FIRST DRAFT MEETING MINUTES

NFPA Technical Committee on Hazardous Chemicals (HCS-AAA)
NFPA 400/40 First Draft Meeting (A2027)

October 14-16, 2025
11:00 a.m. – 4:00 p.m. (ET)

Web/Teleconference

1. **Call to order.** Lynne Kilpatrick, chair, called the meeting to order at 11:00 a.m. on October 14, 2025.
2. **Introductions.** Attendees introduced themselves and identified their affiliation. NFPA staff took attendance.
3. **Chair report.** Lynne Kilpatrick welcomed attendees and provided an overview of the meeting.
4. **Staff liaison report.** Sarah Frey provided an overview of the standards development process and the revision cycle schedule.
5. **Previous meeting minutes.** The minutes from September 19, 2025 were approved without revision.
6. **NFPA 40 First Draft.**
   a. **Review of Public Inputs.** No public input received.
   b. **Task group report.** The following task groups provided their reports and recommendations.
   c. **Task Group on Storage of Nitrate Film**. Milt Shefter. The task group provided a report, revisions were made. These will be available in the First Draft Report at www.nfpa.org/40. The task group was reconstituted to continue work. See attached.
7. **NFPA 400 First Draft.**
   a. **Review of Public Inputs.** The Technical Committee reviewed the Public Inputs and developed First Revisions and Committee Inputs as necessary. These will be available in the First Draft Report at www.nfpa.org/400.
   b. **Task group reports.** The following task groups provided their reports and recommendations.
      i. **Task Group on Chapter 15 Tanks and Bulk Storage**. Tony Ordile. The task group provided a report, no revisions were made. The task group was reconstituted to continue work.
      ii. **Task Group on Tanks**. Jerry Wallace. The task group provided a report, no revisions were made. The task group was reconstituted to continue work.

iii. **Task Group on Overview of NFPA 400**. Bob James. The task group provided a report, no revisions were made. The task group was reconstituted to continue work. See attached.
iv. **Task Group on Table (Section 15.3.2.4.13(B) and Chapter 14 and 15) Alignment with NFPA 30**. John LeBlanc. The task group provided a report, no revisions were made. The task group was reconstituted to continue work. See attached.
v. **Task Group on Chapter 21 Review**. Marty Gresho, Irene Uriarte Villanueva. The task group provided a report, no revisions were made. The task group was reconstituted to continue work.
vi. **Task Group on Ammonium Nitrate Emulsions**. Josh Hoffman. The task group provided a report, no revisions were made. The task group has been discharged with thanks.
vii. **Task Group on Section 5.2.1.1.3 MAQ Requirements**. Lynne Kilpatrick. The task group provided a report, no revisions were made. The task group was reconstituted to continue work.
viii. **Task Group on Bulk Storage**. Josh Hoffman. The task group provided a report, no revisions were made. The task group has been discharged with thanks.
ix. **Task Group on Chapter 19 Review for Protection Features for Unstable Materials**. Paul Iacobucci. The task group provided a report, no revisions were made. The task group was reconstituted to continue work.
x. **Task Group on Hazardous Materials Separation Table**. Mohamed AlMarri. The task group provided a report, no revisions were made. The task group was reconstituted to continue work. See attached.
xi. **Task Group on Chapter 15 Oxidizer General Requirements for Storage**. David Chicca. The task group provided a report, no revisions were made. The task group has been discharged with thanks.

c. **New task groups.** The following task groups were appointed to work subsequent to the meeting:
i. **Elevated Open Structures and Emergency Egress**. TG Chair: Ed Hawthorn. Members: Bob James, Joyce Milles, Win Kwon, Elizabeth Buc, Pranav Bagaria, Tim Burchett. A task group was created to review proposals from Public Inputs 23 - 27 from CSB. The task group will look at the risk and consider other solutions to the problems presented. Will review NFPA 101 and any other applicable sources during the review process. The task group will provide recommendations at the Second Draft meeting. The guidance should address egress situations for workers on unwalled, elevated structures in the presence of materials posing physical and health hazards.
ii. **Annex J Update**. TG Chair: Jeff Foisel. Members: Ed Cope, John Leblanc, Katie Mulligan, Lynne Kilpatrick. A task group was created to update Annex J.1 with OSHA HSC 2025..
iii. **Materials Definition Update**. TG Chair: John LeBlanc. Members: Elizabeth Buc, Jeff Foisel, Irene Uriarte Villanueva, Josh Hoffman, Todd Oliver, Mohamed Al-Marri, Pranav Bagaria, Katie Mulligan, Bing deLeyos, Kirk Mitchell. Task group was created to develop and update hazard class definitions under the control of NFPA 400, with the GHS (Rev 7). Proposal will be developed for documents that are not within NFPA 400s scope. Will evaluate and provide recommendations on updating the definition to Water-

Reactive Material, including adding distinctions to Class 1-3 to the main body of the Code.

iv. **Hazardous Materials Regulatory Governance**. TG Chair: Alwin Kelly. Members: Tim Burchett, Joyce Miles. Task Group for doing a high-level review of NFPA 400 language and overall regulatory paradigm for hazardous materials. Will consider which documents have control over hazardous material (e.g. 5000, 30, 55) content and extract material. To coordinate with related Technical Committees and provide recommendations as needed.

8. **Other Business.**

9. **Future meetings.** The next committee meeting will be Fall 2026. A meeting notification will be posted at www.nfpa.org/400next when the meeting is scheduled.

10. **Adjournment.** The meeting was adjourned at 4:00 p.m. on October 16, 2025.

Attendees:

Committee Members:

X	**Kilpatrick, Lynne**	Chair	LMK Associates LLC
X	**Al-Marri, Mohamed**	Principal	Qatar Civil Defence MOI
X	**Bagaria, Pranav**	Principal	The Dow Chemical Company
X	**Buc, Elizabeth**	Principal	Fire & Materials Research Laboratory, LLC
X	**Burchett, Timothy**	Principal	Starr Technical Risks Agency, Inc.
X	**Carolan, Michael**	Principal	Dekra Process Safety - Chilworth
X	**Cope, Edwin**	Principal	Cope Engineering
	Cosey, William	Principal	Savannah River Nuclear Solutions, LLC
X	**deLeyos, Robert**	Principal	Lawrence Livermore National Laboratory
	Der Kinderen, Dirk	Principal	US Department of Transportation
	Gresho, Martin	Principal	FP2Fire, Inc.
X	**Hawthorne, Edward**	Principal	American Petroleum Institute
X	**Hoffman, Joshua**	Principal	Institute of Makers of Explosives (IME)
	Howell, Peter	Principal	Mark V, Inc.
	Hsu, Noel	Principal	The Fertilizer Institute
X	**Iacobucci, Paul**	Principal	SPI/Organic Peroxide Producers Safety
X	**James, Robert**	Principal	Ione Rose Consulting
X	**Kelly, Alwin**	Principal	Jensen Hughes
	Koffel, William	Principal	Compressed Gas Association
X	**Kreitman, Kevin**	Principal	Albany Fire Department
X	**Kwok, Win**	Principal	Aon Corporation
X	**LaBerge, Todd**	Principal	TLB Fire Protection Engineering, Inc.
	Lagomarsino, Howard	Principal	Virginia Fire Prevention Association
X	**Lee, R. Kenneth**	Principal	Axiall LLC
X	**Mennella, Michael**	Principal	Nassau County Fire Marshal's Office
X	**Miles, Joyce**	Principal	American Chemistry Council

X	**Mitchell, Kirk**	Principal	Isocyanurates Industry Adhoc Committee
	Myers, Philip	Principal	PEMY Consulting LLC
X	**Ordile, Anthony**	Principal	Haines Fire & Risk Consulting Corporation
X	**Ramo, Leonard**	Principal	Telgian Corporation
X	**Roberts, Selwyn**	Principal	Charles County Goverment-La Plata, MD
X	**Schumacher, John**	Principal	Advanced Engineering Investigations
X	**Shefter, Milton**	Principal	Miljoy Ent. Incorporated
	Shriner, Jonathan	Principal	US Architect of the Capitol
	Suarez, Robert	Principal	International Association of Fire Fighters
X	**Uriarte-Villanueva, Irene**	Principal	FM
X	**Vigerust, James**	Principal	NFPA Industrial Fire Protection Section
	Wallace, Jerry	Principal	Safety Engineering Laboratories, Inc.
	Butler, Keith	Alternate	Telgian Corporation
X	**Dluzneski, Peter**	Alternate	SPI/Organic Peroxide Producers Safety
	Drullinger, Benjamin	Alternate	Safety Engineering Laboratories. Inc.
	Early, Rob	Alternate	Compressed Gas Association
X	**Foisel, Jeffrey**	Alternate	Dekra
	Gay, Amy	Alternate	Isocyanurates Industry Adhoc Committee
	Jason, Zachary	Alternate	Advanced Engineering Investigations
X	**LeBlanc, John**	Alternate	FM
X	**Mulligan, Katie**	Alternate	The Dow Chemical Company
	Norsworthy, Milton	Alternate	Fire and Materials Research Laboratories
X	**Oliver, Todd**	Alternate	Jensen Hughes
X	**Shatzer, David**	Alternate	Shatzer & Associates Consulting
	Theis, Amy	Alternate	NFPA Industrial Fire Protection Section
	Wagner, Casey	Alternate	Haines Fire & Risk Consulting
	Chicca, David	Nonvoting Member	Occupational Safety & Health
X	**Frey, Sarah**	Staff Liaison	National Fire Protection Association

Guests:

Nick Kuehl	Guest	IME Institute of Makers of Explosives
Chris Reimer	Guest	Fike
Rachel Del gaudo	Guest	Association of Moving Image Archivists' Nitrate Committee

Total in Attendance:
37

DEPARTMENT	PREPARED BY/DATE	REVIEWED/APPROVED BY/DATE
Research and Special Projects	B. Stilwell - 9/23/2019 ENGINEERING	ENGINEERING
SUBJECT Nitrate Film Fire Testing	**KEYWORDS**	**REPORT RELEASE DATE** 09/23/2019
CUSTOMER and REQUESTING ORGANIZATION NFPA 40	**FIKE WORK ORDER No** **PURCHASE ORDER No. (if appl.)**	**RELATED TEST REPORTS**
DISTRIBUTION		

REVIEW/DATE	REVISIONS DESCRIPTION
11/2019	Added lower concentration tests for 50% Argon and 38% Nitrogen

1. OBJECTIVE

Fike was approached by Chris Reimer/NFPA 40 to conduct research for alternate methods for extinguishing nitrate film fires. Because cellulose nitrate contains oxygen, nitrate fires can be difficult to extinguish. The goal of this project is to conduct tests with nitrate film provided and use clean agents, both chemical and inert to determine the effectiveness of the agents.

Background

Currently high density sprinklers are installed in nitrate film storage areas and it is assumed the effectiveness of these systems is limited.

2. EXECUTIVE SUMMARY

The testing conducted showed that when nitrate film is burned in a roll it is a violent fire that was unable to be extinguished by chemical agents. Argon at 50% and 75% concentration was able to keep the film from flaming visibly although the roll of film was completely consumed after being exposed to the Argon concentration. Nitrogen at 38% performed similar to Argon at 50% and 75%. It is estimated that inert gas may be able to prevent fire spread from going from one film reel to another.

3. TESTING

3.1. To assess the burning characteristics of the film a 35mm x 6 foot strip was cut from a reel and laid on a flat surface and ignited. The 6 feet of film burned in a total of 51 seconds. The burning was a bit like a fuse as there were short flashes during the burning.
https://www.youtube.com/watch?v=ScIKhAmZqO8

3.2. The next test consisted of the 6 foot length of film on the floor of a 12 cubic foot enclosure. The film was ignited on one end and after sustained ignition a concentration of chemical agent was introduced into the enclosure. The agent rapidly extinguished the fire after discharge. This test was repeated with the same result.
https://www.youtube.com/watch?v=LXq8nskuhgg&feature=youtu.be

3.3. The next test was to wrap a 6 foot section of film around a ¾ inch diameter rod and secure the outside of the film with a thin wire. The center rod was removed and the roll of film was ignited in

the air. The observation of this fire was it burned much more severe than the flat roll of film on the ground. The 6 feet of rolled film was consumed in 20 seconds. https://youtu.be/Zhm5rUgXecI

3.4. The fire described in 3.3 was ignited and a chemical clean agent was operated to see if it could extinguish the fire. The concentration of agent used was just under the quantity that could be safely used for human exposure. The system did not extinguish the fire. https://youtu.be/NvsIejkI5Ys

3.5. The fire described in 3.3 was ignited and placed into a 75% concentration of Argon inside the 12 cubic foot test enclosure. The reason it was done this way is because it takes a significant amount of time to introduce a 75% Argon concentration in a room (longer then it takes this sample to be totally consumed by fire). Observation of this fire was that there were no visible flames coming from the film, only a significant amount of smoke, which indicated incomplete combustion. After the test the film was completely consumed. https://youtu.be/EAnDmfT_G10

3.6. The fire described in 3.3 was ignited and placed into a 50% concentration of Argon inside the 12 cubic foot test enclosure. This fire behaved the same as the test described in 3.5. https://youtu.be/TDC8-jD2dOY

3.7. The fire described in 3.3 was ignited and placed into a 38% concentration of Nitrogen inside the 12 cubic foot test enclosure. This fire behaved the same as the test in 3.5 with the exception that there was a second or two of flames before the sample went to complete visible smoke. With this design concentration there are no time delays required and would be safe for human exposure up to 5-minutes. https://youtu.be/Mv_vsOBqu5k

4. RESULTS & DISCUSSION

4.1. A single layer of film is relatively easy to extinguish.

4.2. Chemical agents at concentrations suitable for exposure to personnel are not effective at extinguishing a film fire.

4.3. At Class C and above inert gas concentrations the film does not visibly flame, but does open smoke until the entire roll is consumed.

4.4. Design concentrations less than 43% inert gas are allowed with the same maximum exposure time as all agents in NFPA 2001(5-minutes)

4.5. Extinguishing a burning roll of film is likely next to impossible. Protecting the spread/adjacent rolls is likely possible if an inert gas agent is used.

4.6. A final test needs to take place that integrates an ignition source, detection, and suppression of a nitrate film fire.

APPENDIX A – PHOTOGRAPHS

Burning film laid flat

Roll of film prior to burning

Film roll after open burn

Smoking film roll in 75% Argon

Film roll after smoking in 75% Argon concentration

Committee Input

The current methods of fire protection of nitrate films are outdated. Water does not extinguish fires from cellulose nitrate film and does not protect the loss of property. The Committee is seeking to add gas fire suppression systems as part of the protection for Nitrate Film Vaults and looking for possible existing test data to prove the safety and reliability for updating the methods of protection during the Second Draft Meeting.

Background:

This project would be of interest to the broad safety community in that the results would amend the NFPA 40 code to include gas fire suppression systems in nitrate film vaults.

Current code mandates only water/sprinkler systems but there is ample evidence that water will NOT extinguish a cellulose nitrate film fire because the material generates its own oxygen.

This change is an urgent need because presently there is no code system for extinguishing cellulose nitrate film fires, and the underlying content has both significant cultural and financial value (as IP).

Some years agio, FM Global, with Vanderweil Engineering set up a simulated test for the Library of Congress' National Audio-Visual Conservation Center (NAVCC) to show how strong a nitrate film fire was. Using a few cans of nitrate film stacked as in a normal configuration with 4 X 4 beams set vertically three feet away to mirror "across the aisle" storage, the ignited fire, despite the water sprinkler fire suppression system, blew off the lids of the can/containers and turned the vertical beams into "toothpicks".

We suggest a similar test set-up but using gas suppression in various gas combinations to see which combination will effectively extinguish the fire.

Before COVID, FIKE ran some tests and noted that various gas combinations had different effectiveness. The most effective combination protected the surrounding cans but the ignited material did burn up.

Further testing is needed to determine the most effective combination of gases.

Determine which combination of gases is most effective in fire suppression. If the original ignition is contained from burning any but the originally ignited material, that would be a noteworthy value and reason to include gas suppression systems in the NFPA 40 code for Cellulose Nitrate film.

Project Data Collection:

Commented [SF1]: To attach to CI

FIKE results of various gas suppression combinations

Most importantly, the test results and the inclusion of gas suppression systems in NFPA 40 will help save iconic collections of iconic and historically important films.

The current code still requires sprinkler systems installed in original (existing) and newly constructed cellulose nitrate film storage vaults. The data allows the ability to increase protection for people and property with a gas suppression system that is validated with and have best practices in mind.

Nitrate cellulose film is a heritage preservation medium and at present a fire consumes all the product since the water sprinkler systems cannot extinguish a fire in the vault. More importantly, a fire in just one reel can spread to the entire contents of the vault since there is no extinguishing of the fire. This means we lose irreplaceable records and until a more effective system is tested and approved, all collections of nitrate cellulose films are in danger of being lost.

This is an URGENT project – time is not on our side!

NFPA 400 Overview

Chapter Number and Name	Information Covered
1. Administration	Provides the administrative details including the scope, applicability and exemptions of this code for all the occupancies and facilities that store, use or handle the following hazardous materials: 1) Ammonium Nitrate – solids, liquids and emulsions. 2) Corrosive solids and liquids 3) Flammable solids 4) Organic peroxide formulations 5) Oxidizers – solids and liquids 6) Pyrophoric solids and liquids 7) Toxic and highly toxic solids and liquids 8) Unstable (reactive) solids and liquids 9) Water-reactive solids and liquids 10) Compress gases and cryogenic fluids as included within the context of NFPA 55 Requirements for the compliance of the Hazardous Materials Management Plan (HMMP), Hazardous Material Inventory Statement (HMIS) and Plan Review are included in this chapter.
2. Referenced Publications	All the different documents referenced within this code are listed in this chapter.
3. Definitions	Contains all the definitions of the different terms used in this code including all the hazardous materials regulated by this code.
4. Classification of Materials, Wastes, and Hazard of Content.	This chapter provides the different hazard classification groups as defined in Chapter 3 for the code user to determine the applicability of requirements based on hazard category and class related to the physical and health hazards of materials. The following classifications are included: • Hazardous Materials Classification 1) Corrosive solids, liquids or gases 2) Flammable solids 3) Flammable gases 4) Flammable cryogenic fluids 5) Inert cryogenic fluids 6) Inert gases 7) Organic peroxide formulations 8) Oxidizers – solids and liquids 9) Oxidizing gases

	10) Oxidizing cryogenic fluids 11) Pyrophoric solids, liquids and gases 12) Toxic and highly toxic solids, liquids and gases 13) Unstable (reactive) solids and liquids 14) Water-reactive solids and liquids • Classification of High-Hazard Contents 1) High-Hazard Level 1 Contents. Materials that present a detonation hazard. 2) High-Hazard Level 2 Contents. Materials that present a deflagration hazard or a hazard from accelerated burning. 3) High-Hazard Level 3 Contents. Materials that readily support combustion or present a physical hazard. 4) High-Hazard Level 4 Contents. Materials that are acute health hazard. • Classification of Mixtures • Classification of Waste • Classification of Ignitable (Flammable or Combustible) Liquids 1) Class I Liquids 2) Class II Liquids 3) Class III Liquids
5. Permissible Storage and Protection Required	This chapter introduces the concepts of control area and Maximum Allowable Quantity (MAQ). The purpose is to permit limited amounts of hazardous contents in occupancies having minimum controls without triggering the more restrictive Protection Levels 1 through 4. Figure 5.1 presents the application of requirements in Chapter 5.

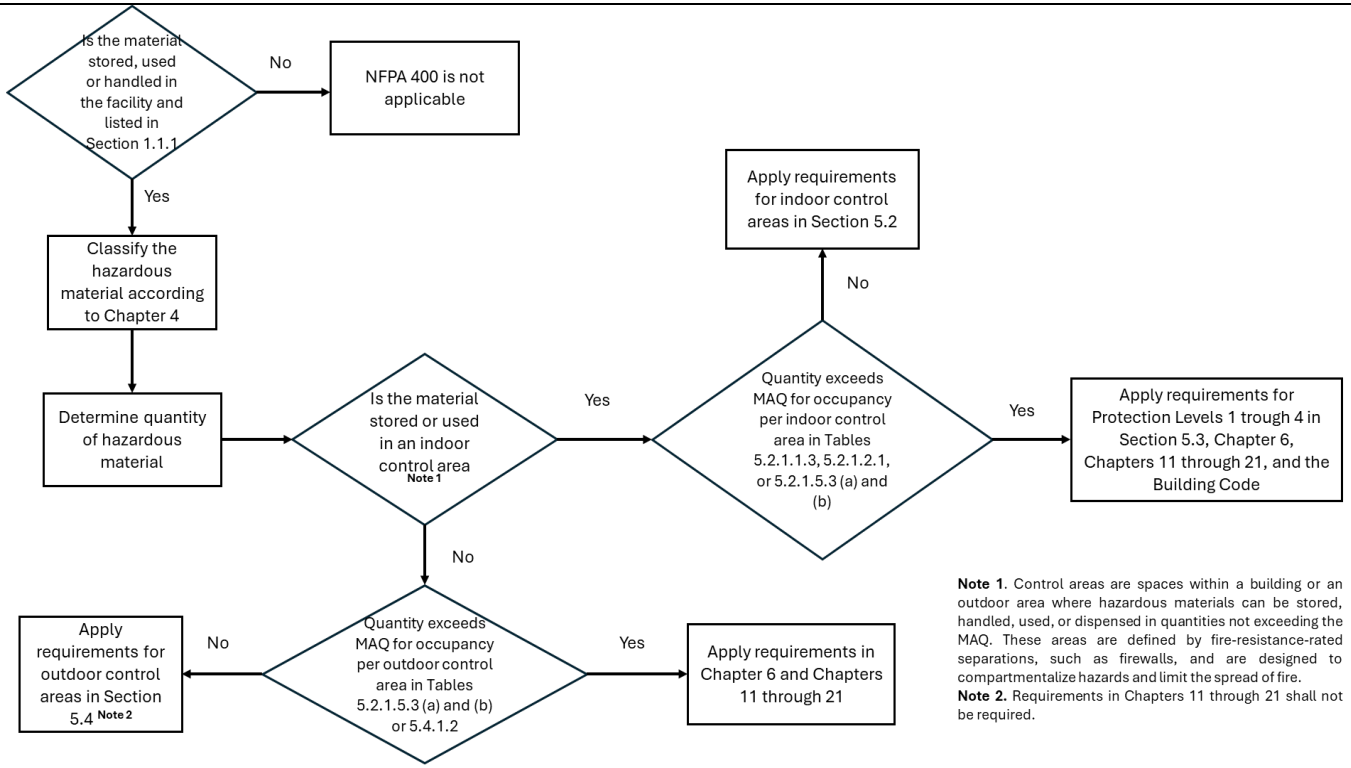


Figure 5.1 Applicability of Requirements in Chapter 5

6. Fundamental Requirements	The requirements in this Chapter, as well as the applicable material-specific requirements in Chapter 11 through 21, should be applied according to the following cases: 1. Storage, use and handling of hazardous materials in any quantities – Requirements from Chapter 6.1 2. Storage of hazardous materials in quantities exceeding the MAQ from Chapter 5 or when indicated in Figure 5.1- Requirements from Chapter 6.2. Outdoor control areas are not classified with protection levels. 3. Use, dispensing and handling of hazardous materials in quantities exceeding the MAQ from Chapter 5 or when indicated in Figure 5.1 – Requirements from Chapter 6.3. Outdoor control areas are not classified with protection levels.

7. Emergency Planning, Fire Risk Control, and Chemical Hazard Requirements for Industrial Processes.	This Chapter should be applied to emergency planning, fire risk control, and chemical hazard requirements associated with industrial processes consisting of interconnected equipment or vessels when all the following are present: 1. Facilities where the quantities of materials in use in the industrial processes require compliance with Protection Level 1, Protection Level 2, Protection Level 3 or Protection Level 4. 2. Presence of one or more of the following materials: a) Unpacked organic peroxide formulations that are capable of explosive decomposition in their unpacked state. b) Oxidizers Class 3 and Class 4 – solids and liquids c) Pyrophoric solids, liquids and gases d) Unstable reactive Class 3 and Class4 – solids, liquids and gases e) Highly toxic solids, liquids and gases f) Water-reactive liquids, Class 3 This Chapter should not be applied when a qualified design professional documents that the unmitigated consequences of a process upset condition will not result in the following: 1. Explosion with blast overpressure exceeding 1 psi (6.9 kPa) at 60 ft (20 m) or at the property line, whichever is less. 2. Fire with radiant energy exceeding 1500 BTU/hr/ft^2 (4.73 kW/m2) over 15 seconds duration at 60 ft (20 m) (flux value) or at the property line, whichever is less. 3. Maximum airborne concentration from a release of material that, with a 1-hour exposure, would cause irreversible or other serious health effects or symptoms that could impair an individual's ability to take protection action at a distance of 60 ft (20 m) from the process or at the property line, whichever is less.
8. Reserved	
9. Security for Hazardous Materials	This Chapter should be applied to facilities where all the following are present: 1. Quantities of materials in use in the industrial processes require compliance with Protection Level 1, Protection Level 2, Protection Level 3 or Protection Level 4. 2. Presence of one or more of the following materials: a) Unpacked organic peroxide formulations that are capable of explosive decomposition in their unpacked state. b) Oxidizers Class 3 and Class 4 – solids and liquids c) Pyrophoric solids, liquids and gases d) Unstable reactive Class 3 and Class4 – solids, liquids and gases e) Highly toxic solids, liquids and gases f) Water-reactive liquids, Class 3

10. Performance-Based Option	The requirements of this Chapter should be applied to facilities designed to the performance-based option permitted by Chapter 4 of NFPA 1.
11. Ammonium Nitrate Solids, Liquids and Emulsions	This chapter should be applied to the storage, use and handling of solid, liquid or emulsions of ammonium nitrate in quantities greater than 1000 lb (450 kg), when the following is present according to the physical form: 1. Solid ammonium nitrate in the form of crystals, flakes, grains or prills including fertilizer grade and industrial grade or other mixtures containing 60 percent or more by weight of ammonium nitrate. 2. Liquid ammonium nitrate solutions containing 70 percent or more by weight of ammonium nitrate. 3. Ammonium nitrate emulsions that are classified as Division 5.1 substances by the US Department of Transportation (DOT). In addition of the requirements of this Chapter for the applicable cases, Chapters 1 and 4 should apply, as well as Chapters 6 through 10, unless otherwise indicated in this Chapter. Also, where Chapter 11 is applicable, Chapters 15 and 19 should not apply. This chapter should not be applied to the following cases: 1. Liquid ammonium nitrate solutions used as fertilizers unless classified as a hazardous material by the US Department of Transportation (DOT) 2. Ammonium nitrate and ammonium nitrate mixtures that are DOT Hazard Class 1 explosives. 3. Calcium ammonium nitrate (CAN) as defined in Chapter 3 and that complies with the manufacturing specification in section 11.1.1.8. 4. Agricultural application of ammonium nitrate and ammonium nitrate-based fertilizers in outdoor agricultural uses. The applicable requirements of Chapters 1-10 and Chapters 12-20 should apply to solid or liquid ammonium nitrate that is not regulated by Chapter 11.
12. Corrosive Solids and Liquids	This chapter applies to the storage, use and handling of corrosive solids or liquids when the amount exceeds the MAQ from Chapter 5. The storage, use and handling of corrosive solids or liquids in any quantity should also comply with the requirements of Chapters 1 and 4 and the applicable requirements of Chapters 5 through 10.
13. Flammable Solids	This Chapter applies to the storage, use and handling of flammable solids when the amount exceeds the MAQ from Chapter 5.

	The storage, use and handling of flammable solids in any quantity should also comply with the requirements of Chapters 1 and 4 and the applicable requirements of Chapters 5 through 10.
14. Organic Peroxide Formulations	This Chapter should apply to the storage, use and handling of classified solid or liquid organic peroxide formulations in Classes I, IIA, IIB, III, IV and V of any quantity. In addition to the requirements of this Chapter, requirements of Chapters 1 and 4 and the applicable requirements of Chapters 5 through 10 should be applied. When the quantities do not exceed the MAQs from Chapter 5, only the sections listed in 14.1.1.2 should apply.
15. Oxidizers Solids and Liquids	This Chapter applies to the storage, use and handling of oxidizers solids or liquids when the amount exceeds the MAQ from Chapter 5, except for the following cases: 1. Where Class 1 oxidizers are stored in quantities that exceed 4000 lb (1814.4 kg), the requirements in 15.3.2.1 should apply, irrespective of whether the amount of oxidizer solid or liquids exceed the MAQs permitted in control areas. 2. Where Class 1 through Class 3 oxidizers are displayed and stored in mercantile, storage, or industrial occupancies where the general public has access to the material for sale and to the storage of oxidizing materials in such occupancies in areas that are not accessible to the public, the requirements in 15.3.5 should apply. The storage, use and handling of oxidizers, solids or liquids in any quantity should also comply with the requirements of Chapters 1 and 4 and the applicable requirements of Chapters 5 through 10.
16. Reserved	
17. Pyrophoric Solids and Liquids	This Chapter applies to the storage, use and handling of pyrophoric solids and liquids when the amount exceeds the MAQ from Chapter 5. The storage, use and handling of pyrophoric solids and liquids in any quantity should also comply with the requirements of Chapters 1 and 4 and the applicable requirements of Chapters 5 through 10.
18. Toxic or Highly Toxic Solids and Liquids	This Chapter applies to the storage, use and handling of toxic or highly toxic solids and liquids when the amount exceeds the MAQ from Chapter 5. The storage, use and handling of toxic or highly toxic solids and liquids in any quantity should also comply with the requirements of Chapters 1 and 4 and the applicable requirements of Chapters 5 through 10.
19. Unstable (Reactive) Solids and Liquids	This Chapter applies to the storage, use and handling of unstable (reactive) solids and liquids when the amount exceeds the MAQ from Chapter 5. The storage, use and handling of unstable (reactive) solids and liquids in any quantity should also comply with the requirements of Chapters 1 and 4 and the applicable requirements of Chapters 5 through 10.
20. Water-Reactive Solids and Liquids	This Chapter applies to the storage, use and handling of water-reactive solids and liquids when the amount exceeds the MAQ from Chapter 5.

	The storage, use and handling of water-reactive solids and liquids in any quantity should also comply with the requirements of Chapters 1 and 4 and the applicable requirements of Chapters 5 through 10.
21. Storage, Use and Handling of Compressed Gases and Cryogenic Fluids.	This chapter should apply to the installation, storage, use, and handling of compressed gases and cryogenic fluids in portable and stationary cylinders, containers, equipment, and tanks in all occupancies. The requirements in this chapter apply to users, producers, distributors, and others who are involved with the storage, use, or handling of compressed gases or cryogenic fluids. This chapter should not apply to the following: 1. Off-site transportation of [compressed gases or cryogenic fluids] 2. Storage, use, and handling of radioactive gases in accordance with NFPA 801 3. Use and handling of medical compressed gases at health care facilities in accordance with NFPA 99, except as specified in Chapter 17 of NFPA 55 4. Systems consisting of cylinders of oxygen and cylinders of fuel gas used for welding and cutting in accordance with NFPA 51 5. Flammable gases used as a vehicle fuel when stored on a vehicle 6. Storage, use, and handling of liquefied and non-liquefied compressed gases in laboratory work areas in accordance with NFPA 45 7. Storage, use, and handling of liquefied petroleum gases in accordance with NFPA 58 8. Storage, use, and handling of compressed gases within closed-cycle refrigeration systems complying with the mechanical code 9. Liquefied natural gas (LNG) storage at utility plants under NFPA 59A 10. Compressed natural gas (CNG) and LNG utilized as a vehicle fuel in accordance with NFPA 52 11. Compressed hydrogen gas (GH_2), or liquefied hydrogen gas (LH_2) generated, installed, stored, piped, used, or handled in accordance with NFPA 2 when there are no specific or applicable requirements in NFPA 55 12. Nonflammable mixtures of ethylene oxide with other chemicals 13. Ethylene oxide in chambers 10 scf (0.283 Nm^3) or less in volume or for containers holding 7.05 oz (200 g) of ethylene oxide or less
Annex A. Explanatory Material	This annex is not part of the requirements of this NFPA document, but contains explanatory material, numbered to correspond with the applicable text paragraphs of the requirements. It is included for informational purposes only.
Annex B. Chemical Data	The information in this annex is not a part of the requirements of this NFPA document but provides support information to identify chemical hazards and classification of the substance. The following topics are included in this annex: a) Hazard recognition b) Chemical family – a pointer to hazard classification

	c) Description of chemical families d) Hazard category based on concentration e) Safety Data Sheets (SDSs) -a starter point for hazards identification. This annex is included for informational purposes only.
Annex C. Hazardous Materials Management Plans and Hazardous Materials Inventory Statements	Annex C provides guidance for the development of hazardous materials inventory statements (HMIS) and hazardous materials management plans (HMMP), which are required by the AHJ pursuant to Chapter 1 for hazardous materials. The following exceptions should apply: 1. Materials that have been satisfactorily demonstrated not to present a potential danger to public health, safety, or welfare, based upon the quantity or condition of storage, when approved. 2. Chromium, copper, lead, nickel, and silver need not be considered hazardous materials for the purposes of this annex unless they are stored in a friable, powdered, or finely divided state. Proprietary and trade secret information must be protected under the laws of the state or AHJ. This annex is not a part of the requirements of this NFPA document unless specifically adopted by the authority having jurisdiction.
Annex D. Security Information	This annex includes references that are relevant to the security of information, which are listed as informational resources only. This annex is included for informational purposes only.
Annex E. Properties and Uses of Ammonium Nitrate and Firefighting Procedures	This annex provides general guidance of the properties and hazards of ammonium nitrate and ammonium nitrate emulsions as well as suggested firefighting procedures and references for additional information on storage, test data and safety and security of ammonium nitrate. This annex is included for informational purposes only.
Annex F. Typical Organic Peroxide Formulations	This annex lists all typical organic peroxide formulations, their fire hazards characteristics and firefighting information according to the different hazard classification (Class I, IIA, IIB, III, IV and V). This annex is included for informational purposes only.
Annex G. Oxidizers	This annex is included for informational purposes only. The following is included: • Testing procedure and criteria for the classification of solid oxidizers. • List of typical oxidizers for Class 1, Class 2, Class 3 and Class 4. • General safety information on oxidizers used in detergents, swimming pools and as fertilizers (AN prills). • Methods and procedures for emergency responses involving solid oxidizers.

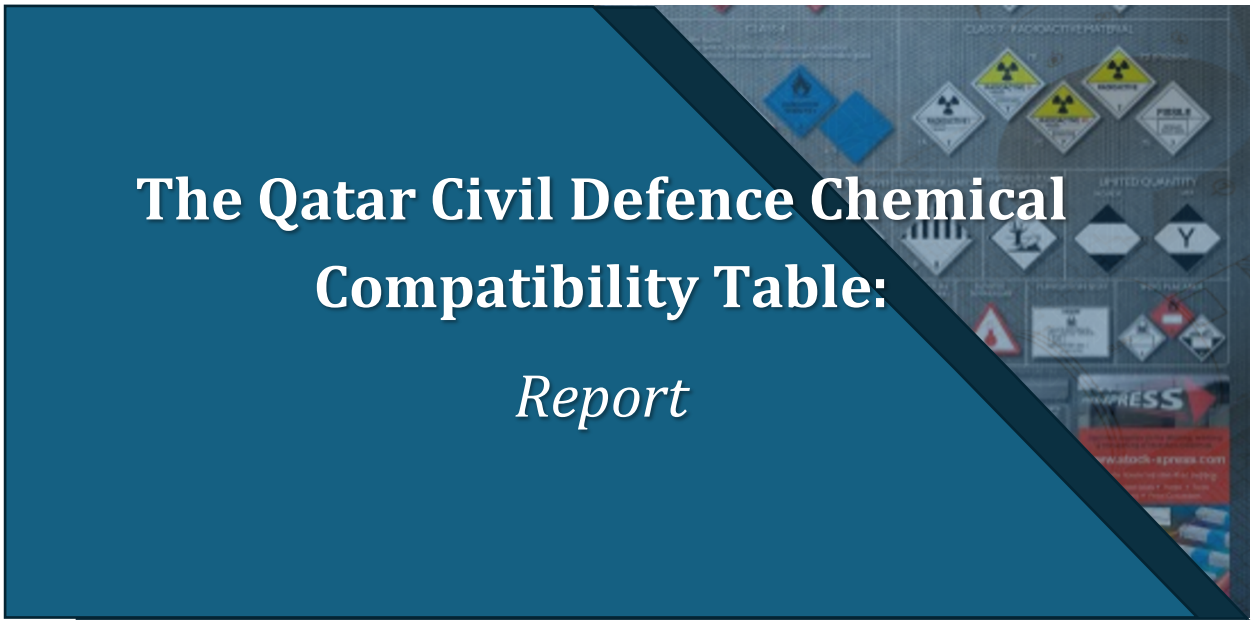
Annex H. Compressed Gases and Cryogenic Fluids	This annex provides general guidance for the analysis and determination of potential releases of regulated toxic and flammable substances. Physical properties of hydrogen are also included. This annex is included for informational purposes only.
Annex I. Emergency Response Guideline	The following is included in this annex for emergency response: • Emergency response • What is an emergency response according to OSHA • What is not an emergency response • Training curriculum for emergency response • Example training curriculum • Competencies – Analyzing the incident • Competencies – Implementing the planned response • Competencies – Evaluating progress • Competencies – Termination the incident This annex is included for informational purposes only.
Annex J. Hazardous Material Definitions Comparison Table	This annex provides a tabular presentation of the various definitions published within NFPA 400 as well as the source NFPA document for those definitions that are extracted. In addition, the table presents corresponding definitions, where available, from both the 2012 edition of the International Fire Code as well as from the 2012 edition of the Hazard Communication Standard developed by the Occupational Health and Safety Administration (OSHA). OSHA's Hazard Communication Standard aligns with the United Nations' Globally Harmonized System of Classification and Labeling of Chemicals. This annex is included for informational purposes only.
Annex K. Sample Ordinance for Adopting NFPA 400	This annex provides a sample ordinance to assist a jurisdiction in the adoption of this code. This annex is not a part of the requirements of this NFPA document but is included for informational purposes only.
Annex L. Informational References	The documents or portions thereof listed in this annex are referenced within the informational sections of this code and are not part of the requirements of this document unless also listed in Chapter 2 for other reasons.

CHEMICAL CLASS			2				3	4			5		6	8	9
			[2.1] Flammable gases	[2.2] Non flammable gases	[5.1][2.2] Oxidizing gas	[2.3]Toxic gases	[3] Flammable liquids	[4.1] Flammable solids	[4.2] Spontaneously combustible	[4.3] Dangerous when wet	[5.1] Oxidizing agent	[5.2] Organic peroxide	[6.1] Toxic	[8] Corrosive	[9] Miscellaneous
2		[2.1] Flammable gases	A	B	S1	S1	S2	S2	S4	S5	S2	S4	S1	S1	C
		[2.2] Non flammable gases	B	A	B	S1	S2	S2	S4	S5	B	S4	B	S1	C
		[5.1][2.2] Oxidizing gas	S1	B	A	S1	S2	S2	S4	S5	S2	S4	C	S1	C
		[2.3]Toxic gases	S1	S1	S1	A	S2	S2	S4	S5	S2	S4	C	S1	C
3		[3] Flammable liquids	S2	S2	S2	S2	A	S2	S4	S5	S2	S4	S3	S2	B
4		[4.1] Flammable solids	S2	S2	S2	S2	S2	A	S4	S5	S2	S4	S3	S2	B
		[4.2] Spontaneously combustible	S4	S4	S4	S4	S4	S4	A	S5	S4	S4	S4	S2	B
		[4.3] Dangerous when wet	S5	S5	S5	S5	S5	S5	S5	A	S5	S5	S5	S5	S5
5		[5.1] Oxidizing agent	S2	B	S2	S2	S2	S2	S4	S5	A	S4	C	S3	C
		[5.2] Organic peroxide	S4	S4	S4	S4	S4	S4	S4	S5	S4	A	S4	S4	S4
6		[6.1] Toxic	S1	B	C	C	S3	S3	S4	S5	C	S4	A	B	B
8		[8] Corrosive	S1	S1	S1	S1	S2	S2	S2	S5	S3	S4	B	A	C
9		[9] Miscellaneous	C	C	C	C	B	B	B	S5	C	S4	B	C	A

Code	Description
S1	The chemicals must be segregated by a minimum distance of ***3m (9.8 ft).***
S2	The chemicals must be segregated by a minimum distance of ***5m (16.4 ft).***
S3	Segregation of chemicals **must** be as follows: • PG I and II: at least ***5m (16.4 ft)*** • PG III: at least ***3m (9.8 ft)*** • Solid hazardous chemicals: at least ***1m (3.3 ft)***
S4	Fire rated partitioned area is preferred for this class of chemicals.
S5	Fire rated detached building is preferred for **Class 4.3** and other **water-reactive solids or liquids** where the usage of water-based suppression system is ***banned***
A	***SDS* must** be checked to guarantee the compatibility of the chemicals under the same class. If they are incompatible minimum segregation distance must be ***3m (9.8 ft)***
B	***SDS* must** be checked to guarantee the compatibility of the chemicals under different classes. If they are incompatible minimum segregation distance must be ***3m (9.8 ft)***
C	***SDS* must** be checked to guarantee the compatibility of the chemicals. If the incompatible chemicals have fire risk **(primary or subsidiary)**, at least ***5m (16.4 ft)*** of segregation distance is required

Ministry of Interior
General Admin. of Civil Defence
Preventive Department

وزارة الداخلية
الإدارة العامة للدفاع المدني
إدارة الوقائية



The Qatar Civil Defence Chemical Compatibility Table:

Report

Task Group Members: Lynne Kilpatrick, Bob James, Tim Burchett, Jim Vigerust,**(Chir)**Mohamed Talal AL-Marri

Sep 2025

Table of Contents

I. Introduction to Hazardous Materials

Hazardous Materials are inevitably present in countless industries, extending from manufacturing and agriculture to healthcare and research. While these materials of substances contribute to our economy and improvement of human lives, they also pose inherent and inevitable threats to human health and environment, if mishandled. Hence, safeguarding these materials is critical for the sustainable progress of the State of Qatar.

According to NFPA 400, a Hazardous Material is a chemical or a substance that is classified as a physical hazard material or a health hazard material, whether the chemical or substance is in usable or waste condition.[1] Due to the danger brought by the inherent hazard of these materials, substances must be managed carefully as they behave and react based on their physical and chemical properties. For example, the misuse of chemicals may result in fires and explosions.

II. Hazardous Materials Separation and Segregation Concept

Hazardous Materials Separation and Segregation Concept is an important safeguarding principle in the chemical storage requirements. This is primarily due to the undesirable effects of chemical reactions (i.e., fire, explosion, heat and smoke generation) of incompatible materials that may be detrimental to life, property, and the environment. To aid in the process of establishing a set of guidelines in the segregation process, a comprehensive and clear chemical compatibility table is necessary. The compatibility table was created and conceptualized to provide guidance in the safe chemical storage, handling, and use of hazardous chemicals and enforce measures to prevent incompatible materials/ chemicals from coming into contact with each other.

To attain this, an examination of relevant international and local codes and standards is essential to provide a robust and effective compatibility table guide. However, the discrepancies and inconsistencies in terms of definitions, classifications, and manner of labelling can sometimes be a cause of confusion and challenges due to their inconsistent systems. For instance, the State of Qatar has been reliant to the importation of chemicals and goods which typically adheres to standards different from what is being used locally. Hence, it is important to consider the existence and implementation of other standards currently used in the field. It is therefore paramount to discuss relevant standards to provide foundation for the proposed Qatar Civil Defence Compatibility Table.

Separation vs. Segregation

The safe storage of hazardous materials requires clear understanding of the principles of segregation and separation. While both terms aim to minimize risks from

[1] *NFPA 400-2025 Hazardous Materials Code, Section 3.3.66.4*

chemical incompatibilities, they differ in application and degree of isolation. Separation is a general term used to manage storage of incompatible chemicals. For instance, NFPA 400 6.1.12.2 defines how separation can be accomplished such as:

(1) Segregating incompatible materials storage by a distance of not less than 20 ft (6.1m);
(2) Isolating incompatible materials storage by a noncombustible partition extending not less than 18 in. (457 mm) above and to me sides of the stored material or by a noncombustible partition that interrupts the line of sight between the incompatible materials;
(3) Storing liquid and solid materials in hazardous materials storage cabinets complying with 6.1.18; and
(4) Storing compressed gases in gas cabinets or exhausted enclosures complying with Chapter 21.

Segregation, on the other hand, means storing hazardous materials in such a way that they are kept apart within the same area, usually achieved by using physical barriers or distance within the same storage room.

A. NFPA Requirements

a. NFPA 400 Hazardous Materials Code Requirements

In the NFPA 400, also known as the Hazardous Materials Code, provisions for the storage, handling, and use of hazardous materials, some moderate changes to the separation and segregation distances between chemical storage relative to the MAQ requirements per occupancy will be enforced from the following existing categories of hazardous materials to adapt with the working conditions by establishments in the State of Qatar. These materials can include a broad range of substances further categorized into 14 classes covering materials such as flammable liquids, toxic chemicals, corrosive agents, and reactive compounds.

Hazardous Material Classification (NFPA 400-2025)

(1). Corrosive solids, liquids, or gases
(2). Flammable solids
(3). Flammable gases
(4). Flammable cryogenic fluids
(5). Inert cryogenic fluids
(6). Inert gases
(7). Organic peroxide formulations
(8). Oxidizer solids or liquids
(9). Oxidizing gases
(10). Oxidizing cryogenic fluids
(11). Pyrophoric solids, liquids, or gases
(12). Toxic or highly toxic solids, liquids, or gases
(13). Unstable (reactive) solids, liquids, or gases
(14). Water-reactive solids or liquids

b. NFPA 30 Hazardous Materials Code Requirements

The NFPA 30 Flammable and Combustible Code provides the requirements for storage, handling, and use of flammable and combustible liquids, including waste liquids with similar properties. This code classifies liquid substances into flammable and combustible groups defined below:

> ***4.3.1*** *Flammable liquids, as defined in 3.3.33.2 and 4.2.3, shall be classified as Class I liquids and shall be further subclassified in accordance with the following:*
>
> *(1) Class IA Liquid — Any liquid that has a flash point below 73°F (22.8°C) and a boiling point below 100°F (37.8°C)*
>
> *(2) Class IB Liquid — Any liquid that has a flash point below 73°F (22.8°C) and a boiling point at or above 100°F (37.8°C)*
>
> *(3) Class IC Liquid — Any liquid that has a flash point at or above 73°F (22.8°C), but below 100°F (37.8°C)*

> ***4.3.2*** *Combustible liquids, as defined in 3.3.33.1 and 4.2.2, shall be classified in accordance with the following:*
>
> *(1) Class II Liquid — Any liquid that has a flash point at or above 100°F (37.8°C) and below 140°F (60°C)*
>
> *(2) Class III Liquid — Any liquid that has a flash point at or above 140°F (60°C)*
>
> *(a) Class IIIA Liquid — Any liquid that has a flash point at or above 140°F (60°C), but below 200°F (93°C)*
>
> *(b) Class IIIB Liquid — Any liquid that has a flash point at or above 200°F (93°C)*

B. US Department of Transportation (DOT) Hazard Classification System

The US Department of Transportation (DOT) is a widely recognized hazard classification system that regulates how materials are packaged, labeled, and transported based on the type of risk they present and the conditions under which the item is dangerous.[2] It is important to note that the US DOT is primarily implemented for the purpose of providing guidelines in the transportation of dangerous goods, and that there's a dedicated lead agency to oversee its implementation, the QCD finds it vital that this standard still be adapted to ensure that safety measures are implemented from the initial and final storage of chemicals which will fall under the jurisdiction of the QCD. The DOT classifies hazardous materials and dangerous goods into nine (9) categories, most of which are further broken down into divisions described and illustrated below.

[2] Code of Federal Regulations (US) for Hazardous Materials 49 CFR 172.101

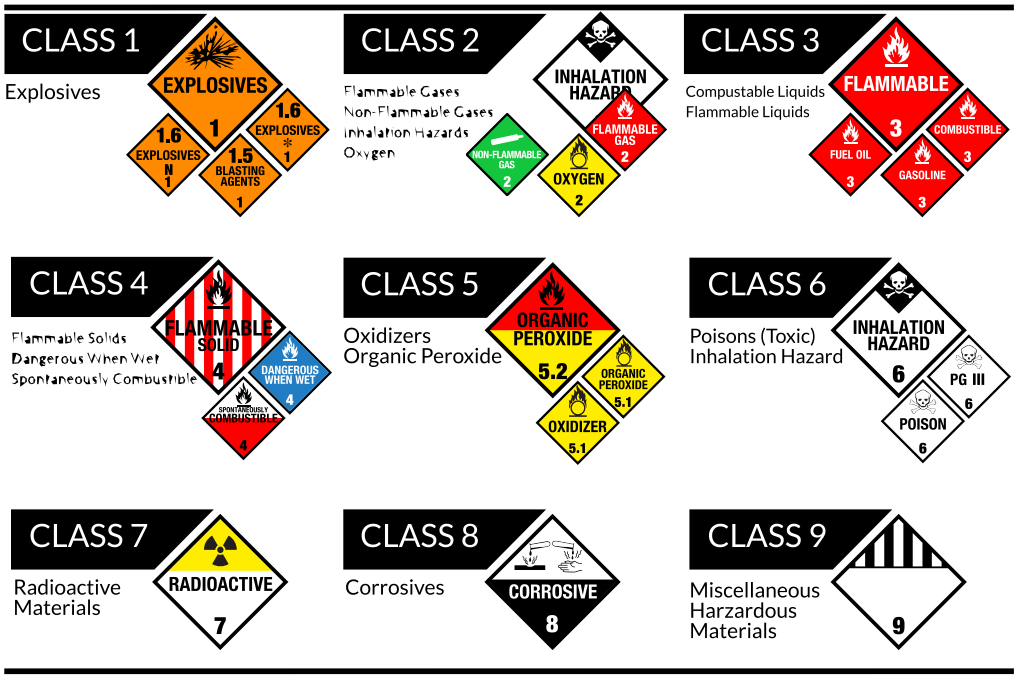


Figure 1. **Hazard Placards based on US DOT**

US Department of Transportation (DOT) Nine (9) Hazard Classifications

Class 2: Gases

Division 2.1: Flammable Gases
Division 2.2: Non-flammable, non-toxic gases
Division 2.3: Toxic Gases

Class 3: Flammable Liquids

Class 4: Flammable Solids

Division 4.1: Flammable solids, self-reactive substances, solid desensitized explosives
Division 4.2: Substances liable to spontaneous combustion
Division 4.3: Substances which, on contact with water, emit flammable gases

Class 5: Oxidizing Substances

Division 5.1: Oxidizing substances
Division 5.2: Organic peroxides

Class 6: Toxic & Infectious Substances

Division 6.1: Toxic substances

Class 8: Corrosive Substances

Class 9: Miscellaneous Hazardous Materials

To provide some basic information or a point of reference for determining the dangerous goods that are transported by air, land, and sea, the QCD Compatibility Table will also adopt the US DOT Hazard Classification System. For consistency, the term dangerous goods are deemed synonymous with the operational definition of hazardous materials. The DOT's hazard classes will help in identifying the primary hazard by the hazard class number assigned to a particular material prior to permanent storage, handling and use in the respective establishment.

C. United Nations Globally Harmonized System of Classification and Labeling of Chemicals (GHS)

The United Nations Globally Harmonized System of Classification and Labeling of Chemicals (GHS) is a global effort to standardize the handling of chemicals. It is an internationally agreed-upon system to standardize chemical hazard classification and communication.[3] Due to the wide use of this standard among nations, it is deemed beneficial to consider the inclusion of this system in the State of Qatar. Hence, the QCD Hazmat Branch will similarly adapt the United Nations Globally Harmonized System of Classification and Labeling of Chemicals (GHS) for the packaging of goods during transportation. To classify the chemicals by types of hazards (physical hazards, health and Environmental hazards) and to communicate information about the nature and the degree of hazard of the chemical product on labels and safety data sheets, the QCD Hazmat Compatibility Table will also employ the UN GHS pictograms for harmonization with the international standards as shown in Figure 2.

Figure 2. **Hazard Pictograms based on UN GHS**

[3] Globally Harmonized System of Classification and Labelling of Chemicals (GHS) Rev. 10, 2023

The QCD Hazmat Branch also emphasized the importance of the US DOT Hazard Classification markings, labels, and placards for the awareness and guidance of emergency response personnel associated to the transport of dangerous goods. However, it is important to note that these systems of chemical classifications provide varying ways of grouping substances. For instance, the Unstable (reactive) solids, liquids, or gases in NFPA 400 classification may not be directly classified under the US DOT. Hence, due diligence on classification should be practiced avoiding improper classification and segregation. In summary, the following is the general hazard classification using the three (3) chemical classification systems: NFPA 400, US DOT, and UN GHS, shown below:

Table 1. **Summary of Hazard Classification using DOT, NFPA, and GHS**

US DOT	NFPA 400	UN GHS
Class 2: Gases		
Division 2.1: Flammable Gases	Flammable gases	Flammable gases
		Aerosols
Division 2.2: Non-flammable, non-toxic gases	Inert gases	Gases under pressure
Division 2.3: Toxic Gases	Toxic or highly toxic gases	Acute toxicity (gas)
Class 3: Flammable Liquids	*Not covered by NFPA 400 (see NFPA 30)*	Flammable liquids
Class 4: Flammable Solids		
Division 4.1: Flammable solids, self-reactive substances, solid desensitized explosives	Flammable solids	Flammable solids
	Unstable (reactive) solids [a]	Self-reactive substances and mixtures [b]
Division 4.2: Substances liable to spontaneous combustion	Pyrophoric solids, liquids, or gases	Organic peroxides
		Pyrophoric solids
Division 4.3: Substances which, on contact with water, emit flammable gases	Water-reactive solids or liquids [c]	Substances which in contact with water emit flammable gases
Class 5: Oxidizing Substances		
Division 5.1: Oxidizing substances	Oxidizer solids, liquids or gases	Oxidizing solids
		Oxidizing liquids
		Oxidizing gases
Division 5.2: Organic peroxides	Organic peroxide formulations	Organic peroxides
Class 6: Toxic & Infectious Substances		
Division 6.1: Toxic substances	Toxic or highly toxic solids, liquids, or gases	Acute toxicity (oral, dermal, inhalation)
Class 8: Corrosive Substances	Corrosive solids, liquids, or gases	Serious eye damage/eye irritation
		Skin corrosion/irritation
Class 9: Miscellaneous Hazardous Materials		Hazardous to the aquatic environment

Notes:

[a] Unstable (reactive) solids, liquids, or gases are best categorized under US DOT Class 4 (solids).

[b] Self-reactive substances and mixtures do not have an equivalent with NFPA 400 and US DOT. However, this may be best classified with the US DOT's Division 4.2: Substances liable to spontaneous combustion

[c] Not all water-reactive solids or liquids are substances which, on contact with water, emit flammable gases

Packing Group

In addition to the classification of dangerous goods, certain substances and articles are further categorized into UN Packing Groups, which indicate the degree of danger presented by a substance. Packing groups are crucial in determining the type of packaging required for safe transport, storage, and handling. The UN Model Regulations on the Transport of Dangerous Goods establish a standardized global system for packaging.

Packing Group Categories

There are three packing groups, each reflecting the relative hazard level:

- Packing Group I – High danger
- Packing Group II – Medium danger
- Packing Group III – Low danger

Assignment of packing groups is determined by referencing the substance's Safety Data Sheet (SDS) and relevant regulatory codes (e.g., the Australian Dangerous Goods Code or equivalent international standards).

Table 2. **Packing Group Applicability by Class/Division**

Dangerous Goods Class/Division	Packing Groups Applicable
Class 3 – Flammable Liquids	I, II, III
Division 4.1 – Flammable Solids	I, II, III
Division 4.2 – Spontaneous Combustibles	I, II, III
Division 4.3 – Dangerous When Wet	I, II, III
Division 5.1 – Oxidizing Agents	I, II, III
Division 6.1 – Toxic Substances	I, II, III
Class 8 – Corrosive Substances	I, II, III
Class 9 – Miscellaneous Dangerous Goods	II, III

III. Proposed QCD Control Measures for the Storing, Handling, and Use of Hazardous Materials

The QCD Control Measures for Storing, Handling, and Use of Hazardous Materials were conceptualized in reference to the following provisions stated from NFPA 400 (Hazardous Materials Code) to wit:

FOR THE QCD CONTROL MEASURES ON GENERAL STORAGE:

(A) ON INCOMPATIBLE MATERIALS:

6.1 General Requirements. (NFPA 400, 2025)

6.1.12 Separation of Incompatible Materials.

6.1.12.2 *Separation shall be accomplished by one of the following methods:*

(1).Segregating incompatible materials storage by a distance of not less than 20 ft (6.1 m)

(2). Isolating incompatible materials storage by a noncombustible partition extending not less than 18 in. (457 mm) above and to the sides of the stored material or by a noncombustible partition that interrupts the line of sight between the incompatible materials

(3). Storing liquid and solid materials in hazardous materials storage cabinets complying with 6.1.18

(4). Storing compressed gases in gas cabinets or exhausted enclosures complying with Chapter 21

(B) ON FIRE BARRIERS / SEPARATION / PARTITIONED AREAS:

5.2 Control Areas

5.2.2 Construction Requirements for Control Areas

5.2.2.3 Where more than one control area is present in a building, control areas shall be separated from each other by fire barriers in accordance with Table 5.2.2.1

Δ Table 5.2.2.1 Design and Number of Control Areas

Floor Level	Maximum Allowable Quantity per Control Area (%)*	Number of Control Areas per Floor	Fire Resistance Rating for Fire Barriers† (hr)
Above grade			
>9	5.0	1	2
7–9	5.0	2	2
4–6	12.5	2	2
3	50.0	2	1
2	75.0	3	1
1	100.0	4	1
Below grade			
1	75.0	3	1
2	50.0	2	1
Lower than 2	NP	NP	N/A

NP: Not permitted. N/A: Not applicable.

*Percentages represent the applicable MAQ per control area shown in Table 5.2.1.1.3 or Table 5.2.1.2.1 with all the increases permitted in the footnotes of that table.

†Fire barriers are required to include floors and walls, as necessary, to provide a complete separation from other control areas.

6.2 Requirements for Occupancies Storing Quantities of Hazardous Materials Exceeding the Maximum Allowable Quantities per Control Area for High-Hazard Contents. (NFPA 400, 2025)

6.2.1 Indoor Storage General Requirements

6.2.1.3 Separation of Occupancies Having High Hazards. *The separation of areas containing high-hazard contents from each other and from other use areas shall be as required by Table 6.2.1.3 and shall not be permitted to be reduced with the installation of fire protection systems as required by 6.2.1.1.*

6.3.2 Indoor Dispensing and Use

6.3.2.1 General Indoor Requirements

6.3.2.1.2 Protection Level 1 through Protection Level 4

6.3.2.1.2.2 Separation of Occupancies Having High Hazards. The separation of areas containing high-hazard contents from each other and from other use areas shall be as required by Table 6.2.1.3 and shall not be permitted to be reduced with the installation of fire protection systems as required by 6.3.2.1.1.

Other Material-Specific Control Measures from NFPA 400-2025:

- *Chapter 11 Ammonium Nitrate Solids and Liquids*
- *Chapter 12 Corrosive Solids and Liquids*
- *Chapter 13 Flammable Solids*
- *Chapter 14 Organic Peroxide Formulations*
- *Chapter 15 Oxidizer Solids and Liquids*
- *Chapter 17 Pyrophoric Solids and Liquids*
- *Chapter 18 Toxic or Highly Toxic Solids and Liquids*
- *Chapter 19 Unstable (Reactive) Solids and Liquids*
- *Chapter 20 Water-Reactive Solids and Liquids*
- *Chapter 21 Storage, Use, and Handling of Compressed Gases and Cryogenic Fluids*

In reference herewith, the QCD Hazmat Branch then proposes the following parameters for the Chemical Compatibility Chart which aims to provide the minimum separation and segregation measures and control requirements on the storage, handling and use of hazardous materials to the establishments in the State of Qatar. These proposed moderate changes described in the following sections shall form part of the QCD compatibility table and incompatible materials separation and segregation requirements, to wit:

Table 3. **Parameters for the Control Measures in the Chemical Compatibility Chart**

Control Measure	NFPA 400	QCD Requirement
Segregation distance for incompatible materials	• 7.6 m (25 ft) distance between Organic peroxides/ Oxidizers and Flammable/Combustible Substances • 6.1 m (20 ft) distance for all other incompatible chemicals	General segregation distance requirement: • 1 m (3.3 ft) - Nonflammable solids and liquids • 3 m (9.8 ft) - Noncombustible Material (*i.e. solid, liquid, gas and categorized under UN PG III*) • 5 m (16.4 ft) - Flammable and Limited-Combustible Materials (*i.e. solid, liquid, gas, and categorized under UN PG I & II*)
Fire barriers / Separation (*i.e. including floors and walls*) in a building with Control Area/s (Table 5.2.2.1)	• 1H - above grade floor levels 1F, 2F, 3F only • 2H - Rooms in excess of 150 ft^2 (14 m^2) storing flammable liquids, combustible liquids, or Class 5.1 oxidizers	• 1H - Fire barriers / Separation: ✓ Toxic or highly toxic solids, liquids, or gases ✓ Nonflammable and Noncombustible Solids and Liquids • 2H - Fire barriers / Separation: ✓ Flammable and Combustible liquids ✓ Class 5.1 oxidizers
Fire barriers / Separation for Protection Levels: • Protection Level 2 - deflagration hazard • Protection Level 3 - physical hazard • Protection Level 4 - health hazards (Table 6.2.1.3 Required Separation (hr) of Occupancies Containing High-Hazard Contents)	For Protection Level 2: • 2H – general purpose industrial occupancy • 2H – special purpose industrial occupancy • 2H – mercantile class A • 2H – mercantile class B • 2H – mercantile class C • 2H – mercantile bulk retail • 2H – storage, low and ordinary hazard For Protection Level 3 and 4: • 1H – general purpose industrial occupancy • 1H – special purpose industrial occupancy • 1H – mercantile class A • 1H – mercantile class B • 1H – mercantile class C • 1H – mercantile bulk retail • 1H – storage, low and ordinary hazard	• 2H - For Protection Level 2 • 1H - For Protection Levels 3 and 4
FR-detached bldg. for water-reactive solids or liquids (NFPA 400.20.4.1.3)	• 2-hour fire-resistive wall extending not less than 30 in. (762 mm) above and to the side of the storage area	• 2H - fire resistive enclosure in closed systems • 1H - fire resistive enclosure in open systems
Detached Building	• Detached Building required for Protection Level 1	• Detached Building required for Protection Level 1

Discussion on Segregation Distance Reduction

The NFPA 400 (2025) prescribes a minimum segregation distance of 6.1 meters (20 feet) between incompatible hazardous materials, regardless of hazard class or packing group. While this provides a conservative margin of safety, practical experience and global best practices indicate that a uniform distance requirement can be impractical, space-inefficient, and overly restrictive, particularly in facilities with engineered fire protection measures.

The QCD Chemical Compatibility Table methodology and development presents a more risk-based and material-specific approach which aligns better with both international guidance and operational needs in the State of Qatar. The proposed reduction to 1 meter, 3 meters, and 5 meters, depending on the degree of hazard, provides a balanced compromise between safety assurance and efficient land use towards economic growth among industries.

A. Nonflammable Solids and Liquids (1 m)

These materials present minimal hazard beyond accidental spillage. A 1-meter segregation ensures sufficient space for inspection, handling, and emergency access without unnecessarily consuming storage area. Major fire/smoke spread drivers (ignitable vapors, oxidizing potential, reactive energy) are absent or minimal for nonflammable, nonreactive materials; segregation is primarily for inspection/egress and spill management, not flame impingement.

B. Noncombustible Materials / PG III (3 m)

Classified as low hazard under UN GHS and DOT standards, PG III substances require only moderate precautions. A 3-meter buffer is sufficient to minimize the risk of contamination, allow vapor dispersion, and provide safe firefighting access. The UN Orange Book assigns PG III to “low danger” substances; risk of rapid flame spread/overpressure is comparatively low, so the segregation driver is cross-contamination, minor reactions, and safe intervention.

C. Flammable and Limited-Combustible Materials / PG I & II (5 m)

These categories pose the highest fire and explosion risk. A 5-meter segregation maintains a conservative buffer to prevent flame spread or flash fire ignition, especially in the event of vapor release. The reduction from 6.1 meters to 5 meters remains within the bounds of international best practice while addressing land use constraints.

In summary, the QCD Hazmat Branch then proposes the following parameters for the Chemical Compatibility Chart as described in Table 4 and Figures 3 and 4.

Table 4. **Segregation Group Requirements**

Code	Description
S1	The chemicals must be segregated by a minimum distance of ***3m (9.8 ft).***
S2	The chemicals must be segregated by a minimum distance of ***5m (16.4 ft).***
S3	Segregation of chemicals **must** be as follows: • PG I and II: at least ***5m (16.4 ft)*** • PG III: at least ***3m (9.8 ft)*** • Solid hazardous chemicals: at least ***1m (3.3 ft)***
S4	Fire rated partitioned area is preferred for this class of chemicals.
S5	Fire rated detached building is preferred for **Class 4.3** and other **water-reactive solids or liquids** where the usage of water-based suppression system is ***banned***
A	***SDS* must** be checked to guarantee the compatibility of the chemicals under the same class. If they are incompatible minimum segregation distance must be ***3m (9.8 ft)***
B	***SDS* must** be checked to guarantee the compatibility of the chemicals under different classes. If they are incompatible minimum segregation distance must be ***3m (9.8 ft)***
C	***SDS* must** be checked to guarantee the compatibility of the chemicals. If the incompatible chemicals have fire risk **(primary or subsidiary)**, at least ***5m (16.4 ft)*** of segregation distance is required

Wherein:

- *"**S**" - Stands for the QCD-HAZMAT **STRUCTURE REQUIREMENTS**, where:*
  - ***S1** – Chemicals with a low material incompatibility*
  - ***S2** – Chemicals with a moderate material incompatibility*
  - ***S3** – Chemicals with a requirement dependent on the Material Packaging Group (PG) Declarations, where:*
    - ***PG1** are substances presenting high danger;*
    - ***PG2** are substances presenting medium danger; and*
    - ***PG3** are substances presenting low danger materials.*
  - ***S4** - Materials signify a chemical with high material incompatibilities*
  - ***S5** - Materials signify a chemical with extreme material incompatibilities*
- *"**A**" - Material segregation that is dependent on the SDS compatibility section where the **SAME CLASS OF SUBSTANCE/MATERIAL** will be stored and handled.*
- *"**B**" - Material segregation that is dependent on the SDS compatibility section where **DIFFERENT CLASS OF SUBSTANCE/MATERIAL** will be stored and handled.*
- *"**C**" - Material segregation that is dependent on the SDS compatibility section where the substance/material represents a **FIRE-RISK HAZARD** when stored and handled with other substances/materials.*

The proposed moderate changes for the QCD compatibility table and incompatible materials separation and segregation requirements are as shown in Tables 5. The format for the Compatibility Chart is illustrated in Tables 6 and 7.

Table 5. **Segregation via Hazard Classification for the Storing, Handling, and Use of Hazardous Materials**

CHEMICAL CLASS	**Segregation Group**							
	S1	**S2**	**S3**	**S4**	**S5**	**A (same class)**	**B (different class)**	**C (fire risk)**
[2.1] Flammable gases	• [5.1][2.2] • [2.3] • [6.1] • [8]	• [3] • [4.1] • [5.1]		• [4.2] • [5.2]	• [4.3]	• [2.1]	• [2.2]	• [9]
[2.2] Non-flammable gases	• [2.3] • [8]	• [3] • [4.1]		• [4.2] • [5.2]	• [4.3]	• [2.2]	• [2.1] • [5.1][2.2] • [6.1]	• [9]
[5.1][2.2] Oxidizing gas	• [2.1] • [2.3] • [8]	• [3] • [4.1] • [5.1]		• [4.2] • [5.2]	• [4.3]	• [5.1][2.2]	• [2.2]	• [6.1] • [9]
[2.3] Toxic gases	• [2.1] • [2.2] • [5.1][2.2] • [8]	• [3] • [4.1] • [5.1]		• [4.2] • [5.2]	• [4.3]	• [2.3]		• [6.1] • [9]
[3] Flammable liquids		• [2.1] • [2.2] • [5.1][2.2] • [2.3] • [4.1] • [5.1] • [8]	• [6.1]	• [4.ff2] • [5.2]	• [4.3]	• [3]	• [9]	
[4.1] Flammable solids		• [2.1] • [2.2] • [5.1][2.2] • [2.3] • [3] • [5.1] • [8]	• [6.1]	• [4.2] • [5.2]	• [4.3]	• [4.1]	• [9]	
[4.2] Spontaneously combustible		• [8]		• [2.1] • [2.2] • [5.1][2.2] • [2.3] • [3] • [4.1] • [5.1] • [5.2] • [6.1]	• [4.3]	• [4.2]	• [9]	
[4.3] Dangerous when wet					• [2.1] • [2.2] • [5.1][2.2] • [2.3] • [3] • [4.1] • [4.2] • [5.1] • [5.2] • [6.1] • [8] • [9]	• [4.3]		

CHEMICAL CLASS	Segregation Group							
	S1	**S2**	**S3**	**S4**	**S5**	**A (same class)**	**B (different class)**	**C (fire risk)**
[5.1]		• [2.1] • [5.1][2.2] • [2.3] • [3] • [4.1]	• [8]	• [4.2] • [5.2]	• [4.3]	• [5.1]	• [2.2]	• [6] • [9]
[5.2]				• [2.1] • [2.2] • [5.1][2.2] • [2.3] • [3] • [4.1] • [4.2] • [5.1] • [6.1] • [8] • [9]	• [4.3]	• [5.2]		
[6.1]	• [2.1]		• [3] • [4.1]	• [4.2] • [5.2]	• [4.3]	• [6.1]	• [2.2] • [8] • [9]	• [5.1][2.2] • [2.3] • 5.1
[8]	• [2.1] • [2.2] • [5.1][2.2] • [2.3]	• [3] • [4.1] • [4.2]	• [5.1]	• [5.2]	• [4.3]	• [8]	• [6]	• [9]
[9]				• [5.2]	• [4.3]	• [9]	• [3] • [4.1] • [4.2]	• [2.1] • [2.2] • [5.1][2.2] • [2.3]

Table 6. **QCD Chemical Compatibility Table Template**

CHEMICAL CLASS			2				3	4			5		6	8	9
			[2.1] Flammable gases	[2.2] Non flammable gases	[5.1][2.2] Oxidizing gas	[2.3]Toxic gases	[3] Flammable liquids	[4.1] Flammable solids	[4.2] Spontaneously combustible	[4.3] Dangerous when wet	[5.1] Oxidizing agent	[5.2] Organic peroxide	[6.1] Toxic	[8] Corrosive	[9] Miscellaneous
2		[2.1] Flammable gases													
		[2.2] Non flammable gases													
		[5.1][2.2] Oxidizing gas													
		[2.3]Toxic gases													
3		[3] Flammable liquids													
4		[4.1] Flammable solids													
		[4.2] Spontaneously combustible													
		[4.3] Dangerous when wet													
5		[5.1] Oxidizing agent													
		[5.2] Organic peroxide													
6		[6.1] Toxic													
8		[8] Corrosive													
9		[9] Miscellaneous													

Table 7a. **QCD Hazmat Branch Chemical Compatibility Table**

		CHEMICAL CLASS	2				3	4			5		6	8	9
			[2.1] Flammable gases	[2.2] Non flammable gases	[5.1][2.2] Oxidizing gas	[2.3]Toxic gases	[3] Flammable liquids	[4.1] Flammable solids	[4.2] Spontaneously combustible	[4.3] Dangerous when wet	[5.1] Oxidizing agent	[5.2] Organic peroxide	[6.1] Toxic	[8] Corrosive	[9] Miscellaneous
2		[2.1] Flammable gases	A	B	S1	S1	S2	S2	S4	S5	S2	S4	S1	S1	C
		[2.2] Non flammable gases	B	A	B	S1	S2	S2	S4	S5	B	S4	B	S1	C
		[5.1][2.2] Oxidizing gas	S1	B	A	S1	S2	S2	S4	S5	S2	S4	C	S1	C
		[2.3]Toxic gases	S1	S1	S1	A	S2	S2	S4	S5	S2	S4	C	S1	C
3		[3] Flammable liquids	S2	S2	S2	S2	A	S2	S4	S5	S2	S4	S3	S2	B
4		[4.1] Flammable solids	S2	S2	S2	S2	S2	A	S4	S5	S2	S4	S3	S2	B
		[4.2] Spontaneously combustible	S4	S4	S4	S4	S4	S4	A	S5	S4	S4	S4	S2	B
		[4.3] Dangerous when wet	S5	S5	S5	S5	S5	S5	S5	A	S5	S5	S5	S5	S5
5		[5.1] Oxidizing agent	S2	B	S2	S2	S2	S2	S4	S5	A	S4	C	S3	C
		[5.2] Organic peroxide	S4	S4	S4	S4	S4	S4	S4	S5	S4	A	S4	S4	S4
6		[6.1] Toxic	S1	B	C	C	S3	S3	S4	S5	C	S4	A	B	B
8		[8] Corrosive	S1	S1	S1	S1	S2	S2	S2	S5	S3	S4	B	A	C
9		[9] Miscellaneous	C	C	C	C	B	B	B	S5	C	S4	B	C	A

Table 7b. **Final Layout of the QCD Hazmat Branch Chemical Compatibility Table**

CHEMICAL CLASS			2				3	4			5		6	8	9
			[2.1] Flammable gases	[2.2] Non flammable gases	[5.1][2.2] Oxidizing gas	[2.3]Toxic gases	[3] Flammable liquids	[4.1] Flammable solids	[4.2] Spontaneously combustible	[4.3] Dangerous when wet	[5.1] Oxidizing agent	[5.2] Organic peroxide	[6.1] Toxic	[8] Corrosive	[9] Miscellaneous
2		[2.1] Flammable gases	A	B	S1	S1	S2	S2	S4	S5	S2	S4	S1	S1	C
		[2.2] Non flammable gases	B	A	B	S1	S2	S2	S4	S5	B	S4	B	S1	C
		[5.1][2.2] Oxidizing gas	S1	B	A	S1	S2	S2	S4	S5	S2	S4	C	S1	C
		[2.3]Toxic gases	S1	S1	S1	A	S2	S2	S4	S5	S2	S4	C	S1	C
3		[3] Flammable liquids	S2	S2	S2	S2	A	S2	S4	S5	S2	S4	S3	S2	B
4		[4.1] Flammable solids	S2	S2	S2	S2	S2	A	S4	S5	S2	S4	S3	S2	B
		[4.2] Spontaneously combustible	S4	S4	S4	S4	S4	S4	A	S5	S4	S4	S4	S2	B
		[4.3] Dangerous when wet	S5	S5	S5	S5	S5	S5	S5	A	S5	S5	S5	S5	S5
5		[5.1] Oxidizing agent	S2	B	S2	S2	S2	S2	S4	S5	A	S4	C	S3	C
		[5.2] Organic peroxide	S4	S4	S4	S4	S4	S4	S4	S5	S4	A	S4	S4	S4
6		[6.1] Toxic	S1	B	C	C	S3	S3	S4	S5	C	S4	A	B	B
8		[8] Corrosive	S1	S1	S1	S1	S2	S2	S2	S5	S3	S4	B	A	C
9		[9] Miscellaneous	C	C	C	C	B	B	B	S5	C	S4	B	C	A

IV. Referenced Publications

1. NFPA 1, Fire Code, 2018 edition.
2. NFPA 101®, Life Safety Code®, 2018 Edition.
3. NFPA 30, Flammable and Combustible Liquids Code, 2018 Edition.
4. NFPA 400, Hazardous Materials Code, 2025 Edition
5. NFPA 495, Explosive Materials Code, 2018 edition.
6. The Globally Harmonized System of Classification and Labelling of Chemicals (GHS) Rev. 10, 2023
7. Code of Federal Regulations (US) for Hazardous Materials 49 CFR 172.101

ANNEX A

Illustrations

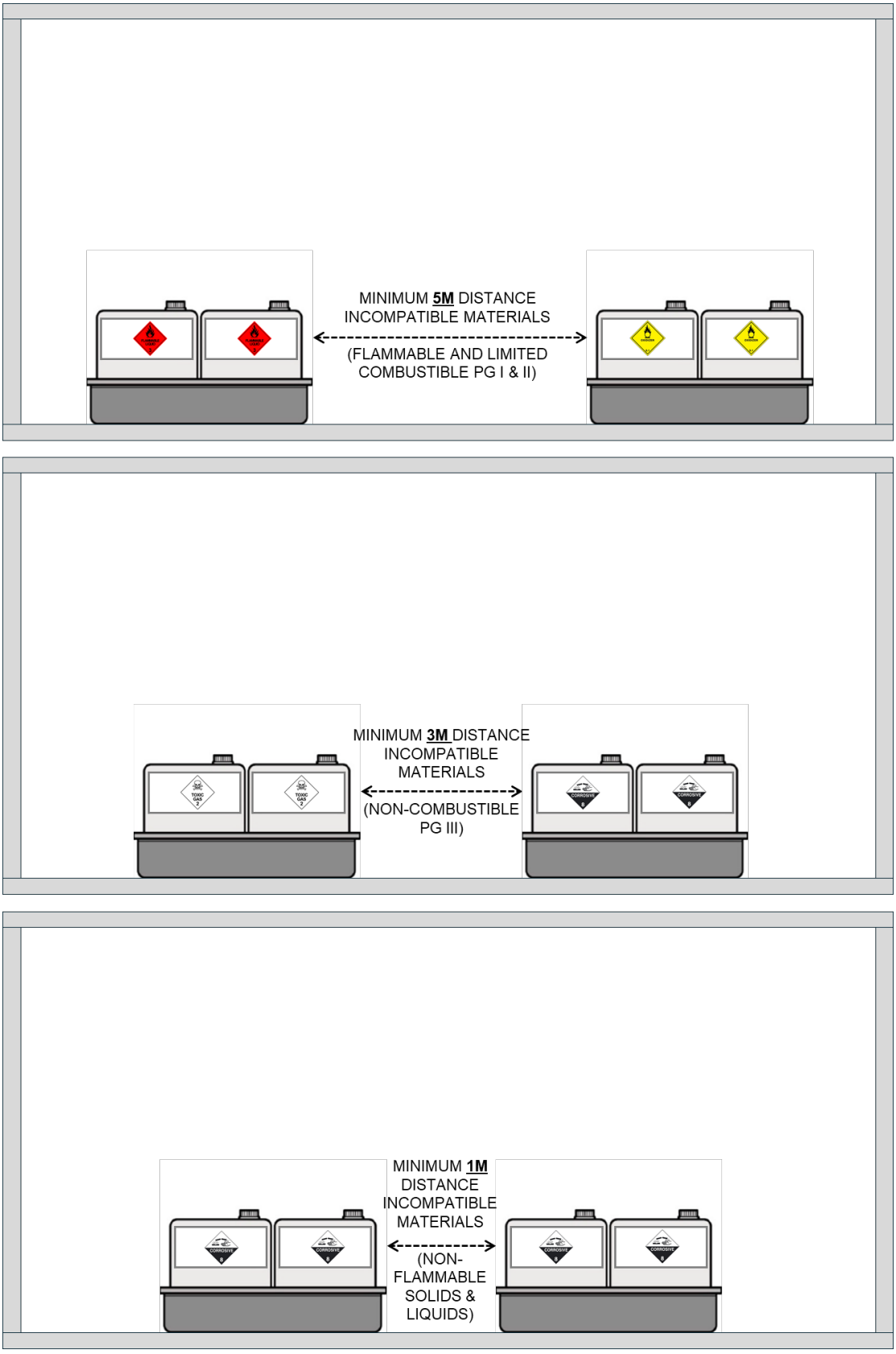


Figure 3. **Segregation Distance for Incompatible Materials**

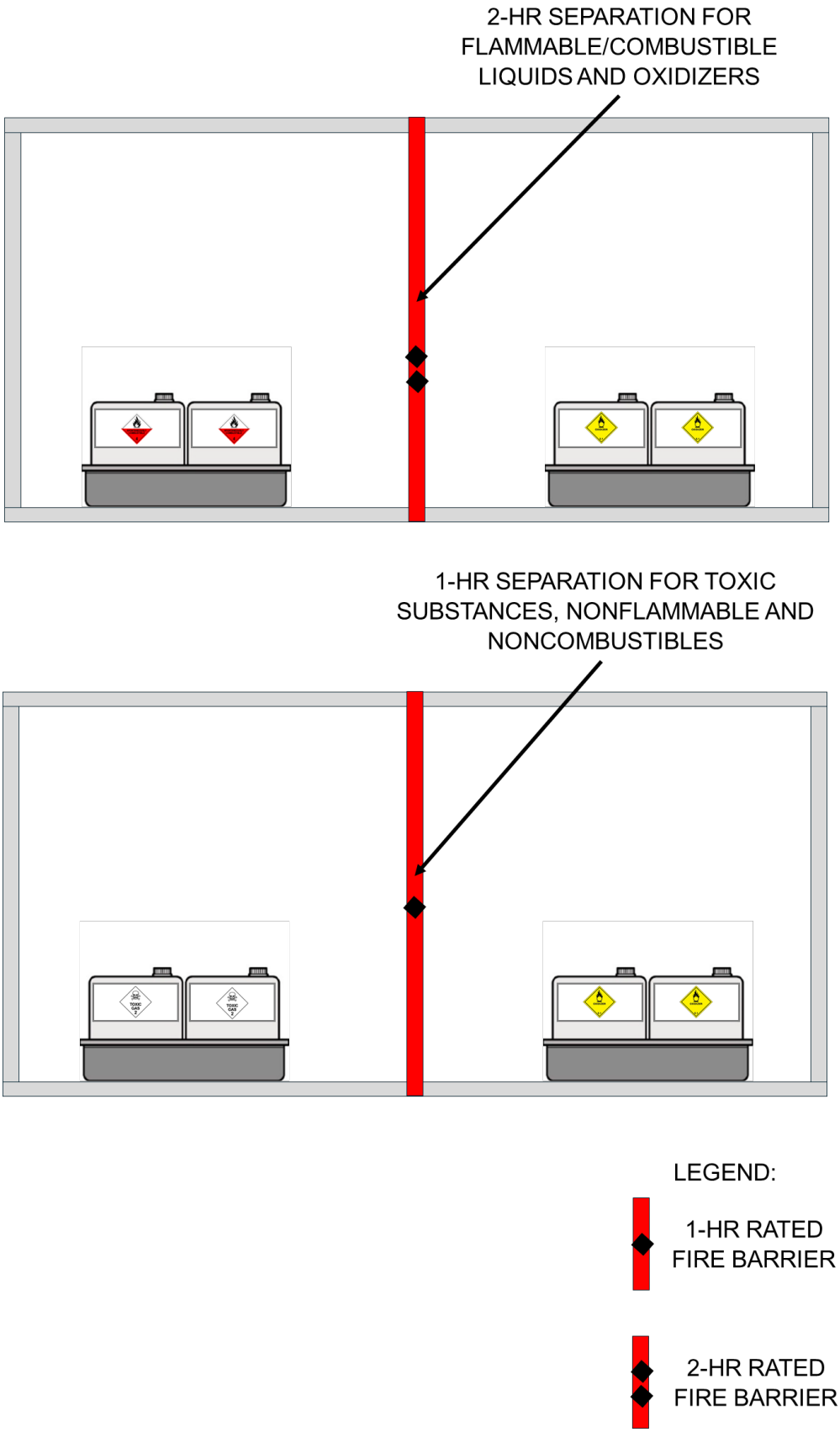


Figure 4. **Fire Barrier/Separation Requirements based on Hazard Classification**

ANNEX B

GHS Classification (Rev.10, 2023) Summary

GHS Hazard Class	GHS Division/Subcategory	DOT Model Regulations Class or Division
Flammable gases	1A: Flammable gas, Pyrophoric gas, Chemically unstable gas A, B	Div 2.1
Flammable gases	1B	Div 2.1
Flammable gases	Category 2	-
Aerosols	Category 1	Div 2.1
Aerosols	Category 2	Div 2.1
Flammable liquids	Category 1	Class 3
Flammable liquids	Category 2	Class 3
Flammable liquids	Category 3	Class 3
Flammable liquids	Category 4	-
Flammable solids	Category 1	Div 4.1
Flammable solids	Category 2	Div 4.1
Aerosols	Category 1	Div 2.1
Aerosols	Category 2	Div 2.1
Aerosols	Category 3	Div 2.2
Flammable gases	1A, Chemically unstable gas A	Div 2.1
Flammable gases	1A, Chemically unstable gas B	Div 2.1
Flammable gases	1A, Pyrophoric gas	Div 2.1
Self-reactive substances and mixtures; Organic peroxides	Type A	Div 4.1, 5.2 Type A
Self-reactive substances and mixtures; Organic peroxides	Type B	Div 4.1, 5.2 Type B
Self-reactive substances and mixtures; Organic peroxides	Type C, D	Div 4.1, 5.2 Type C, D
Self-reactive substances and mixtures; Organic peroxides	Type E, F	Div 4.1, 5.2 Type E, F
Self-reactive substances and mixtures; Organic peroxides	Type G	-
Pyrophoric liquids	Category 1	Div 4.2
Pyrophoric solids	Category 1	Div 4.2
Self-heating substances and mixtures	Category 1	Div 4.2
Self-heating substances and mixtures	Category 2	Div 4.2
Substances and mixtures which in contact with water, emit flammable gases	Category 1	Div 4.3
Substances and mixtures which in contact with water, emit flammable gases	Category 2	Div 4.3
Substances and mixtures which in contact with water, emit flammable gases	Category 3	Div 4.3

GHS Hazard Class	GHS Division/Subcategory	DOT Model Regulations Class or Division
Oxidizing gases	Category 1	Class 2
Oxidizing liquids; Oxidizing solids	Category 1	Div 5.1
Oxidizing liquids; Oxidizing solids	Category 2	Div 5.1
Oxidizing liquids; Oxidizing solids	Category 3	Div 5.1
Gases under pressure	Compressed gas, Liquefied gas, Dissolved gas	Div 2.2
Gases under pressure	Refrigerated liquefied gas	Div 2.2
Chemicals under pressure	Category 1	Div 2.1
Chemicals under pressure	Category 2	Div 2.1
Chemicals under pressure	Category 3	Div 2.2
Corrosive to Metals	Category 1	Class 8
Acute toxicity, oral	Category 1, 2	Div 2.3 or 6.1
Acute toxicity, oral	Category 3	Div 2.3 or 6.1
Acute toxicity, oral	Category 4	-
Acute toxicity, oral	Category 5	-
Aspiration hazard	Category 1	-
Aspiration hazard	Category 2	-
Acute toxicity, dermal	Category 1, 2	Div 2.3 or 6.1
Acute toxicity, dermal	Category 3	Div 2.3 or 6.1
Acute toxicity, dermal	Category 4	-
Acute toxicity, dermal	Category 5	-
Skin corrosion/irritation	Category 1, 1A, 1B, 1C	Class 8
Skin corrosion/irritation	Category 2	-
Skin corrosion/irritation	Category 3	-
Sensitization, Skin	Category 1, 1A, 1B	-
Serious eye damage/eye irritation	Category 1	-
Serious eye damage/eye irritation	Category 2A	-
Serious eye damage/eye irritation	Category 2B	-
Acute toxicity, inhalation	Category 1, 2	Div 2.3 or 6.1
Acute toxicity, inhalation	Category 3	Div 2.3 or 6.1
Acute toxicity, inhalation	Category 4	-
Acute toxicity, inhalation	Category 5	-
Sensitization, respiratory	Category 1, 1A, 1B	-
Specific target organ toxicity, single exposure; Respiratory tract irritation	Category 3	-
Specific target organ toxicity, single exposure; Narcotic effects	Category 3	-
Germ cell mutagenicity	Category 1, 1A, 1B	-
Germ cell mutagenicity	Category 2	-
Carcinogenicity	Category 1, 1A, 1B	-
Carcinogenicity	Category 1, 1A, 1B	-
Carcinogenicity	Category 2	-
Reproductive toxicity	Category 1, 1A, 1B	-
Reproductive toxicity	Category 1, 1A, 1B	-

GHS Hazard Class	GHS Division/Subcategory	DOT Model Regulations Class or Division
Reproductive toxicity	Category 1, 1A, 1B	-
Reproductive toxicity	Category 1, 1A, 1B	-
Reproductive toxicity	Category 1, 1A, 1B	-
Reproductive toxicity	Category 1, 1A, 1B	-
Reproductive toxicity	Category 2	-
Reproductive toxicity	Category 2	-
Reproductive toxicity	Category 2	-
Reproductive toxicity	Category 2	-
Reproductive toxicity, effects on or via lactation	Additional category	-
Specific target organ toxicity, single exposure	Category 1	-
Specific target organ toxicity, single exposure	Category 2	-
Specific target organ toxicity, repeated exposure	Category 1	-
Specific target organ toxicity, repeated exposure	Category 2	-
Hazardous to the aquatic environment, acute hazard	Category 1	Class 9
Hazardous to the aquatic environment, acute hazard	Category 2	-
Hazardous to the aquatic environment, acute hazard	Category 3	-
Hazardous to the aquatic environment, long-term hazard	Category 1	Class 9
Hazardous to the aquatic environment, long-term hazard	Category 2	Class 9
Hazardous to the aquatic environment, long-term hazard	Category 3	-
Hazardous to the aquatic environment, long-term hazard	Category 4	-
Hazardous to the ozone layer	Category 1	-
Acute toxicity, oral; acute toxicity, dermal	Category 1, 2	-
Acute toxicity, oral; acute toxicity, inhalation	Category 1, 2	-
Acute toxicity, dermal; acute toxicity, inhalation	Category 1, 2	-
Acute toxicity, oral; acute toxicity, dermal; acute toxicity, inhalation	Category 1, 2	-
Acute toxicity, oral; acute toxicity, dermal	Category 3	-
Acute toxicity, oral; acute toxicity, inhalation	Category 3	-
Acute toxicity, dermal; acute toxicity, inhalation	Category 3	-

GHS Hazard Class	GHS Division/Subcategory	DOT Model Regulations Class or Division
Acute toxicity, oral; acute toxicity, dermal; acute toxicity, inhalation	Category 3	-
Acute toxicity, oral; acute toxicity, dermal	Category 4	-
Acute toxicity, oral; acute toxicity, inhalation	Category 4	-
Acute toxicity, dermal; acute toxicity, inhalation	Category 4	-
Acute toxicity, oral; acute toxicity, dermal; acute toxicity, inhalation	Category 4	-
Acute toxicity, oral; acute toxicity, dermal	Category 5	-
Acute toxicity, oral; acute toxicity, inhalation	Category 5	-
Acute toxicity, dermal; acute toxicity, inhalation	Category 5	-
Acute toxicity, oral; acute toxicity, dermal; acute toxicity, inhalation	Category 5	-
Skin corrosion/irritation and serious eye damage/eye irritation	Category 2, 2B	-