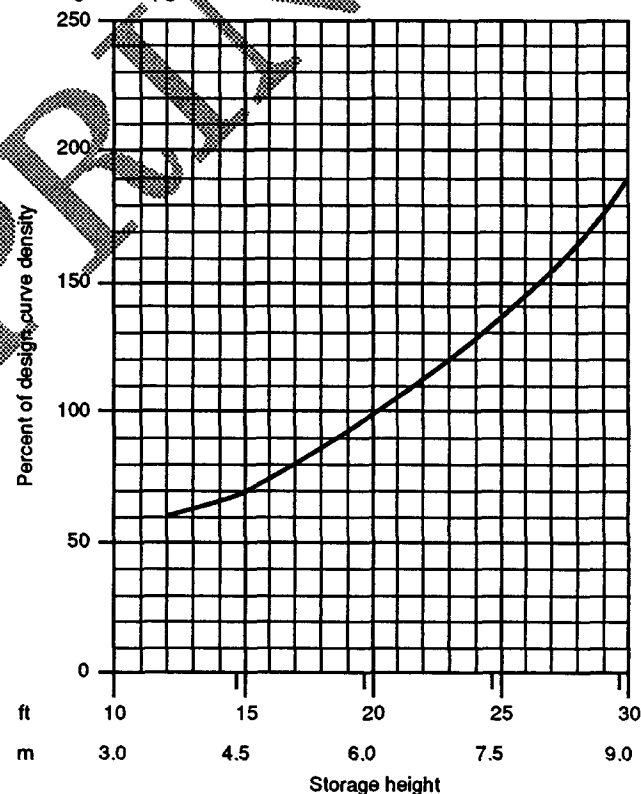


Figure 6-2.2.4 Ceiling sprinkler density vs. storage height.

6-2.2.5 Where dry-pipe systems are used, the areas of operation indicated in the design curves shall be increased by 30 percent.

6-2.2.6 The area of application shall be permitted to be reduced by 50 percent, provided the minimum requirements of Chapter 5 are met. (ROP 231-40)

6-2.2.7 The final area and density shall not be less than the minimum specified in Chapter 5.

6-2.3 Given the area and density determined in accordance with 6-2.2, the fire sprinkler system shall be hydraulically calculated in accordance with NFPA 13, *Standard for the Installation of Sprinkler Systems*.

NFPA 231 — A98 ROP

6-2.4* A minimum of 500 gpm (32 L/s) shall be added to the sprinkler demand for combined large and small hose stream demand.

6-2.5 Water supply duration shall be in accordance with Table 6-2.5.

Table 6-2.5 Water Supply Duration in Hours

Storage Height ft (m)	Commodity Class	
	Classes I, II, and III	Class IV
over 12 (3.7) up to 20 (6.1)	1 1/2	2
over 20 (6.1) up to 30 (9.1)	2	2 1/2

63 High-Expansion Foam. See Section 5-2.

Chapter 7 Fire Protection for Plastic and Rubber Commodities — Spray Sprinklers

7-1* General. See Appendix B.

7-1.1* Plastics stored up to 25 ft (7.62 m) in height protected by spray sprinklers shall be in accordance with Chapter 7. The decision tree (Figure 7-1.1) shall be used to determine the protection in each specific situation.

7-1.2* Factors affecting protection requirements such as closed/open array, clearance between storage and sprinklers, and stable/unstable piles, shall be applicable only to storage of Group A plastics. The factors contained in 7-2.1, A-7-2.1, and Appendix B shall be given serious consideration prior to determining the final protection requirements. 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.

7-1.3 Group B plastics and free-flowing Group A plastics shall be protected in the same manner as a Class IV commodity. See Chapter 6 for protection of these storage commodities with spray sprinklers. (ROP 231-25)

7-1.4 Group C plastics shall be protected in the same manner as a Class III commodity. See Chapter 6 for protection of these storage commodities with spray sprinklers. (ROP 231-25)

7-2 Protection Criteria. (ROP 231-26)

7-2.1* The design of the sprinkler system shall be based on those conditions that routinely or periodically exist in a building that create the greatest water demand. These conditions include the following:

- (a) Pile height
- (b) Clearance

(c) Pile stability

(d) Array

Where the distance between roof/ceiling height and top of storage exceeds 20 ft (6.1 m), protection shall be provided for the storage height that would result in a 20-ft (6.1-m) distance between the roof/ceiling height and top of storage. (ROP 231-29)

7-2.2* Design areas and densities shall be selected for the appropriate storage configuration from Table 7-2.2. The columns A, B, C, D, and E correspond to the protection required by the decision tree (Figure 7-1.1). (ROP 231-27)

7-2.2.1 For Table 7-2.2, the design areas are a minimum of 2500 ft² (232 m²).

Exception No. 1: Where Table 7-2.2 allows densities and areas to be selected in accordance with NFPA 13, Standard for the Installation of Sprinkler Systems, Ordinary Hazard Group 2, any area/density from that curve shall be acceptable.

Exception No. 2: For closed arrays, the area shall be permitted to be reduced to 2000 ft² (186 m²).

(ROP 231-29)

7-2.2.2 Interpolation of densities between storage heights shall be permitted. Densities shall be based upon the 2500 ft² (232 m²) design area except as permitted for closed arrays. The "up to" in the table is intended to aid in the interpolation of densities between storage heights. Interpolation of ceiling/roof heights shall not be permitted.

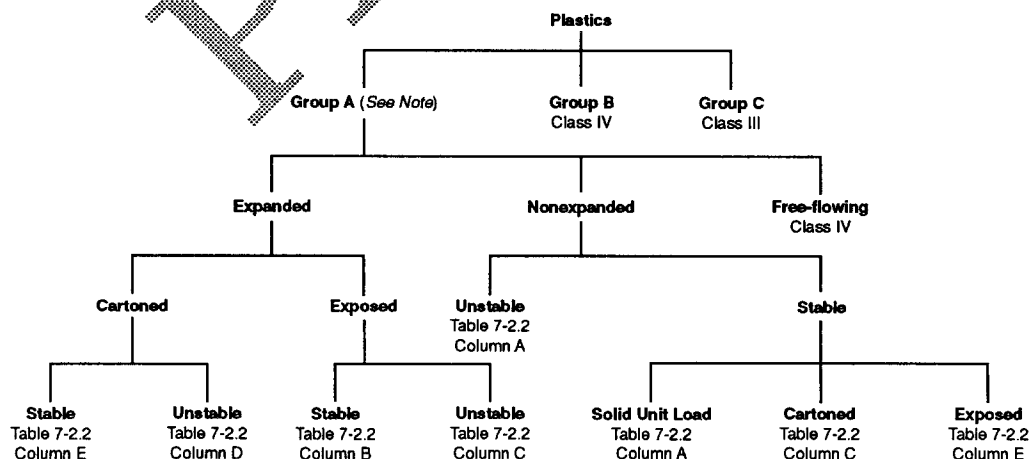
(ROP 231-29)

7-2.2.3 Where Table 7-2.2 requires densities of 0.4 gpm/ft² [0.27 (L/s)/m²] or greater, 1/2-in. (12.7-mm) orifice sprinklers shall not be permitted. (ROP 231-29)

7-2.3 Where sprinkler protection has been designed for Group A plastics, at least 500 gpm (32 L/s) shall be added to the density/area demand for hose streams.

7-2.4 Water supply duration (sprinkler demand plus hose streams) shall be 2-hr duration where storage heights are 5 ft to 20 ft (1.5 m to 6.1 m) and 2 1/2-hr duration where storage heights are over 20 ft up to 25 ft (6.1 m to 7.6 m). (ROP 231-31)

7-2.5* Where dry-pipe systems are used for Group A plastics, the operating area shall be increased by 30 percent without revising the density.



NOTE: Cartons that contain Group A plastic material shall be permitted to be treated as Class IV commodities under the following conditions:

- (a) there shall be multiple layers of corrugation or equivalent outer material that would significantly delay fire involvement of the Group A plastic, and
- (b) the amount and arrangement of Group A plastic material within an ordinary carton would not be expected to significantly increase the fire hazard.

Figure 7-1.1 Decision tree.

NFPA 231 — A98 ROP

Table 7-2.2 Design Densities for Plastic and Rubber Commodities Sprinkler Systems

Storage Height in ft [m]	Roof/Ceiling Height in ft [m]	Density (gpm/ft ²) [(L/s)m ²]				
		A	B	C	D	E
5 [1.52]	up to 25 [7.62]	OH-2	OH-2	OH-2	OH-2	OH-2
12 [3.66]	up to 15 [4.57]	0.2 [0.14]	EH-2	0.3 [0.20]	EH-1	EH-2
	>15 to 20 [4.57 to 6.1]	0.3 [0.20]	0.6 [0.41]	0.5 [0.34]	EH-2	EH-2
	>20 to 32 [6.1 to 9.75]	0.4 [0.27]	0.8 [0.54]	0.6 [0.41]	0.45 [0.31]	0.7 [0.48]
15 [4.5]	up to 20 [6.1]	0.25 [0.17]	0.5 [0.34]	0.4 [0.27]	0.3 [0.20]	0.45 [0.31]
	>20 to 25 [6.1 to 7.62]	0.4 [0.27]	0.8 [0.54]	0.6 [0.41]	0.45 [0.31]	0.7 [0.48]
	>25 to 35 [7.62 to 10.67]	0.45 [0.31]	0.9 [0.61]	0.7 [0.48]	0.55 [0.37]	0.85 [0.58]
20 [6.1]	up to 25 [7.62]	0.3 [0.20]	0.6 [0.41]	0.45 [0.31]	0.35 [0.24]	0.55 [0.37]
	>25 to 30 [7.62 to 9.14]	0.45 [0.31]	0.9 [0.61]	0.7 [0.48]	0.55 [0.37]	0.85 [0.58]
	>30 to 35 [9.14 to 10.67]	0.6 [0.41]	1.2 [0.82]	0.85 [0.58]	0.7 [0.48]	1.1 [0.75]
25 [7.62]	up to 30 [9.14]	0.4 [0.27]	0.75 [0.51]	0.55 [0.37]	0.45 [0.31]	0.7 [0.48]
	>30 to 35 [9.14 to 10.67]	0.6 [0.41]	1.2 [0.82]	0.85 [0.58]	0.7 [0.48]	1.1 [0.75]

(ROP 231-28, 231-29)

NOTES

- Minimum clearance between sprinkler deflector and top of storage shall be maintained as required. (ROP 231-29)
- 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. OH-2 = Density required for Ordinary Hazard Group 2 occupancies.

EH-1 = Density required for Extra Hazard Group 1 occupancies.

EH-2 = Density required for Extra Hazard Group 2 occupancies as specified in NFPA 13, *Standard for the Installation of Sprinkler Systems*.

Hose streams shall be provided in accordance with 7-2.3.

Chapter 8 Fire Protection — Large Drop Sprinklers

8-1 General.

8-1.1 Large drop sprinklers shall be permitted for use with the hazards listed in Table 8-1.

8-2 Protection Criteria. (ROP 231-36)

8-2.1 Sprinkler water demand for large drop sprinklers shall be in accordance with Table 8-1.

8-2.2 A minimum of 500 gpm (32 L/s) shall be added to the sprinkler demand for combined large and small hose stream demand.

8-2.3 Water supply duration shall be as indicated in Table 8-1.

8-2.4 Where large drop sprinklers are installed under open wood joist construction, their minimum operating pressure shall be 50 psi (3.4 bar). (ROP 231-36)

8-2.5 All requirements contained in NFPA 13, *Standard for the Installation of Sprinkler Systems*, pertaining to large drop sprinklers shall apply.

Exception: Where modified by this standard.

(ROP 231-36)

8-2.6 For the purpose of using Table 8-1, preaction systems shall be classified as dry pipe systems. (ROP 231-36)

8-2.7 For wet pipe systems, ordinary-, intermediate-, or high-temperature sprinklers shall be used. For dry pipe systems, high-temperature sprinklers shall be used. (ROP 231-36)

Table 8-1 Large Drop Sprinkler Data Pressure and Number of Design Sprinklers Required for Various Hazards for Large Drop Sprinkler

508

Configuration	Commodity	Maximum Storage Height	Maximum Building Height		Minimum Operating Pressure [psi (bars)] (See 8-2.4)				
				Type of System	25 (1.7)	50 (3.4)	75 (5.2)	Hose Stream Demand gpm (dm ³ /min)	Water Supply Duration (hr)
					Number of Design Sprinklers				
Palletized	Class I, II or III	25 ft (7.6 m)	35 ft (10.7 m)	Wet	15	15	15	500 (1900)	2
				Dry	25	25	25		
Palletized	Class IV	20 ft (6.1 m)	30 ft (9.1 m)	Wet	20	15	15	500 (1900)	2
				Dry	NA	NA	NA		
Palletized	Unexpanded plastics	20 ft (6.1 m)	30 ft (9.1 m)	Wet	25	15	15	500 (1900)	2
				Dry	NA	NA	NA		
Palletized	Expanded plastics	18 ft (5.5 m)	26 ft (7.9 m)	Wet	NA	15	15	500 (1900)	2
				Dry	NA	NA	NA		
Palletized	Idle wood pallets	20 ft (6.1 m)	30 ft (9.1 m)	Wet	15	15	15	500 (1900)	1 ¹ / ₂
				Dry	25	25	25		
Solid piled	Class I, II, III	20 ft (6.1 m)	30 ft (9.1 m)	Wet	15	15	15	500 (1900)	1 ¹ / ₂
				Dry	25	25	25		
Solid piled	Class IV	20 ft (6.1 m)	30 ft (9.1 m)	Wet	NA	15	15	500 (1900)	1 ¹ / ₂
				Dry	NA	NA	NA		
Solid piled	Unexpanded plastics	20 ft (6.1 m)	30 ft (9.1 m)	Wet	NA	15	15	500 (1900)	1 ¹ / ₂
				Dry	NA	NA	NA		
(ROP 231-33, 231-34, 231-36)									

(ROP 231-33, 231-34, 231-36)

NA: Not allowed. (ROP 231-35)

NFPA 231 — A98 ROP

Chapter 9 Fire Protection — Early Suppression Fast Response (ESFR) Sprinklers

9-1* General.

9-1.1 ESFR sprinklers shall be permitted for the protection of commodities in accordance with Table 9-1.

Table 9-1 ESFR Sprinkler Data

Type of Storage	Commodity	Maximum Height of Storage ft (m)	Maximum Roof/Ceiling Height of Building ft (m)	Nominal K factor	Sprinkler Design Pressure psi (bars)
Palletized and solid pile storage (no open-top containers or solid shelves)	1. Cartoned unexpanded plastic; 2. Cartoned expanded plastic; 3. Uncartoned unexpanded plastic; 4. Class I, II, III, or IV commodities encapsulated or unencapsulated; 5. Idle wood or plastic pallets	25 (7.6)	30 (9.1)	13.5–14.5	50 (3.4)
	1. Cartoned or uncartoned, unexpanded plastic; 2. Class I, II, III, or IV commodities, encapsulated or unencapsulated; 3. Idle wood or plastic pallets	35 (10.7)	40 (12.2)	13.5–14.5	75 (5.2)
	1. Cartoned or uncartoned, unexpanded plastic; 2. Class I, II, III, or IV commodities, encapsulated or unencapsulated	35 (10.7)	45 (13.7)	13.5–14.5	90 (27.4)

(ROP 231-38)

9-1.2 Maximum building height shall be measured to the underside of the roof deck or ceiling. (ROP 231-38)

9-1.3* ESFR sprinklers shall be permitted for use in buildings with the following types of roof construction:

- (a) Smooth ceiling
- (b) Bar joist
- (c) Beam and girder
- (d) Panel

9-1.4 Roof slope shall not exceed 1 in 12.

9-2* Water Supplies.

9-2.1 The design area shall consist of the most hydraulically demanding area of 12 sprinklers, consisting of four sprinklers on each of three branch lines. The design shall include a minimum of 960 ft² (89.2 m²).

9-2.2 A minimum of 250 gpm (946 L/min) shall be added to the sprinkler demand for combined large and small hose streams.

9-2.3 Water supply duration shall be at least 1 hour.

9-2.4 ESFR sprinklers shall be limited to wet-pipe systems.

9-3 Sprinkler System Design.

9-3.1 All requirements contained in NFPA 13, *Standard for the Installation of Sprinkler Systems*, shall apply.

Exception: Where modified by this standard.

Chapter 10 Building Equipment, Maintenance, and Operations

10-1* Mechanical Handling Equipment.

10-1.1* **Industrial Trucks.** Power-operated industrial trucks shall comply with NFPA 505, *Fire Safety Standard for Powered Industrial Trucks Including Type Designations, Areas of Use, Conversions, Maintenance, and Operation*.

10-2 Building Service Equipment.

10-2.1 Electrical equipment shall be installed in accordance with the provisions of NFPA 70, *National Electrical Code*®.

10-3 Cutting and Welding Operations.

10-3.1* Where welding or cutting operations are necessary, the requirements of NFPA 51B, *Standard for Fire Prevention in Use of Cutting and Welding Processes*, shall apply. Where possible, work shall be removed to a safe area.

10-3.2 Welding, soldering, brazing, and cutting shall be permitted to be performed on building components that cannot be removed, provided no storage is located below and within 25 ft (7.6 m) of the working area and flameproof tarpaulins enclose this area. During any of these operations, the sprinkler system shall be in service. Extinguishers suitable for Class A fires with a minimum rating of 2A and charged and attended inside hose lines, where provided, shall be located in the working area. A fire watch shall be maintained during these operations and for not less than 30 minutes following completion of open-flame operation.

10-4 **Waste Disposal.** Rubbish, trash, and other waste material shall be disposed of at regular intervals.

10-5 **Smoking.** Smoking shall be strictly prohibited. "No Smoking" signs shall be posted in prohibited areas.

Exception: Smoking shall be permitted in locations prominently designated as smoking areas.

10-6 Maintenance and Inspection.

10-6.1 Fire walls, fire doors, and floors shall be maintained in good repair at all times.

10-6.2 The sprinkler system and the water supplies shall be inspected, tested, and maintained in accordance with NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems*.

10-7 **Refrigeration Systems.** Refrigeration systems, if used, shall conform to ASHRAE 15, *Safety Code for Mechanical Refrigeration*.

Chapter 11 Referenced Publications

11-1 The following documents or portions thereof are referenced within this standard as mandatory requirements and shall be considered part of the requirements of this standard. The edition indicated for each referenced mandatory document is the current edition as of the date of the NFPA issuance of this standard. Some of these mandatory documents might also be referenced in this standard for specific informational purposes and, therefore, are also listed in Appendix D.

11-1.1 **NFPA Publications.** National Fire Protection Association, 1 Batterymarch Park, P.O. Box 9101, Quincy, MA 02269-9101.

NFPA 10, *Standard for Portable Fire Extinguishers*, 1994 edition.

NFPA 11A, *Standard for Medium- and High-Expansion Foam Systems*, 1994 edition.

NFPA 13, *Standard for the Installation of Sprinkler Systems*, 1996 edition.

NFPA 24, *Standard for the Installation of Private Fire Service Mains and Their Appurtenances*, 1995 edition.

NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems*, 1995 edition.

NFPA 30, *Flammable and Combustible Liquids Code*, 1996 edition.

NFPA 30B, *Code for the Manufacture and Storage of Aerosol Products*, 1994 edition.

NFPA 40, *Standard for the Storage and Handling of Cellulose Nitrate Motion Picture Film*, 1997 edition.

NFPA 51B, *Standard for Fire Prevention in Use of Cutting and Welding Processes*, 1994 edition.

NFPA 58, *Standard for the Storage and Handling of Liquefied Petroleum Gases*, 1995 edition.

NFPA 70, *National Electrical Code*, 1996 edition.

NFPA 91, *Standard for Exhaust Systems for Air Conveying of Materials*, 1995 edition.

NFPA 220, *Standard on Types of Building Construction*, 1995 edition.

NFPA 231C, *Standard for Rack Storage of Materials*, 1995 edition.

NFPA 231D, *Standard for Storage of Rubber Tires*, 1994 edition.

NFPA 231F, *Standard for the Storage of Roll Paper*, 1996 edition.

NFPA 232, *Standard for the Protection of Records*, 1995 edition.

NFPA 430, *Code for the Storage of Liquid and Solid Oxidizers*, 1995 edition.

NFPA 490, *Code for the Storage of Ammonium Nitrate*, 1993 edition.

NFPA 505, *Fire Safety Standard for Powered Industrial Trucks Including Type Designations, Areas of Use, Conversions, Maintenance, and Operation*, 1996 edition.

11-1.2 **ASHRAE Publication.** American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc., 1791 Tullie Circle N.E., Atlanta, GA 30329-2305.

ASHRAE 15, *Safety Code for Mechanical Refrigeration*, 1992.

Appendix A Explanatory Material

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

A-1-3 Array, Open. Fire tests conducted to represent a closed array utilized 6-in. (152-mm) longitudinal flues and no transverse flues. Fire tests conducted to represent an open array utilized 12-in. (305-mm) longitudinal flues.

A-1-3 Available Height for Storage. For new sprinkler installations, maximum height of storage is the height at which commodities can be stored above the floor where the minimum required unobstructed space below sprinklers is maintained. For the evaluation of existing situations, maximum height of storage is the maximum existing height, if space between sprinklers and storage is equal to or greater than required.

A-1-3 Compartmented. Cartons used in most of the Factory Mutual-sponsored plastic tests involved an ordinary 200-lb (90.7-kg) test of outside corrugated cartons with five layers of vertical pieces of corrugated carton used as dividers on the inside. There

were also single horizontal pieces of corrugated carton between each layer. Other tests sponsored by the Society of Plastics Industry, Industrial Risk Insurers, Factory Mutual, and Kemper used two vertical pieces of carton (not corrugated) to form an "X" in the carton for separation of product. This was not considered compartmented, as the pieces of carton used for separations were flexible (not rigid), and only two pieces were in each carton.

A-1-3 Container. The term container includes items such as cartons and wrappings. Fire-retardant containers or tote boxes do not of themselves create a need for automatic sprinklers unless coated with oil or grease. Containers can lose their fire-retardant properties if washed. For obvious reasons, they should not be exposed to rainfall.

A-1-3 Encapsulated. Banding (i.e., stretch-wrapping) around the sides only of a pallet load is not considered to be encapsulation.

A-1-3 Pile Stability. Pile stability performance has been shown to be a difficult factor to judge prior to being subjected to an actual fire. In the test work completed, compartmented cartons (see A-1-2, *Compartmented*) have been shown to be stable under fire conditions. Those tests on cartons that were not compartmented tended to be unstable under fire conditions.

A-1-3 Stable Piles. Storage on pallets, compartmented storage, and plastic components that are held in place by materials that do not deform readily under fire conditions are examples of stable storage.

A-1-3 Unstable Piles. Leaning stacks, crushed bottom cartons, and reliance on combustible bands for stability are examples of potential pile instability under a fire condition. An increase in pile height tends to increase instability.

A-2-1. Specifying 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 that commodity class. In real life, however, many storage arrays will not fit precisely into one of the fundamental classifications, thus requiring the user to make judgments after comparing each classification to the storage conditions at hand. With the thousands of products possible in storage arrays, it becomes impossible to define in words all the possible variations that could be acceptable in any class. As an alternative, to help the user, the Technical Committee on General Storage has classified a variety of common products in Appendix A, based on judgment, loss experience, and fire test results.

Table A-2-1 lists examples of commodities that are outside the scope of this standard.

Table A-2-1.3 is an alphabetized listing of commodities with corresponding classifications.

Tables A-2-1.3.1 and A-2-1.4.1 give examples of commodities all within a given class.

Table A-2-1 Examples of Commodities Outside the Scope of this Standard

Boxes, Crates
- Empty, wood, slatted ¹
Lighters
(butane)
- Loose in large containers (Level 3 aerosol)

NOTE:

¹ Should be treated as idle pallets.

(ROP 231-5)

A-2-1.1.1 Commodity classification is governed by the type and amounts of materials (e.g., metal, paper, wood, plastics) involved in a product and its primary packaging. However, in a storage or warehousing situation it is also affected by such factors as the material of the main storage or shipping container, the amount of air space, and the location of the more hazardous materials within the container. For example, a Group A plastic product enclosed in a five- or six-sided metal container could be considered Class II; while a ceramic product heavily wrapped in tissue paper and placed in a corrugated carton could be Class III.

(ROP 231-5)

NFPA 231 — A98 ROP

A-2-1.3

Table A-2-1.3 Alphabetized Listing of Commodity Classes

Commodity	Commodity Class	Commodity	Commodity Class
Aerosols		Canned Foods	Class I
Cartoned or uncartoned		In ordinary cartons	
- Level 1	Class III	Cans	
Alcoholic Beverages		Metal	
Cartoned or uncartoned	Class I	- Empty	Class I
- Up to 20% alcohol in metal, glass, or ceramic containers	Class II	Carpet Tiles	Group A plastics
- Up to 20% alcohol in wood containers		Cartoned	
Ammunition		Cartons:	
Small arms, shotgun		Corrugated	
- Packaged, cartoned	Class IV	- Unassembled (neat piles)	Class III
Appliances, Major (i.e., stoves, refrigerators)	Class I	- Partially assembled	Class IV
- Not packaged, no appreciable plastic exterior trim	Class II	Wax coated, single walled	Group A plastics
- Corrugated, cartoned, (no appreciable plastic trim)		Cement	Class I
Baked Goods		Bagged	
Cookies, cakes, pies		Cereals	Class III
- Frozen, packaged in cartons ¹	Class II	Packaged, cartoned	
- Packaged, in cartons	Class III	Charcoal	
Barley, Rice, Oats		Bagged	
- Packaged, in cartons	Class III	- Standard	Class III
Batteries:		Cheese	
Dry cells		- Packaged, cartoned	Class III
- Packaged in cartons	Class I	- Wheels, cartoned	Class III
- In blister pack in cartons	Class II	Chewing Gum	Class III
Automobile		Packaged, cartoned	
- Filled ²	Class I	Chocolate	Class III
Truck or larger		Packaged, cartoned	
Empty or filled ²	Group A plastics	Cloth	
Beans		Cartoned or not	
Dried		- Natural fiber, viscose	Class III
- Packaged, cartoned	Class III	- Synthetic ⁵	Class IV
Bottles/Jars		Cocoa Products	Class III
Empty, cartoned		Packaged, cartoned	
- Glass	Class I	Coffee	
- Plastic PET (polyethylene terephthalate)	Class IV	- Canned, cartoned	Class I
Filled noncombustible powders		- Packaged, cartoned	Class III
- Glass, cartoned	Class I	Coffee Beans	Class III
- Plastic, cartoned (< 1 gallon)	Class IV	Bagged	
- Plastic (other than PET) (any size)	Group A plastics	Cotton	
Filled noncombustible liquids		- Packaged, cartoned	Class III
- Glass, cartoned	Class I	Diapers	
- Plastic, cartoned (less than 5 gallon)	Class I	- Cotton, linen	Class III
- Plastic, open or solid plastic crates	Group A plastics	- Disposable with plastics & nonwoven fabric (in cartons)	Class IV
Filled noncombustible powders		- Disposable with plastics & nonwoven fabric (uncartoned), plastic wrapped	Group A plastics
- Plastic cartoned or uncartoned (>1 gallon)	Group A plastics	Dried Foods	Class III
- Plastic, solid plastic crates	Group A plastics	Packaged, cartoned	
- Plastic, open plastic crates	Group A plastics	Fertilizers	
Boxes, Crates		Bagged	
- Empty, wood, solid walls	Class II	- Phosphates	Class I
- Empty, wood, slatted ⁴	Outside of scope	- Nitrates	Class II
Bread	Class III	Fiberglass Insulation	
Wrapped cartoned		- Paper-backed rolls (bagged or unbagged)	Class IV
Butter		File Cabinets	
- Whipped spread	Class III	Metal	
Candles		- Cardboard box or shroud	Class I
Packaged, cartoned		Fish or Fish Products	
- Treat as expanded plastic	Group A plastics	Frozen	
Candy	Class III	- Nonwax, nonplastic packaging	Class I
Packaged, cartoned		- Waxed paper containers, cartoned	Class II
		- Boxed or barreled	Class II

NFPA 231 — A98 ROP

- Plastic trays, cartoned	Class III	Nail Polish	
- Canned		- 1 oz to 2 oz glass, cartoned	Class IV
- Cartoned	Class I	- 1 oz to 2 oz plastic bottles, cartoned	Group A plastics
Frozen Foods	Class I	Nuts	
- Nonwax, nonplastic packaging		- Canned, cartoned	Class I
- Waxed-paper containers, cartoned	Class II	- Packaged, cartoned	Class III
- Plastic trays	Class III	- Bagged	Class III
Fruit		Paints	
- Fresh		- Friction top cans, cartoned	
- Nonplastic trays or containers	Class I	- Water-based (latex)	Class I
- With wood spacers	Class I	- Oil-based	Class IV
Furniture		Paper Products	
- Wood		- Books, magazines, stationery, plastic-coated paper food containers, newspapers, cardboard games, or cartoned tissue products	Class III
- No plastic coverings or foam plastic cushioning	Class III	- Tissue products, uncartoned and plastic wrapped	Group A plastics
- With plastic coverings	Class IV		
- With foam plastic cushioning	Group A plastics	Paper, Waxed	
Ice Cream	Class I	- Packaged in cartons	Class IV
Leather Goods	Class III	Pharmaceuticals	
Leather Hides	Class II	- Pills, powders	
- Baled		- Glass bottles, cartoned	Class II
Light Fixtures		- Plastic bottles, cartoned	Class IV
- Nonplastic		- Nonflammable liquids	
- Cartoned	Class II	- Glass bottles, cartoned	Class II
Lighters		Photographic	
- Butane		- Film	
- Blister-packed, cartoned	Group A plastics	- Motion picture or bulk rolls of film in polycarbonate, polyethylene, or metal cans, polyethylene bagged in cardboard boxes	Class II
- Loose in large containers (Level 3 aerosol)	Outside of scope	- 35 mm in metal film cartridges in polyethylene cans in cardboard boxes	Class III
Liquor		- Paper, in sheets, bagged in polyethylene, in cardboard boxes	Class III
- 100 proof or less, one gallon or less, cartoned		- Roll film in polycarbonate plastic cassettes, bulk wrapped in cardboard boxes	Class IV
- Glass (palletized) ⁶	Class IV		
- Plastic bottles	Class IV	Plastic Containers	
Marble		- Noncombustible liquids or semiliquids in plastic containers less than 5 gallon capacity	Class I
- Artificial sinks, countertops	Class II	- Noncombustible liquids or semiliquids in plastic containers larger than 5 gallons	Class II
- Cartoned, crated		- Combustible or noncombustible solids in plastic containers and empty plastic containers	Group A plastics
Margarine		Polyurethane	
- Up to 50% oil (in paper or plastic containers)	Class III	- Cartoned or uncartoned expanded	Group A plastics
- Between 50% and 80% oil (in any packaging)	Group A plastics	Poultry Products	
Matches		- Canned, cartoned	Class I
- Packaged, cartoned		- Frozen, nonwax nonplastic containers	Class I
- Paper	Class IV	- Frozen (on paper or expanded plastic trays)	Class II
- Wood	Group A plastics	Powders	
Mattresses		- Ordinary combustibles — free flowing	
- Standard (box spring)	Class III	- In paper bags (i.e., flour, sugar, etc.)	Class II
- Foam (in finished form)	Group A plastics	PVA (polyvinyl alcohol) Resins	
Meat, Meat Products		- Bagged	Class IV
- Bulk	Class I	PVC (polyvinyl chloride)	
- Canned, cartoned	Class I	- Flexible (e.g., cable jackets, plasticized sheets)	Class III
- Frozen, nonwaxed, nonplastic containers	Class I	- Rigid (e.g., pipe, pipe fittings)	Class III
- Frozen, waxed-paper containers	Class II	- Bagged resins	Class III
- Frozen, expanded plastic trays	Class II	Rags	
Metal Desks		- Baled	
- With plastic tops and trim	Class I	- Natural fibers	Class III
Milk		- Synthetic fibers	Class IV
- Nonwax paper containers	Class I		
- Waxed paper containers	Class I		
- Plastic containers	Class I		
- Containers in plastic crates	Group A plastics		
Motors			
- Electrical	Class I		

NFPA 231 — A98 ROP

Rubber			metal spools on wood skids	
- Natural, blocks in cartons			- Insulated (PVC) cable on large wood	Class II
- Synthetic			or metal spools on wood skids	
	Class IV		- Bare wire on plastic spools in	Class IV
	Group A plastics		cardboard boxes on wood skids	
Salt			- Single or multiple (PVC) covered wire	Class IV
- Bagged	Class I		on plastic spools in cardboard boxes on	
- Packaged, cartoned	Class II		wood skids	
			- Single, multiple, or power cables	Class IV
Shingles			(PVC) on large plastic spools	
- Asphalt-coated fiberglass	Class III		- Bulk storage of empty plastic spools	Group A plastics
- Asphalt-impregnated felt	Class IV			
Shock Absorbers			Wood Products	
- Metal dust cover	Class II		- Solid piles — lumber, plywood, particle	Class II
- Plastic dust cover	Class III		board, pressboard (smooth ends and	
			edges)	
Signatures			- Spools (empty)	Class III
Book, magazines			- Toothpicks, clothespins, hangers in	Class III
- Solid array on pallet	Class II		cartons	
			- Doors, windows, wood cabinets, and	Class III
Skis			furniture	
- Wood	Class III		- Patterns	Class IV
- Foam core	Class IV			
Stuffed Toys			NOTES:	
Foam or synthetic	Group A plastics		¹ Presumes product is in a plastic-coated package in a corrugated	
			carton. If packaged in a metal foil, it can be considered Class I.	
Syrup			² Most batteries have a polypropylene case and if stored empty	
- Drummed (metal containers)	Class I		should be treated as a Group A plastic. Truck batteries, even	
- Barreled, wood	Class II		when filled, should be considered a Group A plastic because of	
			the thicker walls.	
Textiles			³ As the openings in plastic crates become larger, the commodity	
- Natural fiber clothing or textile	Class III		behaves more like Class III. Conversely, as the openings become	
products			smaller, the product makeup behaves more like a plastic.	
Synthetics (except rayon and nylon)			⁴ Should be treated as idle pallets.	
50/50 blend or less			⁵ Tests conducted clearly indicated synthetics or synthetic blends	
- Thread, yarn on wood or paper spools	Class III		are considered greater than Class III.	
- Fabrics	Class III		⁶ When liquors stored in glass containers in racks, it should be	
- Thread, yarn on plastic spools	Class IV		considered a Class III commodity; when it is palletized, it should	
- Baled fiber	Group A plastics		be considered a Class IV commodity.	
Greater than 50/50 blend			A-2-1.3.1	
- Thread, yarn on wood or paper spools	Class IV		Table A-2-1.3.1 Examples of Class I Commodities	
- Fabrics	Class IV		Alcoholic Beverages	
- Baled fiber	Group A plastics		Cartoned or uncartoned	
- Thread, yarn on plastic spools	Group A plastics		- Up to 20% alcohol in metal, glass, or ceramic containers	
Rayon and Nylon				
- Baled fiber	Class IV		Appliances, Major (i.e., stoves, refrigerators)	
- Thread, yarn on wood or paper spools	Class IV		- Not packaged, no appreciable plastic exterior trim	
- Fabrics	Class IV			
- Thread, yarn on plastic spools	Group A plastics		Batteries	
			Dry cells — packaged in cartons	
Tobacco Products			Automobile — filled ¹	
- In paperboard cartons	Class III			
Transformers			Bottles/Jars	
Dry and oil-filled	Class I		Empty, cartoned	
			- Glass	
Vinyl Coated Fabric			Filled noncombustible liquids	
- Cartoned	Group A plastics		- Glass, cartoned	
			- Plastic, cartoned (less than 5 gallon)	
Vinyl Floor Coverings			Filled noncombustible powders	
- Tiles in cartons	Class IV		- Glass, cartoned	
- Rolled	Group A plastics			
Wax-Coated Paper			Canned Foods	
Cups, plates			In ordinary cartons	
- Boxed or packaged inside cartons	Class IV			
(emphasis is on packaging)			Cans	
- Loose inside large cartons	Group A plastics		Metal	
			- Empty	
Wax			Cement	
Paraffin, blocks, cartoned	Group A plastics		Bagged	
Wire			Coffee	
- Bare wire on metal spools on wood	Class I		- Canned, cartoned	
skids				
- Bare wire on wood or cardboard	Class II		Fertilizers	
spools on wood skids			Bagged	
- Bare wire on metal, wood, or	Class II		- Phosphates	
cardboard spools in cardboard boxes on				
wood skids				
- Single or multiple PVC-covered wire on	Class II			

NFPA 231 — A98 ROP

File Cabinets
Metal
- Cardboard box or shroud

Fish or Fish Products
Frozen
- Nonwax, nonplastic packaging

Fish or Fish Products
Canned
- Cartoned

Frozen Foods
- Nonwax, nonplastic packaging

Fruit
Fresh
- Nonplastic trays or containers
- With wood spacers

Ice Cream

Meat, Meat Products
- Bulk
- Canned, cartoned
- Frozen, nonwaxed, nonplastic containers

Metal Desks
- With plastic tops and trim

Milk
- Nonwax paper containers
- Waxed paper containers
- Plastic containers

Motors
- Electrical

Nuts
- Canned, cartoned

Paints
Friction-top cans, cartoned
- Water-based (latex)

Plastic Containers
- Noncombustible liquids or semiliquids in plastic containers less than 5 gallon capacity

Poultry Products
- Canned, cartoned
- Frozen, nonwax nonplastic containers

Salt
- Bagged

Syrup
- Drummed (metal containers)

Transformers
Dry and oil-filled

Wire
- Bare wire on metal spools on wood skids

NOTE:

¹ Most batteries have a polypropylene case and if stored empty should be treated as a Group A plastic. Truck batteries, even when filled, should be considered a Group A plastic because of the thicker walls.

A-2-1.3.2

Table A-2-1.3.2 Examples of Class II Commodities

Alcoholic Beverages
- Up to 20% alcohol in wood containers

Appliances, major (e.g., stoves)
- Corrugated, cartoned (no appreciable plastic trim)

Baked Goods
Cookies, cakes, pies

- Frozen, packaged in cartons¹

Batteries
Dry cells, in blister pack in cartons

Boxes, Crates
- Empty, wood, solid walls

Fertilizers
Bagged
- Nitrates

Fish or Fish Products
Frozen
- Waxed-paper containers, cartoned
- Boxed or barreled

Frozen Foods
- Waxed-paper containers, cartoned

Leather Hides
Baled

Light Fixtures
Nonplastic
- Cartoned

Marble
Artificial sink, countertops
- Cartoned, crated

Meat, Meat Products
- Frozen, waxed-paper containers
- Frozen, expanded plastic trays

Pharmaceuticals
Pills, powders:
- Glass bottles, cartoned
Nonflammable liquids
- Glass bottles, cartoned

Photographic
Film
- Motion picture or bulk rolls of film in polycarbonate, polyethylene, or metal cans; polyethylene bagged in cardboard boxes

Plastic Containers
- Noncombustible liquids or semiliquids in plastic containers larger than 5 gallons

Poultry Products
- Frozen (on paper or expanded plastic trays)

Powders (ordinary combustibles — free flowing)
- In paper bags (i.e., flour, sugar, etc.)

Salt
- Packaged, cartoned

Shock Absorbers
- Metal dust cover

Signatures
Book, magazines
- Solid array on pallet

Syrup
- Barreled, wood

Wire
- Bare wire on wood or cardboard spools on wood skids
- Bare wire on metal, wood, or cardboard spools in cardboard boxes on wood skids
- Single or multiple PVC covered wire on metal spools on wood skids
- Insulated (PVC) cable on large wood or metal spools on wood skids

Wood Products
Solid piles
- Lumber, plywood, particle board, pressboard (smooth ends and edges)

NFPA 231 — A98 ROP

NOTE:

¹ Presumes product is in a plastic-coated package in a corrugated carton. If packaged in a metal foil, it can be considered Class I.

A-2-1.3.3

A-2-1.3.3 Examples of Class III Commodities

Aerosols
 - Cartoned or uncartoned
 - Level 1

Baked Goods
 - Cookies, cakes, pies
 - Packaged, in cartons

Barley, Rice, Oats
 - Packaged, in cartons

Beans
 - Dried
 - Packaged, cartoned

Bread
 - Wrapped, cartoned

Butter
 - Whipped spread

Candy
 - Packaged, cartoned

Cartons
 - Corrugated
 - Unassembled (neat piles)

Cereals
 - Packaged, cartoned

Charcoal
 - Bagged
 - Standard

Cheese
 - Packaged, cartoned
 - Wheels, cartoned

Chewing Gum
 - Packaged, cartoned

Chocolate
 - Packaged, cartoned

Cloth
 - Cartoned or not
 - Natural fiber, viscose

Cocoa Products
 - Packaged, cartoned

Coffee
 - Packaged, cartoned

Coffee Beans
 - Bagged

Cotton
 - Packaged, cartoned

Diapers
 - Cotton, linen

Dried Foods
 - Packaged, cartoned

Fish or Fish Products
 - Frozen
 - Plastic trays, cartoned

Frozen Foods
 - Plastic trays

Furniture
 - Wood (no plastic coverings or foam plastic cushioning)

Leather Goods

Margarine
 - Up to 50% oil (in paper or plastic containers)

Mattresses
 - Standard (box spring)

Nuts
 - Packaged, cartoned
 - Bagged

Paper Products
 - Books, magazines, stationery, plastic-coated paper food containers, newspapers, cardboard games, or cartoned tissue products

Paper, Rolled
 - In racks or on side
 - Medium or heavyweight

Photographic Film
 - 35 mm in metal film cartridges in polyethylene cans in cardboard boxes
 - Paper, in sheets bagged in polyethylene, in cardboard boxes

PVC (polyvinyl chloride)
 - Flexible (e.g., cable jackets, plasticized sheets)
 - Rigid (e.g., pipe, pipe fittings)
 - Bagged resins

Rags
 - Baled
 - Natural fibers

Shingles
 - Asphalt-coated fiberglass

Shock Absorbers
 - Plastic dust cover

Skis
 - Wood

Textiles
 - Natural fiber clothing or textile products
 - Synthetics (except rayon and nylon)
 - 50/50 blend or less
 - Thread, yarn on wood or paper spools
 - Fabrics

Tobacco Products
 - In paperboard cartons

Wood Products
 - Spools (empty)
 - Toothpicks, clothespins, hangers in cartons
 - Doors, windows, wood cabinets, and furniture

A-2-1.3.4

Table A-2-1.3.4 Examples of Class IV Commodities.

Ammunition
 - Small arms, shotgun
 - Packaged, cartoned

Bottles/Jars
 - Empty, cartoned
 - Plastic PET (polyethylene terephthalate)
 - Filled noncombustible powders
 - Plastic, cartoned (< 1 gallon)

Cartons
 - Corrugated
 - Partially assembled

NFPA 231 — A98 ROP

Cloth
 - Cartoned or not
 - Synthetic¹

Diapers
 - Disposable with plastics and nonwoven fabric (in cartons)

Fiber Glass Insulation
 - Paper-backed rolls
 Bagged or unbagged

Furniture
 Wood
 - With plastic coverings

Liquor
 100 proof or less, one gallon or less, cartoned
 - Glass (palletized)²
 - Plastic bottles

Matches
 Packaged, cartoned
 - Paper

Nail Polish
 - 1 oz to 2 oz glass, cartoned

Paints
 Friction top cans, cartoned
 - Oil-based

Paper, Waxed
 Packaged in cartons

Pharmaceuticals
 Pills, powders
 - Plastic bottles, cartoned

Photographic
 - Roll film in polycarbonate plastic cassettes, bulk wrapped
 in cardboard boxes

PVA (polyvinyl alcohol) Resins
 - Bagged

Rags
 Baled
 - Synthetic fibers

Rubber
 - Natural, blocks in cartons

Shingles
 - Asphalt-impregnated felt

Skis
 - Foam core

Textiles
 Synthetics (except rayon and nylon)
 50/50 blend or less
 - Thread, yarn on plastic spools
 greater than 50/50 blend
 - Thread, yarn on wood or paper spools
 - Fabrics
 Rayon and nylon
 - Baled fiber
 - Thread, yarn on wood or paper spools
 - Fabrics

Vinyl Floor Coverings
 - Tiles in cartons

Wax-Coated Paper
 Cups, plates
 - Boxed or packaged inside cartons (emphasis is on
 packaging)

Wire
 - Bare wire on plastic spools in cardboard boxes on wood
 skids
 - Single or multiple (PVC) covered wire on plastic spools in
 cardboard boxes on wood skids

- Single, multiple, or power cables (PVC) on large plastic
 spools

Wood Products
 - Patterns

NOTES:

¹ Tests conducted clearly indicated synthetics or synthetic blends
 are considered greater than Class III.

² When liquor is stored in glass containers in racks, it should be
 considered a Class III commodity; when it is palletized, it should
 be considered a Class IV commodity.

A-2-1.4.1

Table A-2-1.4.1 Examples of Group A Plastic Commodities

Batteries
 Truck or larger
 - Empty or filled¹

Bottles/Jars
 Empty, cartoned
 - Plastic (other than PET) (any size)
 Filled noncombustible liquids
 - Plastic, open or solid plastic crates²
 Filled noncombustible powders
 - Plastic cartoned or uncartoned (>1 gallon)
 - Plastic, solid plastic crates
 - Plastic, open plastic crates

Candles
 Packaged, cartoned
 - Treat as expanded plastic

Carpet Tiles
 Cartoned

Cartons
 Wax coated, single walled

Diapers
 - Disposable with plastics and nonwoven fabric (uncartoned),
 plastic wrapped

Furniture
 Wood
 - With foam plastic cushioning

Lighters
 Butane
 - Blister-packed, cartoned

Margarine
 - Between 50% and 80% oil (in any packaging)

Matches
 Packaged, cartoned
 - Wood

Mattresses
 - Foam (in finished form)

Milk
 - Containers in plastic crates

Nail Polish
 - 1 oz to 2 oz plastic bottles, cartoned

Paper Products
 - Tissue products, uncartoned and plastic wrapped

Plastic Containers
 - Combustible or noncombustible solids in plastic containers
 and empty plastic containers

Polyurethane
 - Cartoned or uncartoned expanded

Rubber
 - Synthetic

NFPA 231 — A98 ROP

Stuffed Toys

Foam or synthetic

Textiles

Synthetics (except rayon and nylon)

50/50 blend or less

- Baled fiber

Greater than 50/50 blend

- Baled fiber

- Thread, yarn on plastic spools

Rayon and nylon

- Thread, yarn on plastic spools

Vinyl Coated Fabric

- Cartoned

Vinyl Floor Coverings

- Rolled

Wax-Coated Paper

Cups, plates

- Loose inside large cartons

Wax

Paraffin, blocks, cartoned

Wire

- Bulk storage of empty plastic spools

NOTES:

¹ Most batteries have a polypropylene case and if stored empty should be treated as a Group A plastic. Truck batteries, even when filled, should be considered a Group A plastic because of the thicker walls.

² As the openings in plastic crates become larger, the commodity behaves more like Class III. Conversely, as the openings become smaller, the product makeup behaves more like a plastic. (ROP 231-5)

A-3.1.1 With protection installed in accordance with this standard, fire protection of overhead steel and steel columns might not be necessary.

Consideration should be given to subdividing large-area warehouses in order to reduce the amount of merchandise that could be affected by a single fire.

It is recommended that walls or partitions be provided to separate the storage area from mercantile, manufacturing, or other occupancies to prevent the possibility of transmission of fire or smoke between the two occupancies. Door openings should be equipped with automatic-closing fire doors appropriate for the fire resistance rating of the wall or partition.

A-3.2 Smoke removal is important to manual fire fighting and overhaul. Since most fire tests were conducted without smoke and heat venting, protection specified in Sections 5-1, 6-1, and 7-1 was developed without the use of such venting. However, venting through eave-line windows, doors, monitors, gravity, or mechanical exhaust systems is essential to smoke removal after control of the fire is achieved. (See NFPA 204, *Guide for Smoke and Heat Venting*.)

A-4.1.2 Commodities that are particularly susceptible to water damage should be stored on skids, dunnage, pallets, or elevated platforms in order to maintain at least 4 in. (10.2 cm) clearance from the floor.

A-4.2.2 Protection for exposed steel structural roof members might be needed and should be provided as indicated by the authority having jurisdiction.

A-4.2.5 Incandescent light fixtures should have shades or guards to prevent the ignition of commodity from hot bulbs where possibility of contact with storage exists.

A-4.3.2 Storage should be separated by aisles so that piles are not more than 50 ft (15.2 m) wide or 25 ft (7.6 m) wide if they abut a wall. Main and cross aisles should be located opposite window or door openings in exterior walls. This is of particular importance in buildings where few exterior openings exist. Aisle width should be at least 8 ft (2.4 m). In judging the adequacy of existing sprinkler protection, aisle spacing and frequency should be given consideration.

A-4.4 Idle pallet storage introduces a severe fire condition. Stacking idle pallets in piles is the best arrangement of combustibles to promote rapid spread of fire, heat release, and complete combustion. After pallets are used for a short time in warehouses, they dry out and edges become frayed and splintered. In this condition they are subject to easy ignition from a small ignition source. Again, high piling increases considerably both the challenge to sprinklers and the probability of involving a large number of pallets when fire occurs. Therefore, it is preferable to store pallets outdoors where possible.

A fire in stacks of idle plastic or wooden pallets is one of the greatest challenges to sprinklers. The undersides of the pallets create a dry area on which a fire can grow and expand to other dry or partially wet areas. This process of jumping to other dry, closely located, parallel, combustible surfaces continues until the fire bursts through the top of the stack. Once this happens, very little water is able to reach the base of the fire. The only practical method of stopping a fire in a large concentration of pallets with ceiling sprinklers is by means of prewetting. In high stacks, this cannot be done without abnormally high water supplies. The storage of empty wood pallets should not be permitted in an unsprinklered warehouse containing other storage. (ROP 231-11)

A-4.4.1.1 See Table A-4.4.1.1.

A-4.4.1.2 No additional protection is necessary, provided the requirements of 4-4.1.2(a) and (b) are met.

A-4.5 For further information, see Chapter 4 of NFPA 30, *Flammable and Combustible Liquids Code*.

A-5.3.1(d) For further information on adjacent sprinkler systems, see NFPA 13, *Standard for the Installation of Sprinkler Systems*.

A-5.4 At windowless warehouses and where windows are scant, hydrants should be located at or in the vicinity of entrances.

Table A-4.4.1.1 Recommended Clearance Between Outside Idle Pallet Storage and Building

Wall Construction		Minimum Distance [ft (m)] of Wall from Storage of		
Wall Type	Openings	Under 50 Pallets	50 to 200 Pallets	Over 200 Pallets
Masonry	None	0	0	0
	Wired glass with outside sprinklers and 1-hr doors	0	10 (3.0)	20 (6.1)
	Wired or plain glass with outside sprinklers and 3/4-hr doors	10 (3.0)	20 (6.1)	30 (9.1)
Wood or metal with outside sprinklers				
Wood, metal, or other		20 (6.1)	30 (9.1)	50 (15.2)

NOTES:

- Fire-resistive protection comparable to that of the wall also should be provided for combustible eave lines, vent openings, etc.
- Where pallets are stored close to a building, the height of storage should be restricted to prevent burning pallets from falling on the building.
- Manual outside open sprinklers generally are not a reliable means of protection unless property is attended to at all times by plant emergency personnel.
- Open sprinklers controlled by a deluge valve are preferred.

A-5-5 Manual fire-fighting operations in a storage warehouse are not a substitute for sprinkler operation. The sprinkler system should be kept in operation during manual fire-fighting operations until visibility has cleared so that the fire can be seen clearly and the extent of fire reduced to a stage that needs only mopping up. It is essential that charged hose lines be available before venting is started because of a possible increase in fire intensity. Where a sprinkler valve has been closed, a responsible person should remain at the valve so it can be opened promptly if necessary. The water supply for the sprinkler system should be augmented where possible and care exercised so that the water supply for the sprinkler system is not rendered ineffective by the use of excessive hose streams.

Where a private fire brigade is provided, sufficient large hose [$2\frac{1}{2}$ in. (64 mm)] and related equipment should be available.

Information on emergency organization and preincident planning is provided in the following publications:

NFPA *Industrial Fire Brigades Training Manual*

NFPA 600, *Standard on Industrial Fire Brigades*

NFPA 1420, *Recommended Practice for Pre-Incident Planning for Warehouse Occupancies*

A-5-6 For further information, see NFPA 72, *National Fire Alarm Code*.

A-6 The following procedure should be followed in determining the proper density and area as specified in Chapter 6.

- Determine the commodity class.
- Select the density and area of application from Figure 6-2.2.2 or Figure 6-2.2.3.
- Adjust the required density for storage height in accordance with Figure 6-2.2.4.
- Increase the operating area by 30 percent in accordance with 6-2.2.5 where a dry-pipe system is used.
- Satisfy the minimum densities and areas as indicated in 5-1.2 and 5-1.2.1.

Example:

Storage — greeting cards in boxes in cartons on pallets

Height — 22 ft (6.7 m)

Clearance — 6 ft (1.8 m)

Sprinklers — ordinary temperature (ROP 231-1)

System type — dry

- Classification — Class III
- Selection of density/area — 0.225 gpm/ft^2 over 3000 ft^2 [0.014 (L/s)/m^2 over 276 m^2] from Figure 6-2.2.2
- Adjustment for height of storage using Figure 6-2.2.4 — $1.15 \times 0.225 = 0.259 \text{ gpm/ft}^2$; round up to 0.26 gpm/ft^2
- Adjustment of area of operation for dry system — $1.3 \times 3000 \text{ ft}^2 = 3900 \text{ ft}^2$ (363 m^2)
- Confirmation that minimum densities and areas have been achieved

In 5-1.2, the minimum design density for a dry sprinkler system is 0.15 gpm/ft^2 over 2600 ft^2 [0.10 (L/s)/m^2 over 242 m^2] (this has been satisfied) for Class III.

Paragraph 5-1.2.1 refers to Ordinary Hazard Group 2 of NFPA 13, *Standard for the Installation of Sprinkler Systems*. That density at 3000 ft^2 (279 m^2) is 0.17 gpm/ft^2 [0.12 (L/s)/m^2] (this minimum has been satisfied); $3000 \text{ ft}^2 \times 1.3 = 3900 \text{ ft}^2$ (363 m^2), 0.17 gpm/ft^2 over 3900 ft^2 [0.12 (L/s)/m^2 over 363 m^2].

The design density and area of application equals 0.26 gpm/ft^2 [0.18 (L/s)/m^2] over 3900 ft^2 (363 m^2).

A-6-1.1(c) Full-scale tests show no appreciable difference in the number of sprinkler heads that open for either nonencapsulated or encapsulated products up to 15 ft (4.6 m) high. Test data is not available for encapsulated products stored higher than 15 ft (4.6 m). However, in rack storage tests involving encapsulated storage 20 ft (6 m) high, increased protection was needed over that for nonencapsulated storage.

The protection specified in Chapter 6 contemplates a maximum of 10-ft (3-m) clearances from top of storage to sprinkler deflectors for storage heights of 15 ft (4.6 m) and higher.

A-6-2.4 Recommended water supplies anticipate successful sprinkler operation. Because of the small but still significant number of uncontrolled fires in sprinklered properties, which have various causes, there should be an adequate water supply available for fire department use.

A-7-1 The densities and area of application have been developed from fire test data. Most of these tests were conducted with $\frac{17}{32}$ -in. (13.5-mm) orifice sprinklers and 80-ft^2 or 100-ft^2 (7.4-m^2 or 9.3-m^2) sprinkler spacing. These and other tests have indicated that, with densities of 0.40 gpm/ft^2 [0.27 (L/s)/m^2] and higher, better results are obtained with $\frac{17}{32}$ -in. (13.5-mm) orifice and 70-ft^2 to 100-ft^2 (7.4-m^2 to 9.3-m^2) sprinkler spacing than where using $\frac{1}{2}$ -in. (12.7-mm) orifice sprinklers at 50-ft^2 (4.6-m^2) spacing. A discharge pressure of 100 psi (689 kPa) was used as a starting point on one of the fire tests. It was successful, but has a $1\frac{1}{2}$ -ft (0.5-m) clearance between the top of storage and ceiling sprinklers. A clearance of 10 ft (3.0 m) could have produced a different result due to the tendency of the higher pressure to atomize the water and the greater distance that the fine water droplets had to travel to the burning fuel. (ROP 231-1)

A-7-1.1 Two direct comparisons between ordinary-temperature- and high-temperature-rated sprinklers are possible:

- With nonexpanded polyethylene 1-gal (3.8-L) bottles in corrugated cartons, a 3-ft (0.9-m) clearance, and the same density, approximately the same number of sprinklers operated (9 at high temperature versus 7 at ordinary temperature). (ROP 231-1)
- With exposed, expanded polystyrene meat trays, a 9.5-ft (1.9-m) clearance, and the same density, three times as many ordinary-temperature-rated sprinklers operated as did high-temperature-rated sprinklers (11 at high temperature versus 33 at ordinary temperature). (ROP 231-1)

The cartoned plastics requirements of this standard are based to a great extent on test work that used a specific commodity — 16-oz (0.473-L) polystyrene plastic jars individually separated by thin carton stock within a large corrugated carton [$3\frac{1}{2}\text{-ft}^2$ (0.32 m^2)]. [See Figure A-7-1.1(a).]

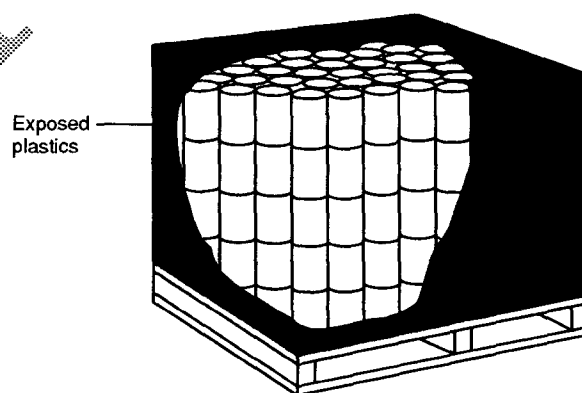


Figure A-7-1.1(a) Corrugated carton containing individually separated plastic jars.

Other Group A plastic commodities can be arranged in cartons so that they are separated by multiple thicknesses of carton material. In such arrangements, less plastic becomes involved in the fire at any one time. This could result in a less vigorous fire that can be controlled by Class IV commodity protection.

Other situations exist in which the plastics component is surrounded by several layers of less hazardous material and is therefore temporarily protected or insulated from a fire involving adjacent plastic products. Such conditions also could produce a less vigorous fire and be successfully handled by Class IV protection. [See Figure A-7-1.1(b).]

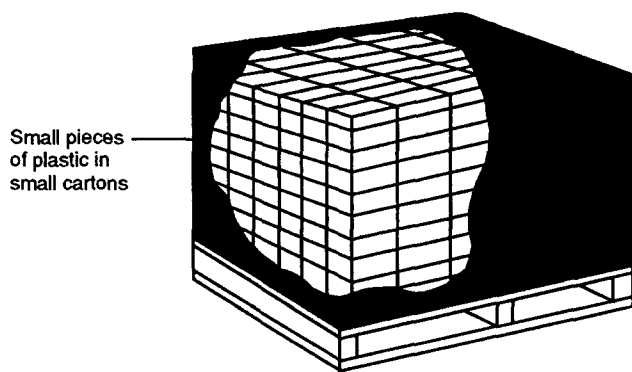


Figure A-7-1.1(b) Corrugated carton containing plastic pieces individually separated by carton material.

The decision to protect as a Class IV commodity, however, should be made only based on experienced judgment and only with an understanding of the consequences of underprotecting the storage segment.

A-7-1.2 There are few storage facilities in which the commodity mix or storage arrangement remains constant, and a designer should be aware that the introduction of different materials can change protection requirements considerably. Design should be based on higher densities and areas of application, and the various reductions allowed should be applied cautiously. For evaluation of existing situations, however, the allowances can be quite helpful.

A-7-2.1 An evaluation for each field situation should be made to determine the worst applicable height-clearance relationship that can be expected to appear in a particular case. Fire tests have shown that considerably greater demands occur where clearance is 10 ft (3.0 m) as compared to 3 ft (0.9 m), and where a pile is stable as compared to an unstable pile. Since a system is designed for a particular clearance, the system could be inadequate when significant areas do not have piling to the design height and larger clearances exist between stock and sprinklers. This can also be true where the packaging or arrangement is changed so that stable piling is created where unstable piling existed. Recognition of these conditions is essential to avoid installation of protection that is inadequate or becomes inadequate because of changes.

No tests were conducted simulating a peaked roof configuration. However, it is expected that the principles of Chapter 7 still apply. The worst applicable height-clearance relationship that can be expected to occur should be found, and protection should be designed for it. If storage is all at the same height, the worst height-clearance relationship creating the greatest water demand would occur under the peak. If commodities are stored higher under the peak, the various height-clearance relationships should be tried and the one creating the greatest water demand used for designing protection.

A-7-2.2 Test data is not available for all combinations of commodities, storage heights, and clearances. Some of the protection criteria in this standard are based on extrapolations of test data for other commodities and storage configurations, as well as available loss data.

For example, there is very limited test data for storage of expanded plastics higher than 20 ft (6 m). The protection criteria in this standard for expanded plastics higher than 20 ft (6 m) are extrapolated from test data for expanded plastics storage 20 ft (6 m) and less in height and test data for unexpanded plastics above 20 ft (6 m).

Further examples can be found in the protection criteria for clearances up to 15 ft (4.6 m). Test data is limited for clearances greater than 10 ft (3.0 m). It should be assumed that, if protection is adequate for a given storage height in a building of a given height, the same protection will protect storage of any lesser height in the same building. For example, protection adequate for 20-ft (6.1-m) storage in a 30-ft (10-m) building [10-ft (3.0-m) clearance] would also protect 15-ft (4.6-m) storage in a 30-ft (10-m) building [15-ft (4.6-m) clearance]. Therefore, the protection criteria in Table 7-2.2 for 15-ft (4.6-m) clearance are based on the protection criteria for storage 5 ft (1.5 m) higher than the indicated height with 10-ft (3.0-m) clearance.

Table 7-2.2 is based on tests that were conducted primarily with high-temperature-rated, $1\frac{1}{2}$ -in. (13.5-mm) orifice sprinklers. Other tests have demonstrated that where sprinklers are used with orifices greater than $1\frac{1}{2}$ in. (13.5 mm), ordinary temperature sprinklers are acceptable. (ROP 231-27)

A-7-2.5 Wet systems are recommended for storage occupancies. Dry-pipe systems should be permitted only where it is impractical to provide heat.

A-9-1 ESFR sprinklers were designed to respond quickly to growing fires and deliver heavy discharge to suppress fires rather than to control them. ESFR sprinklers should not be relied upon to provide suppression if they are used outside these design parameters.

A-9-1.3 Storage in single-story or multistory buildings can be permitted, provided the maximum ceiling/roof height as specified in Table 9-1 is satisfied for each storage area.

A-9-2 Design parameters were determined from a series of full-scale fire tests conducted as a joint effort between Factory Mutual Research Corporation and the National Fire Protection Research Foundation. (Copies of the test reports are available from the NFPRF.)

A-10-1 Locomotives should not be allowed to enter storage areas.

A-10-1.1 Industrial trucks using gas or liquid fuel should be refueled outside of the storage building at a location designated for that purpose.

A-10-3.1 The use of cutting, cutting, soldering, or brazing torches in the storage areas introduces a severe fire hazard. The use of mechanical fastenings and mechanical saws or cutting wheels is recommended.

Appendix B Example Determining Protection Criteria for Plastic and Rubber Commodities

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

Appendix B explains and provides an example of the method and procedure to follow in using this standard to determine proper protection for Group A plastics. (See Chapter 7.)

Table B Metric Conversion Factors for Examples

To convert from	to	Multiply
feet (ft)	meter (m)	0.3048
square feet (ft ²)	meter/square (m ²)	0.0929
gal/min (gpm)	liter/second (L/s)	0.0631
gal per min/ft ² (gpm/ft ²)	liter per second/m ² [(L/s)/m ²]	0.679

Example 1. Storage is expanded-cartoned-stable, 15 ft (4.57 m) high in a 20-ft (6.1-m) building.

Answer 1. Column E — design density = 0.45 gpm/ft² [0.31 (L/s)/m²].

Example 2. Storage is nonexpanded-unstable, 15 ft (4.57 m) high in a 20-ft (6.1-m) building.

Answer 2. Column A — design density is listed as 0.25 gpm/ft² [0.17 (L/s)/m²], however, it is also possible that the storage can be 12 ft (3.66 m) in this 20-ft (6.1-m) building, which would require 0.3 [0.2 (L/s)/m²]. Unless the owner can guarantee that the storage will always be 15 ft (4.57 m), the design density = 0.3 gpm/ft².

Example 3. Storage is a nonexpanded-stable 15-ft (4.57-m) fixed-height unit load, one high, in an 18-ft (5.5-m) building.

Answer 3. Column A — design density is 0.25 gpm/ft². Note that this does not go up to 0.3 gpm/ft² [0.2 (L/s)/m²] like the previous example because of the use of a fixed-height unit load. It will never be 12 ft (3.66 m) It will always be 15 ft (4.57 m) or nothing.

Example 4. Storage is expanded-exposed-unstable, 20-ft (6.1-m) high in a 27-ft (8.2-m) building.

Answer 4. Column C — design density = 0.7 gpm/ft² [0.48 (L/s)/m²]. Note that other lower storage heights should also be checked, but they reveal the same, or lower, densities (0.7 and 0.6)

[0.48 (L/s)/m² and 0.41 (L/s)/m²] so the design density remains at 0.7 gpm/ft² [0.48 (L/s)/m²].

Example 5. Expanded-cartoned-unstable, 17 ft (5.2 m) high in 32-ft (9.75-m) building.

Answer 5. Column D — 15-ft (4.57 m) storage in a 32-ft (9.75-m) building would be 0.55 gpm/ft² [0.37 (L/s)/m²]. 20-ft (6.1-m) storage in a 32-ft (9.75-m) building would be 0.70 gpm/ft² [0.48 (L/s)/m²]. Interpolation for 17-ft (5.2-m) storage is as follows:

$$\begin{aligned} 0.7 - 0.55 &= 0.15 \\ 0.15 / (20 - 15) &= 0.03 \\ 0.03 \times (17 - 15) &= 0.06 \\ 0.55 + 0.06 &= 0.61 \\ \text{Design density} &= 0.61 \text{ gpm/ft}^2 [0.41 \text{ (L/s)/m}^2] \end{aligned}$$

Example 6. Storage is expanded-exposed-stable, 22-ft (6.71-m) storage in 23.5-ft (7.16-m) building.

Answer 6. Column B — Could interpolate between 0.6 gpm/ft² [0.41 (L/s)/m²] and 0.75 gpm/ft² [0.51 (L/s)/m²], however, this would be a moot point since the density for 15-ft (4.57-m) storage in this 23.5-ft (7.16-m) building would be 0.8 gpm/ft² [0.54 (L/s)/m²]. Unless the owner can guarantee 22-ft (6.71-m) storage, the design density = 0.8 gpm/ft² [0.54 (L/s)/m²]. If the owner can, in some way acceptable to the authority having jurisdiction guarantee 22-ft (6.71-m) storage, the interpolation would yield a design density of 0.66 gpm/ft² [0.45 (L/s)/m²].

Example 7. Storage is nonexpanded-stable-exposed, 13.5 ft (4.1 m) high in a 15-ft (4.57-m) building.

Answer 7. Column E — 12-ft (3.66-m) storage in a 15-ft (4.57-m) building would be EH-2 (0.4 gpm/ft² over 2500 ft²) [0.27 (L/s)/m² over 230 m²].

15-ft (4.57-m) storage in a 15-ft (4.57-m) building would be 0.45 gpm/ft² [0.31 (L/s)/m²]. Interpolation for 13.5-ft (4.1 m) storage is as follows:

$$\begin{aligned} 0.45 - 0.4 &= 0.05 \\ 0.05 / (15 - 12) &= 0.017 \\ 0.017 \times (13.5 - 12) &= 0.026 \\ 0.4 + 0.026 &= 0.426 \end{aligned}$$

Design density = 0.426 gpm/ft² [0.29 (L/s)/m²]

(ROP 231-41)

Appendix C Protection of Outdoor Storage

C-1 General.

C-1.1 The hazards of exposure to outdoor storage from ignition sources and exposing fires and the infinite variety of conditions under which such exposures can occur render impossible the formulation of any single table, formulae, or set of rules that can cover all conditions adequately.

C-1.2 Recommendations contained in this appendix are for the protection of outdoor storage of commodities covered by the standard. (See Section 1-1.)

C-1.3 In general, the provision of automatic fire protection is impractical for outdoor storage. As a result, emphasis must be placed upon the following:

- (a) Control of potential ignition sources, such as from exposing buildings, transformers, yard equipment, refuse burners, overhead power lines, and vandals
- (b) Elimination of adverse factors such as trash accumulations, weeds, and brush
- (c) Provision of favorable physical conditions, such as limited pile sizes, low storage heights, wide aisles, and possible use of fire-retardant covers (e.g., tarpaulins)
- (d) The rapid and effective application of manual fire-fighting efforts by the provision of fire alarms, strategically located hydrants, and adequate hose houses or hose reels

C-1.4 Outdoor storage should be avoided in most cases but is recognized as a necessity in many industries.

C-1.4.1 Outdoor storage is acceptable for materials that are:

- (a) Of low fire hazard, not requiring protection even if located indoors

(b) Of sufficiently low value that a potential loss would not justify the utilization of building space

(c) Of such severe fire hazard that indoor protection is impractical when balanced against potential loss

(d) Of large volume and bulk, making it impractical to construct and protect a building to house the storage

C-1.4.2 Where materials that normally would be stored in buildings are stored outdoors in temporary emergencies, it is recommended that special precautions be taken for their safeguard and that they be moved to a storage warehouse as soon as possible.

C-1.5 Standards that address outdoor storage of specific commodities are found in Chapter 11.

C-2 Responsibility of Management.

C-2.1 It is the responsibility of management to properly consider the hazards of the various materials handled. Protection requirements and storage arrangements vary with the combustibility of the materials. Management should determine any special precautions that should be followed for the types of material stored. The care, cleanliness, and maintenance exercised by management determine to a large extent the relative fire safety in the storage area.

C-2.2 Consideration should be given by management to proper storage of materials in order to prevent the undue concentration of quantities of such materials in a single location, subject to one catastrophe. The criteria used to determine the amount of such material that should be stored in a single location are not only dependent upon the dollar value of the commodity but also upon the total supply and availability of the material. The impact of the loss of the storage upon the ability to continue production should be considered.

C-3 Site.

C-3.1 In selecting a site for outdoor storage, preference should be given to a location that can provide the following:

- (a) Adequate municipal fire and police protection
- (b) An adequate public water system with hydrants suitably located for protection of the storage
- (c) Adequate all-weather roads for fire department apparatus response
- (d) Sufficient clear space from buildings or from other combustible storage that constitutes an exposure hazard
- (e) Absence of flood hazard
- (f) Adequate clearance space between storage piles and any highways, bridges, railroads, and woodlands
- (g) Topography as level as possible to provide storage stability

C-3.2 The entire site should be surrounded by a fence or other suitable means to prevent access of unauthorized persons. An adequate number of gates should be provided in the surrounding fence or other barriers to permit ready access of fire apparatus.

C-4 Material Piling.

C-4.1 Materials should be stored in unit piles as low in height and small in area as is consistent with good practice for the materials stored. The maximum height should be determined by the stability of pile, effective reach of hose streams, combustibility of the commodity, and ease of pile breakdown under fire or mop-up conditions. Long narrow piles are preferred over large square piles to facilitate manual fire fighting. (The short dimension increases the effectiveness of hose streams and eases pile breakdown.)

C-4.2 Aisles should be maintained between individual piles, between piles and buildings, and between piles and the boundary line of the storage site. Sufficient driveways having the width of at least 15 ft (4.57 m) should be provided to allow the travel of fire equipment to all portions of the storage area. Aisles should be at least twice the pile height to reduce the spread of fire from pile to pile and to allow ready access for fire fighting, emergency removal of material, or salvage purposes.

C4.3 As the commodity class increases in combustibility or where storage could be ignited easily from radiation, wider aisles should be provided. Smaller unit piles might be an alternative to wider aisles if yard space is limited.

C4.4 For outdoor idle pallet storage, see Section 4-4 and A-4.4.1.1 of this standard. Separation between piles of idle pallets and other yard storage should be as specified in Table C-4.4.

Table C-4.4 Pile Separation		
Pile Size	Minimum Distance in ft (m)	
Fewer than 50 pallets	20	(6)
50–200 pallets	30	(9.1)
More than 200 pallets	50	(15.2)

C4.5 Boundary posts with signs designating piling limits should be provided to indicate yard area, roadway, and aisle limits.

C5 Buildings and Other Structures.

C5.1 Yard storage, particularly storage of commodities in the higher heat release category, should have as much separation as is practical from important buildings and structures, but not less than that offered by NFPA 80A, *Recommended Practice for Protection of Buildings from Exterior Fire Exposures*.

C5.1.1 As guidance in using NFPA 80A, *Recommended Practice for Protection of Buildings from Exterior Fire Exposures*, to establish clear spaces, the following classification of severity with commodity classes of this standard should be used on the basis of 100 percent openings representing yard storage:

- (a) *Light Severity.* Commodity Class I
- (b) *Moderate Severity.* Commodity Class II
- (c) Interpolate between moderate and severe severity for Commodity Class III
- (d) *Severe Severity.* Commodity Class IV and Class A plastics

NOTE: The guidelines of C-5.1.1 apply to the equivalent commodity classes of this standard. The severity of the exposing building or structure also should be a consideration where establishing a clear space.

C6 Yard Maintenance and Operations.

C6.1 The entire storage site should be kept free from accumulation of unnecessary combustible materials. Vegetation should be kept cut low. Procedures should be provided for weed control and the periodic cleanup of the yard area.

C6.2 Adequate lighting should be provided to allow supervision of all parts of the storage area at night.

C6.3 All electrical equipment and installations should conform to the provisions of NFPA 70, *National Electrical Code*.

C6.4 No heating equipment should be located or used within the storage area. Salamanders, braziers, portable heaters, and other open fires should not be used.

C6.5 Smoking should be prohibited, except in locations prominently designated as smoking areas. "No Smoking" signs should be posted in prohibited areas.

C6.6 Welding and cutting operations should be prohibited in the storage area, unless in compliance with NFPA 51B, *Standard for Fire Prevention in Use of Cutting and Welding Processes*.

C6.7 Tarpaulins used for protection of storage against the weather should be of fire-retardant fabric.

C6.8 Locomotives from which glowing particles could be emitted from exhaust stacks should not be permitted in the yard.

C6.9 Motorized vehicles using gasoline, diesel fuel, or liquefied petroleum gas as fuel should be garaged in a separate, detached building.

C6.9.1 Storage and handling of fuel should conform with NFPA 30, *Flammable and Combustible Liquids Code*, and NFPA 58, *Standard for the Storage and Handling of Liquefied Petroleum Gases*.

C6.9.2 Repair operations should be conducted outside the yard unless a separate masonry wall building is provided. Vehicles should not be greased, repaired, painted, or otherwise serviced in the yard. Such work should be conducted in conformity with NFPA 88B, *Standard for Repair Garages*.

C7 Fire Protection.

C7.1 Provisions should be made for promptly notifying the public fire department and private fire brigade (if available) in case of fire or other emergency.

C7.2 Hydrants should be spaced to provide a sufficient number of hose streams. (See NFPA 24, *Standard for the Installation of Private Fire Service Mains and Their Appurtenances*.)

C7.2.1 Provisions should be made to permit the direction of an adequate number of hose streams on any pile or portion of the storage area that could be involved in fire. It is recommended that, unless adequate protection is provided by the municipal fire department, sufficient hose and other equipment should be kept on hand at the storage property, suitably housed, and provision should be made for trained personnel available to put it into operation.

C7.2.2 Hydrants and all fire-fighting equipment should be accessible for use at all times. No temporary storage should be allowed to obstruct access to fire-fighting equipment, and any accumulation of snow or obstructing material should be removed promptly.

C7.3 Monitor nozzles should be provided at strategic points where large quantities of highly combustible materials are stored or where average amounts of combustible materials are stored in inaccessible locations.

C7.4 Fire extinguishers of an appropriate type should be placed at well-marked, strategic points throughout the storage area so that one or more portable fire extinguisher units can be made available quickly for use at any point. Where the climate is such that there is a danger of freezing, suitable extinguishers for freezing temperatures should be used. For guidance in the type and use of extinguishers refer to NFPA 10, *Standard for Portable Fire Extinguishers*.

C8 Guard Service.

C8.1 Guard service should be provided and continuously maintained throughout the yard and storage area at all times while the yard is otherwise unoccupied. The responsibilities and the training of guards should be as specified in NFPA 601, *Standard for Security Services in Fire Loss Prevention*. It is recommended that there be some suitable means of supervising guard activities to ensure that required rounds are made at regular intervals.

C8.2 The value of strategically placed watchtowers in large yards where a guard stationed at a point of advantage can keep the entire property under observation should be considered. It is recommended that such watchtowers be connected to the alarm system for prompt notification of fire.

Appendix D Referenced Publications

D-1 The following documents or portions thereof are referenced within this standard for informational purposes only and are thus not considered part of the requirements of this standard unless also listed in Chapter 11. The edition indicated here for each reference is the current edition as of the date of the NFPA issuance of this standard.

D-1.1 NFPA Publications. National Fire Protection Association, 1 Batterymarch Park, P.O. Box 9101, Quincy, MA 02269-9101.

NFPA 10, *Standard for Portable Extinguishers*, 1994 edition.

NFPA 13, *Standard for the Installation of Sprinkler Systems*, 1996 edition.

NFPA 231 — A98 ROP

NFPA 24, *Standard for the Installation of Private Fire Service Mains and Their Appurtenances*, 1995 edition.

NFPA 30, *Flammable and Combustible Liquids Code*, 1996 edition.

NFPA 51B, *Standard for Fire Prevention in Use of Cutting and Welding Processes*, 1994 edition.

NFPA 58, *Standard for the Storage and Handling of Liquefied Petroleum Gases*, 1995 edition.

NFPA 70, *National Electrical Code*, 1996 edition.

NFPA 72, *National Fire Alarm Code*, 1996 edition.

NFPA 80A, *Recommended Practice for Protection of Buildings from Exterior Fire Exposures*, 1996 edition.

NFPA 88B, *Standard for Repair Garages*, 1991 edition.

NFPA 204, *Guide for Smoke and Heat Venting*, 1997 edition.

NFPA 600, *Standard on Industrial Fire Brigades*, 1996 edition.

NFPA 601, *Standard for Security Services in Fire Loss Prevention*, 1996 edition.

NFPA 1420, *Recommended Practice for Pre-Incident Planning for Warehouse Occupancies*, 1993 edition.

NFPA *Industrial Fire Brigades Training Manual*.

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