Delete Consumer fireworks row from the tables below.
Also, add new footnote with subsequent letter to Tables listed below as shown AND add superscript associated with the footnote letter to both Combustible Liquids AND Flammable Liquids in the material column of the table.
Medicines, foodstuffs, cosmetics, and other consumer products that contain not more than 50% by volume water-miscible flammable or combustible liquids, with the remainder of the product consisting of components that do not burn, shall not be limited, where packaged in individual containers that do not exceed a 1.3-gallon capacity. [30: 2015]

These footnotes with associated letters specific for each table (different letters depending on the table as shown above) ALSO need to be added to BOTH Combustible Liquid AND Flammable Liquid in the MATERIAL column in each Table.

For example in Table 5.2.1.1.3 the two are separated
Combustible Liquid (o)
Flammable Liquid (o)
and in the remaining tables such as Table 5.2.1.10.1 they are together.
Flammable and Combustible Liquid (k) [Add the k to existing footnote superscripts]
In Chapter 6, delete all NFPA 1, Chapter 60 extract tags. For example, in 6.3.1.2.3.1 delete [1:60.4.4]. No changes to section text.

Committee Statement: Remove extract tags since no longer in current edition of NFPA 1. (Extracts were in 2009 version.)

Response Message:
Chapter 6  Fundamental Requirements

6.1  General Requirements.

6.1.1  Applicability.

Storage, use, and handling of hazardous materials in any quantity shall comply with Section 6.1.

6.1.1.1  Storage of hazardous materials in quantities exceeding the MAQ set forth in Chapter 5 shall comply with Section 6.2 and the applicable material specific requirements in Chapters 11 through 21.

6.1.1.2  The use, dispensing, and handling of hazardous materials in quantities exceeding the MAQ set forth in Chapter 5 shall comply with Section 6.3 and the applicable material specific requirements in Chapters 11 through 21.

6.1.2  Safety Data Sheets (SDS).

Safety data sheets (SDS) shall be available on the premises for hazardous materials regulated by this code. When approved, SDSs shall be permitted to be retrievable by electronic access.


6.1.3.1  Prohibited Releases.

Hazardous materials shall not be released into a sewer, storm drain, ditch, drainage canal, lake, river, or tidal waterway; upon the ground, a sidewalk, a street, or a highway; or into the atmosphere, unless such release is permitted by the following:

(1)  Federal, state, or local governing regulations
(2)  Permits of the jurisdictional air quality management board
(3)  National Pollutant Discharge Elimination System permit
(4)  Waste discharge requirements established by the jurisdictional water quality control board
(5)  Sewer pretreatment requirements for publicly or privately owned treatment works

6.1.3.2  Control and Mitigation of Unauthorized Releases.

Provisions shall be made for controlling and mitigating unauthorized releases.

6.1.3.3  Records of Unauthorized Releases.

Accurate records of the unauthorized release of hazardous materials shall be kept by the permittee.

6.1.3.4  Notification of Unauthorized Releases.

The fire department shall be notified immediately or in accordance with approved emergency procedures when an unauthorized release becomes reportable under state, federal, or local regulations.

6.1.3.5  Container Failure.
When an unauthorized release due to primary container failure is discovered, the involved primary container shall be repaired or removed from service.

6.1.3.6 Overpack Containers.

Overpack containers shall be permitted to be used as a means to provide protection for primary containers to be transported for repair or removal from service.

6.1.3.7 Responsibility for Cleanup of Unauthorized Releases.

6.1.3.7.1

The person, firm, or corporation responsible for an unauthorized release shall institute and complete all actions necessary to remedy the effects of such unauthorized release, whether sudden or gradual, at no cost to the AHJ.

6.1.3.7.2

When deemed necessary by the AHJ, cleanup of an unauthorized release shall be permitted to be initiated by the fire department or by an authorized individual or firm, and costs associated with such cleanup shall be borne by the owner, operator, or other person responsible for the unauthorized release.

6.1.4 Personnel Training.

Persons in areas where hazardous materials are stored, dispensed, handled, or used shall be trained in the hazards of the materials employed and actions required by the emergency plan. The level of training to be conducted shall be consistent with the responsibilities of the persons to be trained in accordance with 6.1.4.1 through 6.1.4.5.

6.1.4.1 Awareness.

The training provided for persons designated in 6.1.4 shall include awareness training in accordance with 6.1.4.1.1 through 6.1.4.1.3.

6.1.4.1.1 Completion.

Initial training shall be completed prior to beginning work in the work area.

6.1.4.1.2 Hazard Communications.

Training shall be provided prior to beginning work in the work area to enable personnel to recognize and identify hazardous materials stored, dispensed, handled, or used on site and where to find safety information pertaining to the hazards of the materials employed.

6.1.4.1.3 Emergency Plan.

Training shall be provided prior to beginning work in the work area to enable personnel to implement the emergency plan.

6.1.4.2 Operations Personnel.

Persons engaged in storing, using, or handling hazardous materials shall be designated as operations personnel and shall be trained in accordance with 6.1.4.1 and 6.1.4.2.1 through 6.1.4.2.6.
6.1.4.2.1 Physical and Health Hazard Properties.

Operations personnel shall be trained in the chemical nature of the materials, including their physical hazards and the symptoms of acute or chronic exposure as provided by the safety data sheet (SDS) furnished by the manufacturer or other authoritative sources.

6.1.4.2.2 Dispensing, Using, and Processing.

Operations personnel shall be trained in the use of specific safeguards applicable to the dispensing, processing, or use of the materials and equipment employed.

6.1.4.2.3 Storage.

Operations personnel shall be trained in the application of storage arrangements and site-specific limitations on storage for the materials employed.

6.1.4.2.4 Transport (Handling).

Operations personnel involved in materials handling shall be trained in the requirements for on-site transport of the materials employed.

6.1.4.2.5 Actions in an Emergency.

Operations personnel shall be trained in the necessary actions to take in the event of an emergency, including the operation and activation of emergency controls prior to evacuation.

6.1.4.2.6 Changes.

Training shall be provided whenever a new hazardous material is introduced into the work area that presents a new physical or health hazard, or when new information is obtained pertaining to physical or health hazards of an existing hazardous material that has not been included in previous training, and when there are changes in any of the following:

(1) Equipment
(2) Operations
(3) Hazardous materials

6.1.4.3 Emergency Response Liaison.

6.1.4.3.1

Responsible persons shall be designated and trained to be emergency response (ER) liaison personnel.

6.1.4.3.2

Emergency response liaison personnel shall do the following:

(1) Aid emergency responders in pre-planning responses to emergencies
(2) Identify locations where hazardous materials are located
(3) Have access to safety data sheets
(4) Be knowledgeable in the site emergency response procedures

6.1.4.4* Emergency Responders.
Emergency responders shall be trained to be competent in the actions to be taken in an emergency event.

6.1.4.4.1* Emergency Response Team Leader.

Persons acting as ER team leaders shall be trained under the Incident Command System concept or equivalent.

6.1.4.4.2* Response to Incipient Events.

Responses to incidental releases of hazardous materials where the material can be absorbed, neutralized, or otherwise controlled at the time of release by employees in the immediate release area, or by maintenance personnel, shall not be considered emergency responses as defined within the scope of this code.

6.1.4.4.3* On-Site Emergency Response Team.

When an on-site emergency response team is provided, emergency responders shall be trained in accordance with the requirements of the specific site emergency plan or as required by federal, state, or local governmental agencies.

6.1.4.5 Training Mandated by Other Agencies.

Training required by federal, state, or local regulations that is required based on the quantity or type of hazardous materials stored, dispensed, handled, or used shall be conducted in accordance with the requirements of and under the jurisdiction of the governing agency.

6.1.4.6 Documentation.

Training shall be documented and the documentation made available to the AHJ upon written request.

6.1.5 Ignition Source Controls.

6.1.5.1 Smoking.

Smoking shall be prohibited in the following locations:

(1) Within 25 ft (7.6 m) of outdoor storage areas, dispensing areas, or open use areas

(2) In rooms or areas where hazardous materials are stored or dispensed or used in open systems in amounts requiring a permit in accordance with Section 1.8

6.1.5.2 Open Flames and High-Temperature Devices.

Open flames and high-temperature devices shall not be used in a manner that creates a hazardous condition.

6.1.5.3 Energy-Consuming Equipment.

Energy-consuming equipment with the potential to serve as a source of ignition shall be listed or approved for use with the hazardous materials stored or used.

6.1.5.3.1* Powered Industrial Trucks.

Powered industrial trucks shall be operated and maintained in accordance with NFPA 505. [1:10.18]
6.1.6 Systems, Equipment, and Processes.

Processes, methods, specifications, equipment testing and maintenance, design standards, performance, installation, equipment design and construction, and other pertinent criteria shall be in accordance with this section.

6.1.6.1 Design and Construction of Containers and Tanks.

Containers, cylinders, and tanks shall be designed and constructed in accordance with approved standards. Containers, cylinders, tanks, and other means used for containment of hazardous materials shall be of an approved type.

6.1.6.2 Piping, Tubing, Valves, and Fittings.

Piping, tubing, valves, fittings, and related components used for hazardous materials shall be in accordance with the following:

(1) Piping, tubing, valves, fittings, and related components shall be designed and fabricated from materials compatible with the material to be contained and shall be of a strength and durability to withstand the pressure, structural and seismic stress, and exposure to which they are subject.

(2) Piping and tubing shall be identified in accordance with ASME A13.1, *Scheme for the Identification of Piping Systems*, to indicate the material conveyed.

(3) Accessible manual valves, or fail-safe emergency shutoff valves operated by a remotely located manually or automatically activated shutdown control, shall be installed on supply piping and tubing at the following locations:
   
   (a) Point of use
   
   (b) Tank or bulk source

(4) Manual emergency shutoff valves and remotely located manually activated shutdown controls for emergency shutoff valves shall be identified, and the location shall be clearly visible, accessible, and indicated by means of a sign.

(5) Backflow prevention or check valves shall be provided when the backflow of hazardous materials could create a hazardous condition or cause the unauthorized discharge of hazardous materials.

(6) Liquids classified in accordance with NFPA 704, shall be carried in pressurized piping above a gauge pressure of 15 psi (103 kPa) having a hazard ranking as follows:
   
   (a) Health hazard Class 3 or Class 4
   
   (b) Flammability Class 4
   
   (c) Instability Class 3 or Class 4

(7) The pressurized piping specified in 6.1.6.2(6) shall be provided with an approved means of leak detection and emergency shutoff or excess flow control in accordance with the following:
   
   (a) Where the piping originates from within a hazardous material storage room or area, the excess flow control shall be located within the storage room or area.
(b) Where the piping originates from a bulk source, the excess flow control shall be located at the bulk source.

(c) Piping for inlet connections designed to prevent backflow shall not be required to be equipped with excess flow control.

6.1.6.3 Additional Regulations for Supply Piping for Health Hazard Materials.

Supply piping and tubing for liquids or solids having a health hazard ranking of Class 3 or Class 4 in accordance with NFPA 704 shall be in accordance with ASME B31.3, Process Piping, and the following:

(1) Piping and tubing utilized for the transmission of highly toxic, toxic, or highly volatile corrosive liquids shall have welded, threaded, or flanged connections throughout, except for connections located within a ventilated enclosure, or an approved method of drainage or containment.

(2) Piping and tubing shall not be located within corridors, within any portion of a means of egress required to be enclosed in fire resistance–rated construction, or in concealed spaces in areas not classified as protection level 1 through protection level 4 occupancies.

6.1.6.4 Equipment, Machinery, and Alarms.

Equipment, machinery, and required detection and alarm systems associated with the use, storage, or handling of hazardous materials shall be listed or approved.

6.1.7 Empty Containers and Tanks.

Empty containers and tanks previously used for the storage of hazardous materials shall be free from residual material and vapor as defined by DOT, the Resource Conservation and Recovery Act (RCRA), or other regulating authority or shall be maintained as specified for the storage of hazardous material.

6.1.8 Signs.

6.1.8.1 General.

6.1.8.1.1 Design and Construction.

Signs shall be durable, and the size, color, and lettering of signs shall be in accordance with nationally recognized standards.

6.1.8.1.2 Language.

Signs shall be in English as the primary language or in symbols permitted by this code.

6.1.8.1.3 Maintenance.

Signs shall meet the following criteria:

(1) They shall not be obscured.

(2) They shall be maintained in a legible condition.

(3) They shall not be removed, unless for replacement.

6.1.8.2 Hazardous Materials Identification.
6.1.8.2.1 **NFPA 704 Placard.**

Visible hazard identification signs in accordance with NFPA 704 shall be placed at the following locations, except where the AHJ has received a hazardous materials management plan and a hazardous materials inventory statement in accordance with Sections 1.11 and 1.12 and has determined that omission of such signs is consistent with safety:

1. On stationary aboveground tanks
2. On stationary aboveground containers
3. At entrances to locations where hazardous materials are stored, dispensed, used, or handled in quantities requiring a permit
4. At other entrances and locations designated by the AHJ

6.1.8.2.2 **Identification of Containers, Cartons, and Packages.**

Individual containers, cartons, or packages shall be conspicuously marked or labeled in accordance with nationally recognized standards.

6.1.8.3 **No Smoking Signs.**

Where “no smoking” is not applicable to an entire site or building, signs shall be provided as follows:

1. In rooms or areas where hazardous materials are stored or dispensed or used in open systems in amounts requiring a permit in accordance with Section 1.8
2. Within 25 ft (7.6 m) of outdoor storage, dispensing, or open-use areas

6.1.9 **Protection from Vehicles.**

6.1.9.1 Guard posts or other approved means shall be provided to protect the following where subject to vehicular damage:

1. Storage tanks and connected piping, valves, and fittings
2. Storage areas containing tanks or portable containers except where the exposing vehicles are powered industrial trucks used for transporting the hazardous materials
3. Use areas

6.1.9.2 Where guard posts are installed, the posts shall meet the following criteria:

1. They shall be constructed of steel not less than 4 in. (102 mm) in diameter and concrete filled.
2. They shall be spaced not more than 4 ft (1.2 m) between posts on center.
3. They shall be set not less than 3 ft (0.9 m) deep in a concrete footing of not less than a 15 in. (381 mm) diameter.
4. They shall be set with the top of the posts not less than 3 ft (0.9 m) above ground.
5. They shall be located not less than 3 ft (0.9 m) from the tank.
6.1.10 Electrical Wiring and Equipment.

6.1.10.1 General.
Electrical wiring and equipment shall be installed in accordance with NFPA 70.

6.1.10.2 Static Accumulation.
When processes or use conditions exist where flammable gases, dusts, or vapors can be ignited by static electricity, means shall be provided to prevent the accumulation of a static charge and to dissipate the static charge to ground.

6.1.11 Protection from Light.
Materials that are sensitive to light shall be stored in containers designed to protect them from such exposure.

6.1.12 Separation of Incompatible Materials.

6.1.12.1
Incompatible materials in storage and storage of materials incompatible with materials in use shall be separated when the stored materials are in containers having a capacity of more than 5 lb (2.268 kg) or \( \frac{1}{2} \) gal (1.89 L).

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

6.1.12.3
Materials that are incompatible shall not be stored within the same cabinet or enclosure.

6.1.13 General Storage.

6.1.13.1 Storage.
The storage arrangement of materials shall be in accordance with this chapter and the material specific requirements of Chapters 11 through 21 as applicable.

6.1.13.2 Shelf Storage.
Shelving shall be constructed to carry the design loads and shall be braced and anchored in accordance with the seismic design requirements of the applicable building code.

6.1.13.2.1 Shelf Construction.
6.1.13.2.1.1
Shelving shall be treated, coated, or constructed of materials that are compatible with the hazardous materials stored.

6.1.13.2.1.2
Shelves shall be provided with a lip or guard where used for the storage of individual containers, except under either of the following conditions:

(1) Where storage is located in hazardous materials storage cabinets or laboratory furniture specifically designed for such use

(2) Where amounts of hazardous materials in storage do not exceed the quantity threshold for requiring a permit in accordance with Section 1.8

6.1.13.2.2
Shelf storage of hazardous materials shall be maintained in an orderly manner.

6.1.14* Seismic Protection.
Machinery and equipment utilizing hazardous materials in areas subject to seismic activity shall be seismically anchored in accordance with the building code.

Materials that are shock sensitive shall be padded, suspended, or otherwise protected against accidental dislodgement and dislodgement during seismic activity.

6.1.15 Outdoor Storage and Use Areas.
Outdoor storage and use areas for hazardous materials shall comply with the following:

(1) Outdoor storage and use areas shall be kept free of weeds, debris, and common combustible materials not necessary to the storage or use of hazardous materials.

(2) The area surrounding an outdoor storage and use area shall be kept clear of weeds, debris, and common combustible materials not necessary to the storage or use of hazardous materials for a minimum distance of 15 ft (4.5 m).

(3) Outdoor storage and use areas for hazardous materials shall be located not closer than 20 ft (6.1 m) from a property line that can be built upon, a street, an alley, or a public way, except that a 2-hour fire barrier wall, without openings and extending not less than 30 in. (762 mm) above and to the sides of the storage area, shall be permitted in lieu of such distance.

6.1.16 Maintenance Required.

6.1.16.1* Equipment, machinery, and required detection and alarm systems associated with hazardous materials shall be maintained in an operable condition.

6.1.16.2 Stationary tanks not used for a period of 90 days shall be safeguarded or removed in an approved manner.
6.1.16.2.1
The tanks specified in 6.1.16.2 shall have the fill line, gauge opening, and pump connection secured against tampering.

6.1.16.2.2
Vent lines shall be maintained.

6.1.16.2.3*
Tanks that are to be placed back in service shall be tested in an approved manner.

6.1.16.3
The following shall apply to defective containers, cylinders, and tanks:

(1) They shall be removed from service, repaired, or disposed of in an approved manner.

(2) Overpack containers shall be permitted to be used as a means to provide protection for primary containers that are transported for repair or removal from service.

6.1.16.4
Defective equipment or machinery shall be removed from service and repaired or replaced.

6.1.16.5
Required detection and alarm systems that are defective shall be replaced or repaired.

6.1.17 Testing.

6.1.17.1
The equipment, devices, and systems listed in 6.1.17.2.1 shall be tested at one of the intervals listed in 6.1.17.2.2. Written records of the tests conducted or maintenance performed shall be maintained.

6.1.17.2
Testing shall not be required under the following conditions:

(1) Where approved written documentation is provided that testing will damage the equipment, device, or system and the equipment, device, or system is maintained as specified by the manufacturer

(2) Where equipment, devices, and systems fail in a fail-safe manner

(3) Where equipment, devices, and systems self-diagnose and report trouble, with records of the self-diagnosis and trouble reporting made available to the AHJ

(4) Where system activation occurs during the required test cycle for the components activated during the test cycle

(5) Where approved maintenance in accordance with 6.1.16.1 is performed not less than annually or in accordance with an approved schedule, in which case the testing requirements set forth in 6.1.17.2.1 and 6.1.17.2.2 are permitted to apply.

The following equipment, devices, and systems shall be tested in accordance with 6.1.17 and 6.1.17.2.2:

1. Limit control systems for liquid level, temperature, and pressure required by 6.2.1.7
2. Monitoring and supervisory systems required by 6.2.1.1

6.1.17.2.2 Testing Frequency.

The equipment, systems, and devices listed in 6.1.17.2.1 shall be tested at one of the following frequencies:

1. Not less than annually
2. In accordance with the approved manufacturer’s requirements
3. In accordance with approved recognized industry standards
4. In accordance with an approved schedule

6.1.18 Hazardous Materials Storage Cabinets.

When storage cabinets are used to increase MAQ per control area or to otherwise comply with a specific provision in Chapter 6, such cabinets shall be in accordance with the following:

1. Cabinets shall be constructed of metal.
2. The interior of cabinets shall be treated, coated, or constructed of materials that are nonreactive with the hazardous material stored, and such treatment, coating, or construction shall include the entire interior of the cabinet.
3. Cabinets shall be either listed as suitable for the intended storage or constructed in accordance with the following:
   (a) Cabinets shall be of steel having a thickness of not less than 0.044 in. (1.12 mm) (18 gauge).
   (b) The cabinet, including the door, shall be double-walled with 1½ in. (38.1 mm) airspace between the walls.
   (c) Joints shall be riveted or welded and shall be tight-fitting.
   (d) Doors shall be well fitted, self-closing, and equipped with a self-latching device.
   (e) The bottoms of cabinets utilized for the storage of liquids shall be liquidtight to a minimum height of 2 in. (51 mm).
   (f) For requirements regarding electrical equipment and devices within cabinets used for the storage of hazardous liquids, compressed gases, or cryogenic fluids, see NFPA 70.
4. Cabinets shall be marked in conspicuous lettering that reads as follows: HAZARDOUS — KEEP FIRE AWAY

6.1.19 Installation of Tanks.

Installation of tanks shall be in accordance with 6.1.19.1 through 6.1.19.2.

6.1.19.1 Underground Tanks.
6.1.19.1.1
Underground tanks used for the storage of liquid hazardous materials shall be provided with secondary containment.

6.1.19.1.2
In lieu of providing secondary containment for an underground tank, an aboveground tank in an underground vault complying with NFPA 30 shall be permitted.

6.1.19.2 Aboveground Tanks.

Aboveground stationary tanks installed outdoors and used for the storage of hazardous materials shall be located and protected in accordance with the requirements for outdoor storage of the particular material involved and in accordance with the requirements of Chapters 11 through 21.

6.1.19.2.1
Aboveground tanks that are installed in vaults complying with NFPA 30 shall not be required to comply with location and protection requirements for outdoor storage.

6.1.19.2.2
Aboveground tanks that are installed inside buildings and used for the storage of hazardous materials shall be located and protected in accordance with the requirements for indoor storage of the particular material involved.

6.1.19.2.3 Marking.

Aboveground stationary tanks shall be marked as required by 6.1.8.2.1.

6.1.20
When required, fire alarm systems and smoke detection systems shall be installed in accordance with NFPA 72.

6.2 Requirements for Occupancies Storing Quantities of Hazardous Materials Exceeding the Maximum Allowable Quantities per Control Area for High Hazard Contents.

6.2.1 Indoor Storage General Requirements.

The requirements set forth in 6.2.1 provide general design requirements for protection levels and shall apply to buildings, or portions thereof, that are required to comply with protection level 1 through protection level 4 where required by Section 5.3. [5000:34.3.2]

6.2.1.1 Fire Protection Systems.

Buildings, or portions thereof, required to comply with protection level 1 through protection level 4 shall be protected by an approved automatic fire sprinkler system complying with Section 13.3 of NFPA 1. [5000:34.3.2.1]

6.2.1.1.1
The design of the sprinkler system shall be not less than ordinary hazard group 2 in accordance with NFPA 13 except as follows:

(1) Where different requirements are specified in Chapters 11 through 21 of NFPA 400
Where the materials or storage arrangement requires a higher level of sprinkler system protection in accordance with nationally recognized standards.

(3) Where approved alternative automatic fire extinguishing systems are permitted.

6.2.1.1.2

Electronic supervision of supervisory signals shall be provided in accordance with Section 13.3 of NFPA 1. [5000:34.3.2.1.1]

6.2.1.1.3

Waterflow alarms shall be monitored in accordance with Section 13.3 of NFPA 1. [5000:34.3.2.1.2]

6.2.1.1.4

Rooms or areas that are of noncombustible construction with wholly noncombustible contents shall not be required to comply with 6.2.1. [5000:34.3.2.1.3]

6.2.1.2 Building Height Exception.

The height of a single-story building, or portion thereof, containing only tanks or industrial process equipment shall not be limited based on the type of construction. [5000:34.3.2.2]

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. [5000:34.3.2.3]

Table 6.2.1.3 Required Separation of Occupancies Containing High Hazard Contents (hr)

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<th>Occupancy</th>
<th>Protection Level 1</th>
<th>Protection Level 2</th>
<th>Protection Level 3*</th>
<th>Protection Level 4</th>
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<td>Board and care, small</td>
<td>NP</td>
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### Occupancy Protection

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<th>Protection Level 3*</th>
<th>Protection Level 4</th>
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<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Hotels and dormitories</td>
<td>NP</td>
<td>4</td>
<td>3</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Industrial, general purpose</td>
<td>NP</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Industrial, special purpose</td>
<td>NP</td>
<td>2</td>
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<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Lodging and rooming houses</td>
<td>NP</td>
<td>4</td>
<td>3</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Mercantile, Class A</td>
<td>NP</td>
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</tr>
<tr>
<td>Mercantile, Class B</td>
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</tr>
<tr>
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<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Mercantile, covered mall</td>
<td>NP</td>
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<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
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<td>NP</td>
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<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Protection Level 1</td>
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<td>NP</td>
<td>NP</td>
<td>NP</td>
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<td>2</td>
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<td>NP</td>
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<td>1</td>
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<td>NP</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
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</table>

NP: Not permitted.

*Rooms in excess of 150 ft² (14 m²) storing flammable liquids, combustible liquids, or Class 3 oxidizers are required to be provided with not less than a 2-hour separation. [5000: Table 34.3.2.3]

### 6.2.1.4 Egress

Egress from areas required to comply with protection level 1, protection level 2, protection level 3, or protection level 4 shall comply with Chapter 14 of NFPA 1. [5000:34.3.2.4]

#### 6.2.1.4.1 Travel Distance Limit

Travel distance to an exit from areas required to comply with protection level 1 through protection level 4 shall not exceed the distance given in Table 6.2.1.4.1, measured as required in Chapter 14 of NFPA 1. [5000:34.3.2.4.1]

<table>
<thead>
<tr>
<th>Protection Level</th>
<th>Distance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ft</td>
</tr>
<tr>
<td>1</td>
<td>75</td>
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### Table 34.3.2.4.1

<table>
<thead>
<tr>
<th>Protection Level</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>ft</td>
</tr>
<tr>
<td>2</td>
<td>100</td>
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<tr>
<td>3</td>
<td>150</td>
</tr>
<tr>
<td>4</td>
<td>175</td>
</tr>
<tr>
<td>5</td>
<td>200</td>
</tr>
</tbody>
</table>

[5000: Table 34.3.2.4.1]

#### 6.2.1.4.2 Capacity of Means of Egress.

Egress capacity for high hazard contents areas shall be based on 0.7 in. (18 mm) per person for stairs or 0.4 in. (10 mm) per person for level components and ramps in accordance with 14.8.3 of NFPA 1. [5000:34.3.2.4.2]

#### 6.2.1.4.3 Number of Means of Egress.

Not less than two means of egress shall be provided from each building, or portion thereof, required to comply with Section 6.2, unless rooms or spaces do not exceed 200 ft² (18.6 m²), have an occupant load not exceeding three persons, and have a travel distance to the room door not exceeding 25 ft (7.6 m). [5000: 34.3.2.4.3]

#### 6.2.1.4.4 Dead Ends.

Means of egress, for other than rooms or spaces that do not exceed 200 ft² (18.6 m²), have an occupant load not exceeding three persons, and have a travel distance to the room door not exceeding 25 ft (7.6 m), shall be arranged so that there are no dead ends in corridors. [5000:34.3.2.4.4]

#### 6.2.1.4.5 Doors.

Doors serving high hazard contents areas with occupant loads in excess of five shall be permitted to be provided with a latch or lock only if the latch or lock is panic hardware or fire exit hardware complying with 14.5.3.3 of NFPA 1. [5000:34.3.2.4.5]

#### 6.2.1.5 Ventilation.

Buildings, or portions thereof, in which explosive, flammable, combustible, corrosive, or highly toxic dusts, mists, fumes, vapors, or gases are, or might be, emitted shall be provided with mechanical exhaust ventilation or natural ventilation where natural ventilation can be shown to be acceptable for the materials as stored. [5000:34.3.2.5.1]

#### 6.2.1.5.1

Solids and liquids stored in closed containers shall not be required to comply with 6.2.1.5. [5000:34.3.2.5.1.2]

#### 6.2.1.5.2

Mechanical exhaust systems shall comply with the mechanical code. [5000:34.3.2.5.2]

#### 6.2.1.5.3
Mechanical ventilation shall be at a rate of not less than 1 ft$^3$/min/ft$^2$ (5.1 L/s/m$^2$) of floor area over areas required to comply with protection level 1 through protection level 4. [5000:34.3.2.5.3]

6.2.1.5.4

Ventilation requirements shall be determined by calculations based on anticipated fugitive emissions or by sampling of the actual vapor concentration levels under normal operating conditions. [5000:34.3.2.5.5]

6.2.1.5.5

Make-up air shall be provided, and provision shall be made for locating make-up air openings to avoid short-circuiting the ventilation. [5000:34.3.2.5.6]

6.2.1.5.6

Ducts conveying explosives or flammable vapors, fumes, or dusts shall extend directly to the exterior of the building without entering other spaces. [5000:34.3.2.5.7]

6.2.1.5.6.1

Exhaust ducts shall not extend into or through ducts and plenums. [5000:34.3.2.5.7.1]

6.2.1.5.6.2

Ducts conveying vapor or fumes having flammable constituents less than 25 percent of their lower flammability limit shall be permitted to pass through other spaces. [5000:34.3.2.5.7.2]

6.2.1.5.7

Emissions generated by workstations shall be removed from the areas in which they are generated by means of local exhaust installed in accordance with the mechanical code.

6.2.1.5.8

The location of supply and exhaust openings shall be in accordance with the mechanical code. [5000:34.3.2.5.9]

6.2.1.5.9

Systems shall operate continuously unless alternate designs are approved. [5000:34.3.2.5.11]

6.2.1.5.10

A manual shutoff control for ventilation equipment required by 6.2.1.5 shall be provided outside the room adjacent to the principal access door to the room. [5000:34.3.2.5.12]

6.2.1.5.11

The shutoff control described in 6.2.1.5.10 shall be of the break-glass type and shall be labeled as follows:

VENTILATION SYSTEM EMERGENCY SHUTOFF

[5000:34.3.2.5.13]

6.2.1.5.12
Exhaust ventilation shall be arranged to consider the density of the potential fumes or vapors released. [5000:34.3.2.5.14]

6.2.1.5.12.1

For fumes or vapors that are lighter than air, exhaust shall be taken from a point within 12 in. (305 mm) of the high point of the room or area in which they are generated.

6.2.1.5.12.2

For fumes or vapors that are heavier than air, exhaust shall be taken from a point within 12 in. (305 mm) of the floor. [5000:34.3.2.5.14.1]

6.2.1.5.12.3

The location of both the exhaust and inlet air openings shall be arranged to provide air movement across all portions of the floor or room to prevent the accumulation of vapors. [5000:34.3.2.5.14.2]

6.2.1.5.12.4

Exhaust ventilation shall not be recirculated within the room or building if the materials stored are capable of emitting hazardous vapors. [5000:34.3.2.5.14.3]

6.2.1.5.12.5

Recirculation shall be permitted where it is monitored continuously using a fail-safe system that is designed to automatically sound an alarm, stop recirculation, and provide full exhaust to the outside in the event that vapor–air mixtures in concentrations over one-fourth of the lower flammable limit are detected. [5000:34.3.2.5.14.4]

6.2.1.5.12.6

Air contaminated with explosive or flammable vapors, fumes, or dusts, or with radioactive materials, shall not be recirculated.

6.2.1.6* Explosion Control.

Buildings, or portions thereof, required to comply with protection level 1 through protection level 3 and containing materials shown in Table 6.2.1.6 shall be provided with a means of explosion control. [5000:34.3.2.6]

<table>
<thead>
<tr>
<th>Hazard Category</th>
<th>Class</th>
<th>Protection Method</th>
</tr>
</thead>
<tbody>
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<td>Combustible dust presenting an explosion hazard</td>
<td>NA</td>
<td>Explosion control†</td>
</tr>
<tr>
<td>Organic peroxides</td>
<td>Unclassified</td>
<td>Barricade†</td>
</tr>
<tr>
<td></td>
<td>Class I</td>
<td>Barricade†</td>
</tr>
<tr>
<td>Oxidizer liquids and solids</td>
<td>Class 4</td>
<td>Barricade†</td>
</tr>
<tr>
<td>Unstable (reactive)</td>
<td>Class 4</td>
<td>Barricade†</td>
</tr>
<tr>
<td></td>
<td>Class 3, detonating</td>
<td>Barricade†</td>
</tr>
<tr>
<td></td>
<td>Class 3, deflagrating</td>
<td>Explosion control†</td>
</tr>
<tr>
<td>Hazard Category</td>
<td>Class</td>
<td>Protection Method</td>
</tr>
<tr>
<td>-------------------------------------</td>
<td>----------------</td>
<td>---------------------------</td>
</tr>
<tr>
<td>Water-reactive liquids and solids</td>
<td>Class 3</td>
<td>Explosion control</td>
</tr>
<tr>
<td></td>
<td>Class 2, deflagrating</td>
<td>Explosion control</td>
</tr>
</tbody>
</table>

NA: Not applicable.

* Explosion control is required to be a deflagration prevention method, such as combustible concentration reduction or oxidant concentration reduction, or a deflagration control method complying with NFPA 69 or an approved, engineered deflagration-venting method.

† Barricades are required to comply with NFPA 495.

[5000: Table 34.3.2.6]

6.2.1.7 Limit Controls.

Limit controls shall be provided in accordance with 6.2.1.7.1 and 6.2.1.7.2.

6.2.1.7.1 Temperature Control.

Materials that must be kept at temperatures other than normal ambient temperatures to prevent a hazardous reaction shall be provided with an approved means to maintain the temperature within a safe range.

6.2.1.7.1.1

Redundant temperature control equipment that will operate on failure of the primary temperature control system shall be provided.

6.2.1.7.1.2

The use of alternative means that prevent a hazardous reaction shall be permitted subject to the approval of the AHJ.

6.2.1.7.2 Pressure Control.

6.2.1.7.2.1

Stationary tanks and equipment containing hazardous material liquids that can generate pressures exceeding design limits due to exposure fires or internal reaction shall have some form of construction or other approved means that will relieve excessive internal pressure.

6.2.1.7.2.2

The termination point for piped vent systems used for the purpose of operational or emergency venting shall be located to prevent impingement exposure on the system served and to minimize the effects of high-temperature thermal radiation or the effects of contact with the material being vented from the escaping plume on the supply system, personnel, adjacent structures, and ignition sources.

6.2.1.8 Standby and Emergency Power.

6.2.1.8.1
Where mechanical ventilation, treatment systems, temperature control, alarm, detection, or other electrically operated safety systems are required by this code or the building code, such systems shall be provided with standby power or emergency power as required by 6.2.1.8. [5000:34.3.2.7.1]

6.2.1.8.2
Standby power for mechanical ventilation, exhaust treatment, and temperature control systems shall not be required where such systems are engineered and approved as fail-safe. [5000:34.3.2.7.2]

6.2.1.8.3
The secondary source of power shall be an approved means of legally required standby power in accordance with NFPA 70.

6.2.1.9 Spill Control and Secondary Containment for Hazardous Materials Liquids and Solids.

6.2.1.9.1 General.
Buildings, or portions thereof, required to comply with Protection Level 1 through Protection Level 4 shall be provided with spill control and secondary containment in accordance with 6.2.1.9.2 and 6.2.1.9.3, except for outdoor storage on containment pallets complying with 6.2.7.3.3.

6.2.1.9.2 Spill Control.
6.2.1.9.2.1
Buildings, or portions thereof, used for storage of hazardous materials liquids in individual containers having a capacity of more than 55 gal (208.2 L) shall be provided with spill control to prevent the flow of liquids to adjoining areas.

6.2.1.9.2.2
Where spill control is required, floors in indoor locations and similar surfaces in outdoor locations shall be constructed to contain a spill from the largest single vessel by one of the following methods:

1. Liquidtight sloped or recessed floors in indoor locations or similar areas in outdoor locations
2. Liquidtight floors in indoor locations or similar areas in outdoor locations provided with liquidtight raised or recessed sills or dikes
3. Sumps and collection systems

6.2.1.9.2.3
Except for surfacing, the floors, sills, dikes, sumps, and collection systems shall be constructed of noncombustible material, and the liquidtight seal shall be compatible with the material stored.

6.2.1.9.2.4
Where liquidtight sills or dikes are provided, they shall not be required at perimeter openings that are provided with an open-grate trench across the opening that connects to an approved collection system.

6.2.1.9.3 Secondary Containment.
6.2.1.9.3.1
Buildings, or portions thereof, used for any of the following shall be provided with secondary containment:

(1) Storage of liquids where the capacity of an individual vessel exceeds 55 gal (208.2 L) or the aggregate capacity of multiple vessels exceeds 1000 gal (3785 L)

(2) Storage of solids where the capacity of an individual vessel exceeds 550 lb (248.8 kg) or the aggregate capacity of multiple vessels exceeds 10,000 lb (4524.8 kg)

6.2.1.9.3.2

Buildings, or portions thereof, containing only hazardous materials in listed secondary containment tanks or systems shall not be required to comply with 6.2.1.9.3.1.

6.2.1.9.3.3

Buildings, or portions thereof, containing only ammonium nitrate solids, organic peroxide solids, flammable solids, pyrophoric solids, or corrosive solids shall not be required to comply with 6.2.1.9.3.1.

6.2.1.9.3.4

The building, room, or area shall contain or drain the hazardous materials and fire protection water through the use of one of the following methods:

(1) Liquidtight sloped or recessed floors in indoor locations or similar areas in outdoor locations

(2) Liquidtight floors in indoor locations or similar areas in outdoor locations provided with liquidtight raised or recessed sills or dikes

(3) Sumps and collection systems

(4) Drainage systems leading to an approved location

6.2.1.9.3.5

Where incompatible materials are present in open containers or systems, such materials shall be separated from each other in the secondary containment system.

6.2.1.9.3.6

Secondary containment for indoor storage areas shall be designed to contain a spill from the largest vessel plus the design flow volume of fire protection water calculated to discharge from the fire-extinguishing system over the minimum required system design area, or area of the room or area in which the storage is located, whichever is smaller, for a period of 20 minutes.

6.2.1.9.3.7

A monitoring method shall be provided to detect hazardous materials in the secondary containment system.

6.2.1.9.3.8

The monitoring method specified in 6.2.1.9.3.7 shall be permitted to be visual inspection of the primary or secondary containment or other approved means.

6.2.1.9.3.9
Where secondary containment is subject to the intrusion of water, a monitoring method for detecting water shall be provided.

6.2.1.9.3.10
Where monitoring devices are provided, they shall be connected to distinct visual or audible alarms.

6.2.1.9.3.11
Where remote containment systems are provided, drainage systems shall be in accordance with the plumbing code, as referenced in Chapter 2, and the following provisions also shall be met:

1. The slope of floors in indoor locations to drains or similar areas in outdoor locations shall be not less than 1 percent.
2. Drains from indoor storage areas shall be sized to carry the volume of the fire protection water, as determined by the design density discharged from the automatic fire-extinguishing system over the minimum required system design area, or area of the room or area in which the storage is located, whichever is smaller.
3. Materials of construction for drainage systems shall be compatible with the materials stored.
4. Separate drainage systems shall be provided to avoid mixing incompatible materials where such materials are present in an open-use condition.
5. Drains shall terminate in an approved location away from buildings, valves, means of egress, fire access roadways, adjoining property, and storm drains.

6.2.1.10 Floors in Storage Rooms.
Floors in storage areas for ammonium nitrate, organic peroxides, oxidizers, pyrophoric materials, unstable (reactive) materials, water-reactive solids and liquids, corrosive materials, and toxic and highly toxic materials shall be of liquidtight, noncombustible construction.

6.2.1.11 Supervision of Alarm, Detection, and Automatic Fire-Extinguishing Systems.
Alarm, detection, and automatic fire-extinguishing systems required by Chapter 6 or other chapters of this code regulating hazardous materials shall be supervised by an approved central, proprietary, or remote station service or shall initiate audible and visual signals at a constantly attended on-site location.

6.2.2 Protection Level 1.
6.2.2.1 General.
Buildings, or portions thereof, required to comply with protection level 1 shall comply with 6.2.2 and the building code.

6.2.2.2 Detached Building Required.
6.2.2.2.1*
Buildings required to comply with protection level 1 shall be used for no other purpose, shall not exceed one story in height, and shall be without basements, crawl spaces, or other under-floor spaces. [5000:34.3.3.2.1]
6.2.2.2.2

Roofs of buildings described in 6.2.2.2.1 shall be of lightweight construction with suitable thermal insulation to prevent sensitive material from reaching its decomposition temperature. [5000:34.3.3.2.2]

6.2.2.2.3

Buildings required to comply with both protection level 1 and protection level 4 shall comply with the most restrictive requirements for both protection levels. [5000:34.3.3.2.3]

6.2.2.3 Minimum Distance to Property Lines or Horizontal Separation.

Buildings required to comply with protection level 1 shall be set back from property lines, or be provided with a horizontal separation in accordance with NFPA 5000 by a distance of not less than 75 ft (23 m) and of not less than that required by Table 6.2.2.3. [5000:34.3.3.3]

Table 6.2.2.3 The American Table of Distances for Storage of Explosives

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
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<td>Pound Pounds Over</td>
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</table>

Table 6.2.2.3 The American Table of Distances for Storage of Explosives
<table>
<thead>
<tr>
<th>Quantity of Explosive Materials(^1,2,3,4)</th>
<th>Inhabited Buildings(^9)</th>
<th>Public Highways Traffic Volume of 3,000 Vehicles/Day or Less(^11)</th>
<th>Passenger Railways — Public Highways with Traffic Volume of More Than 3,000 Vehicles/Day(^10,11)</th>
<th>Separation of Magazines(^12)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pound Pounds Over</td>
<td>Un-barricaded (^6,7,8)</td>
<td>Barricade (^6,7,8)</td>
<td>Un-barricaded (^6,7,8)</td>
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<td>Pound s Over 1,2,3,4 Not Over</td>
<td>Barricaded $d^{6,7,8}$</td>
<td>Unbarricaded $d^{6,7,8}$</td>
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<td>Unbarricaded $d^{6,7,8}$</td>
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<tr>
<td>Quantity of Explosive Materials(^1,2,3,4)</td>
<td>Distances in Feet</td>
<td>Passenger Railways — Public Highways with Traffic Volume of More Than 3,000 Vehicles/Day(^10,11)</td>
<td>Separation of Magazines(^12)</td>
<td></td>
</tr>
<tr>
<td>----------------------------------</td>
<td>------------------</td>
<td>-------------------------------------------------</td>
<td>------------------</td>
<td></td>
</tr>
<tr>
<td>OUNG Pounds Not over 100,000</td>
<td>Inhabited Buildings(^9)</td>
<td>Public Highways Traffic Volume of 3,000 Vehicles/Day or Less(^11)</td>
<td>Un-barricaded</td>
<td>Un-barricaded</td>
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<td>200,000</td>
<td>1,990</td>
<td>600</td>
<td>1,695</td>
<td>265</td>
</tr>
</tbody>
</table>
### Explanatory Notes Essential to the Application of the American Table of Distances for Storage of Explosives.

(1) "Explosive materials" means explosives, blasting agents, and detonators.

(2) "Explosives" means any chemical compound, mixture, or device, the primary or common purpose of which is to function by explosion. A list of explosives determined to be within the coverage of Title 18, United States Code, Chapter 40, “Importation, Manufacture, Distribution and Storage of Explosive Materials,” is issued at least annually by the Director of the Bureau of Alcohol, Tobacco, and Firearms of the Department of the Treasury. For quantity and distance purposes, detonating cord of 50 grains per foot should be calculated as equivalent to 8 lb (3.7 kg) of high explosives per 1000 ft (305 m). Heavier or lighter core loads should be rated proportionately.

(3) "Blasting agents" means any material or mixture consisting of fuel and oxidizer, intended for blasting, and not otherwise defined as an explosive, provided that the finished product, as mixed for use or shipment, cannot be detonated by means of a No. 8 test blasting cap where unconfined.
(4) “Detonator” means any device containing any initiating or primary explosive that is used for initiating detonation. A detonator may not be permitted to contain more than 10 g of total explosives by weight, excluding ignition or delay charges. The term includes, but is not limited to, electric blasting caps of instantaneous and delay types, blasting caps for use with safety fuses, detonating cord delay connectors, and nonelectric instantaneous and delay blasting caps that use detonating cord, shock tube, or any other replacement for electric leg wires. All types of detonators in strengths through No. 8 cap should be rated at 1½ lb (0.7 kg) of explosives per 1000 caps.

(5) For strengths higher than No. 8 cap, the manufacturer should be consulted.

(6) “Magazine” means any building, structure, or container, other than an explosives manufacturing building, approved for the storage of explosive materials.

(7) “Natural barricade” means natural features of the ground, such as hills, or timber of sufficient density that the surrounding exposures that need protection cannot be seen from the magazine when the trees are bare of leaves.

(8) “Artificial barricade” means an artificial mound or revetted wall of earth of a minimum thickness of 3 ft (0.9 m).

(9) “Barricaded” means the effective screening of a building containing explosive materials from the magazine or another building, a railway, or a highway by a natural or an artificial barrier. A straight line from the top of any sidewall of the building containing explosive materials to the eave line of any magazine or other building or to a point 12 ft (3.7 m) above the center of a railway or highway shall pass through such barrier.

(10) “Inhabited building” means a building regularly occupied in whole or part as a habitation for human beings, or any church, schoolhouse, railroad station, store, or other structure where people are accustomed to assemble, but does not include any building or structure occupied in connection with the manufacture, transportation, storage, or use of explosive materials.

(11) “Railway” means any steam, electric, or other railroad or railway that carries passengers for hire.

(12) “Public highway” means any road, street, or way, whether on public or private property, open to public travel.

(13) Where two or more storage magazines are located on the same property, each magazine shall comply with the minimum distances specified from inhabited buildings, railways, and highways, and, in addition, they should be separated from each other by not less than the distances shown for “separation of magazines,” except that the quantity of explosive materials contained in detonator magazines shall govern with regard to the spacing of said detonator magazines from magazines containing other explosive materials. If any two or more magazines are separated from each other by less than the specified “separation of magazines” distances, such magazines, as a group, shall be considered as one magazine, and the total quantity of explosive materials stored in such group shall be treated as if stored in a single magazine located on the site of any magazine of the group, and shall comply with the minimum specified distances from other magazines, inhabited buildings, railways, and highways.
(14) Storage in excess of 300,000 lb (136,200 kg) of explosive materials in one magazine generally is not necessary for commercial enterprises.

(15) This table applies only to the manufacture and permanent storage of commercial explosive materials. It is not applicable to the transportation of explosives or any handling or temporary storage necessary or incident thereto. It is not intended to apply to bombs, projectiles, or other heavily encased explosives.

(16) Where a manufacturing building on an explosive materials plant site is designed to contain explosive materials, the building shall be located at a distance from inhabited buildings, public highways, and passenger railways in accordance with the American Table of Distances based on the maximum quantity of explosive materials permitted to be in the building at one time.


[495: Table 9.4.1(b)]

6.2.2.3.1
Explosives that are in accordance with NFPA 495 shall not be required to comply with 6.2.2.3.

[5000:34.3.3.1]

6.2.2.3.2
Distances shall be measured from the perimeter wall to property lines, including those on a public way. [5000:34.3.3.2]

6.2.2.3.3
Quantities of explosives used in applying Table 6.2.2.3 shall be based on equivalent pounds (kilograms) of TNT. [5000:34.3.3.3]

6.2.2.4 Frangible Building.
Frangible buildings complying with 7.4.1.3.5.3 of NFPA 5000 shall not be required to be protected with an automatic sprinkler system. [5000:34.3.3.4]

6.2.3 Protection Level 2.

6.2.3.1 General.
Buildings, or portions thereof, required to comply with protection level 2 shall comply with 6.2.1 and 6.2.3.2 through 6.2.3.5.2. [5000:34.3.4.1]

6.2.3.2 Exterior Wall Required.

6.2.3.2.1
Buildings, or portions thereof, required to comply with protection level 2 shall be located on property such that not less than 25 percent of the perimeter wall is an exterior wall. [5000:34.3.4.2.1]
Rooms utilized for the use, dispensing, mixing, and storage of flammable and combustible liquids having a floor area of not more than 500 ft$^2$ (46.5 m$^2$) shall not be required to be located on the outer perimeter of the building where such rooms comply with NFPA 30. [5000:34.3.4.2.2]

6.2.3.3 Minimum Distance to Property Lines or Horizontal Separation.

6.2.3.3.1

Buildings, or portions thereof, required to comply with protection level 2 shall be set back from property lines, or be provided with a horizontal separation in accordance with 7.3.4.2 of NFPA 5000 at the following distances:

(1) Not less than 30 ft (9.1 m) where the area of the occupancy exceeds 1000 ft$^2$ (93 m$^2$) and a detached building is not required

(2) Not less than 50 ft (15 m) where a detached building is required by Table 5.3.7.

(3) Not less than the distances required by Table 6.2.2.3 for buildings containing materials with explosive characteristics. [5000:34.3.4.3.1]

6.2.3.3.2

Distances shall be measured from the walls enclosing the protection level 2 area to property lines, including those on a public way, or in accordance with 7.3.4.2 of NFPA 5000 for buildings on the same lot. [5000:34.3.4.3.2]

6.2.3.4 Detached Building Required.

6.2.3.4.1*

Buildings required to comply with protection level 2 and containing quantities of high hazard contents exceeding the quantity limits set forth in Table 5.3.7 shall be used for no other purpose, shall not exceed one story in height, and shall be without basements, crawl spaces, or other under-floor spaces. [5000:34.3.4.4.1]

6.2.3.4.2

Buildings that contain high hazard level 2 contents also shall be permitted to contain high hazard level 3 or high hazard level 4 contents, provided that the materials are separated as otherwise required by the provisions of this code and NFPA 1. [5000:34.3.4.4.2]

6.2.3.5 Water-Reactive Materials.

6.2.3.5.1

Rooms or areas containing Class 2 or Class 3 water-reactive materials shall be resistant to water penetration. [5000:34.3.4.5.1]
Piping for conveying water, other than fire protection piping, shall not route over or through areas containing Class 2 or Class 3 water-reactive materials, unless isolated by approved liquidtight construction. [5000:34.3.4.5.2]

6.2.4 Protection Level 3.

6.2.4.1 General.

Buildings, or portions thereof, required to comply with protection level 3 shall comply with 6.2.1 and 6.2.4.2 through 6.2.4.7.2. [5000:34.3.5.1]

6.2.4.2 Exterior Wall Required.

6.2.4.2.1

Buildings, or portions thereof, required to comply with protection level 3 shall be located on property such that not less than 25 percent of the perimeter wall is an exterior wall. [5000:34.3.5.2.1]

6.2.4.2.2

Rooms utilized for the use, dispensing, mixing, and storage of flammable and combustible liquids having a floor area of not more than 500 ft² (46.5 m²) shall not be required to be located on the outer perimeter of the building where such rooms are in accordance with NFPA 30. [5000:34.3.5.2.2]

6.2.4.3 Minimum Distance to Property Lines or Horizontal Separation.

6.2.4.3.1

Buildings, or portions thereof, required to comply with protection level 3 shall be set back from property lines, or be provided with a horizontal separation in accordance with 7.3.4.2 of NFPA 5000 at the following distances:

(1) Not less than 30 ft (9.1 m) where the area of the occupancy exceeds 1000 ft² (93 m²) and a detached building is not required

(2) Not less than 50 ft (15 m) where a detached building is required by Table 5.3.7

(3) Not less than the distances required by Table 34.3.3.3 of NFPA 5000 for buildings containing materials with explosive characteristics [5000:34.3.5.3.1]

6.2.4.3.2

Distances shall be measured from the walls enclosing the protection level 3 area to property lines, including those on a public way, or in accordance with 7.3.4.2 of NFPA 5000 for buildings on the same lot. [5000:34.3.5.3.2]

6.2.4.4 Detached Building Required.

6.2.4.4.1*

Buildings required to comply with protection level 3 and containing quantities of high hazard contents exceeding the quantity limits set forth in Table 5.3.7 shall be used for no other purpose, shall not exceed one story in height, and shall be without basements, crawl spaces, or other under-floor spaces. [5000:34.3.5.4.1]
6.2.4.4.2

Buildings that contain high hazard level 3 contents also shall be permitted to contain high hazard level 2 or high hazard level 4 contents, provided that the materials are separated as otherwise required by the provisions of this code and NFPA 1. [5000:34.3.4.2]

6.2.4.5 Detached Unprotected Building.

Where acceptable to the AHJ, based on a determination that a protected building is not practical and an assessment of acceptable risk, storage buildings required to comply with protection level 3 shall be permitted without fire protection systems, provided that the following provisions are met:

(1) The building, or portions thereof, shall have a horizontal separation of at least 200 ft (61 m) from exposed business, industrial, mercantile, and storage occupancies on the same lot and from any property line that is or can be built upon. Where protection for exposures is provided in accordance with 6.2.4.5(9), the horizontal separation shall be at least 100 ft (30.5 m).

(2) The building, or portions thereof, shall have a horizontal separation of at least 1000 ft (305 m) from exposed occupancies other than business, industrial, mercantile, and storage occupancies on the same lot and from any property line that is or can be built upon. Where protection for exposures is provided in accordance with 6.2.4.5(9), the horizontal separation shall be at least 500 ft (150 m).

(3) The building shall not exceed one story in height.

(4) The building shall not have basements, crawl spaces, or other under-floor accessible spaces.

(5) Egress from the building shall not exceed 50 percent of the distances listed in Table 6.2.1.4.1, measured as required in 11.6.2 of NFPA 5000, and in compliance with 34.3.2.4.2 through 34.3.2.4.5 of NFPA 5000.

(6) The building shall comply with the requirements of the following:

   (a) 34.3.2.2 of NFPA 5000 for building height

   (b) 6.2.1.5 for ventilation

   (c) 6.2.1.6 for explosion control

   (d) 6.2.1.8 for standby and emergency power

   (e) 6.2.1.10 for floor construction

   (f) Table 34.3.2.10 of NFPA 5000 for unprotected vertical openings

(7) Spill control shall comply with 6.2.1.9.

(8) Secondary containment shall comply with 6.2.1.9.3, except that containment for fire protection water shall not be required if the building is not provided with a fire protection sprinkler system.

(9) Where credit is taken for protection for exposures in accordance with 34.3.5.5(1) and 34.3.5.5(2) of NFPA 5000 protection of exposures shall consist of fire protection for structures on property adjacent to the storage building that is provided by (1) a public fire department or (2) a private fire brigade maintained on the property adjacent to the storage building, either of which shall be capable of providing cooling water streams to protect the property adjacent to the storage building. [5000:34.3.5.5]
6.2.4.6 Roofs.

The roofs of buildings specified in 6.2.4.4.1 shall be of lightweight construction.

6.2.4.7 Water-Reactive Materials.

6.2.4.7.1

Rooms or areas containing Class 2 or Class 3 water-reactive materials shall be resistant to water penetration. [5000:34.3.5.7.1]

6.2.4.7.2

Piping for conveying water, other than fire protection piping, shall not route over or through areas containing Class 2 or Class 3 water-reactive materials, unless isolated by approved liquidtight construction. [5000:34.3.5.7.2]

6.2.5 Protection Level 4.

6.2.5.1

Buildings, or portions thereof, required to comply with protection level 4 shall comply with 6.2.1 and 6.2.5.2. [5000:34.3.6]

6.2.5.2 Highly Toxic Solids and Liquids.

Highly toxic solids and liquids not stored in approved hazardous materials storage cabinets shall be isolated from other hazardous materials storage by a 1-hour fire barrier. [5000:34.3.6.2]

6.2.6 Protection Level 5.

In addition to the requirements set forth elsewhere in NFPA 5000 buildings, and portions thereof, required to comply with protection level 5 shall comply with NFPA 1 and NFPA 318. [5000:34.3.7.1]

6.2.7 Outdoor Storage.

Outdoor storage areas shall be in accordance with the requirements of Chapters 11 through 21, as applicable.

6.2.7.1 Clearance from Combustibles.

Clearance from combustibles shall comply with 6.1.15(2).

6.2.7.2 Weather Protection.

Where weather protection is provided for sheltering outside hazardous material storage areas, such storage areas shall be considered outside storage areas, provided that all of the following conditions are met: [5000:34.2.6]

1. The overhead structure shall be approved noncombustible construction with a maximum area of 1500 ft² (140 m²) except that area increases based on location or fire protection systems under the requirements of the building code shall be allowed.

2. Supports and walls shall not obstruct more than one side or more than 25 percent of the perimeter of the storage area.
(3) The distance from the structure and the structural supports to buildings, lot lines, or public
egress to a public way shall not be less than the distance required by Chapters 11 through 21 for
an outside hazardous material storage area without weather protection.

(4) Weather protection structures containing storage of explosive or detonable materials shall be
considered indoor storage.

6.2.7.3 Secondary Containment.

6.2.7.3.1 General.
Where secondary containment is required, it shall be in accordance with 6.2.1.9.3.

6.2.7.3.2 Where Required.
Where required by Table 6.2.7.3.2, outdoor storage areas used for hazardous materials solids or
liquids shall be provided with secondary containment in accordance with 6.2.1.9.3.

Table 6.2.7.3.2 Required Secondary Containment — Hazardous Materials Solids and Liquids
Storage

<p>| Material                          | Outdoor Storage |</p>
<table>
<thead>
<tr>
<th></th>
<th>Class</th>
<th>Solids</th>
<th>Liquids</th>
</tr>
</thead>
<tbody>
<tr>
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<td>---</td>
</tr>
<tr>
<td>Flammable solids</td>
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<td>Organic peroxide liquids</td>
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<td>NR</td>
</tr>
<tr>
<td></td>
<td></td>
<td>II</td>
<td>NR</td>
</tr>
<tr>
<td></td>
<td></td>
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<td>IV</td>
<td>NR</td>
</tr>
<tr>
<td>Oxidizer liquids</td>
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</tr>
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<td>4</td>
<td>NR</td>
<td>NR</td>
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</tr>
<tr>
<td>3</td>
<td>NR</td>
<td>NR</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>NR</td>
<td>NR</td>
<td></td>
</tr>
<tr>
<td>Pyrophoric liquids</td>
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<td>R</td>
<td>R</td>
</tr>
<tr>
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<td>R</td>
<td>R</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>R</td>
<td>R</td>
</tr>
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<td></td>
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</tr>
<tr>
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<td>1</td>
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</tr>
<tr>
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<td></td>
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<td>R</td>
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<tr>
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<td>NR</td>
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</tr>
</tbody>
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Health Hazard Materials
### Outdoor Storage

<table>
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<th>Class</th>
<th>Solids</th>
<th>Liquids</th>
</tr>
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<tbody>
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</tr>
<tr>
<td>Highly toxic liquids</td>
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</tr>
<tr>
<td>Toxic liquids</td>
<td>R</td>
<td>R</td>
<td></td>
</tr>
</tbody>
</table>

NR: Not required. NA: Not applicable. R: Required.

#### 6.2.7.3.3 Containment Pallets.

Where used as a substitute for spill control and secondary containment for outdoor storage in accordance with 6.2.1.9.1, containment pallets shall comply with the following:

1. A liquidtight sump accessible for visual inspection shall be provided.
2. The sump shall be designed to contain not less than 66 gal (249.8 L).
3. Exposed surfaces shall be compatible with the material stored.
4. Containment pallets shall be protected to prevent collection of rainwater within the sump.

#### 6.3 Requirements for Use, Dispensing, and Handling of Hazardous Materials in Amounts Exceeding Maximum Allowable Quantities.

**6.3.1* General.**

The following shall apply to aggregate quantities of hazardous materials used, dispensed, or handled:

1. Where the aggregate quantity of hazardous materials used, dispensed, or handled exceeds the MAQ, the requirements set forth in Section 6.3 shall apply, except as specified in 6.3.1.1.
2. Where the aggregate quantity of hazardous materials used, dispensed, or handled does not exceed the MAQ, Section 6.3 shall not apply.

**6.3.1.1 Uses Not Required to Comply.**

The following use conditions shall not be required to comply with Section 6.3:

1. Corrosives used in stationary lead–acid battery systems used for standby power, emergency power, or uninterrupted power supply complying with Chapter 52 of NFPA 1
2. Application and release of pesticide products and materials intended for use in weed abatement, erosion control, soil amendment or similar applications, where applied in accordance with the manufacturer’s instructions and label directions

**6.3.1.2 Limit Controls.**

**6.3.1.2.1 General.**

Limit controls shall be provided in accordance with 6.3.1.2.1 through 6.3.1.2.4.2.

**6.3.1.2.2 Temperature Control.**
Process tanks and equipment, which involve temperature control of the material to prevent a hazardous reaction, shall be provided with limit controls to maintain the temperature within a safe range. [1:60.4.4]

6.3.1.2.3 Pressure Control.

6.3.1.2.3.1
Stationary tanks and equipment containing hazardous materials liquids that can generate pressures exceeding design limits due to exposure fires or internal reaction shall have a form of construction or other approved means that relieves excessive internal pressure. [1:60.4.4]

6.3.1.2.3.2
The means of pressure relief shall vent to an approved location.

6.3.1.2.3.3
Where required by Chapter 21, the means of pressure relief shall vent to an exhaust scrubber or treatment system.

6.3.1.2.4 Liquid Level.

6.3.1.2.4.1 High Level.
Open tanks in which hazardous materials are used shall be equipped with a liquid level limit control or other means to prevent overfilling of the tank. [1:60.4.4]

6.3.1.2.4.2 Low Level.
Open tanks and containers in which hazardous materials are heated shall be equipped with approved automatic shutoff controls, which will sense low liquid levels and shut off the source of heat. [1:60.4.4]

6.3.1.3 Standby and Emergency Power.
Standby or emergency power shall be provided in accordance with 6.3.1.3.1 and 6.3.1.3.2 for required mechanical ventilation, treatment systems, temperature control, alarm, detection, or other electrically operated safety systems. [5000:34.3.2.7.1]

6.3.1.3.1
Standby power for mechanical ventilation, exhaust treatment, and temperature control systems shall not be required where such systems are engineered and approved as fail-safe. [5000:34.3.2.7.2]

6.3.1.3.2
The secondary source of power shall be an approved means of legally required standby power in accordance with NFPA 70. [5000:34.3.2.7.3]

6.3.1.4 Spill Control and Secondary Containment for Hazardous Materials Liquids.

6.3.1.4.1 Spill Control.
Where spill control is specifically required in 6.3.2 or 6.3.3, such systems shall be in accordance with 6.3.1.4.1.1 through 6.3.1.4.1.3.
6.3.1.4.1.1 General.

Where spill control is required, floors in indoor locations and similar surfaces in outdoor locations shall be constructed to contain a spill from the largest single vessel by one of the following methods:

1. Liquidtight sloped or recessed floors in indoor locations or similar areas in outdoor locations
2. Liquidtight floors in indoor locations or similar areas in outdoor locations provided with liquidtight raised or recessed sills or dikes
3. Sumps and collection systems [5000:34.3.2.8.2.2]

6.3.1.4.1.2

Except for surfacing, the floors, sills, dikes, sumps, and collection systems shall be constructed of noncombustible material, and the liquidtight seal shall be compatible with the material stored. [5000:34.3.2.8.2.3]

6.3.1.4.1.3

Where liquidtight sills or dikes are provided, they shall not be required at perimeter openings that are provided with an open-grate trench across the opening that connects to an approved collection system. [5000:34.3.2.8.2.4]

6.3.1.4.2 Secondary Containment.

Where secondary containment is specifically required in 6.3.2 or 6.3.3, such systems shall be in accordance with 6.3.1.4.2.1 through 6.3.1.4.2.10.

6.3.1.4.2.1

Buildings, or portions thereof, containing only hazardous materials in listed secondary containment tanks or systems shall not be required to comply with 6.3.1.4.2. [5000:34.3.2.8.3.2]

6.3.1.4.2.2

Secondary containment shall be achieved by means of drainage control where required by NFPA 30. [5000:34.3.2.8.3.4]

6.3.1.4.2.3

The building, room, or area shall contain or drain the hazardous materials and fire protection water through the use of one of the following methods:

1. Liquidtight sloped or recessed floors in indoor locations or similar areas in outdoor locations
2. Liquidtight floors in indoor locations or similar areas in outdoor locations provided with liquidtight raised or recessed sills or dikes
3. Sumps and collection systems
4. Drainage systems leading to an approved location [5000:34.3.2.8.3.5]

6.3.1.4.2.4

Where incompatible materials are present in open containers or systems, such materials shall be separated from each other in the secondary containment system. [5000:34.3.2.8.3.6]
Secondary containment for indoor storage areas shall be designed to contain a spill from the largest vessel plus the design flow volume of fire protection water calculated to discharge from the fire-extinguishing system over the minimum required system design area, or area of the room or area in which the storage is located, whichever is smaller, for a period of 20 minutes. [5000:34.3.2.8.3.7]

A monitoring method shall be provided to detect hazardous materials in the secondary containment system. [5000:34.3.2.8.3.8]

The monitoring method shall be permitted to be visual inspection of the primary or secondary containment, or other approved means. [5000:34.3.2.8.3.9]

Where secondary containment is subject to the intrusion of water, a monitoring method for detecting water shall be provided. [5000:34.3.2.8.3.10]

Where monitoring devices are provided, they shall be connected to distinct visual or audible alarms. [5000:34.3.2.8.3.11]

Where remote containment systems are provided, drainage systems shall be in accordance with the plumbing code, as referenced in Chapter 2, and the following provisions also shall be met:

1. The slope of floors in indoor locations to drains or similar areas in outdoor locations shall be not less than 1 percent.

2. Drains from indoor storage areas shall be sized to carry the volume of the fire protection water, as determined by the design density discharged from the automatic fire-extinguishing system over the minimum required system design area, or area of the room or area in which the storage is located, whichever is smaller

3. Materials of construction for drainage systems shall be compatible with the materials stored

4. Separate drainage systems shall be provided to avoid mixing incompatible materials where such materials are present in an open-use condition

5. Drains shall terminate in an approved location away from buildings, valves, means of egress, fire access roadways, adjoining property, and storm drains. [5000:34.3.2.8.3.12]

Lighting by natural or artificial means shall be provided, and artificial lighting, where provided, shall be in accordance with nationally recognized standards. [1:60.4.6]

System Design.

6.3.1.6.1
Systems shall be suitable for the use intended and shall be designed by persons competent in such design. [1:60.4.8]

6.3.1.6.2
Where nationally recognized good practices or standards have been established for the processes employed, they shall be followed in the design. [1:60.4.8]

6.3.1.6.3
Controls shall be designed to prevent materials from entering or leaving process or reaction systems at other than the intended time, rate, or path. [1:60.4.8]

6.3.1.6.4
Where automatic controls are provided, they shall be designed to be fail-safe. [1:60.4.8]

6.3.1.7 Liquid Transfer.

6.3.1.7.1
Approved containers shall be used where liquids are dispensed from containers. [1:60.4.9]

6.3.1.7.2
Liquids having a hazard ranking of 3 when exceeding 5.3 gal (20 L), or liquids having a hazard ranking of 4 when exceeding 1.1 gal (4 L), shall be transferred by one of the following methods:

(1) From safety cans

(2) Through an approved closed-piping system

(3) From containers or tanks by an approved pump taking suction through an opening in the top of the container or tank

(4) For other than highly toxic liquids, from containers or tanks by gravity through an approved self-closing or automatic-closing valve where the container or tank and dispensing operations are provided with spill control and secondary containment complying with 6.3.1.4.1 through 6.3.1.4.2.10

(5) By the use of approved engineered liquid transfer systems [1:60.4.9]

6.3.1.8 Supervision of Alarm, Detection, and Automatic Fire-Extinguishing Systems.

Alarm, detection, and automatic fire-extinguishing systems required by Section 6.3 shall be supervised by an approved central, proprietary, or remote station service or shall initiate an audible and visual signal at a constantly attended on-site location. [1:60.4.5]

6.3.2 Indoor Dispensing and Use.

6.3.2.1 General Indoor Requirements.

6.3.2.1.1 Fire Protection Systems.

6.3.2.1.1.1 General.

Indoor dispensing and use areas shall be provided with approved fire protection systems in accordance with 6.2.1.1.

6.3.2.1.2 Fire-Extinguishing System for Laboratory Fume Hoods and Spray Booths.
In addition to the requirements of 6.2.1.1, laboratory fume hoods and spray booths where flammable materials are dispensed or used shall be protected by an automatic fire-extinguishing system.

6.3.2.1.2 Protection Level 1 through Protection Level 4.

Buildings and structures required to comply with protection level 1, protection level 2, protection level 3, or protection level 4 controls shall be constructed in accordance with the specific protection level controls of Section 6.2 and the requirements of NFPA 5000.

6.3.2.1.2.1 Building Height Exception.

The height of a single-story building, or portion thereof, containing only tanks or industrial process equipment shall not be limited based on the type of construction. [5000:34.3.2.2]

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. [5000:34.3.2.3]

6.3.2.1.2.3 Egress.

Egress from areas required to comply with protection level 1, protection level 2, protection level 3, or protection level 4 shall comply with 6.2.1.4 and Chapter 14 of NFPA 1. [5000:34.3.2.4]

6.3.2.1.3 Ventilation.

6.3.2.1.3.1 General.

Indoor dispensing and use areas shall be provided with exhaust ventilation in accordance with 6.2.1.5. [5000:34.3.2.5]

6.3.2.1.3.2 Exceptions to Ventilation Requirement.

Exhaust ventilation required by 6.3.2.1.3.1 shall not be required for dispensing and use of flammable solids other than those with finely divided particles.

6.3.2.1.3.3 Standby and Emergency Power.

Standby or emergency power shall be provided in accordance with 6.2.1.8.

6.3.2.1.4 Explosion Control.

6.3.2.1.4.1 General.

Explosion control shall be provided in accordance with 6.2.1.6 where an explosive environment can occur because of the characteristics or nature of the hazardous materials dispensed or used, or as a result of the dispensing or use process, unless process vessels comply with 6.3.2.1.4.2. [5000:34.3.2.6]

6.3.2.1.4.2 Process Vessels.

Additional explosion control shall not be required for materials and processes that are located in process vessels designed to fully contain or vent the worst-case explosion anticipated within the vessel under process conditions considering the most likely failure. When deflagration venting from process vessels is provided, the discharge from venting systems shall be in accordance with NFPA
68 and arranged so that overpressures produced will not endanger personnel or damage the building, structure, or surrounding buildings or structures in which the process is located.

**6.3.2.2 Indoor — Open Systems.**

**6.3.2.2.1 General.**

Dispensing and use of hazardous materials in open containers or systems in amounts exceeding the MAQ specified in Section 5.2 shall be in accordance with 6.3.2.2.2 through 6.3.2.2.4.2.

**6.3.2.2.2 Ventilation.**

In addition to the requirements of 6.3.2.1.3, where liquids or solids having a health, instability, or flammability hazard ranking of Class 3 or Class 4 in accordance with NFPA 704 are dispensed or used, mechanical exhaust ventilation shall be provided to capture fumes, mists, or vapors at the point of generation, unless such liquids or solids can be demonstrated as not creating harmful fumes, mists, or vapors.

**6.3.2.2.3 Floor Construction.**

Except for surfacing, floors of areas where liquid or solid hazardous materials are dispensed or used in open systems shall be of noncombustible, liquidtight construction. [5000:34.3.2.9; 1:60.4.7]

**6.3.2.2.4 Spill Control and Secondary Containment for Hazardous Materials Liquids.**

**6.3.2.4.1 Spill Control.**

Buildings, or portions thereof, used for either of the following shall be provided with spill control in accordance with 6.3.1.4.1 to prevent the flow of liquids to adjoining areas:

1. Dispensing of hazardous materials liquids into vessels exceeding a 1.1 gal (4 L) capacity
2. Open use of hazardous materials liquids in vessels or systems exceeding a 5.3 gal (20 L) capacity [5000:34.3.2.8.2.1]

**6.3.2.4.2 Secondary Containment.**

(A)

Where required by Table 6.3.2.4.2(A), buildings, or portions thereof, used for either of the following shall be provided with secondary containment in accordance with 6.3.1.4.2.1 through 6.3.1.4.2.10:

1. Open use of liquids where the capacity of an individual vessel or system exceeds 1.1 gal (4 L)
2. Open use of liquids where the capacity of multiple vessels or systems exceeds 5.3 gal (20 L) [5000:34.3.2.8.3.1]

**Table 6.3.2.4.2(A) Required Secondary Containment — Hazardous Materials Liquids Use**

<table>
<thead>
<tr>
<th>Material</th>
<th>Class</th>
<th>Indoor Use</th>
<th>Outdoor Use</th>
</tr>
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<tbody>
<tr>
<td><strong>Physical Hazard Materials</strong></td>
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<td></td>
<td></td>
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<tr>
<td>Organic peroxide liquids</td>
<td>I</td>
<td>R</td>
<td>R</td>
</tr>
<tr>
<td></td>
<td>II</td>
<td>R</td>
<td>R</td>
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<td>Indoor Use</td>
<td>Outdoor Use</td>
</tr>
<tr>
<td>----------------------------------</td>
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<td>-------------</td>
</tr>
<tr>
<td><a href="#">III</a> Oxidizer liquids</td>
<td>4 R</td>
<td>R</td>
<td>R</td>
</tr>
<tr>
<td></td>
<td>3 R</td>
<td>R</td>
<td>R</td>
</tr>
<tr>
<td></td>
<td>2 R</td>
<td>R</td>
<td>R</td>
</tr>
<tr>
<td>Pyrophoric liquids</td>
<td></td>
<td>R</td>
<td>R</td>
</tr>
<tr>
<td>Unstable (reactive) liquids</td>
<td>4 R</td>
<td>R</td>
<td>R</td>
</tr>
<tr>
<td></td>
<td>3 R</td>
<td>R</td>
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<tr>
<td></td>
<td>2 R</td>
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<td>1 NR</td>
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<td>R</td>
</tr>
<tr>
<td>Water-reactive liquids</td>
<td>3 R</td>
<td>R</td>
<td>R</td>
</tr>
<tr>
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<td>2 R</td>
<td>R</td>
<td>R</td>
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<tr>
<td></td>
<td>1 NR</td>
<td>R</td>
<td>R</td>
</tr>
</tbody>
</table>

**Health Hazard Materials**

| Corrosive liquids                | R     | R          |
| Highly toxic liquids             | R     | R          |
| Toxic liquids                    | R     | R          |

R: required. NR: Not required.

**B**

Buildings, or portions thereof, containing only hazardous materials in listed secondary containment tanks or systems shall not be required to be provided with secondary containment.

[5000:34.3.2.8.3.2]

**6.3.2.3 Indoor — Closed Systems.**

**6.3.2.3.1 General.**

Dispensing and use of hazardous materials in closed containers or systems in amounts exceeding the MAQ specified in Chapter 5 shall be in accordance with 6.3.2.3.1 through 6.3.2.3.2.

**6.3.2.3.2 Ventilation.**

If closed systems are designed to be opened as part of normal operations, ventilation shall be provided in accordance with 6.3.2.1.3.1.

**6.3.2.3.3 Spill Control and Secondary Containment for Hazardous Materials Liquids.**

**6.3.2.3.3.1 Spill Control.**
Buildings, or portions thereof, where hazardous materials liquids are used in individual closed vessels exceeding a 55 gal (208.2 L) capacity shall be provided with spill control in accordance with 6.3.1.4.1 through 6.3.1.4.1.3 to prevent the flow of liquids to adjoining areas. [5000:34.3.2.8.2.1]

6.3.2.3.2 Secondary Containment.

Where required by Table 6.3.2.2.4.2(A), buildings, or portions thereof, used for either of the following shall be provided with secondary containment in accordance with 6.3.1.4.2.1 through 6.3.1.4.2.10:

1) Closed-use capacity of an individual vessel or system exceeds 55 gal (208 L)
2) Closed-use aggregate capacity of multiple vessels or systems exceeds 1000 gal (3785 L) [5000:34.3.2.8.3.1]

6.3.3 Outdoor Dispensing and Use.

6.3.3.1 General.

6.3.3.1.1 Location.

Outdoor dispensing and use areas shall be located as required for outdoor storage of hazardous materials in quantities exceeding the MAQ. [1:60.4.11.1.2]

6.3.3.1.2 Clearance from Combustibles.

Clearance from combustibles shall be in accordance with 6.1.15(2).

6.3.3.1.3 Weather Protection.

Weather protection, when provided, shall comply with 6.2.7.2.

6.3.3.2 Outdoor — Open Systems.

6.3.3.2.1 General.

In addition to the requirements set forth in 6.3.3.1 through 6.3.3.1.3, dispensing and use of hazardous materials in open containers or systems in amounts exceeding the MAQ specified in Chapter 5 shall be in accordance with 6.3.3.2.1 through 6.3.3.2.2.

6.3.3.2.2 Spill Control and Secondary Containment for Hazardous Materials Liquids.

6.3.3.2.2.1 Spill Control.

Outdoor areas used for either of the following shall be provided with spill control in accordance with 6.3.1.4.1 through 6.3.1.4.1.3 to prevent the flow of liquids to adjoining areas:

1) Dispensing of hazardous materials liquids into vessels exceeding a 1.1 gal (4 L) capacity
2) Open use of hazardous materials liquids in vessels or systems exceeding a 5.3 gal (20 L) capacity [5000:34.3.2.8.2.1]

6.3.3.2.2.2 Secondary Containment.

(A)
Where Required. Where required by Table 6.3.2.4.2(A), outdoor areas used for either of the following shall be provided with secondary containment in accordance with 6.3.1.4.2.1 through 6.3.1.4.2.10:

1. Open-use of liquids where the capacity of an individual vessel or system exceeds 1.1 gal (4 L)
2. Open-use of liquids where the capacity of multiple vessels or systems exceeds 5.3 gal (20 L)

(B)

Incompatible Materials. Incompatible materials used in open systems shall be separated from each other in the secondary containment system.

6.3.3.3 Outdoor — Closed Systems.

6.3.3.3.1 General.

In addition to the requirements set forth in 6.3.3.1 through 6.3.3.1.3, dispensing and use of hazardous materials in closed containers or systems in amounts exceeding the MAQ specified in Chapter 5 shall be in accordance with 6.3.3.3.1 through 6.3.3.3.2.2.

6.3.3.3.2 Spill Control and Secondary Containment for Hazardous Materials Liquids.

6.3.3.3.2.1 Spill Control.

Outdoor areas where hazardous materials liquids are used in individual closed vessels exceeding a 55 gal (208 L) capacity shall be provided with spill control in accordance with 6.3.1.4.1 through 6.3.1.4.1.3 to prevent the flow of liquids to adjoining areas. [5000:34.3.2.8.2.1]

6.3.3.3.2.2 Secondary Containment.

Where required by Table 6.3.2.4.2(A), outdoor areas used for either of the following shall be provided with secondary containment in accordance with 6.3.1.4.2.1 through 6.3.1.4.2.10:

1. Closed-use capacity of an individual vessel or system exceeds 55 gal (208 L)
2. Closed-use aggregate capacity of multiple vessels or systems exceeds 1000 gal (3785 L)

[5000:34.3.2.8.3.1]

6.3.4 Handling.

6.3.4.1 General.

The handling and transportation of hazardous materials in exit access corridors or exit enclosures shall be in accordance with 6.3.4.2 through 6.3.4.4.2.

6.3.4.2 Carts and Trucks Required.

Liquids in containers exceeding 5 gal (19 L) in an exit access corridor or exit enclosure shall be transported on a cart or truck.

6.3.4.2.1

Containers of hazardous materials having a hazard ranking of 3 or 4 in accordance with NFPA 704 and transported within corridors or exit enclosures shall be on a cart or truck.
6.3.4.2.2
Where carts and trucks are required for transporting hazardous materials, they shall be in accordance with 6.3.4.3, except for the following:

(1) Two hazardous material liquid containers that are hand carried in safety carriers
(2) Not more than four drums not exceeding 55 gal (208 L) each that are transported by drum trucks
(3) Solid hazardous materials not exceeding 100 lb (45 kg) that are transported by hand trucks
(4) Single container not exceeding 50 lb (23 kg) that is hand carried

6.3.4.3 Carts and Trucks.
Carts and trucks required by 6.3.4.2 to be used to transport hazardous materials shall be in accordance with 6.3.4.3.1 through 6.3.4.3.6.

6.3.4.3.1 Design.
Carts and trucks used to transport hazardous materials shall be designed to provide a stable base for the commodities to be transported and shall have a means of restraining containers to prevent accidental dislodgement.

6.3.4.3.2 Speed-Control Devices.
Carts and trucks shall be provided with a device that will enable the operator to control movement safely by providing stops or speed-reduction devices.

6.3.4.3.3 Construction.
Construction materials for hazardous material carts or trucks shall be compatible with the material transported.

6.3.4.3.4 Spill Control.
Carts and trucks transporting liquids shall be capable of containing a spill from the largest single container transported.

6.3.4.3.5 Attendance.
Carts and trucks used to transport materials shall not obstruct or be left unattended within any part of a means of egress.

6.3.4.3.6 Incompatible Materials.
Incompatible materials shall not be transported on the same cart or truck.

6.3.4.4 Emergency Alarm for Transportation of Hazardous Materials in Corridors or Exit Enclosures.

6.3.4.4.1
When hazardous materials having a hazard ranking of 3 or 4 in accordance with NFPA 704 are transported through corridors or exit enclosures, there shall be an emergency telephone system, a
local manual alarm station, or an approved alarm-initiating device at not more than 150 ft (46 m) intervals and at each exit throughout the transport route.

6.3.4.4.2

The signal shall be relayed to an approved central, proprietary, or remote station service or constantly attended on-site location and shall also initiate a local audible alarm. [1:60.4.12.2]
<table>
<thead>
<tr>
<th>Second Revision No. 176-NFPA 400-2014 [ Global Comment ]</th>
</tr>
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<tbody>
<tr>
<td>Change the heading on the columns for all Annex F Tables (F.1, F.2.3, F.3.3m F.4.3, F.5.3, F.6.3) from Reactivity to Instability.</td>
</tr>
<tr>
<td>Change the footnote for Annex F tables from 'health, flammability, and reactivity' to 'health, flammability, and instability'</td>
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<table>
<thead>
<tr>
<th>Submitter Information Verification</th>
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<tbody>
<tr>
<td>Submitter Full Name: Michael Beady</td>
</tr>
<tr>
<td>Organization: [ Not Specified ]</td>
</tr>
<tr>
<td>Street Address:</td>
</tr>
<tr>
<td>City:</td>
</tr>
<tr>
<td>State:</td>
</tr>
<tr>
<td>Zip:</td>
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<tr>
<td>Submittal Date: Mon Oct 06 14:23:03 EDT 2014</td>
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<table>
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<tr>
<th>Committee Statement</th>
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<tbody>
<tr>
<td>Committee</td>
</tr>
<tr>
<td>Statement: The term reactivity was changed to instability in the 1996 edition of NFPA 704. Table headings and footnotes were corrected to correspond to match the terminology used in NFPA 704.</td>
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<td>Response Message:</td>
</tr>
</tbody>
</table>

Committee Statement:

The term reactivity was changed to instability in the 1996 edition of NFPA 704. Table headings and footnotes were corrected to correspond to match the terminology used in NFPA 704.
5.2.1.1.3 For all occupancies not covered by 5.2.1.2 through 5.2.1.13, the MAQ of hazardous materials per control area shall be as specified in Table 5.2.1.1.3.

1. Add the following new section with text as follows:

5.2.1.1.3.1

Ammonium nitrate shall also comply with Chapter 11.

Submitter Information Verification

Submitter Full Name: [Not Specified]
Organization: [Not Specified]
Street Address: [Not Specified]
City: [Not Specified]
State: [Not Specified]
Zip: [Not Specified]
Submittal Date: Wed Aug 20 14:52:28 EDT 2014

Committee Statement

Committee Statement: The committee placed the reference to Ammonium nitrate (AN) in the text of the document rather than in the table thereby creating a category specifically for AN.

Response Message:
Public Comment No. 19-NFPA 400-2014 [Section No. 5.2.1.1.3]
In Table 5.2.1.1.3 Maximum Allowable Quantity (MAQ) of Hazardous Materials per Control Area:
Delete entire line Ammonium nitrate See Chapter 11 See Chapter 11 etc...(currently under Physical Hazard Materials)

Submitter Information Verification
Submitter Full Name: Michael Beady
Organization: [ Not Specified ]
Street Address:
City:
State:
Zip:
Submittal Date: Mon Oct 06 10:17:40 EDT 2014

Committee Statement
Committee Statement: The committee placed the reference to Ammonium nitrate (AN) in the text of the document rather than in the table thereby creating a category specifically for AN.
Response Message:
1.1.2.2

This code shall not apply to the following:

1. Storage or use of hazardous materials for individual use on the premises of one- and two-family dwellings
2. Explosives or blasting agents, which are regulated by NFPA 495, and display fireworks, which are regulated by NFPA 1124
3. Refrigerants and refrigerant oil contained within closed-cycle refrigeration systems complying with the fire code and the mechanical code adopted by the jurisdiction
4. Ref. 1., High-hazard contents stored or used in farm buildings or similar occupancies and in remote locations for on-premises agricultural use
5. Corrosive materials in stationary batteries utilized for facility emergency power or uninterrupted power supply, or similar purposes, in accordance with NFPA 1
6. Aerosols complying with NFPA 30B
7. Consumer fireworks, 1.4G complying with NFPA 1124
8. Corrosive materials displayed in original packaging in mercantile occupancies and intended for personal or household use or as building materials
9. Flammable and combustible liquids having no other physical or health hazard properties covered by this code
10. Organic peroxide formulations that are capable of detonation as manufactured or when unpackaged or in authorized shipping containers under conditions of fire exposure, when stored, manufactured, or used in accordance with NFPA 495
11. Combustible metals, as defined in NFPA 484
12. LP-Gas complying with NFPA 58 or NFPA 59
13. 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
14. The off-site transportation of hazardous materials when in accordance with Department of Transportation (DOT) regulations

Submitter Information Verification

Submitter Full Name: Michael Beady
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Street Address: 
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Submittal Date: Tue Sep 30 16:18:02 EDT 2014

Committee Statement

Committee Statement: Update per TIA 13-2
Response Message:
2.2 NFPA Publications.
National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.
NFPA 40, Standard for the Storage and Handling of Cellulose Nitrate Film, 2016 edition.
Submitter Information Verification

Submitter Full Name: Michael Beady
Organization: [Not Specified]
Street Address: 
City: 
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Submittal Date: Tue Sep 30 16:24:06 EDT 2014

Committee Statement

Committee Statement: Deleted 2.3.1 per TIA 13-2
Response Message:
2.3.4 ASTM Publications.
ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959.

Submitter Information Verification
Submitter Full Name: [ Not Specified ]
Organization: [ Not Specified ]
Street Address: 
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Submittal Date: Wed Aug 06 10:58:02 EDT 2014

Committee Statement
Committee Statement: Update year dates
Response Message:
Public Comment No. 16-NFPA 400-2014 [Section No. 2.3.5]
Submitter Information Verification

Submitter Full Name: Michael Beady
Organization: [ Not Specified ]
Street Address:
City:
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Submittal Date: Fri Oct 03 15:29:58 EDT 2014

Committee Statement

Committee Statement: Reference not in chapter sections of document
Response Message:
2.4 References for Extracts in Mandatory Sections.

Submitter Information Verification
Submitter Full Name: Michael Beady
Organization: [Not Specified]
Street Address: 
City: 
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Zip: 
Submittal Date: Tue Sep 30 16:26:09 EDT 2014

Committee Statement
Committee Statement: Deleted 1124 entry per TIA 13-2
Response Message:
3.3.2.2 Indoor Area (Gas). An area that is within a building or structure having overhead cover, other than a structure qualifying as "weather protection" in accordance with Section 6.6 of NFPA 55. [§5, 2016]

(See also 3.3.2.4, Outdoor Area.)

Submitter Information Verification

Submitter Full Name: [Not Specified]
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Wed Aug 06 11:00:42 EDT 2014

Committee Statement

Committee Statement:
This definition is extracted from NFPA 55 and any recommended changes to or issues with this definition as written must be to NFPA 55 and not NFPA 400. The committee placed "gas" and "in NFPA 55" in brackets to indicate any text changes from original definition.

Response Message:
Public Comment No. 8-NFPA 400-2014 [Section No. 3.3.2.2]
3.3.8  **Bulk Ammonium Nitrate.**
Large quantities of ammonium nitrate solids in the form of a pile, not divided into parts or packaged into separate units.

**Submitter Information Verification**

Submitter Full Name:  [Not Specified]
Organization:  [Not Specified]
Street Address:  
City:  
State:  
Zip:  
Submittal Date:  Fri Aug 08 15:52:25 EDT 2014

**Committee Statement**

Committee Statement:  A new definition was added to clarify the meaning of "bulk" as it applies to ammonium nitrate.
Response Message:  

---

[Link to National Fire Protection Association Report](http://submittals.nfpa.org/TerraViewWeb/ContentFetcher?commentPara...13 of 222 12/12/2014 5:06 PM)
3.3.9* Bulk Hydrogen Compressed Gas System

An assembly of equipment that consists of, but is not limited to, storage containers, pressure regulators, pressure relief devices, compressors, manifolds, and piping, with a storage capacity of more than 5000 scf (141.6 Nm$^3$) of compressed hydrogen gas and that terminates at the source valve. A gaseous hydrogen (GH$_2$) system with a storage capacity of more than 5000 scf (141.6 Nm$^3$) of compressed hydrogen gas. [55, 2016]
A.3.3.8 Bulk Hydrogen Compressed Gas System.
The bulk system terminates at the source valve, which is the point where the gas supply, at service pressure, first enters the supply line, or at a piece of equipment that utilizes the hydrogen gas, such as a hydrogen dispenser. The containers are either stationary or movable, and the source gas for the system is stored as a compressed gas. Bulk hydrogen compressed gas systems can include a bulk storage source, transfer piping and manifold system, compression system, and other components. The gaseous source can include a tube trailer, high-pressure storage vessels used to serve the piping system that transports hydrogen to the end user. Compressors can be installed downstream of the storage supply to boost the pressure of the source gas, and intermediate high-pressure storage might be present. This is done where the end use requires hydrogen at a pressure higher than that of the bulk supply. In these instances, there might be intermediate storage vessels used to store the gas at elevated pressures. It is not uncommon for the bulk supply as delivered to be furnished at nominal gauge pressure of 3000 psi (20,684 kPa), and the intermediate high-pressure storage to be stored at gauge pressures up to 15,000 psi (103,421 kPa). (See Figure A.3.3.8(a) through Figure A.3.3.8(f). [55, 2016])

Figure A.3.3.8(a) Symbol Legend for Figures A.3.3.8(b) through A.3.3.8(f).

Figure A.3.3.8(b) Typical Tube Trailer.

Figure A.3.3.8(c) Typical Bulk Compressed Gaseous Storage System.

Figure A.3.3.8(d) Typical Tube Trailer Discharge Stanchion and Pressure Control Manifold.

Figure A.3.3.8(e) Typical Chemical Energy Storage Model (CESM).

Figure A.3.3.8(f) Typical Compressor Module.

note: renumber figures below as A.3.8 (a through f). These are taken from NFPA 55-2016 Also note that in NFPA 55 the Diagram SHOULD read Symbol Legend for Figure 3.3.9(a) through Figure A.3.3.9(f). Therefore in THIS document it should read Symbol Legend for Figure 3.3.8 (a) through Figure A.3.3.8 (f). Artwork should be taken from NFPA 55-2016.
Figure A.3.3.93.9.1(a) Symbol Legend for Figure A.3.3.12(b) through Figure A.3.3.12(f).

Figure A.3.3.93.9.1(b) Typical Tube Trailer.
Figure A.3.3.93.9.1(c) Typical Bulk Compressed Gaseous Storage System.

Figure A.3.3.93.9.1(d) Typical Tube Trailer Discharge Stanchion and Pressure Control Manifold.
Figure A.3.3.93.9.1(e) Typical Chemical Energy Storage Module (CESM).

Figure A.3.3.93.9.1(f) Typical Compressor Module.
3.3.10* Bulk Inert Gas System

An assembly of equipment, that consists of, but is not limited to, storage containers, pressure regulators, pressure relief devices, vaporizers, manifolds, and piping, with a storage capacity of more than 20,000 ft³ (566 m³) of inert gas, including unconnected reserves on hand at the site, and that terminates at the source valve. [85, 2016]
**A.3.3.9 Bulk Inert Gas System.**
The bulk system terminates at the source valve, which is commonly the point where the gas supply, at service pressure, first enters the supply line or a piece of equipment that utilizes the gas or the liquid. The containers are either stationary or movable, and the source gas is stored as a compressed gas or cryogenic fluid. [55, 2016]

Bulk inert gas systems can be used to supply gas in either its compressed gaseous or liquefied form. Systems that may can be used to supply both gaseous and liquid forms are referred to as hybrid systems. The following bulk inert gas systems are typical of those in use:

1. When the primary supply of the gas as stored is from a compressed gaseous source that is used in the compressed and gaseous form, the bulk inert gas system is said to be a bulk inert compressed gas system.

2. When the primary supply of the gas as stored is in a liquid form and the system is designed to transfer only liquid, the system is said to be a bulk liquefied inert gas system.

3. When the primary supply of the gas as stored is in a liquid form and the system is designed to transfer or store the gas in a compressed gaseous form, with or without a feature that may can also allow the subsequent transfer and use of liquid, the bulk inert gas system is said to be a hybrid bulk inert gas system.

[55, 2016]

For the purposes of the application of the code, a hybrid system is viewed as a bulk liquefied inert gas system. [55, 2016]
3.3.11* Bulk Liquefied Hydrogen System (Gas).
An assembly of equipment that consists of, but is not limited to, storage containers, pressure regulators, pressure relief devices, support structures, liquid pumps, compressors, manifolds, and piping, with a storage capacity of more than 39.7 gal (150 L) of liquefied hydrogen (LH₂) system with a storage capacity of more than 39.7 gal (150 L) of liquefied hydrogen. [55, 2016]
3.3.12* Bulk Oxygen System (Gas).
An assembly of equipment, such as oxygen storage containers, pressure regulators, pressure relief devices, vaporizers, manifolds, and interconnecting piping, that has a storage capacity of more than 20,000 ft^3 (566 m^3) of oxygen and that terminates at the source valve. [SS, 2016]
A.3.3.11 Bulk Oxygen System.

The bulk oxygen system terminates at the source valve, which is commonly the point where oxygen at service pressure first enters the supply line or a piece of equipment that utilizes the oxygen gas or liquid. The oxygen containers are either stationary or movable, and the oxygen is stored as a compressed gas or cryogenic fluid. [55, 2016]

Bulk oxygen systems can be used to supply gas in either its compressed gaseous or liquefied form. Systems that may can be used to supply both gaseous and liquid forms are referred to as hybrid systems. The following bulk oxygen systems are typical of those in use:

1. When the primary supply of the gas as stored is from a compressed gaseous source that is used in the compressed and gaseous form, the bulk oxygen system is said to be a bulk compressed oxygen gas system.

2. When the primary supply of the gas as stored is in a liquid form and the system is designed to transfer only liquid, the system is said to be a bulk liquefied oxygen system.

3. When the primary supply of the gas as stored is in a liquid form and the system is designed to transfer or store the gas in a compressed gaseous form, with or without a feature that may can also allow the subsequent transfer and use of liquid, the bulk oxygen system is said to be a hybrid bulk oxygen system.

[55, 2016]

For the purposes of the application of the code, a hybrid system is viewed as a bulk liquefied oxygen system. [55, 2016]
3.3.17 Combustible Liquid.

Any liquid that has a closed-cup flash point at or above 100°F (37.8°C), as determined by the test procedures and apparatus set forth in Section 4.4 of NFPA 30. Combustible liquids are classified according to Section 4.3 of NFPA 30. Combustible liquids, as defined in 3.3.30.1 and 4.2.2 of NFPA 30, 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).
3.3.19 Consumer Fireworks.

Small fireworks devices containing restricted amounts of pyrotechnic composition, designed primarily to produce visible or audible effects by combustion, that comply with the construction, chemical composition, and labeling regulations of the U.S. Consumer Product Safety Commission (CPSC), as set forth in CPSC 16 CFR 1500 and 1507, 49 CFR 172, and ASA Standard 87–1, Standard for the Construction and Approval for Transportation of Fireworks, Novelties, and Theatrical Pyrotechnics [1124, 2013].

Submitter Information Verification

Submitter Full Name: [Not Specified]
Organization: [Not Specified]
Street Address: 
City: 
State: 
Zip: 
Submittal Date: Wed Aug 06 11:11:35 EDT 2014

Committee Statement

Committee Statement: This was deleted to be consistent with the TIA to remove consumer fireworks requirements from NFPA 400.

Response Message:
Public Comment No. 9-NFPA 400-2014 [Section No. 3.3.18]
### Second Revision No. 155-NFPA 400-2014 [ Section No. 3.3.19.2 ]

| 3.3.19.2 Closed Container {{ Flammable and Combustible Liquid }}, A container as herein defined, so sealed by means of a lid or other device that neither liquid nor vapor will escape from it at ordinary temperatures. [30, 2015] |

### Submitter Information Verification

- **Submitter Full Name:** Michael Beady
- **Organization:** [ Not Specified ]
- **Street Address:**
- **City:**
- **State:**
- **Zip:**
- **Submit Date:** Tue Sep 23 11:54:22 EDT 2014

### Committee Statement

- **Committee Statement:** Updated text to match extract source
- **Response Message:**
3.3.19.10.1* Atmospheric Tank ([Flammable and Combustible Liquid]).
A storage tank that has been designed to operate at pressures from atmospheric through a gauge pressure of 1.0 psi (6.9 kPa) (i.e., 760 mm Hg through 812 mm Hg) measured at the top of the tank. [36, 2015]
3.3.19.11.1 Portable Tank (Gas). A liquid storage container having a capacity of more than 60 U.S. gal (227.1 L) designed primarily to be loaded into or on, or temporarily attached to, a transport vehicle or ship and equipped with skids, mountings, or accessories to facilitate handling of the tank by mechanical means. ([S, 2016])

Submitter Information Verification

Submitter Full Name: Michael Beady
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Street Address:
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Submit Date: Tue Sep 23 11:55:46 EDT 2014

Committee Statement

Committee Statement: Updated text to match extract source
Response Message:
3.3.19.16* Safety Can [Liquid].
A listed container of not more than 5.3 gal (20 L) capacity having a screen or strainer in each fill and pour opening and having a spring closing lid and spout cover designed to safely relieve internal pressure when subjected to exposure.
3.3.19.17 Aerosol Container (Liquid).
A metal can or plastic container up to a maximum size of 33.8 fl oz (1000 ml) or a glass, stone, or plastic metal bottle up to a maximum size of 4 fl oz (118 ml) that is designed and intended to dispense an aerosol. [30B, 2015]
3.3.24 Cylinder Containment System (Gas)

A gastight recovery system comprising equipment or devices that can be placed over a leak in a compressed gas container, thereby stopping or controlling the escape of gas from the leaking container. [55, 2016]

Submitter Information Verification

Submitter Full Name: Michael Beady
Organization: [ Not Specified ]
Street Address: 
City: 
State: 
Zip: 
Submit Date: Tue Sep 23 12:03:54 EDT 2014

Committee Statement

Committee Statement: Updated text to match extracted text
Response Message: 

http://submittals.nfpa.org/TerraViewWeb/ContentFetcher?commentPara...
3.3.47.7* Irritant Gas [Gas].
A chemical that is not corrosive, but that causes a reversible inflammatory effect on living tissue by chemical action at the site of contact. [55, 2016]

Submitter Information Verification
Submitter Full Name: [Not Specified]
Organization: [Not Specified]
Street Address: 
City: 
State: 
Zip: 
Submit Date: Fri Aug 01 16:53:17 EDT 2014

Committee Statement
Committee Statement: Deleted extract tag since no longer defined in NFPA 55. Delete extract tag on annex as well.
Response Message:
### 3.3.47.10 Oxidizing Gas (Gas)

A gas that can support and accelerate combustion of other materials more than air does. [55, 2016]

### Submitter Information Verification

<table>
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<th>Submitter Full Name</th>
<th>[Not Specified]</th>
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<tbody>
<tr>
<td>Organization</td>
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<td>Fri Aug 01 16:54:17 EDT 2014</td>
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### Committee Statement

Committee Statement: Modified to match current edition text.

3.3.51* Gaseous Hydrogen System (Gas \( \text{GH}_2 \) ) System

A system in which the hydrogen is delivered, stored, and discharged in the gaseous form to a piping system. The gaseous hydrogen system terminates at the point where hydrogen at service pressure first enters the distribution piping. An assembly of equipment that consists of, but is not limited to, storage containers, pressure regulators, pressure relief devices, compressors, manifolds, and piping and that terminates at the source valve. [§5, 2016]

Supplemental Information

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Submitter Information Verification

Submitter Full Name: [Not Specified]
Organization: [Not Specified]
Street Address: [Not Specified]
City: [Not Specified]
State: [Not Specified]
Zip: [Not Specified]
Submittal Date: Fri Aug 01 16:55:34 EDT 2014

Committee Statement

Committee Statement: Modified to match current edition text. Annex material also modified as attached.
Response Message: [Not Specified]
A.3.3.51 Gaseous Hydrogen (H₂) System.
The system includes stationary or portable containers, pressure regulators, pressure-relief devices, manifolds, interconnecting piping, and controls as required. ([55, 2016])
3.3.54 Hazard Rating (Gas)

The numerical rating of the health, flammability, and self-reactivity, and other hazards of the material, including its reaction with water, specified in NFPA 704.

Submitter Information Verification

Submitter Full Name: [Not Specified]
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submit Date: Wed Aug 06 11:22:33 EDT 2014

Committee Statement

Committee Statement: This term is only used in annex and in one definition in NFPA 400.
Response Message:
Public Comment No. 10-NFPA 400-2014 [Section No. 3.3.53]
3.3.58 Liquefied Hydrogen System (Gas LH₂) System

A system into which liquefied hydrogen is delivered and stored and from which it is discharged in the liquid or gaseous form to a piping system. An assembly of equipment that consists of, but is not limited to, storage containers, pressure regulators, pressure relief devices, compressors, manifolds, and piping and that terminates at the source valve. [55, 2016]

Submitter Information Verification

Submitter Full Name: [Not Specified]
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submit Date: Fri Aug 01 16:58:54 EDT 2014

Committee Statement

Committee Statement: Modified to match current edition text. DELETE existing annex since annex has been deleted from current edition of NFPA 55.
Response Message:
3.3.61* Safety Data Sheet (SDS).
The document that describes composition of a material, hazardous properties and hazard mitigation, and disposal information prepared in accordance with the Occupational Safety and Health Administration (OSHA) hazard communication standard (29 CFR, 1910.1200, “Hazard Communication”), and disposal information.

Supplemental Information

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Submitter Information Verification

Submitter Full Name: [Not Specified]
Organization: [Not Specified]
Street Address:
City:
State:
Zip: 
Submittal Date: Wed Aug 06 11:25:53 EDT 2014

Committee Statement

Committee Statement: The Committee moved the reference to OSHA to annex and added additional information about international requirements and referred the user to Annex B.

Response Message:
Public Comment No. 11-NFPA 400-2014 [Section No. 3.3.62]
A.3.3.62 Safety Data Sheet (SDS).

SDSs in the U.S. are prepared in accordance with the Occupational Safety and Health Administration (OSHA) hazard communication standard (29 CFR, 1910.1200, “Hazard Communication”). Chemicals transported internationally may include additional requirements. *See Annex B for Additional information regarding SDSs.* can be found in Annex B.
3.3.66 Nonbulk Flammable Gas System.
A system consisting of cylinders or other storage systems, with each individual cylinder and each individual set of connected cylinders having less than 5000 scf (141.6 Nm³).

Committee Statement:
New definition added to match NFPA 55. Annex material to be added also. See attached.

Response Message:
A.3.3.XX Non-bulk Bulk flammable Flammable gas Gas system System.

Non-bulk systems may can have more than 5,000 SCF as long as the volume of any individual container or connected system is less than 5,000 SCF. Table 21.3.6.2 shows exposure distances for non-bulk flammable gases with a bulk threshold of 5,000 SCF and with total storage up to 200,000 SCF. [55, 2016]
An occupancy used for purposes of to provide medical or other treatment or care of simultaneously to, four or more persons patients, on an inpatient basis, where such occupants patients are mostly incapable of self-preservation due to age, physical or mental disability, or because of security measures not under the occupants' control. [5000, 2015]

Submitter Information Verification

Submitter Full Name: [Not Specified]
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submit Date: Fri Aug 01 17:06:56 EDT 2014

Committee Statement

Committee Statement: Modified to match current edition text.
Response Message:
3.3.73 Person.
Any individual, firm, copartnership, corporation, company, association, or joint-stock association, including any trustee, receiver, assignee, or personal representative thereof.
[1124, 2013]

Committee Statement
Committee Statement: Removed definition. NFPA 1124 temporarily withdrawn.
Response Message:
3.3.78 Standard Cubic Foot (scf) of Gas

An amount of gas that occupies one cubic foot at an absolute pressure of 14.7 psi (101 kPa) and a temperature of 70°F (21°C). [55, 2016]

Submitter Information Verification

Submitter Full Name: Michael Beady
Organization: [ Not Specified ]
Street Address: 
City: 
State: 
Zip: 
Submittal Date: Tue Sep 23 12:22:37 EDT 2014

Committee Statement

Committee Statement: Updated text to match extract source
Response Message:
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<td>Detail SR-127</td>
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<td>Detail SR-175</td>
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</table>
### Physical Hazard Materials

#### Material
- **Combustible liquid**: See Chapter 11.
- **Cryogenic fluid**: Flammable gas [5B: Table 5.2.1.1.3](#).
- **Explosives**: Gaseous, Liquefied.
- **Flammable gas**: Gaseous, Liquefied (LP).
- **Flammable liquid**: Gaseous, Liquefied (LP).
- **Organic peroxide**: Gaseous, Liquefied.
- **Oxidizer**: Gaseous, Liquefied.
- **Oxidizing gas**: Gaseous, Liquefied.
- **Pyrophoric Gas**: Gaseous, Liquefied.
- **Water-reactive**: Gaseous, Liquefied.

#### Class
- **I**: Flammable.
- **II**: Oxidizing.
- **III**:
  - **A**: Inert.
  - **B**: 2 or 3.
  - **C**: 1.
  - **D**: 3.
  - **E**: 5.
  - **F**: 1.
  - **G**: 4.
  - **H**: 5.
  - **K**: 1.
  - **L**: 3.
  - **M**: 2.
  - **N**: 3.
  - **O**: 1.
  - **P**: 2.
  - **Q**: 4.
  - **R**: 3.
  - **S**: 3.
  - **T**: 1.
  - **U**: 4.
  - **V**: 1.

#### Use — Closed Systems
- **Solid Pounds**
- **Liquid Gallons (lb)**

#### Use — Open Systems
- **Solid Pounds**
- **Liquid Gallons (lb)**

### Table 5.2.1.1.3 Maximum Allowable Quantity (MAQ) of Hazardous Materials per Control Area

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<th>Material</th>
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<th>Storage</th>
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<td>See Chapter 11</td>
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Note: See Chapter 11 for more details.
Table 6.3.1.1 | Health Hazard Materials

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<tr>
<th>Material</th>
<th>Class</th>
<th>Storage</th>
<th>Use — Closed Systems</th>
<th>Use — Open Systems</th>
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<td>Solid Pounds</td>
<td>Liquid Gallons (lb)</td>
<td>Gas b, scf (lb)</td>
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<td>810 c,d, (150 c,d)</td>
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</table>

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

UD: Unclassified detonable For SI units, 1 lb = 0.454 kg; 1 gal = 3.785 L; 1 scf = 0.0283 Nm³.

Note: The hazardous material categories and MAQs that are shaded in this table are not regulated by NFPA 400 but are provided here for informational purposes. See Chapter 2 for the reference code or standard governing these materials and establishing the MAQs. In accordance with 1.1.1.2, materials having multiple hazards that fall within the scope of NFPA 400 shall comply with NFPA 400.

Parking values in parentheses correspond to the unit name in parentheses at the top of the column. The aggregate quantity in use and storage is not permitted to exceed the quantity listed for storage.

b Measured at NTP or 70°F (21°C) and absolute pressure of 14.7 psi (101.3 kPa).

c Quantities are permitted to be increased 100 percent where stored or used in approved cabinets, gas cabinets, exhausted enclosures, gas rooms explosives magazines, or safety cans, as appropriate for the material stored, in accordance with this code. Where footnote d also applies, the increase for both footnote c and footnote d is permitted to be applied accumulatively.

d Maximum quantities are permitted to be increased 100 percent in buildings equipped throughout with an automatic sprinkler system in accordance with NFPA 13. Where footnote c also applies, the increase for both footnote c and footnote d is permitted to be applied accumulatively.

e The permitted quantities are not limited in a building equipped throughout with an automatic sprinkler system in accordance with NFPA 13.

f A maximum quantity of 220 lb (99 kg) of solid or 22 gal (83 L) of liquid Class 3 oxidizer is permitted where such materials are necessary for maintenance purposes, operation, or sanitation of equipment. Storage containers and the manner of storage are required to be approved.

g Allowed only where stored or used in gas rooms or approved cabinets, exhausted gas cabinets or exhausted enclosures, as specified in this code. [5000: Table 34.1.3.1]

h Conversion. Where quantities are indicated in pounds and when the weight per gallon of the liquid is not provided to the AHJ, a conversion factor of 10 lb/gal (1.2 kg/L) shall be used.

i Permitted only in buildings equipped throughout with an automatic sprinkler system in accordance with NFPA 13.

j None allowed in unspinklered buildings unless stored or used in gas rooms or in approved gas cabinets or exhausted enclosures, as specified in this code.

k With pressure-relief devices for stationary or portable containers vented directly outdoors or to an exhaust hood. [55: Table 6.3.1.1]

l Flammable gases in the fuel tanks of mobile equipment or vehicles are permitted to exceed the MAQ where the equipment is stored and operated in accordance with the fire code.

m The permitted quantities are not limited in a building equipped throughout with an automatic sprinkler system installed in accordance with NFPA 13 and designed in accordance with the protection criteria contained in Chapter 16 of NFPA 30.

n Containing not more than the maximum allowable quantity per control area of Class I-A, Class I-B, or Class I-C flammable liquids, individually.

o Machines, tools, skids, cosmetics, and other consumer products that contain not more than 50% by volume water-miscible flammable or combustible liquids, with the remainder of the product consisting of components that do not burn, shall not be limited, where packaged in individual containers that do not exceed a 1-gallon capacity. [35: 6.1.4(d)]

p Additional storage locations are required to be separated by a minimum of 300 ft (92 m).

q In mercantile occupancies, storage of LP-gas is limited to a maximum of 200 lb (91 kg) in nominal 1 lb (0.45 kg) LP-gas containers.

r See NFPA 58 for liquefied petroleum gas (LP-gas) requirements. LP-gas is not within the scope of NFPA 400.

Supplemental Information

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Submitter Information Verification

Submitter Full Name: [Not Specified]
Organization: [Not Specified]
City: [Not Specified]
State: [Not Specified]
Zip: [Not Specified]
Submittal Date: Wed Aug 20 15:21:04 EDT 2014

Committee Statement

Committee Statement: Table has been edited to correct errors and to point to the correct footnotes. See attached with changes highlighted.

Response Message:
### Table 5.2.1.1.3 Maximum Allowable Quantity (MAQ) of Hazardous Materials per Control Area

<table>
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<tr>
<th>Material</th>
<th>Class</th>
<th>High Hazard Protection Level</th>
<th>Storage</th>
<th>Use — Closed Systems</th>
<th>Use — Open Systems</th>
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<tr>
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<td>Solid Pounds</td>
<td>Liquid Gallons (lb)</td>
<td>Gas(^b) scf (lb)</td>
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</table>

### Table Notes:
- **Solid Pounds**: The amount of solid material in pounds.
- **Liquid Gallons (lb)**: The amount of liquid material in gallons, followed by pounds in parentheses.
- **Gas^b scf (lb)**: The amount of gas material in cubic feet, followed by pounds in parentheses.
- **Use — Closed Systems**: The storage and use requirements for closed systems.
- **Use — Open Systems**: The storage and use requirements for open systems.

### Material Classifications:
- **Unstable (reactive)**: Indicates materials that are unstable or reactive.
- **Gaseous**: Materials that are gaseous.
- **Liquefied**: Materials that are liquefied.
- **Water-reactive**: Materials that are water-reactive.
### Table 6.3.1.1

<table>
<thead>
<tr>
<th>Material</th>
<th>Class</th>
<th>High Hazard Protection Level</th>
<th>Storage</th>
<th>Use — Closed Systems</th>
<th>Use — Open Systems</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Solid</td>
<td>Liquid Gallons (lb)</td>
<td>Gas b scf (lb)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Pounds</td>
<td>(lb)</td>
<td>(lb)</td>
</tr>
<tr>
<td>Highly toxic</td>
<td>N/A</td>
<td>4</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(150)c,d</td>
<td></td>
<td>(150)c,d</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>N/A</td>
<td>N/A</td>
<td>3d</td>
</tr>
<tr>
<td>Highly toxic gas [55: 5000: Table 34.1.3.1]</td>
<td>Gaseous</td>
<td>4</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>20d,g</td>
<td></td>
<td>20d,g</td>
</tr>
<tr>
<td>Toxic</td>
<td>N/A</td>
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<td>500d</td>
<td>(500)c,d</td>
<td>125d</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(500)c,d</td>
<td></td>
<td>(125)d</td>
</tr>
<tr>
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<td>Gaseous</td>
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<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>810c,d</td>
<td></td>
<td>N/A</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>(150)c,d</td>
<td></td>
<td>N/A</td>
</tr>
<tr>
<td>Liquefied</td>
<td>4</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
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<td></td>
<td></td>
<td></td>
<td>(150)c,d</td>
<td></td>
<td>N/A</td>
</tr>
</tbody>
</table>

N/A: Not applicable. NL: Not limited. NP: Not permitted.
UD: Unclassified detonable
For SI units, 1 lb = 0.454 kg; 1 gal = 3.785 L; 1 scf = 0.0283 Nm³.

Note: The hazardous material categories and MAQs that are shaded in this table are not regulated by NFPA 400 but are provided here for informational purposes. See Chapter 2 for the reference code or standard governing these materials and establishing the MAQs. In accordance with 1.1.1.2, materials having multiple hazards that fall within the scope of NFPA 400 shall comply with NFPA 400.

a Table values in parentheses correspond to the unit name in parentheses at the top of the column. The aggregate quantity in use and storage is not permitted to exceed the quantity listed for storage.
b Measured at NTP or 70°F (21°C) and absolute pressure of 14.7 psi (101.3 kPa).
c Quantities are permitted to be increased 100 percent where stored or used in approved cabinets, gas cabinets, exhausted enclosures, gas rooms explosives magazines, or safety cans, as appropriate for the material stored, in accordance with this code. Where footnote d also applies, the increase for both footnote c and footnote d is permitted to be applied cumulatively.
d Maximum quantities are permitted to be increased 100 percent in buildings equipped throughout with an automatic sprinkler system in accordance with NFPA 13. Where footnote c also applies, the increase for both footnote c and footnote d is permitted to be applied accumulatively.
e The permitted quantities are not limited in a building equipped throughout with an automatic sprinkler system in accordance with NFPA 13.

f A maximum quantity of 220 lb (99 kg) of solid or 22 gal (83 L) of liquid Class 3 oxidizer is permitted where such materials are necessary for maintenance purposes, operation, or sanitation of equipment. Storage containers and the manner of storage are required to be approved.
g Allowed only where stored or used in gas rooms or approved cabinets, exhausted gas cabinets or exhausted enclosures, as specified in this code. [5000: Table 34.1.3.1]
Conversion. Where quantities are indicated in pounds and when the weight per gallon of the liquid is not provided to the AHJ, a conversion factor of 10 lb/gal (1.2 kg/L) shall be used.

Permitted only in buildings equipped throughout with an automatic sprinkler system in accordance with NFPA 13.

None allowed in unsprinklered buildings unless stored or used in gas rooms or in approved gas cabinets or exhausted enclosures, as specified in this code.

With pressure-relief devices for stationary or portable containers vented directly outdoors or to an exhaust hood. [55: Table 6.3.1.1]

Flammable gases in the fuel tanks of mobile equipment or vehicles are permitted to exceed the MAQ where the equipment is stored and operated in accordance with the fire code.

The permitted quantities are not limited in a building equipped throughout with an automatic sprinkler system installed in accordance with NFPA 13 and designed in accordance with the protection criteria contained in Chapter 16 of NFPA 30.

Containing not more than the maximum allowable quantity per control area of Class I-A, Class I-B, or Class I-C flammable liquids, individually.

Additional storage locations are required to be separated by a minimum of 300 ft (92 m).

In mercantile occupancies, storage of LP-gas is limited to a maximum of 200 lb (91 kg) in nominal 1 lb (0.45 kg) LP-gas containers.

See NFPA 58, Liquefied Petroleum Gas Code, for liquefied petroleum gas (LP-gas) requirements. LP-gas is not within the scope of NFPA 400.
### Assembly Occupancies

The MAQ of hazardous materials per control area in assembly occupancies shall be as specified in Table 5.2.1.2.

#### Table 5.2.1.2 Maximum Allowable Quantities (MAQ) of Hazardous Materials per Control Area in Assembly Occupancies

<table>
<thead>
<tr>
<th>Material</th>
<th>Class</th>
<th>Solid Pounds</th>
<th>Liquid Gallons</th>
<th>Gas @ (at NTP) scf (lb)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flammable and combustible liquid</td>
<td>I and II</td>
<td>N/A</td>
<td>10</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>III-A</td>
<td>N/A</td>
<td>60</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>III-B</td>
<td>N/A</td>
<td>120</td>
<td>N/A</td>
</tr>
<tr>
<td>Cryogenic fluid</td>
<td>Flammable</td>
<td>N/A</td>
<td>10</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>Oxidizing</td>
<td>N/A</td>
<td>10</td>
<td>N/A</td>
</tr>
<tr>
<td>Explosives</td>
<td>See note</td>
<td>See note</td>
<td>See note</td>
<td>See note</td>
</tr>
<tr>
<td>Flammable gas</td>
<td>Gaseous</td>
<td>N/A</td>
<td>N/A</td>
<td>NP</td>
</tr>
<tr>
<td></td>
<td>Liquefied</td>
<td>N/A</td>
<td>N/A</td>
<td>(20)</td>
</tr>
<tr>
<td></td>
<td>Liquefied Petroleum</td>
<td>N/A</td>
<td>N/A</td>
<td>(20)</td>
</tr>
<tr>
<td>Consumer fireworks</td>
<td>Gaseous</td>
<td>N/A</td>
<td>N/A</td>
<td>NP</td>
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<tr>
<td></td>
<td>Liquefied</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
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<td>Oxidizing gas</td>
<td>Gaseous</td>
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<td>Liquefied</td>
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<td>N/A</td>
<td>N/A</td>
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<td>Organic peroxides</td>
<td>I</td>
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<td>N/A</td>
<td>N/A</td>
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<tr>
<td>Pyrophoric materials</td>
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<td>(1)</td>
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<td>(1)</td>
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<td>10</td>
<td>(10)</td>
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<td></td>
<td>1</td>
<td>NL</td>
<td>NL</td>
<td>N/A</td>
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<tr>
<td>Corrosives</td>
<td>N/A</td>
<td>1,000</td>
<td>100</td>
<td>NP</td>
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<tr>
<td>Highly toxic</td>
<td>N/A</td>
<td>3</td>
<td>(3)</td>
<td>NP</td>
</tr>
<tr>
<td>Toxic</td>
<td>N/A</td>
<td>125</td>
<td>(125)</td>
<td>NP</td>
</tr>
</tbody>
</table>

For SI units, 1 lb = 0.454 kg; 1 gal = 3.785 L.

NTP: Normal temperature and pressure (measured at 70°F (21°C) and 14.7 psi (101 kPa)]. N/A: Not applicable. NP: Not permitted. NL: Not limited.

Note: The hazardous material categories and MAQs that are shaded in this table are not regulated by NFPA 400 but are provided here for informational purposes. See Chapter 2 for the reference code or standard governing these materials and establishing the MAQs. In accordance with 1.1.1.2, materials having multiple hazards that fall within the scope of NFPA 400 shall comply with NFPA 400.

- Unlimited amounts of gas are permitted to be used for personal medical or emergency medical use.
- Storage in excess of 10 gal (38 L) of Class I and Class II liquids combined or 60 gal (227 L) of Class IIIA liquids is permitted where stored in safety cabinets with an aggregate quantity not to exceed 180 gal (681 L).
- Fuel in the tank of operating mobile equipment is permitted to exceed the specified quantity where the equipment is operated in accordance with this code.
- The use of explosive materials required by federal, state, or municipal agencies while engaged in normal or emergency performance of duties is not required to be limited. The storage of explosive materials is required to be in accordance with the requirements of NFPA 495.
- The storage and use of explosive materials in medicines and medicinal agents in the forms prescribed by the official United States Pharmacopeia or the National Formulary are not required to be limited.
- The storage of propellant-actuated devices or propellant-actuated industrial tools manufactured, imported, or distributed for their intended purposes are required to be limited to 50 lb (23 kg) net explosive weight.
- The storage and use of small arms ammunition, and components thereof, are permitted where in accordance with NFPA 495.
- Containers, cylinders, or tanks not exceeding 250 scf (7.1 m³) content measured at 70°F (21°C) and 14.7 psi (101 kPa) and used for maintenance purposes, patient care, or operation of equipment shall be permitted.
- A maximum quantity of 220 lb (99 kg) of solid or 22 gal (83 L) of liquid Class 3 oxidizer is permitted where such materials are necessary for maintenance purposes, operation, or sanitation of equipment. Storage containers and the manner of storage are required to be approved.
- Gas cylinders not exceeding 20 scf (0.57 m³) measured at 70°F (21°C) and 14.7 psi (101 kPa) are permitted in gas cabinets or fume hoods. [5000: Table 34.1.3.2(a(i)]
- Conversion. Where quantities are indicated in pounds and when the weight per gallon of the liquid is not provided to the AHJ, a conversion factor of 10 lb/gal (1.2 kg/L) shall be used.

---

**Supplemental Information**

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<th>Description</th>
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**National Fire Protection Association Report**

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<td><strong>Response Message:</strong></td>
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### Table 5.2.1.2 Maximum Allowable Quantities (MAQ) of Hazardous Materials per Control Area in Assembly Occupancies

<table>
<thead>
<tr>
<th>Material</th>
<th>Class</th>
<th>Solid Pounds</th>
<th>Liquid Gallons[^k] (lb)</th>
<th>Gas[^a] (at NTP) scf (lb)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flammable and combustible liquid[^b,c]</td>
<td>I and II</td>
<td>N/A</td>
<td>10</td>
<td>N/A</td>
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<td>III-B</td>
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<td>120</td>
<td>N/A</td>
</tr>
<tr>
<td>Cryogenic fluid</td>
<td>Flammable</td>
<td>N/A</td>
<td>10</td>
<td>N/A</td>
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<tr>
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<td>10</td>
<td>N/A</td>
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<td>Explo[ds,e,f,g]s</td>
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<td>See note</td>
<td>See note</td>
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<td>N/A</td>
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<tr>
<td></td>
<td>Liquefied Petroleum</td>
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<td>N/A</td>
<td>(20)</td>
</tr>
<tr>
<td>Consumer fireworks</td>
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<td></td>
<td>3</td>
<td>10[^i]</td>
<td>1 gal[^i]</td>
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<td>25</td>
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<td>1</td>
<td>4,000</td>
<td>400</td>
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<tr>
<td>Oxidizing gas[^h]</td>
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<td>N/A</td>
<td>NP[^h]</td>
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<tr>
<td></td>
<td>Liquefied</td>
<td>N/A</td>
<td>N/A</td>
<td>NP[^h]</td>
</tr>
<tr>
<td>Organic peroxides</td>
<td>I</td>
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<td></td>
<td>V</td>
<td>NL</td>
<td>NL</td>
<td>N/A</td>
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<tr>
<td>Pyrophoric materials</td>
<td>N/A</td>
<td>1</td>
<td>(1)</td>
<td>NP</td>
</tr>
<tr>
<td><strong>Unstable Reactive</strong></td>
<td>4</td>
<td>¼</td>
<td>¼</td>
<td>NP</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>1</td>
<td>(1)</td>
<td>NP</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>10</td>
<td>(10)</td>
<td>NP[^h]</td>
</tr>
<tr>
<td>Material</td>
<td>Class</td>
<td>Solid Pounds</td>
<td>Liquid Gallons&lt;sup&gt;k&lt;/sup&gt; (lb)</td>
<td>Gas&lt;sup&gt;a&lt;/sup&gt; (at NTP) scf (lb)</td>
</tr>
<tr>
<td>------------------</td>
<td>-------</td>
<td>--------------</td>
<td>---------------------------------</td>
<td>----------------------------------</td>
</tr>
<tr>
<td>Water-reactive</td>
<td>3</td>
<td>1</td>
<td>(1)</td>
<td>N/A</td>
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<tr>
<td></td>
<td>2</td>
<td>10</td>
<td>(10)</td>
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<td></td>
<td>1</td>
<td>NL</td>
<td>NL</td>
<td>N/A</td>
</tr>
<tr>
<td>Corrosives</td>
<td>N/A</td>
<td>1,000</td>
<td>100</td>
<td>NP</td>
</tr>
<tr>
<td>Highly toxic</td>
<td>N/A</td>
<td>3</td>
<td>(3)</td>
<td>NP</td>
</tr>
<tr>
<td>Toxic</td>
<td>N/A</td>
<td>125</td>
<td>(125)</td>
<td>NP</td>
</tr>
</tbody>
</table>

For SI units, 1 lb = 0.454 kg; 1 gal = 3.785 L.

NTP: Normal temperature and pressure [measured at 70°F (21°C) and 14.7 psi (101 kPa)]. N/A: Not applicable. NP: Not permitted. NL: Not limited.

Note: The hazardous material categories and MAQs that are shaded in this table are not regulated by NFPA 400 but are provided here for informational purposes. See Chapter 2 for the reference code or standard governing these materials and establishing the MAQs. In accordance with 1.1.1.2, materials having multiple hazards that fall within the scope of NFPA 400 shall comply with NFPA 400.

<sup>a</sup>Unlimited amounts of gas are permitted to be used for personal medical or emergency medical use.

<sup>b</sup>Storage in excess of 10 gal (38 L) of Class I and Class II liquids combined or 60 gal (227 L) of Class IIIA liquids is permitted where stored in safety cabinets with an aggregate quantity not to exceed 180 gal (681 L).

<sup>c</sup>Fuel in the tank of operating mobile equipment is permitted to exceed the specified quantity where the equipment is operated in accordance with this code.

<sup>d</sup>The use of explosive materials required by federal, state, or municipal agencies while engaged in normal or emergency performance of duties is not required to be limited. The storage of explosive materials is required to be in accordance with the requirements of NFPA 495.

<sup>e</sup>The storage and use of explosive materials in medicines and medicinal agents in the forms prescribed by the official United States Pharmacopeia or the National Formulary are not required to be limited.

<sup>f</sup>The storage and use of propellant-actuated devices or propellant-actuated industrial tools manufactured, imported, or distributed for their intended purposes are required to be limited to 50 lb (23 kg) net explosive weight.

<sup>g</sup>The storage and use of small arms ammunition, and components thereof, are permitted where in accordance with NFPA 495.

<sup>h</sup>Containers, cylinders, or tanks not exceeding 250 scf<sup>3</sup> (7.1 m<sup>3</sup>) content measured at 70°F (21°C) and 14.7 psi (101 kPa) and used for maintenance purposes, patient care, or operation of equipment shall be permitted.

<sup>i</sup>A maximum quantity of 220 lb (99 kg) of solid or 22 gal (83 L) of liquid Class 3 oxidizer is permitted where such materials are necessary for maintenance purposes, operation, or sanitation of equipment. Storage containers and the manner of storage are required to be approved.

<sup>j</sup>Gas cylinders not exceeding 20 scf<sup>3</sup> (0.57 m<sup>3</sup>) measured at 70°F (21°C) and 14.7 psi (101 kPa) are permitted in gas cabinets or fume hoods. [5000: Table 34.1.3.2(a)]
Conversion. Where quantities are indicated in pounds and when the weight per gallon of the liquid is not provided to the AHJ, a conversion factor of 10 lb/gal (1.2 kg/L) shall be used.
5.2.1.3 Educational Occupancies.
### Maximum Allowable Quantities (MAQ) of Hazardous Materials per Control Area in Educational Occupancies

<table>
<thead>
<tr>
<th>Material</th>
<th>Class</th>
<th>Solid Pounds</th>
<th>Liquid Gallons&lt;sup&gt;a&lt;/sup&gt; (lb)</th>
<th>Gas&lt;sup&gt;b&lt;/sup&gt; (at NTP) scf (lb)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flammable and combustible liquid&lt;sup&gt;c,g&lt;/sup&gt;</td>
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<td>III-B</td>
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<td>Cryogenic fluid</td>
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<td>Explosive&lt;sup&gt;e,f,g&lt;/sup&gt;</td>
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### Consumer fireworks

<table>
<thead>
<tr>
<th>Material</th>
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<th>Liquid Gallons&lt;sup&gt;a&lt;/sup&gt; (lb)</th>
<th>Gas&lt;sup&gt;b&lt;/sup&gt; (at NTP) scf (lb)</th>
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For SI units, 1 lb = 0.454 kg; 1 gal = 3.785 L; 1 ft<sup>3</sup> = 0.0283 m<sup>3</sup>.  
NTP: Normal temperature and pressure [measured at 70°F (21°C) and 14.7 psi (101 kPa)]. N/A: Not applicable. NP: Not permitted. NL: Not limited.  
Note: The hazardous material categories and MAQs that are shaded in this table are not regulated by NFPA 400 but are provided here for informational purposes. See Chapter 2 for the reference code or standard governing these materials and establishing the MAQs. In accordance with 1.1.1.2, materials having multiple hazards that fall within the scope of NFPA 400 shall comply with NFPA 400.  

<sup>a</sup> Unlimited amounts of gas are permitted to be used for personal medical or emergency medical use.  
<sup>b</sup> Storage in excess of 10 gal (38 L) of Class I and Class II liquids combined or 60 gal (227 L) of Class IIIA liquids is permitted where stored in safety cabinets with an aggregate quantity not to exceed 180 gal (681 L).  
<sup>c</sup> Fuel in the tank of operating mobile equipment is permitted to exceed the specified quantity where the equipment is operated in accordance with this code.  
<sup>d</sup> The use of explosive materials required by federal, state, or municipal agencies while engaged in normal or emergency performance of duties is not required to be limited. The storage of explosive materials is required to be in accordance with the requirements of NFPA 495.  
<sup>e</sup> The storage and use of explosive materials in medicines and medicinal agents in the forms prescribed by the official United States Pharmacopeia or the National Formulary are not required to be limited.  
<sup>f</sup> The storage and use of propellant-actuated devices or propellant-actuated industrial tools manufactured, imported, or distributed for their intended purposes are required to be limited to 50 lb (23 kg) net explosive weight.  
<sup>g</sup> The storage and use of small arms ammunition, and components thereof, are permitted where in accordance with NFPA 495.  
<sup>h</sup> Containers, cylinders, or tanks not exceeding 250 scf (7.1 m<sup>3</sup>) content measured at 70°F (21°C) and 14.7 psi (101 kPa) and used for maintenance purposes, patient care, or operation of equipment shall be permitted.  
<sup>i</sup> A maximum quantity of 220 lb (98 kg) of solid or 22 gal (83 L) of liquid Class 3 oxidizer is permitted where such materials are necessary for maintenance purposes, operation, or sanitation of equipment. Storage containers and the manner of storage are required to be approved.  
<sup>j</sup> The permitted quantities are not limited in a building protected throughout by automatic sprinkler systems in accordance with NFPA 13.  
<sup>k</sup> Storage in laboratories only; additional 20 lb (9 kg) units are permitted where minimum 20 ft (6.1 m) separation is provided.  
<sup>l</sup> Gas cylinders not exceeding 20 scf (0.57 m<sup>3</sup>) measured at 70°F (21°C) and 14.7 psi (101 kPa) are permitted in gas cabinets or fume hoods.  
<sup>m</sup> Conversion. Where quantities are indicated in pounds and when the weight per gallon of the liquid is not provided to the AHJ, a conversion factor of 10 lb/gal (1.2 kg/L) shall be used.  
<sup>n</sup> Storage shall be permitted to be increased 100% if the building is protected throughout with an automatic sprinkler system installed in accordance with NFPA 13.
the product consisting of components that do not burn, shall not be limited, where packaged in individual containers that do not exceed a 1.3-gallon capacity. [30: 9.1.4(i)]
<table>
<thead>
<tr>
<th>Material</th>
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<th>Solid Pounds</th>
<th>Liquid Gallons&lt;sup&gt;m&lt;/sup&gt; (lb)</th>
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<td>Corrosives</td>
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<td>Toxic</td>
<td>N/A</td>
<td>125 (125)</td>
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</table>

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5.2.1.4 Day-Care Occupancies.
The MAQ of hazardous materials per control area in day-care occupancies shall be as specified in Table 5.2.1.4.
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The MAQ of hazardous materials per control area in day-care occupancies shall be as specified in Table 5.2.1.4.

<table>
<thead>
<tr>
<th>Material</th>
<th>Class</th>
<th>Solid Pounds</th>
<th>Liquid Gallons&lt;sup&gt;k&lt;/sup&gt; (lb)</th>
<th>Gas&lt;sup&gt;j,l&lt;/sup&gt; (at NTP) scf (lb)</th>
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<td>III-B</td>
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<td>Cryogenic fluid</td>
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<td>NL</td>
<td>N/A</td>
</tr>
<tr>
<td>Corrosives</td>
<td>N/A</td>
<td>1,000</td>
<td>100</td>
<td>NP</td>
</tr>
<tr>
<td>Highly toxic</td>
<td>N/A</td>
<td>3</td>
<td>(3)</td>
<td>NP&lt;sup&gt;Ⅱ&lt;/sup&gt;</td>
</tr>
<tr>
<td>Toxic</td>
<td>N/A</td>
<td>125</td>
<td>(125)</td>
<td>NP&lt;sup&gt;Ⅱ&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

For SI units, 1 lb = 0.454 kg; 1 gal = 3.785 L.

NTP: Normal temperature and pressure [measured at 70°F (21°C) and 14.7 psi (101 kPa)]. N/A: Not applicable. NP: Not permitted. NL: Not limited.

Note: The hazardous material categories and MAQs that are shaded in this table are not regulated by NFPA 400 but are provided here for informational purposes. See Chapter 2 for the reference code or standard governing these materials and establishing the MAQs. In accordance with 1.1.1.2, materials having multiple hazards that fall within the scope of NFPA 400 shall comply with NFPA 400.

Unlimited amounts of gas are permitted to be used for personal medical or emergency medical use.

Storage in excess of 10 gal (38 L) of Class I and Class II liquids combined or 60 gal (227 L) of Class IIIA liquids is permitted where stored in safety cabinets with an aggregate quantity not to exceed 180 gal (681 L).

Fuel in the tank of operating mobile equipment is permitted to exceed the specified quantity where the equipment is operated in accordance with this code.

The use of explosive materials required by federal, state, or municipal agencies while engaged in normal or emergency performance of duties is not required to be limited. The storage of explosive materials is required to be in accordance with the requirements of NFPA 495.

The use of explosive materials in medicines and medical agents in the forms prescribed by the official United States Pharmacopeia or the National Formulary are not required to be limited.

The use of propellant-actuated devices or propellant-actuated industrial tools manufactured, imported, or distributed for their intended purposes are required to be limited to 50 lb (23 kg) net explosive weight.

Containers, cylinders, or tanks not exceed 250 scf (7.1 m<sup>3</sup>) content measured at 70°F (21°C) and 14.7 psi (101 kPa) and used for maintenance purposes, patient care, or operation of equipment shall be permitted.

The permitted quantities are not limited in a building protected throughout by automatic sprinkler systems in accordance with NFPA 13.

A maximum quantity of 220 lb (99 kg) of solid or 22 gal (83 L) of liquid Class 3 oxidizer is permitted where such materials are necessary for maintenance purposes, operation, or sanitation of equipment. Storage containers and the manner of storage are required to be approved.

Gaseous cylinders not exceeding 20 scf (0.57 m<sup>3</sup>) measured at 70°F (21°C) and 14.7 psi (101 kPa) are permitted in gas cabinets or fume hoods.

Conversion. Where quantities are indicated in pounds and when the weight per gallon of the liquid is not provided to the AHJ, a conversion factor of 10 lb/gal (1.2 kg/L) shall be used.

Storage shall be permitted to be increased 100% if the building is protected throughout with an automatic sprinkler system installed in accordance with NFPA 13.

Medicines, foodstuffs, cosmetics, and other consumer products that contain not more than 50% by volume water-miscible flammable or combustible liquids, with the remainder of the product consisting of components that do not burn, shall not be limited, where packaged in individual containers that do not exceed a 1.3-gallon capacity. [39] 1.1.4(3).
<table>
<thead>
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**Submitter Information Verification**

- **Submitter Full Name:** [Not Specified]
- **Organization:** [Not Specified]
- **Street Address:**
- **City:**
- **State:**
- **Zip:**
- **Submittal Date:** Wed Aug 20 15:48:19 EDT 2014

**Committee Statement**

- **Committee Statement:** Corrected references to footnotes. See highlighted sections in attached.
- **Response Message:**

### Table 5.2.1.4 Maximum Allowable Quantities (MAQ) of Hazardous Materials per Control Area in Day-Care Occupancies

<table>
<thead>
<tr>
<th>Material</th>
<th>Class</th>
<th>Solid Pounds</th>
<th>Liquid Gallons* (lb)</th>
<th>Gas* (at NTP) scf (lb)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flammable and combustible liquid**</td>
<td>I and II</td>
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<td>10</td>
<td>N/A</td>
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<tr>
<td></td>
<td>III-A</td>
<td>N/A</td>
<td>60</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>III-B</td>
<td>N/A</td>
<td>120*</td>
<td>N/A</td>
</tr>
<tr>
<td>Cryogenic fluid</td>
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</tr>
<tr>
<td>Flammable</td>
<td>N/A</td>
<td>10</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>Oxidizing</td>
<td>N/A</td>
<td>10</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>Explosives**</td>
<td>See note</td>
<td>See note</td>
<td>See note</td>
<td>See note</td>
</tr>
<tr>
<td>Flammable gas**</td>
<td>Gaseous</td>
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<td>N/A</td>
<td>N/A</td>
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<tr>
<td></td>
<td>Liquefied</td>
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<td>N/A</td>
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<td>Liquefied Petroleum</td>
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<td>Consumer fireworks</td>
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<td>Flammable solid</td>
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<td>4</td>
<td>NP</td>
<td>NP</td>
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</tr>
<tr>
<td></td>
<td>3</td>
<td>10&lt;sup&gt;i&lt;/sup&gt;</td>
<td>1&lt;sup&gt;i&lt;/sup&gt;</td>
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<td>Oxidizing gas**</td>
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<td>N/A</td>
<td>NP&lt;sup&gt;i&lt;/sup&gt;</td>
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<td>Liquefied</td>
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<td>N/A</td>
<td>NP&lt;sup&gt;i&lt;/sup&gt;</td>
</tr>
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<td>Organic peroxides</td>
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<td></td>
<td></td>
<td></td>
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<tr>
<td>I</td>
<td>NP</td>
<td>NP</td>
<td>N/A</td>
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</tr>
<tr>
<td>II</td>
<td>NP</td>
<td>NP</td>
<td>N/A</td>
<td></td>
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<td>V</td>
<td>NL</td>
<td>NL</td>
<td>N/A</td>
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<tr>
<td>Pyrophoric materials</td>
<td>N/A</td>
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<td>(1)</td>
<td>NP&lt;sup&gt;i&lt;/sup&gt;</td>
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<td>Unstable Reactive</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>½ lb</td>
<td>(½) lb</td>
<td>NP&lt;sup&gt;i&lt;/sup&gt;</td>
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<tr>
<td></td>
<td>3</td>
<td>1</td>
<td>(1)</td>
<td>NP&lt;sup&gt;i&lt;/sup&gt;</td>
</tr>
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<td></td>
<td>2</td>
<td>10</td>
<td>(10)</td>
<td>NP&lt;sup&gt;i&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

*See note

**Commented [PN1]: Change from h to g

**Commented [PN2]: H to g

**Commented [PN3]: H to g

**Commented [PN4]: H to g
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<thead>
<tr>
<th>Material</th>
<th>Class</th>
<th>Solid Pounds</th>
<th>Liquid Gallons$^a$ (lb)</th>
<th>Gas$^a$ (at NTP) scf (lb)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water-reactive</td>
<td>1</td>
<td>NL</td>
<td>NL</td>
<td>NP</td>
</tr>
<tr>
<td></td>
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<tr>
<td></td>
<td>3</td>
<td>1</td>
<td>(1)</td>
<td>N/A</td>
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<tr>
<td>Corrosives</td>
<td>N/A</td>
<td>1,000</td>
<td>100</td>
<td>NP</td>
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<td>Highly toxic</td>
<td>N/A</td>
<td>3</td>
<td>(3)</td>
<td>NP$^i$</td>
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<tr>
<td>Toxic</td>
<td>N/A</td>
<td>125</td>
<td>(125)</td>
<td>NP$^i$</td>
</tr>
</tbody>
</table>

For SI units, 1 lb = 0.454 kg; 1 gal = 3.785 L.
NTP: Normal temperature and pressure [measured at 70°F (21°C) and 14.7 psi (101 kPa)]. N/A: Not applicable. NP: Not permitted. NL: Not limited.
Note: The hazardous material categories and MAQs that are shaded in this table are not regulated by NFPA 400 but are provided here for informational purposes. See Chapter 2 for the reference code or standard governing these materials and establishing the MAQs. In accordance with 1.1.1.2, materials having multiple hazards that fall within the scope of NFPA 400 shall comply with NFPA 400.

$^a$Unlimited amounts of gas are permitted to be used for personal medical or emergency medical use.
$^b$Storage in excess of 10 gal (38 L) of Class I and Class II liquids combined or 60 gal (227 L) of Class IIIA liquids is permitted where stored in safety cabinets with an aggregate quantity not to exceed 180 gal (681 L).
$^c$Fuel in the tank of operating mobile equipment is permitted to exceed the specified quantity where the equipment is operated in accordance with this code.
$^d$The use of explosive materials required by federal, state, or municipal agencies while engaged in normal or emergency performance of duties is not required to be limited. The storage of explosive materials is required to be in accordance with the requirements of NFPA 495.
$^e$The storage and use of explosive materials in medicines and medicinal agents in the forms prescribed by the official United States Pharmacopeia or the National Formulary are not required to be limited.
$^f$The storage and use of propellant-actuated devices or propellant-actuated industrial tools manufactured, imported, or distributed for their intended purposes are required to be limited to 50 lb (23 kg) net explosive weight.
$^g$Containers, cylinders, or tanks not exceeding 250 scf (7.1 m$^3$) content measured at 70°F (21°C) and 14.7 psi (101 kPa) and used for maintenance purposes, patient care, or operation of equipment shall be permitted.
$^h$The permitted quantities are not limited in a building protected throughout by automatic sprinkler systems in accordance with NFPA 13.
$^i$A maximum quantity of 220 lb (99 kg) of solid or 22 gal (83 L) of liquid Class 3 oxidizer is permitted where such materials are necessary for maintenance purposes, operation, or sanitation of equipment. Storage containers and the manner of storage are required to be approved.
$^j$Gas cylinders not exceeding 20 scf (0.57 m$^3$) measured at 70°F (21°C) and 14.7 psi (101 kPa) are permitted in gas cabinets or fume hoods.
Conversion. Where quantities are indicated in pounds and when the weight per gallon of the liquid is not provided to the AHJ, a conversion factor of 10 lb/gal (1.2 kg/L) shall be used.

Storage shall be permitted to be increased 100% if the building is protected throughout with an automatic sprinkler system installed in accordance with NFPA 13.
### 5.2.1.5 Health Care Occupancies.

The MAQ of hazardous materials per control area in health care occupancies shall be as specified in Table 5.2.1.5.

#### Table 5.2.1.5 Maximum Allowable Quantities (MAQ) of Hazardous Materials per Control Area in Health Care Occupancies

<table>
<thead>
<tr>
<th>Material</th>
<th>Class</th>
<th>Solid Pounds</th>
<th>Liquid Gallons&lt;sup&gt;b&lt;/sup&gt; (lb)</th>
<th>Gas&lt;sup&gt;a&lt;/sup&gt; (at NTP) scf (lb)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flammable and combustible liquid&lt;sup&gt;0,6,7&lt;/sup&gt;</td>
<td>I and II</td>
<td>N/A</td>
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<td>N/A</td>
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<td>III-A</td>
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<td></td>
<td>III-B</td>
<td>N/A</td>
<td>120&lt;sup&gt;j&lt;/sup&gt;</td>
<td>N/A</td>
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<td>Cryogenic fluid</td>
<td>Flammable</td>
<td>N/A</td>
<td>10</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>Oxidizing</td>
<td>N/A</td>
<td>10</td>
<td>N/A</td>
</tr>
<tr>
<td>Explosives&lt;sup&gt;0,6,8,9&lt;/sup&gt;</td>
<td>See note</td>
<td>See note</td>
<td>See note</td>
<td>See note</td>
</tr>
<tr>
<td>Flammable gas&lt;sup&gt;8,9&lt;/sup&gt;</td>
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<td>N/A</td>
<td>NP</td>
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<td>Liquifed Petroleum</td>
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<td>(20)</td>
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<td>Liquifed</td>
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<td>N/A</td>
<td>(20)</td>
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<tr>
<td>Consumer fireworks</td>
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<td>See note</td>
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<td>Flammable solid</td>
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<td>NP</td>
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<td>3</td>
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<td>Oxidizing gas&lt;sup&gt;8,9&lt;/sup&gt;</td>
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<td>N/A</td>
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<td>1,000</td>
<td>100</td>
<td>NP</td>
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<tr>
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<td>3</td>
<td>NP&lt;sup&gt;h&lt;/sup&gt;</td>
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<tr>
<td>Toxic</td>
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<td>125</td>
<td>125</td>
<td>NP&lt;sup&gt;h&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

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NTP: Normal temperature and pressure [measured at 70°F (21°C) and 14.7 psi (101 kPa)]; N/A: Not applicable; NP: Not permitted; NL: Not limited.

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<sup>c</sup>Fuel in the tank of operating mobile equipment is permitted to exceed the specified quantity where the equipment is operated in accordance with this code.

<sup>d</sup>The use of explosive materials required by federal, state, or municipal agencies while engaged in normal or emergency performance of duties is not required to be limited. The storage of explosive materials is required to be in accordance with the requirements of NFPA 495.

<sup>e</sup>The storage and use of explosive materials in medicines and medicinal agents in the forms prescribed by the official United States Pharmacopeia or the National Formulary are not required to be limited.

<sup>f</sup>The storage and use of propellant-actuated devices or propellant-actuated industrial tools manufactured, imported, or distributed for their intended purposes are required to be limited to 50 lb (23 kg) net explosive weight.

<sup>g</sup>Containers, cylinders, or tanks not exceeding 250 scf (7.1 m³) content measured at 70°F (21°C) and 14.7 psi (101 kPa) and used for maintenance purposes, patient care, or operation of equipment shall be permitted.

<sup>h</sup>A maximum quantity of 220 lb (99 kg) of solid or 22 gal (83 L) of liquid Class 3 oxidizer is permitted where such materials are necessary for maintenance purposes, operation, or sanitation of equipment. Storage containers and the manner of storage are required to be approved.

<sup>i</sup>The permitted quantities are not limited in a building protected throughout by automatic sprinkler systems in accordance with NFPA 13.

<sup>j</sup>Gas cylinders not exceeding 20 scf (0.57 m³) measured at 70°F (21°C) and 14.7 psi (101 kPa) are permitted in gas cabinets or fume hoods.

<sup>k</sup>Conversion. Where quantities are indicated in pounds and when the weight per gallon of the liquid is not provided to the AHJ, a conversion factor of 10 lb/gal (1.2 kg/L) shall be used.

<sup>l</sup>Storage shall be permitted to be increased 100% if the building is protected throughout with an automatic sprinkler system installed in accordance with NFPA 13.

<sup>m</sup>Medicines, foodstuffs, cosmetics, and other consumer products that contain not more than 50% by volume water-miscible flammable or combustible liquids, with the remainder of the product consisting of components that do not burn, shall not be limited, where packaged in individual containers that do not exceed a 1.3-gallon capacity. [30; 9.1.4(4)]
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<thead>
<tr>
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<th>Description</th>
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**Submitter Information Verification**

- **Submitter Full Name:** [Not Specified]
- **Organization:** [Not Specified]
- **Street Address:**
- **City:**
- **State:**
- **Zip:**
- **Submittal Date:** Wed Aug 20 15:53:42 EDT 2014

**Committee Statement**

- **Committee Statement:** Corrected footnotes. See highlights on attached document.
- **Response Message:**

http://submittals.nfpa.org/TerraViewWeb/ContentFetcher?commentPara...
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<thead>
<tr>
<th>Material</th>
<th>Class</th>
<th>Solid Pounds</th>
<th>Liquid Gallons</th>
<th>Gasa (at NTP) scf</th>
<th>Gasb (lb)</th>
<th>Gasc (lb)</th>
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<td>Flammable and combustible liquidb,c</td>
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<td>N/A</td>
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<td>N/A</td>
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For SI units, 1 lb = 0.454 kg; 1 gal = 3.785 L.
NTP: Normal temperature and pressure [measured at 70°F (21°C) and 14.7 psi (101 kPa)]. N/A: Not applicable. NP: Not permitted. NL: Not limited.

Note: The hazardous material categories and MAQs that are shaded in this table are not regulated by NFPA 400 but are provided here for informational purposes. See Chapter 2 for the reference code or standard governing these materials and establishing the MAQs. In accordance with 1.1.1.2, materials having multiple hazards that fall within the scope of NFPA 400 shall comply with NFPA 400.

<sup>a</sup>Unlimited amounts of gas are permitted to be used for personal medical or emergency medical use.

<sup>b</sup>Storage in excess of 10 gal (38 L) of Class I and Class II liquids combined or 60 gal (227 L) of Class IIIA liquids is permitted where stored in safety cabinets with an aggregate quantity not to exceed 180 gal (681 L).

<sup>c</sup>Fuel in the tank of operating mobile equipment is permitted to exceed the specified quantity where the equipment is operated in accordance with this code.

<sup>d</sup>The use of explosive materials required by federal, state, or municipal agencies while engaged in normal or emergency performance of duties is not required to be limited. The storage of explosive materials is required to be in accordance with the requirements of NFPA 495.

<sup>e</sup>The storage and use of explosive materials in medicines and medicinal agents in the forms prescribed by the official United States Pharmacopeia or the National Formulary are not required to be limited.

<sup>f</sup>The storage and use of propellant-actuated devices or propellant-actuated industrial tools manufactured, imported, or distributed for their intended purposes are required to be limited to 50 lb (23 kg) net explosive weight.

<sup>g</sup>Containers, cylinders, or tanks not exceeding 250 scf (7.1 m³) content measured at 70°F (21°C) and 14.7 psi (101 kPa) and used for maintenance purposes, patient care, or operation of equipment shall be permitted.

<sup>h</sup>A maximum quantity of 220 lb (99 kg) of solid or 22 gal (83 L) of liquid Class 3 oxidizer is permitted where such materials are necessary for maintenance purposes, operation, or sanitation of equipment. Storage containers and the manner of storage are required to be approved.

<sup>i</sup>The permitted quantities are not limited in a building protected throughout by automatic sprinkler systems in accordance with NFPA 13.

<sup>j</sup>Gas cylinders not exceeding 20 scf (0.57 m³) measured at 70°F (21°C) and 14.7 psi (101 kPa) are permitted in gas cabinets or fume hoods.

<sup>k</sup>Conversion. Where quantities are indicated in pounds and when the weight per gallon of the liquid is not provided to the AHJ, a conversion factor of 10 lb/gal (1.2 kg/L) shall be used.
Storage shall be permitted to be increased 100% if the building is protected throughout with an automatic sprinkler system installed in accordance with NFPA 13.
### 5.2.1.6 Ambulatory Health Care Occupancies

The MAQ of hazardous materials per control area in ambulatory health care occupancies shall be as specified in **Table 5.2.1.6**.

**Table 5.2.1.6 Maximum Allowable Quantities (MAQ) of Hazardous Materials per Control Area in Ambulatory Health Care Occupancies**

<table>
<thead>
<tr>
<th>Material</th>
<th>Class</th>
<th>Solid Pounds</th>
<th>Liquid Gallons&lt;sup&gt;k&lt;/sup&gt;</th>
<th>Gas&lt;sup&gt;p&lt;/sup&gt; at NTP scf (lb)</th>
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</table>

For SI units, 1 lb = 0.454 kg; 1 gal = 3.785 L.

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<sup>l</sup>Storage shall be permitted to be increased 100% if the building is protected throughout with an automatic sprinkler system installed in accordance with NFPA 13.

<sup>m</sup>Medicines, foodstuffs, cosmetics, and other consumer products that contain not more than 50% by volume water-miscible flammable or combustible liquids, with the remainder of the product consisting of components that do not burn, shall not be limited, where packaged in individual containers that do not exceed a 1.3-gallon capacity. [39; 9.1.4/443]
Submitter Information Verification

Submitter Full Name: [Not Specified]
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submit Date: Wed Aug 20 15:56:26 EDT 2014

Committee Statement

Committee Statement: Corrections made to footnotes. See attached document with highlights.
Response Message:
Table 5.2.1.6 Maximum Allowable Quantities (MAQ) of Hazardous Materials per Control Area in Ambulatory Health Care Occupancies

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<thead>
<tr>
<th>Material</th>
<th>Class</th>
<th>Solid Pounds</th>
<th>Liquid Gallons (lb)</th>
<th>Gas (at NTP) scf (lb)</th>
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<td>NP</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>NP</td>
<td>NP</td>
<td>NP</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>10</td>
<td>(10)</td>
<td>NP&lt;sup&gt;k&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>NL</td>
<td>NL</td>
<td>NP</td>
</tr>
</tbody>
</table>

Commented [PN1]: H to g
<table>
<thead>
<tr>
<th>Material</th>
<th>Class</th>
<th>Solid Pounds</th>
<th>Liquid Gallons&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Gas&lt;sup&gt;b&lt;/sup&gt; (at NTP) scf</th>
<th>Gas&lt;sup&gt;c&lt;/sup&gt; (lb)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water-reactive</td>
<td>3</td>
<td>1</td>
<td>(1)</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>10</td>
<td>(10)</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>NL</td>
<td>NL</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>Corrosives</td>
<td>N/A</td>
<td>1,000</td>
<td>100</td>
<td>NP</td>
<td></td>
</tr>
<tr>
<td>Highly toxic</td>
<td>N/A</td>
<td>3</td>
<td>(3)</td>
<td>NP</td>
<td></td>
</tr>
<tr>
<td>Toxic</td>
<td>N/A</td>
<td>125</td>
<td>(125)</td>
<td>NP</td>
<td></td>
</tr>
</tbody>
</table>

For SI units, 1 lb = 0.454 kg; 1 gal = 3.785 L.

NTP: Normal temperature and pressure [70°F (21°C) and 14.7 psi (101 kPa)]. N/A: Not applicable. NP: Not permitted. NL: Not limited.

Note: The hazardous material categories and MAQs that are shaded in this table are not regulated by NFPA 400 but are provided here for informational purposes. See Chapter 2 for the reference code or standard governing these materials and establishing the MAQs. In accordance with 1.1.1.2, materials having multiple hazards that fall within the scope of NFPA 400 shall comply with NFPA 400.

<sup>a</sup>Unlimited amounts of gas are permitted to be used for personal medical or emergency medical use.

<sup>b</sup>Storage in excess of 10 gal (38 L) of Class I and Class II liquids combined or 60 gal (227 L) of Class IIIA liquids is permitted where stored in safety cabinets with an aggregate quantity not to exceed 180 gal (681 L).

<sup>c</sup>Fuel in the tank of operating mobile equipment is permitted to exceed the specified quantity where the equipment is operated in accordance with this code.

<sup>d</sup>The use of explosive materials required by federal, state, or municipal agencies while engaged in normal or emergency performance of duties is not required to be limited. The storage of explosive materials is required to be in accordance with the requirements of NFPA 495.

<sup>e</sup>The storage and use of explosive materials in medicines and medicinal agents in the forms prescribed by the official United States Pharmacopeia or the National Formulary are not required to be limited.

<sup>f</sup>The storage and use of propellant-actuated devices or propellant-actuated industrial tools manufactured, imported, or distributed for their intended purposes are required to be limited to 50 lb (23 kg) net explosive weight.

<sup>g</sup>Containers, cylinders, or tanks not exceeding 250 scf (7.1 m<sup>3</sup>) content measured at 70°F (21°C) and 14.7 psi (101 kPa) and used for maintenance purposes, patient care, or operation of equipment shall be permitted.

<sup>h</sup>A maximum quantity of220 lb (99 kg) of solid or 22 gal (83 L) of liquid Class 3 oxidizer is permitted where such materials are necessary for maintenance purposes, operation, or sanitation of equipment. Storage containers and the manner of storage are required to be approved.

<sup>i</sup>The permitted quantities are not limited in a building protected throughout by automatic sprinkler systems in accordance with NFPA 13.

<sup>j</sup>Gas cylinders not exceeding 20 scf (0.57 m<sup>3</sup>) measured at 70°F (21°C) and 14.7 psi (101 kPa) are permitted in gas cabinets or fume hoods.

<sup>k</sup>Conversion. Where quantities are indicated in pounds and when the weight per gallon of the liquid is not provided to the AHJ, a conversion factor of 10 lb/gal (1.2 kg/L) shall be used.
Storage shall be permitted to be increased 100% if the building is protected throughout with an automatic sprinkler system installed in accordance with NFPA 13.
5.2.1.7 Detention and Correctional Occupancies.

The MAQ of hazardous materials per control area in detention and correctional occupancies shall be as specified in Table 5.2.1.7.

### Table 5.2.1.7 Maximum Allowable Quantities (MAQ) of Hazardous Materials per Control Area in Detention and Correctional Occupancies

<table>
<thead>
<tr>
<th>Material</th>
<th>Class</th>
<th>Solid Pounds</th>
<th>Liquid Gallons</th>
<th>Gas (at NTP) scf (lb)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flammable and combustible liquid²,³,⁴,⁵</td>
<td>I and II</td>
<td>N/A</td>
<td>10</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>III-A</td>
<td>N/A</td>
<td>60</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>III-B</td>
<td>N/A</td>
<td>120</td>
<td>N/A</td>
</tr>
<tr>
<td>Cryogenic fluid</td>
<td>Flammable</td>
<td>N/A</td>
<td>10</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>Oxidizing</td>
<td>N/A</td>
<td>10</td>
<td>N/A</td>
</tr>
<tr>
<td>Explosives⁶,⁷,⁸</td>
<td>See note</td>
<td>See note</td>
<td>See note</td>
<td>See note</td>
</tr>
<tr>
<td>Flammable gas⁹,¹⁰</td>
<td>Gaseous</td>
<td>N/A</td>
<td>N/A</td>
<td>NP</td>
</tr>
<tr>
<td></td>
<td>Liquefied</td>
<td>N/A</td>
<td>N/A</td>
<td>(20)</td>
</tr>
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<td></td>
<td>Liquefied Petroleum</td>
<td>N/A</td>
<td>N/A</td>
<td>(20)</td>
</tr>
<tr>
<td>Consumer fireworks</td>
<td>See note</td>
<td>See note</td>
<td>See note</td>
<td>See note</td>
</tr>
<tr>
<td>Flammable solid</td>
<td>N/A</td>
<td>5</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Oxidizers</td>
<td>4</td>
<td>NP</td>
<td>NP</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>1⁴</td>
<td>¹¹</td>
<td>N/A</td>
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<tr>
<td></td>
<td>2</td>
<td>250</td>
<td>25</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>4,000</td>
<td>400</td>
<td>N/A</td>
</tr>
<tr>
<td>Oxidizing gas⁶</td>
<td>Gaseous</td>
<td>N/A</td>
<td>N/A</td>
<td>NP</td>
</tr>
<tr>
<td></td>
<td>Liquefied</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Organic peroxides</td>
<td>I</td>
<td>NP</td>
<td>NP</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>II</td>
<td>NP</td>
<td>NP</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>III</td>
<td>25</td>
<td>(25)</td>
<td>N/A</td>
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<td></td>
<td>IV</td>
<td>NL</td>
<td>NL</td>
<td>N/A</td>
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<td></td>
<td>V</td>
<td>NL</td>
<td>NL</td>
<td>N/A</td>
</tr>
<tr>
<td>Pyrophoric materials</td>
<td>NA</td>
<td>1</td>
<td>(1)</td>
<td>NP</td>
</tr>
<tr>
<td>Unstable reactive Reactives</td>
<td>4</td>
<td>1/4</td>
<td>(1/4)</td>
<td>NP</td>
</tr>
<tr>
<td></td>
<td>3</td>
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<td>(1)</td>
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<td></td>
<td>1</td>
<td>NL</td>
<td>NL</td>
<td>NP</td>
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<tr>
<td>Water-reactive</td>
<td>3</td>
<td>1</td>
<td>(1)</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>10</td>
<td>(10)</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>NL</td>
<td>NL</td>
<td>N/A</td>
</tr>
<tr>
<td>Corrosives</td>
<td>N/A</td>
<td>1,000</td>
<td>100</td>
<td>NP</td>
</tr>
<tr>
<td>Highly toxic</td>
<td>N/A</td>
<td>3</td>
<td>3</td>
<td>NP²</td>
</tr>
<tr>
<td>Toxic</td>
<td>N/A</td>
<td>125</td>
<td>125</td>
<td>NP²</td>
</tr>
</tbody>
</table>

For SI units, 1 lb = 0.454 kg; 1 gal = 3.785 L.

NTP: Normal temperature and pressure [measured at 70°F (21°C) and 14.7 psi (101 kPa)]. N/A: Not applicable. NP: Not permitted. NL: Not limited.

Note: The hazardous material categories and MAQs that are shaded in this table are not regulated by NFPA 400 but are provided here for informational purposes. See Chapter 2 for the reference code or standard governing these materials and establishing the MAQs. In accordance with 1.1.1.2, materials having multiple hazards that fall within the scope of NFPA 400 shall comply with NFPA 400.

¹Unlimited amounts of gas are permitted to be used for personal medical or emergency medical use.

²Storage in excess of 10 gal (38 L) of Class I and Class II liquids combined or 60 gal (227 L) of Class IIIA liquids is permitted where stored in safety cabinets with an aggregate quantity not to exceed 180 gal (681 L).

³Fuel in the tank of operating mobile equipment is permitted to exceed the specified quantity where the equipment is operated in accordance with this code.

⁴The use of explosive materials required by federal, state, or municipal agencies while engaged in normal or emergency performance of duties is not required to be limited. The storage of explosive materials is required to be in accordance with the requirements of NFPA 495.

⁵The storage and use of explosive materials in medicines and medicinal agents in the forms prescribed by the official United States Pharmacopeia or the National Formulary are not required to be limited.

⁶The storage and use of propellant-actuated devices or propellant-actuated industrial tools manufactured, imported, or distributed for their intended purposes are required to be limited to 50 lb (23 kg) net explosive weight.

⁷The storage and use of small arms ammunition, and components thereof, are permitted where in accordance with NFPA 495.

⁸Containers, cylinders, or tanks not exceeding 250 scf (7.1 m³) content measured at 70°F (21°C) and 14.7 psi (101 kPa) and used for maintenance purposes, patient care, or operation of equipment shall be permitted.

⁹A maximum quantity of 220 lb (99 kg) of solid or 22 gal (83 L) of liquid Class 3 oxidizer is permitted where such materials are necessary for maintenance purposes, operation, or sanitation of equipment. Storage containers and the manner of storage are required to be approved.

¹⁰Gas cylinders not exceeding 20 scf (0.57 m³) measured at 70°F (21°C) and 14.7 psi (101 kPa) are permitted in gas cabinets or fume hoods.

¹¹Conversion. Where quantities are indicated in pounds and when the weight per gallon of the liquid is not provided to the AHJ, a conversion factor of 10 lb/gal (1.2 kg/L) shall be used.

¹²Medicines, foodstuffs, cosmetics, and other consumer products that contain not more than 50% by volume water-miscible flammable or combustible liquids, with the remainder of the product consisting of components that do not burn, shall not be limited, where packaged in individual containers that do not exceed a 1.3-gallon capacity. [30: 9.1.4(4)]
<table>
<thead>
<tr>
<th><strong>Submitter Information Verification</strong></th>
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<td><strong>Submitter Full Name:</strong> [ Not Specified ]</td>
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<tr>
<td><strong>Organization:</strong> [ Not Specified ]</td>
</tr>
<tr>
<td><strong>Street Address:</strong></td>
</tr>
<tr>
<td><strong>City:</strong></td>
</tr>
<tr>
<td><strong>State:</strong></td>
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<tr>
<td><strong>Zip:</strong></td>
</tr>
<tr>
<td><strong>Submittal Date:</strong> Wed Aug 20 15:59:03 EDT 2014</td>
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</tbody>
</table>

<table>
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<tr>
<th><strong>Committee Statement</strong></th>
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</thead>
<tbody>
<tr>
<td><strong>Committee Statement:</strong> Unstable Reactives should be capitalized.</td>
</tr>
<tr>
<td><strong>Response Message:</strong></td>
</tr>
</tbody>
</table>
### 5.2.1.8 Residential Occupancies

The MAQ of hazardous materials per control area in residential occupancies, including lodging and rooming houses, hotels, dormitories, apartments, and residential board and care facilities, shall be as specified in Table 5.2.1.8.

#### Table 5.2.1.8 Maximum Allowable Quantities of Hazardous Materials per Control Area in Residential Occupancies Consisting of Lodging and Rooming Houses, Hotels, Dormitories, Apartments, and Residential Board and Care Facilities

<table>
<thead>
<tr>
<th>Material</th>
<th>Class</th>
<th>Solid Pounds</th>
<th>Liquid Gallons (lb)</th>
<th>Gas(^a) (at NTP) scf (lb)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flammable and combustible liquid(^b,\text{or},\text{c})</td>
<td>I and II</td>
<td>N/A</td>
<td>10</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>III-A</td>
<td>N/A</td>
<td>60</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>III-B</td>
<td>N/A</td>
<td>120</td>
<td>N/A</td>
</tr>
<tr>
<td>Cryogenic fluid</td>
<td>Flammable</td>
<td>N/A</td>
<td>10</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>Oxidizing</td>
<td>N/A</td>
<td>10</td>
<td>N/A</td>
</tr>
<tr>
<td>Explosives(^d,\text{or},\text{e},\text{or},\text{g})</td>
<td>See note</td>
<td>See note</td>
<td>See note</td>
<td>See note</td>
</tr>
<tr>
<td>Flammable gas(^f,\text{or},\text{g})</td>
<td>Gaseous</td>
<td>N/A</td>
<td>N/A</td>
<td>NP</td>
</tr>
<tr>
<td></td>
<td>Liquified</td>
<td>N/A</td>
<td>N/A</td>
<td>(20)</td>
</tr>
<tr>
<td>Consumer fireworks</td>
<td>Gaseous</td>
<td>N/A</td>
<td>N/A</td>
<td>NP(^h)</td>
</tr>
<tr>
<td></td>
<td>Liquified</td>
<td>N/A</td>
<td>N/A</td>
<td>(20)</td>
</tr>
<tr>
<td>Flammable solid</td>
<td>N/A</td>
<td>5</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Oxidizers</td>
<td>4</td>
<td>NP</td>
<td>NP</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>1(^i)</td>
<td>1(^j)</td>
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</tr>
<tr>
<td></td>
<td>2</td>
<td>250</td>
<td>25</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>4,000</td>
<td>400</td>
<td>N/A</td>
</tr>
<tr>
<td>Oxidizing gas(^l)</td>
<td>Gaseous</td>
<td>N/A</td>
<td>N/A</td>
<td>NP(^h)</td>
</tr>
<tr>
<td></td>
<td>Liquified</td>
<td>N/A</td>
<td>NL</td>
<td>N/A</td>
</tr>
<tr>
<td>Organic peroxides</td>
<td>I</td>
<td>NP</td>
<td>NP</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>II</td>
<td>NP</td>
<td>NP</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>III</td>
<td>25</td>
<td>(25)</td>
<td>N/A</td>
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<td></td>
<td>IV</td>
<td>NL</td>
<td>NL</td>
<td>N/A</td>
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<td></td>
<td>V</td>
<td>NL</td>
<td>NL</td>
<td>N/A</td>
</tr>
<tr>
<td>Pyrophoric materials</td>
<td>N/A</td>
<td>1</td>
<td>(1)</td>
<td>NP</td>
</tr>
<tr>
<td>Unstable reactive Reactives</td>
<td>4</td>
<td>(^{1/4})</td>
<td>(1/4)</td>
<td>NP</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>1</td>
<td>(1)</td>
<td>NP</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>10</td>
<td>(10)</td>
<td>NP(^h)</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>NL</td>
<td>NL</td>
<td>NP</td>
</tr>
<tr>
<td>Water-reactive</td>
<td>3</td>
<td>1</td>
<td>(1)</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>10</td>
<td>(10)</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>NL</td>
<td>NL</td>
<td>N/A</td>
</tr>
<tr>
<td>Corrosives</td>
<td>N/A</td>
<td>1,000</td>
<td>100</td>
<td>NP</td>
</tr>
<tr>
<td>Highly toxic</td>
<td>N/A</td>
<td>3</td>
<td>(3)</td>
<td>NP(^k)</td>
</tr>
<tr>
<td>Toxic</td>
<td>N/A</td>
<td>125</td>
<td>(125)</td>
<td>NP(^k)</td>
</tr>
</tbody>
</table>

For SI units, 1 lb = 0.454 kg; 1 gal = 3.785 L.

NTP: Normal temperature and pressure [measured at 70°F (21°C) and 14.7 psi (101 kPa)]; N/A: Not applicable; NP: Not permitted; NL: Not limited.

Note: The hazardous material categories and MAQs that are shaded in this table are not regulated by NFPA 400 but are provided here for informational purposes. See Chapter 2 for the reference code or standard governing these materials and establishing the MAQs. In accordance with 1.1.1.2, materials having multiple hazards that fall within the scope of NFPA 400 shall comply with NFPA 400.

\(a\) Unlimited amounts of gas are permitted to be used for personal medical or emergency medical use.

\(b\) Storage in excess of 10 gal (38 L) of Class I and Class II liquids combined or 60 gal (227 L) of Class IIIA liquids are permitted where stored in safety cabinets with an aggregate quantity not to exceed 180 gal (681 L).

\(c\) A maximum quantity of 220 lb (99 kg) of solid or 22 gal (83 L) of liquid Class 3 oxidizer is permitted where such materials are necessary for maintenance purposes, operation, or sanitation of equipment. Storage containers and the manner of storage are required to be approved.

\(d\) Storage containers are not permitted to exceed 0.325 ft\(^3\) (0.0092 m\(^3\)) capacity.

\(e\) Gas cylinders not exceeding 20 scf (0.57 m\(^3\)) measured at 70°F (21°C) and 14.7 psi (101 kPa) are permitted in gas cabinets or fume hoods.

\(f\) Conversion. Where quantities are indicated in pounds and when the weight per gallon of the liquid is not provided to the AHJ, a conversion factor of 10 lb/gal (1.2 kg/L) shall be used.

\(g\) Storage of explosive materials in medicines and medicinal agents in the forms prescribed by the official United States Pharmacopeia or the National Formulary are permitted where in accordance with NFPA 495.

\(h\) Containers, cylinders, or tanks not exceeding 250 scf (7.1 m\(^3\)) content measured at 70°F (21°C) and 14.7 psi (101 kPa) and used for maintenance purposes, patient care, or operation of equipment shall be permitted.

\(i\) A maximum quantity of 220 lb (99 kg) of solid or 22 gal (83 L) of liquid Class 3 oxidizer is permitted where such materials are necessary for maintenance purposes, operation, or sanitation of equipment. Storage containers and the manner of storage are required to be approved.

\(j\) Gas cylinders not exceeding 20 scf (0.57 m\(^3\)) measured at 70°F (21°C) and 14.7 psi (101 kPa) are permitted in gas cabinets or fume hoods.

\(k\) Storage containers are not permitted to exceed 0.325 ft\(^3\) (0.0092 m\(^3\)) capacity.

For SI units, 1 lb = 0.454 kg; 1 gal = 3.785 L.

HTML to Markdown conversion performed.
Committee Statement

Committee Statement: Unstable Reactives should be capitalized.

Response Message:
5.3.7 Detached Building Required for High-Hazard Level 2 and High-Hazard Level 3 Materials.

Buildings required to comply with protection level 2 or 3 and containing quantities of high-hazard materials exceeding the quantity limits set forth in Table 5.3.7 shall be in accordance with 6.2.3.4 or 6.2.4.4, as applicable.

**Table 5.3.7 High-Hazard Level 2 and High-Hazard Level 3 Materials — Detached Building Required**

<table>
<thead>
<tr>
<th>Material Gas Hazard</th>
<th>Class</th>
<th>Solids and Liquids (tons)</th>
<th>Gases (scf)</th>
<th>(\text{Gas} \times 10^2 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Individual bulk hydrogen, compressed gas systems</td>
<td>N/A</td>
<td>N/A</td>
<td>15,000</td>
<td>(425)</td>
</tr>
<tr>
<td>Oxidizers</td>
<td>3</td>
<td>1,200</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>2,000</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>Organic peroxides</td>
<td>II</td>
<td>25</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td></td>
<td>III</td>
<td>50</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>Unstable (reactive)</td>
<td>3, nondetonable</td>
<td>1</td>
<td>2,000</td>
<td>(57)</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>25</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>Water-reactive materials</td>
<td>3</td>
<td>1</td>
<td>10,000</td>
<td>(283)</td>
</tr>
<tr>
<td></td>
<td>2, deflagrating</td>
<td>25</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>Pyrophoric gases</td>
<td>N/A</td>
<td>N/A</td>
<td>2,000</td>
<td>(57)</td>
</tr>
</tbody>
</table>

For SI units, 1 ton = 0.9 met ton.

N/A: Not applicable.

\[55: \text{Table 6.5}\]

*See Table 21.2.5.

\[55: \text{Table 6.5}\]

---

Supplemental Information

**File Name**

Table_5.3.7_edited.docx

**Description**


Submitter Information Verification

**Submitter Full Name:** [Not Specified]

**Organization:** [Not Specified]

**Street Address:**

**City:**

**State:**

**Zip:**

**Submittal Date:** Fri Aug 01 17:17:40 EDT 2014

Committee Statement

**Committee Statement:** Table edited to match that shown in current edition of NFPA 55.

**Response Message:**
<table>
<thead>
<tr>
<th>Material</th>
<th>Gas Hazard</th>
<th>Class</th>
<th>Solids and Liquids (tons)</th>
<th>Gases scf (Nm$^3$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Individual bulk hydrogen</td>
<td></td>
<td>N/A</td>
<td>N/A</td>
<td>15,000 (425)</td>
</tr>
<tr>
<td>Oxidizers</td>
<td>3</td>
<td>1,200</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>2,000</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>Organic peroxides</td>
<td>II</td>
<td>25</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td></td>
<td>III</td>
<td>50</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>Unstable (reactive)</td>
<td>3, nondetonable</td>
<td>1</td>
<td>2,000 (57)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>25</td>
<td>10,000 (283)</td>
<td></td>
</tr>
<tr>
<td>Water-reactive materials</td>
<td>2$_{\text{m}}$</td>
<td>25</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>Pyrophoric gases</td>
<td>N/A</td>
<td>2,000</td>
<td>(57)</td>
<td></td>
</tr>
</tbody>
</table>

For SI units, 1 ton = 0.9 met ton.
N/A: Not applicable.

[55: Table 6.5]
*See Table 21.2.5.
5.4.1.2 Maximum Allowable Quantity per Outdoor Control Area

Maximum allowable quantities of hazardous materials in an outdoor control area shall be as specified in Table 5.2.1.13.3(a) and Table 5.2.1.13.3(b) or Table 5.4.1.2.

### Table 5.4.1.2 Maximum Allowable Quantities of Hazardous Materials per Outdoor Control Area

<table>
<thead>
<tr>
<th>Storage</th>
<th>Use — Closed Systems</th>
<th>Use — Open Systems</th>
</tr>
</thead>
<tbody>
<tr>
<td>Material</td>
<td>Class</td>
<td>Solid Pounds</td>
</tr>
<tr>
<td>---------</td>
<td>-------</td>
<td>--------------</td>
</tr>
<tr>
<td>Physical Hazard Materials</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flammable gas</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gaseous</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Liquefied</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flammable solid</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Organic peroxide</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Detonable</td>
<td>I</td>
<td>200</td>
</tr>
<tr>
<td>Organic peroxide</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>II</td>
<td>200</td>
<td>200</td>
</tr>
<tr>
<td>III</td>
<td>500</td>
<td>500</td>
</tr>
<tr>
<td>IV</td>
<td>NL</td>
<td>NL</td>
</tr>
<tr>
<td>V</td>
<td>NL</td>
<td>NL</td>
</tr>
<tr>
<td>Oxidizer</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gaseous</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Liquefied</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oxidizing gas</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gaseous</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Liquefied</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pyrophoric</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unstable</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Liquefied</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water-reactive</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corrosive</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gaseous</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Liquefied</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Toxic</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gaseous</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Liquefied</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Notes:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(1) Table values in parentheses correspond to the unit name in parentheses at the top of the column.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(2) For gallons of liquids, divide the amount in pounds by 10.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(3) The aggregate quantities in storage and use shall not exceed the quantity listed for storage.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(4) The aggregate quantity of nonflammable solid and nonflammable or noncombustible liquid hazardous materials allowed in outdoor storage per single property under the same ownership or control used for retail or wholesale sales is permitted to exceed the MAQ when such storage is in accordance with 5.2.1.13.3.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

For SI units, 1 lb = 0.454 kg; 1 gal = 3.785 L; 1 scf = 0.0283 Nm³.

N/A: Not applicable. NL: Not limited.

Notes:

- (1) Table values in parentheses correspond to the unit name in parentheses at the top of the column.
- (2) For gallons of liquids, divide the amount in pounds by 10.
- (3) The aggregate quantities in storage and use shall not exceed the quantity listed for storage.
- (4) The aggregate quantity of nonflammable solid and nonflammable or noncombustible liquid hazardous materials allowed in outdoor storage per single property under the same ownership or control used for retail or wholesale sales is permitted to exceed the MAQ when such storage is in accordance with 5.2.1.13.3.

*Permitted only where stored or used in approved exhausted gas cabinets, exhausted enclosures, or fume hoods.

### Supplemental Information

<table>
<thead>
<tr>
<th>File Name</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>Table_5.4.1.2_edited.docx</td>
<td></td>
</tr>
</tbody>
</table>

### Submitter Information Verification

Submitter Full Name: [ Not Specified ]
Organization: [ Not Specified ]
Street Address: [ Not Specified ]
City: [ Not Specified ]
State: [ Not Specified ]
Zip: [ Not Specified ]
Committee Statement

Committee Statement: Unstable Reactives should be capitalized.
Response Message:
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Physical Hazard Materials</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flammable gas</td>
<td></td>
<td>N/A</td>
<td>N/A</td>
<td>3000</td>
<td>N/A</td>
<td>N/A</td>
<td>1500</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Liquefied</td>
<td></td>
<td>N/A</td>
<td>N/A</td>
<td>(300)</td>
<td>N/A</td>
<td>N/A</td>
<td>(150)</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Flammable solid</td>
<td>I</td>
<td>20</td>
<td>N/A</td>
<td>10</td>
<td>(10)</td>
<td>N/A</td>
<td>2</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>II</td>
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<td>N/A</td>
<td>100</td>
<td>(100)</td>
<td>N/A</td>
<td>20</td>
<td>20</td>
<td></td>
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<tr>
<td></td>
<td>III</td>
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<td>(250)</td>
<td>N/A</td>
<td>50</td>
<td>50</td>
<td></td>
</tr>
<tr>
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<td>IV</td>
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<td>NL</td>
<td>NL</td>
<td>NL</td>
<td>N/A</td>
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<td>NL</td>
<td></td>
</tr>
<tr>
<td></td>
<td>V</td>
<td>NL</td>
<td>NL</td>
<td>NL</td>
<td>NL</td>
<td>N/A</td>
<td>NL</td>
<td>NL</td>
<td></td>
</tr>
<tr>
<td>Oxidizer</td>
<td>I</td>
<td>4</td>
<td>2</td>
<td>(2)</td>
<td>N/A</td>
<td>(4)</td>
<td>N/A</td>
<td>(4)</td>
<td>(4)</td>
</tr>
<tr>
<td></td>
<td>II</td>
<td>3</td>
<td>40</td>
<td>(40)</td>
<td>N/A</td>
<td>20</td>
<td>(2)</td>
<td>2</td>
<td>(2)</td>
</tr>
<tr>
<td></td>
<td>III</td>
<td>2</td>
<td>1000</td>
<td>(1000)</td>
<td>N/A</td>
<td>500</td>
<td>(250)</td>
<td>50</td>
<td>(50)</td>
</tr>
<tr>
<td></td>
<td>IV</td>
<td>1</td>
<td>NL</td>
<td>NL</td>
<td>N/A</td>
<td>NL</td>
<td>N/A</td>
<td>NL</td>
<td>NL</td>
</tr>
<tr>
<td>Oxidizing gas</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
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<td></td>
<td>N/A</td>
<td>N/A</td>
<td>6000</td>
<td>N/A</td>
<td>N/A</td>
<td>6000</td>
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<td>N/A</td>
<td>(300)</td>
<td>N/A</td>
<td>N/A</td>
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<td>(8)</td>
<td>100</td>
<td>4</td>
<td>(4)</td>
<td>10</td>
<td>0</td>
<td>0</td>
</tr>
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<td>Unstable (reactive)</td>
<td></td>
<td>4</td>
<td>2</td>
<td>(2)</td>
<td>20</td>
<td>1</td>
<td>(1)</td>
<td>2</td>
<td>(4)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3</td>
<td>20</td>
<td>(20)</td>
<td>10</td>
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<td>(10)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1</td>
<td>NL</td>
<td>NL</td>
<td>1500</td>
<td>NL</td>
<td>NL</td>
<td>NL</td>
<td>NL</td>
</tr>
<tr>
<td>Water-reactive</td>
<td></td>
<td>3</td>
<td>20</td>
<td>(20)</td>
<td>N/A</td>
<td>10</td>
<td>(10)</td>
<td>N/A</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2</td>
<td>200</td>
<td>(200)</td>
<td>N/A</td>
<td>10</td>
<td>(100)</td>
<td>N/A</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td></td>
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<td>N/A</td>
<td>NL</td>
<td>N/A</td>
<td>NL</td>
<td>NL</td>
</tr>
</tbody>
</table>
## Health Hazard Materials

<table>
<thead>
<tr>
<th>Material</th>
<th>Class</th>
<th>Storage</th>
<th>Use — Closed Systems</th>
<th>Use — Open Systems</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Solid Pounds</td>
<td>Liquid Gallons (lb)</td>
<td>Gas scf (lb)</td>
</tr>
<tr>
<td>Corrosive</td>
<td></td>
<td>20000</td>
<td>2000 N/A</td>
<td>10000 1000 N/A</td>
</tr>
<tr>
<td>Corrosive gas</td>
<td></td>
<td>N/A N/A</td>
<td>1620 N/A</td>
<td>N/A N/A 810 N/A</td>
</tr>
<tr>
<td>Liquefied</td>
<td></td>
<td>N/A N/A</td>
<td>(300) N/A</td>
<td>N/A N/A (150) N/A</td>
</tr>
<tr>
<td>Highly toxic</td>
<td></td>
<td>20 (20)</td>
<td>N/A 10</td>
<td>N/A 10 N/A 3</td>
</tr>
<tr>
<td>Highly toxic gas</td>
<td></td>
<td>N/A N/A</td>
<td>40* N/A</td>
<td>N/A N/A 20* N/A</td>
</tr>
<tr>
<td>Liquefied</td>
<td></td>
<td>N/A N/A</td>
<td>(8)* N/A</td>
<td>N/A N/A (4)* N/A</td>
</tr>
<tr>
<td>Toxic</td>
<td></td>
<td>1000 (1000)</td>
<td>N/A 500</td>
<td>N/A 50 N/A 125 (125)</td>
</tr>
<tr>
<td>Toxic gas</td>
<td></td>
<td>N/A N/A</td>
<td>1620 N/A</td>
<td>N/A N/A 810 N/A</td>
</tr>
<tr>
<td>Liquefied</td>
<td></td>
<td>N/A N/A</td>
<td>(300) N/A</td>
<td>N/A N/A (150) N/A</td>
</tr>
</tbody>
</table>

For SI units, 1 lb = 0.454 kg; 1 gal = 3.785 L; 1 scf³ = 0.0283 Nm³.

N/A: Not applicable. NL: Not limited.

Notes:
1. Table values in parentheses correspond to the unit name in parentheses at the top of the column.
2. For gallons of liquids, divide the amount in pounds by 10.
3. The aggregate quantities in storage and use shall not exceed the quantity listed for storage.
4. The aggregate quantity of nonflammable solid and nonflammable or noncombustible liquid hazardous materials allowed in outdoor storage per single property under the same ownership or control used for retail or wholesale sales is permitted to exceed the MAQ where such storage is in accordance with 5.2.1.13.3.

*Permitted only where stored or used in approved exhausted gas cabinets, exhausted enclosures, or fume hoods.

Commented [BM1]: Can’t have mandatory language in Table notes. Change to “cannot exceed”?
Second Revision No. 35-NFPA 400-2014 [ Section No. 6.2.1 [Excluding any Sub-Sections] ]

The requirements set forth in 6.2.1 provide general design requirements for protection levels and shall apply to buildings, or portions thereof, that are required to comply with Protection Level 1 through Protection Level [4], where required by Section 5.3. [5000:34.3.2]

Submitter Information Verification

Submitter Full Name: [ Not Specified ]
Organization: [ Not Specified ]
Street Address: 
City:
State:
Zip:
Submittal Date: Fri Aug 01 17:32:54 EDT 2014

Committee Statement

Committee Statement: Modified text to match current edition text. Note that NFPA 5000 includes protection levels 1-5 whereas NFPA 400 covers protection level 5 only in 6.2.6. Therefore the 4 has been placed in brackets to show that it is different from NFPA 5000 text.
### 6.2.1.1 Fire Protection Systems

Buildings, or portions thereof, required to comply with Protection Level 1 through Protection Level [4] shall be protected by an approved automatic fire sprinkler system complying with Section 13.3.55.3 of NFPA 5000:

<table>
<thead>
<tr>
<th>Section No.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>13.3.55.3</td>
<td>NFPA 5000</td>
</tr>
</tbody>
</table>

6.2.1.1.1 The design of the sprinkler system shall be not less than ordinary hazard group 2 in accordance with NFPA 13 except as follows:

1. Where different requirements are specified in Chapters 11 through 21 of NFPA 400 this code
2. Where the materials or storage arrangement requires a higher level of sprinkler system protection in accordance with nationally recognized standards
3. Where approved alternative automatic fire extinguishing systems are permitted

6.2.1.1.2 Electronic supervision of supervisory signals shall be provided in accordance with Section 13.3.55.3.2.1 of NFPA 5000:

<table>
<thead>
<tr>
<th>Section No.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>13.3.55.3.2.1</td>
<td>NFPA 5000</td>
</tr>
</tbody>
</table>

6.2.1.1.3 Waterflow alarms shall be monitored in accordance with Section 13.3.55.3.2.2 of NFPA 5000:

<table>
<thead>
<tr>
<th>Section No.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>13.3.55.3.2.2</td>
<td>NFPA 5000</td>
</tr>
</tbody>
</table>

6.2.1.1.4 Rooms or areas that are of noncombustible construction with wholly noncombustible contents shall not be required to comply with 6.2.1.1. in NFPA 5000:

<table>
<thead>
<tr>
<th>Section No.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>13.3.55.3.2.1</td>
<td>NFPA 5000</td>
</tr>
</tbody>
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**Submitter Information Verification**

- **Submitter Full Name**: [Not Specified]
- **Organization**: [Not Specified]
- **Street Address**: [Not Specified]
- **City**: [Not Specified]
- **State**: [Not Specified]
- **Zip**: [Not Specified]
- **Submittal Date**: Fri Aug 01 17:37:38 EDT 2014

**Committee Statement**

- **Committee Statement**: Modified text to match current edition text. Note that NFPA 5000 includes protection levels 1-5 whereas NFPA 400 covers to protection level 4 in 6.2.6. The 4 has been placed in brackets to show that it is different from NFPA 5000 text.
- **Response Message**: [Not Specified]
6.2.1.2 Building Height Exception.
The height of a single one-story building, or portion thereof, containing only tanks or industrial process equipment shall not be limited based on the type of construction. [5000:34.3.2.2]
6.2.1.4 Egress.
Egress from areas required to comply with Protection Level 1, Protection Level 2, Protection Level 3, or Protection Level 4 shall comply with Chapter 14, Section 34.3.2.4 of NFPA 5000 and with Section 6.2.1.4 of this code. [NFPA: 5000: 34.3.2.4.4]

6.2.1.4.1 Travel Distance Limit.
Travel distance to an exit from areas required to comply with Protection Level 1 through Protection Level 4 shall not exceed the distance given in Table 6.2.1.4.1, measured as required in Section 11.6.3 of NFPA 5000. [NFPA: 5000: 34.3.2.4.1]

<table>
<thead>
<tr>
<th>Protection Level</th>
<th>Distance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ft</td>
</tr>
<tr>
<td>1</td>
<td>75</td>
</tr>
<tr>
<td>2</td>
<td>100</td>
</tr>
<tr>
<td>3</td>
<td>150</td>
</tr>
<tr>
<td>4</td>
<td>175</td>
</tr>
<tr>
<td>5</td>
<td>200</td>
</tr>
</tbody>
</table>

6.2.1.4.2 Capacity of Means of Egress.
Egress capacity for high-hazard content areas shall be based on 0.7 in. (18 mm) per person for stairs or 0.4 in. (10 mm) per person for level components and ramps in accordance with Section 14.8.3 of NFPA 5000. [NFPA: 5000: 34.3.2.4.2]

6.2.1.4.3 Number of Means of Egress.
Not less than two means of egress shall be provided from each building, or portion thereof, required to comply with Section 6.2, unless rooms or spaces do not exceed 200 ft² (18.6 m²), have an occupant load not exceeding three persons, and have a travel distance to the room door not exceeding 25 ft (7.6 m). [NFPA: 5000: 34.3.2.4.3]

6.2.1.4.4 Dead Ends.
Means of egress, for other than rooms or spaces that do not exceed 200 ft² (18.6 m²), have an occupant load not exceeding three persons, and have a travel distance to the room door not exceeding 25 ft (7.6 m), shall be arranged so that there are no dead ends in corridors. [NFPA: 5000: 34.3.2.4.4]

6.2.1.4.5 Doors.
Doors serving high-hazard content areas with occupant loads in excess of five shall be permitted to be provided with a latch or lock only if the latch or lock is panic hardware or fire exit hardware complying with Section 14.5.3.3 of NFPA 5000. [NFPA: 5000: 34.3.2.4.5]

Committee Statement:
Maintained extract tag but placed 4 in brackets to show that this is different from NFPA 5000 which covers up to PL 5. Section 6.2.6 of NFPA 400 deals with PL 5.

Response Message:
6.2.1.5.1
Solids and liquids stored in closed containers shall not be required to comply with 6.2.1.5. [5000: 34.3.2.5.1.2]

6.2.1.5.2
Mechanical exhaust systems shall comply with the mechanical code Uniform Mechanical Code as referenced in Chapter 50 of NFPA 5000. [5000:34.3.2.5.2]

6.2.1.5.3
Mechanical ventilation shall be at a rate of not less than 1 ft³/min/ft² (5.1 L/s/m²) of floor area over areas required to comply with Protection Level 1 through Protection Level 4. [5000:34.3.2.5.3]

Submitter Information Verification
Submitter Full Name: [Not Specified]
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Fri Aug 01 17:57:19 EDT 2014

Committee Statement
Committee Statement: The committee removed the extract tag since NFPA 5000 added flammable and combustible liquids which are not covered by this code. PL 5 requirements are covered in 6.2.6 in their entirety therefore protection level 5 is not included and is placed in brackets to show that it is different from NFPA 5000.
Response Message:
6.2.1.5.8
The location of supply and exhaust openings shall be in accordance with the [mechanical code] Uniform Mechanical Code as referenced in Chapter 50 of NFPA 5000.

Submitter Information Verification
Submitter Full Name: [Not Specified]
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submital Date: Fri Aug 01 18:00:39 EDT 2014

Committee Statement
Committee Statement: Modified to match current edition text.
Response Message:
### 6.2.1.6 Explosion Control

Buildings, or portions thereof, required to comply with Protection Level 1 through Protection Level 3 and containing materials shown in Table 6.2.1.6 shall be provided with a means of explosion control. (5000:34.3.2.6)

<table>
<thead>
<tr>
<th>Hazard Category</th>
<th>Class</th>
<th>Protection Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Combustible dust presenting an explosion hazard</td>
<td>N/A</td>
<td>Explosion control</td>
</tr>
<tr>
<td>Explosives</td>
<td>Detonating</td>
<td>Barricade</td>
</tr>
<tr>
<td></td>
<td>Deflagrating</td>
<td></td>
</tr>
<tr>
<td>Flammable gas or oxygen</td>
<td>N/A</td>
<td>Explosion control</td>
</tr>
<tr>
<td>Flammable liquid</td>
<td>Class IA, storage &gt;1 gal</td>
<td>Explosion control</td>
</tr>
<tr>
<td></td>
<td>Class IA, use</td>
<td>Explosion control</td>
</tr>
<tr>
<td></td>
<td>Class IB, use-open</td>
<td>Explosion control</td>
</tr>
<tr>
<td>Organic peroxides</td>
<td>Unclassified</td>
<td>Barricade</td>
</tr>
<tr>
<td>Oxidizer liquids and solids</td>
<td>Class I</td>
<td>Barricade</td>
</tr>
<tr>
<td></td>
<td>Class 4</td>
<td>Barricade</td>
</tr>
<tr>
<td>Pyrophoric gas</td>
<td>N/A</td>
<td>Barricade</td>
</tr>
<tr>
<td>Unstable (reactive) Reactive</td>
<td>Class 4</td>
<td>Explosion control</td>
</tr>
<tr>
<td></td>
<td>Class 3, detonating</td>
<td>Explosion control</td>
</tr>
<tr>
<td></td>
<td>Class 3, deflagrating</td>
<td>Explosion control</td>
</tr>
<tr>
<td>Water-reactive liquids and solids</td>
<td>Class 3</td>
<td>Explosion control</td>
</tr>
<tr>
<td></td>
<td>Class 2, deflagrating</td>
<td>Explosion control</td>
</tr>
</tbody>
</table>

**N/A**: Not applicable.

1. Explosion control is required to be a deflagration prevention method, such as combustible concentration reduction or oxidant concentration reduction, or a deflagration control method complying with NFPA 69 or an approved, engineered deflagration-venting method.

2. Barricades are required to comply with NFPA 495.

3. Deflagration venting is not required for rooms that are less than or equal to 500 ft² (46.5 m²) in floor area and do not have any exterior walls as set forth in 34.3.4.2.2 of NFPA 5000.

4. A protection method is required where an explosive environment can occur as a result of the dispensing or use process.

5. Where gas-air mixtures are capable of detonation, barricade construction is required to be provided.

[5000: Table 34.3.2.6]
### Table 34.3.2.6.2.1.6 Explosion Control Requirements

<table>
<thead>
<tr>
<th>Hazard Category</th>
<th>Class</th>
<th>Protection Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Combustible dust presenting an explosion hazard</td>
<td>N/A</td>
<td>Explosion control⁴</td>
</tr>
<tr>
<td>Explosives</td>
<td>Detonating</td>
<td>Barricade⁵</td>
</tr>
<tr>
<td></td>
<td>Deflagrating</td>
<td>Explosion control⁴</td>
</tr>
<tr>
<td>Flammable or cryogen</td>
<td>N/A</td>
<td>Explosion control⁴</td>
</tr>
<tr>
<td>Flammable liquid²</td>
<td>Class IA, storage &gt;1 gal</td>
<td>Explosion control⁴</td>
</tr>
<tr>
<td></td>
<td>Class IA, use</td>
<td>Explosion control⁴</td>
</tr>
<tr>
<td></td>
<td>Class IB, use-open²</td>
<td>Explosion control⁴</td>
</tr>
<tr>
<td>Organic peroxides</td>
<td>Unclassified</td>
<td>Barricade⁵</td>
</tr>
<tr>
<td></td>
<td>Class I</td>
<td>Barricade⁵</td>
</tr>
<tr>
<td>Oxidizer liquids and solids</td>
<td>Class 4</td>
<td>Barricade⁵</td>
</tr>
<tr>
<td>Pyrophoric gas²</td>
<td>N/A</td>
<td>Explosion control⁴</td>
</tr>
<tr>
<td>Unstable reactive Reactive</td>
<td>Class 4</td>
<td>Barricade⁵</td>
</tr>
<tr>
<td></td>
<td>Class 3 detonating</td>
<td>Barricade⁵</td>
</tr>
<tr>
<td></td>
<td>Class 3 deflagrating</td>
<td>Explosion control⁴</td>
</tr>
<tr>
<td>Water-reactive liquids and solids</td>
<td>Class 3</td>
<td>Explosion control⁴</td>
</tr>
<tr>
<td></td>
<td>Class 2 deflagrating</td>
<td>Explosion control⁴</td>
</tr>
</tbody>
</table>

N/A: Not applicable.

⁴Explosion control is required to be a deflagration prevention method, such as combustible concentration reduction, or oxidant concentration reduction, or a deflagration control method complying with NFPA 69, *Standard on Explosion Prevention Systems*, or an approved, engineered deflagration-venting method.

⁵Barricades are required to comply with NFPA 495.

²Deflagration venting is not required for rooms that are less than or equal to 500 ft² (46.5 m²) in floor area and do not have any exterior walls as set forth in 34.3.4.2.2 of NFPA 5000.

⁶A protection method is required where an explosive environment can occur as a result of the dispensing or use process.

⁷Where gas–air mixtures are capable of detonation, barricade construction is required to be provided.

[5000:Table 34.3.2.6]
6.2.1.8.1 Where mechanical ventilation, treatment systems, temperature control, alarm, detection, or other electrically operated safety systems are required by this code or the building code, NFPA 1, or NFPA 5000, such systems shall be provided with standby power or emergency power as required by 6.2.1.8. [5000:34.3.2.7.1]
6.2.3.3.1
Buildings, or portions thereof, required to comply with Protection Level 2 shall be set back from property lines, or be provided with a horizontal separation in accordance with 7.3.4.2 of NFPA 5000 at any of the following distances:

(1) Not less than 30 ft (9.1 m) where the area of the occupancy exceeds 1000 ft\(^2\) (93 m\(^2\)) and a detached building is not required

(2) Not less than 50 ft (15 m) where a detached building is required by Table 5.3.7.

(3) Not less than the distances required by Table 6.2.2.3 for buildings containing materials with explosive characteristics.

Submitter Information Verification

Submitter Full Name: Michael Beady
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submit Date: Thu Sep 25 11:36:35 EDT 2014

Committee Statement

Committee Statement: Updated text to match extract source
Response Message:
6.2.3.4.1
Buildings required to comply with Protection Level 2 and containing quantities of high-hazard contents exceeding the quantity limits set forth in Table 5.3.7 shall be used for manufacturing, processing, dispensing, use, or storage of hazardous materials and no other purpose, shall not exceed one story in height, and shall be without basements, crawl spaces, or other under-floor spaces. [5000:34.3.4.4.1]

Submitter Information Verification
Submitter Full Name: [Not Specified]
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Fri Aug 01 18:07:02 EDT 2014

Committee Statement
Committee Statement: Modified to match current edition text.
Response Message:
6.2.3.4.2 Buildings that contain high, hazard level 2 contents also shall be permitted to contain high, hazard level 3 or high, hazard level 4 contents, provided that the incompatible materials are separated as otherwise required by the provisions of this code, NFPA 1 and NFPA 5000. [9660:31.3.4.4.2]
### Section 6.2.4.3.1

Buildings, or portions thereof, required to comply with Protection Level 3 shall be set back from property lines, or be provided with a horizontal separation in accordance with 7.3.4.2 of NFPA 5000 at any of the following distances:

1. Not less than 30 ft (9.1 m) where the area of the occupancy exceeds 1000 ft\(^2\) (93 m\(^2\)) and a detached building is not required
2. Not less than 50 ft (15 m) where a detached building is required by Table 5.3.7
3. Not less than the distances required by Table 34.3.3.3 of NFPA 5000 for buildings containing materials with explosive characteristics

---

### Submitter Information Verification

<table>
<thead>
<tr>
<th>Submitter Full Name:</th>
<th>Michael Beady</th>
</tr>
</thead>
<tbody>
<tr>
<td>Organization:</td>
<td>[Not Specified]</td>
</tr>
<tr>
<td>Street Address:</td>
<td></td>
</tr>
<tr>
<td>City:</td>
<td></td>
</tr>
<tr>
<td>State:</td>
<td></td>
</tr>
<tr>
<td>Zip:</td>
<td></td>
</tr>
<tr>
<td>Submittal Date:</td>
<td>Thu Sep 25 11:41:16 EDT 2014</td>
</tr>
</tbody>
</table>

### Committee Statement

Committee Statement: Updated text to match extract source

Response Message:
6.2.4.4.1*
Buildings required to comply with Protection Level 3 and containing quantities of high-hazard contents exceeding the quantity limits set forth in Table 5.3.7 shall be used for manufacturing, processing, dispensing, use, or storage of hazardous materials and no other purpose, shall not exceed one story in height, and shall be without basements, crawl spaces, or other under-floor spaces.

6.2.4.4.2
Buildings that contain high-hazard level 3 contents also shall be permitted to contain high-hazard level 2 or high-hazard level 4 contents, provided that incompatible materials are separated as otherwise required by the provisions of this code and NFPA 1.

Submitter Information Verification
Submitter Full Name: [Not Specified]
Organization: [Not Specified]
Street Address: 
City: 
State: 
Zip: 
Submit Date: Fri Aug 01 18:11:40 EDT 2014

Committee Statement
Committee Statement: Modified to match current edition text.
Response Message:
6.2.4.5 Detached Unprotected Building.
Where acceptable to the AHJ, based on a determination that a protected building is not practical and an assessment of acceptable risk, storage buildings required to comply with Protection Level 3 shall be permitted without fire protection systems, provided that the following provisions are met:

1. The building, or portions thereof, shall have a horizontal separation of at least 200 ft (61 m) from exposed business, industrial, mercantile, and storage occupancies on the same lot and from any property line that is or can be built upon. Where protection for exposures is provided in accordance with 6.2.4.5(9), the horizontal separation shall be at least 100 ft (30.5 m).

2. The building, or portions thereof, shall have a horizontal separation of at least 1000 ft (305 m) from exposed occupancies other than business, industrial, mercantile, and storage occupancies on the same lot and from any property line that is or can be built upon. Where protection for exposures is provided in accordance with 6.2.4.5(9), the horizontal separation shall be at least 500 ft (150 m).

3. The building shall not exceed one story in height.

4. The building shall not have basements, crawl spaces, or other under-floor accessible spaces.

5. Egress from the building shall not exceed 50 percent of the distances listed in Table 6.2.1.4.1, measured as required in 11.6.2 of NFPA 5000, and in compliance with 34.3.2.4.2 through 34.3.2.4.5 of NFPA 5000.

6. The building shall comply with the requirements of the following:
   a. 34.3.2.2 of NFPA 5000 for building height
   b. 6.2.1.5 for ventilation
   c. 6.2.1.6 for explosion control
   d. 6.2.1.8 for standby and emergency power
   e. 6.2.1.10 for floor construction
      i. 34.3.2.10 of NFPA 5000 for unprotected vertical openings

7. Spill control shall comply with 6.2.1.9.

8. Secondary containment shall comply with 6.2.1.9.3, except that containment for fire protection water shall not be required if the building is not provided with a fire protection sprinkler system.

9. Where credit is taken for protection for exposures in accordance with 34.3.5.5(1) and 34.3.5.5(2) of NFPA 5000, protection of exposures shall consist of fire protection for structures on property adjacent to the storage building that is provided by (1) a public fire department or (2) a private fire brigade maintained on the property adjacent to the storage building, either of which shall be capable of providing cooling water streams to protect the property adjacent to the storage building.

Submitter Information Verification
Submitter Full Name: [ Not Specified ]
Organization: [ Not Specified ]
Street Address: [ Not Specified ]
City: [ Not Specified ]
State: [ Not Specified ]
Zip: [ Not Specified ]
Submittal Date: Sat Aug 02 08:06:41 EDT 2014

Committee Statement
Committee Statement: Modified to show section number in 5000 since there is no table in 5000.
Response Message:
Buildings, or portions thereof, required to comply with Protection Level 4 shall comply with 6.2.1 and 6.2.5.2 and 6.2.5.3. [5000:34.3.6]

Submitter Information Verification

Submitter Full Name: [Not Specified]
Organization: [Not Specified]
Street Address: 
City: 
State: 
Zip: 
Submit Date: Sat Aug 02 08:11:21 EDT 2014

Committee Statement

Committee Statement: Added gas rooms to 6.2.5.3 to match existing text in 5000. Renumbered to match NFPA 400.
Response Message: 

http://submittals.nfpa.org/TerraViewWeb/ContentFetcher?commentPara...
6.2.5.3 Gas Rooms.
Exhaust ventilation for gas rooms shall be designed to operate at a negative pressure in relation to the surrounding areas and shall direct the exhaust ventilation to an exhaust system. [5000: 34.3.6.1]
6.2.6 Protection Level 5.
In addition to the requirements set forth elsewhere in NFPA 5000, Buildings, and portions thereof, required to comply with Protection Level 5 shall comply with NFPA 5000, NFPA 1, and NFPA 318. [5000:34.3.7.1]

Submitter Information Verification
Submitter Full Name: [Not Specified]
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submit Date: Sat Aug 02 08:17:34 EDT 2014

Committee Statement
Committee Statement: Extract tag was removed since changing to the current edition text in 5000 would not require compliance with the rest of the building code.
Response Message:
6.2.7.2 Weather Protection.

Where weather protection is provided for sheltering outside hazardous material storage or use areas, such storage or use areas shall be considered outside storage or use areas, provided that all of the following conditions are met:

1. The overhead structure shall be approved noncombustible construction with a maximum area of 1500 ft² (140 m²) except that area increases based on location or fire protection systems under the requirements of the building code shall be allowed.

2. Supports and walls shall not obstruct more than one side or more than 25 percent of the perimeter of the storage area.

3. The distance from the structure and the structural supports to buildings, lot lines, or public egress to a public way shall not be less than the distance required by Chapters 11 through 21 for an outside hazardous material storage area without weather protection.

4. Weather-protection structures containing storage of explosive or detonable materials shall be considered indoor storage.
6.3.1.3 Standby and Emergency Power. Standby or emergency power shall be provided in accordance with 6.3.1.3.1 and 6.3.1.3.2 for required mechanical ventilation, treatment systems, temperature control, alarm, detection, or other electrically operated safety systems are required by this code, NFPA 1, or NFPA 5000, such systems shall be provided with standby power or emergency power as required by 6.3.1.3.1 [5000:34.3.2.7.1].

6.3.1.3.1 Standby power for mechanical ventilation, exhaust treatment, and temperature control systems shall not be required where such systems are engineered and approved as fail-safe. [5000:34.3.2.7.2]

6.3.1.3.2 The secondary source of power shall be an approved means of legally required standby power in accordance with NFPA 70, except for areas containing highly toxic or toxic gases, where a legally required emergency power system in accordance with Chapter 52 of NFPA 5000 and NFPA 55 shall be provided to operate safety systems required by this code, NFPA 1, and NFPA 5000. [5000:34.3.2.7.3]
Where remote containment systems are provided, drainage systems shall be in accordance with the plumbing code Uniform Mechanical Code, as referenced in Chapter 2, and the following provisions also shall be met:

1. The slope of floors in indoor locations to drains or similar areas in outdoor locations shall be not less than 1 percent.
2. Drains from indoor storage areas shall be sized to carry the volume of the fire protection water, as determined by the design density discharged from the automatic fire-extinguishing system over the minimum required system design area, or area of the room or area in which the storage is located, whichever is smaller.
3. Materials of construction for drainage systems shall be compatible with the materials stored.
4. Separate drainage systems shall be provided to avoid mixing incompatible materials where such materials are present in an open-use condition.
5. Drains shall terminate in an approved location away from buildings, valves, means of egress, fire access roadways, adjoining property, and storm drains.

Submitter Information Verification

Submitter Full Name: [Not Specified]
Organization: [Not Specified]
Street Address: 
City: 
State: 
Zip: 
Submittal Date: Mon Aug 25 11:54:06 EDT 2014

Committee Statement

Committee Statement: The committee wanted to retain existing text and drop extract tag.
Response Message:
6.3.2.1.2.1 Building Height Exception.
The height of a single-story building, or portion thereof, containing only tanks or industrial process equipment shall not be limited based on the type of construction.

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.

6.3.2.1.2.3 Egress.
Egress from areas required to comply with Protection Level 1, Protection Level 2, Protection Level 3, or Protection Level 4 shall comply with 6.2.1.4 and Chapter 14 of NFPA 1.

Submitter Information Verification
Submitter Full Name: [Not Specified]
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Sat Aug 02 14:09:45 EDT 2014

Committee Statement
Committee Statement: New text in NFPA 5000 dealt also with protection level 5. Therefore extract tag removed since PL 5 covered in 6.2.6 in NFPA 400.
Response Message:
6.3.2.1.4.1 General.
Explosion control shall be provided in accordance with 6.2.1.6 where an explosive environment can occur because of the characteristics or nature of the hazardous materials dispensed or used, or as a result of the dispensing or use process, unless process vessels comply with 6.3.2.1.4.2. [5000: 34.3.2.6]

Submitter Information Verification

Submitter Full Name: [Not Specified]
Organization: [Not Specified]
Street Address: [Not Specified]
City: [Not Specified]
State: [Not Specified]
Zip: [Not Specified]
Submittal Date: Sat Aug 02 14:14:35 EDT 2014

Committee Statement

Committee Statement: Deleted extract tag since text no longer in NFPA 5000.
Response Message: [Not Specified]
6.3.2.2.3 Floor Construction.

Except for surfacing, floors of areas where liquid or solid hazardous materials are dispensed or used in open systems shall be of noncombustible, liquidtight construction.

Submitter Information Verification

Submitter Full Name: [Not Specified]
Organization: [Not Specified]
Street Address: [Not Specified]
City: [Not Specified]
State: [Not Specified]
Zip: [Not Specified]
Submit Date: Mon Aug 25 11:41:58 EDT 2014

Committee Statement

Committee Statement: Committee wanted to retain existing text rather than match new text in NFPA 5000 therefore the extract tag was removed.
Response Message: [Not Specified]
6.3.2.2.4.1 Spill Control.
Buildings, or portions thereof, used for either any of the following shall be provided with spill control in accordance with 6.3.1.4.1 to prevent the flow of liquids to adjoining areas:

1. Dispensing of hazardous materials liquids into vessels exceeding a 1.1 gal (4 L) capacity
2. Open use of hazardous materials liquids in vessels or systems exceeding a 5.3 gal (20 L) capacity. [Note: 54.3.2.8.2.1]

Submitter Information Verification
Submitter Full Name: [Not Specified]
Organization: [Not Specified]
Street Address: [Not Specified]
City: [Not Specified]
State: [Not Specified]
Zip: [Not Specified]
Submittal Date: Sat Aug 02 14:20:47 EDT 2014

Committee Statement
Committee Statement: Removed extract tag. 6.3.2.2 deals only with open systems so the extract tag is not appropriate.
Response Message:
Buildings, or portions thereof, containing only hazardous materials in listed secondary containment tanks or systems shall not be required to comply with secondary containment. [5000-34.3.2.8.3.2]
Secondary Containment.
Where required by Table 6.3.2.2.4.2(A), buildings, or portions thereof, used for either of the following shall be provided with secondary containment in accordance with 6.3.1.4.2.1 through 6.3.1.4.2.10:

1. Closed-use capacity of an individual vessel or system exceeds 55 gal (208 L)
2. Closed-use aggregate capacity of multiple vessels or systems exceeds 1000 gal (3785 L)

Submitter Information Verification
Submitter Full Name: [ Not Specified ]
Organization: [ Not Specified ]
Street Address:
City:
State:
Zip:
Submit Date: Sat Aug 02 14:34:54 EDT 2014

Committee Statement
Committee Statement: Removed extract tag. Committee retains original text.
Response Message:
### Second Revision No. 80-NFPA 400-2014 [Sections 6.3.3.2.2.1, 6.3.3.2.2.2]

**6.3.3.2.2.1 Spill Control.**
Outdoor areas used for either of the following shall be provided with spill control in accordance with 6.3.1.4.1 through 6.3.1.4.1.3 to prevent the flow of liquids to adjoining areas:

1. Dispensing of hazardous materials liquids into vessels exceeding a 1.1 gal (4 L) capacity
2. Open use of hazardous materials liquids in vessels or systems exceeding a 5.3 gal (20 L) capacity [5000: 34.3.2.8.2.1]

**6.3.3.2.2.2 Secondary Containment.**

(A) **Where Required.** Where required by Table 6.3.2.2.4.2(A), outdoor areas used for either of the following shall be provided with secondary containment in accordance with 6.3.1.4.2.1 through 6.3.1.4.2.10:

1. Open use of liquids where the capacity of an individual vessel or system exceeds 1.1 gal (4 L)
2. Open use of liquids where the capacity of multiple vessels or systems exceeds 5.3 gal (20 L) [5000: 34.3.2.8.3.1]

(B) **Incompatible Materials.** Incompatible materials used in open systems shall be separated from each other in the secondary containment system.

### Submitter Information Verification

Submitter Full Name: [Not Specified]
Organization: [Not Specified]
Street Address: 
City: 
State: 
Zip: 
Submittal Date: Tue Aug 05 18:15:34 EDT 2014

### Committee Statement

Committee Statement: Removed extract tag. This material originated in the UFC and there is no need for the extract tag for 5000 which is incorrect.

Response Message:
Second Revision No. 81-NFPA 400-2014 [Sections 6.3.3.3.2.1, 6.3.3.3.2.2]

6.3.3.3.2.1 Spill Control.
Outdoor areas where hazardous materials liquids are used in individual closed vessels exceeding a 55 gal (208 L) capacity shall be provided with spill control in accordance with 6.3.1.4.1 through 6.3.1.4.1.3 to prevent the flow of liquids to adjoining areas.

6.3.3.3.2.2 Secondary Containment.
Where required by Table 6.3.2.2.4.2(A), outdoor areas used for either of the following shall be provided with secondary containment in accordance with 6.3.1.4.2.1 through 6.3.1.4.2.10:

1. Closed-use capacity of an individual vessel or system exceeds 55 gal (208 L)
2. Closed-use aggregate capacity of multiple vessels or systems exceeds 1000 gal (3785 L)

Submitter Information Verification

Submitter Full Name: [Not Specified]
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Submital Date: Tue Aug 05 18:18:25 EDT 2014

Committee Statement

Committee Statement: Removed extract tag since this was not extracted from 5000. It was originally taken from the UFC. Incorrect extract tag.
Response Message:
Chapter 11. Ammonium Nitrate Solids and Liquids

11.1 General.
See also Annex E.

11.1.1 Scope.
The requirements of this chapter shall apply to the storage, use, and handling of ammonium nitrate when the amount of solid or liquid ammonium nitrate exceeds the MAQ as set forth in Chapter 6 in quantities greater than 1,000 lb.

11.1.1.1 The storage, use, and handling of ammonium nitrate shall comply with the requirements of Chapters 1 and 4.

11.1.1.2 This chapter shall apply to 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.

11.1.1.3 This chapter shall apply to liquid ammonium nitrate solutions containing 70 percent or more by weight of ammonium nitrate.

11.1.1.4 This chapter shall not apply to liquid ammonium nitrate solutions used as fertilizers unless classified as a hazardous material by the U.S. Department of Transportation (DOT).

11.1.1.5 The storage of ammonium nitrate and ammonium nitrate mixtures that are DOT Hazard Class 1 should not be permitted by this code except on the specific approval of the authority having jurisdiction.

11.1.1.6 The agricultural application of ammonium nitrate and ammonium nitrate-based fertilizers in outdoor agricultural uses is not regulated by this code.

11.1.2 Sources of Ignition.
The storage, use, and handling of ammonium nitrate in any quantity shall also comply with the requirements of Chapters 4 through 10, and the applicable requirements of Chapters 8 through 10.

11.1.3 General Requirements for Storage.
The quantity and arrangement limits in this code shall not apply to the transient storage of ammonium nitrate in process areas at plants where ammonium nitrate is manufactured.

11.1.4 Construction Requirements.
Buildings, or portions thereof, in which ammonium nitrate is stored, used, or handled, or used, shall be constructed in accordance with the building code.

11.1.4.1 The construction requirements of this code shall not apply retroactively to buildings used for the storage and handling of ammonium nitrate in existing buildings at manufacturing plants or other combustible structures shall be of noncombustible (Type I or II) construction.

11.1.4.2 Bins or compartments used for the storage of bulk ammonium nitrate shall be constructed of noncombustible materials that are compatible with ammonium nitrate.

11.1.5 Storage buildings shall not have basements unless the basements are open on at least one side.

11.1.5.1 Where Chapter 11 is applicable, Chapter 15 and Chapter 19 shall apply.

11.1.6 General Requirements for Storage.
The exterior wall of the exposed side of a storage building within 50 ft (15.2 m) of a combustible building shall comply with Type I construction. Noncombustible materials, and/or exposure hazards by exposure protection, such as a freestanding fire barrier wall, shall be permitted to be used where approved by the AHJ.

11.1.6.1 In lieu of the Type I fire barrier wall specified in 11.1.4.6, a means of exposure protection, such as a freestanding fire barrier wall, shall be permitted to be used where approved by the AHJ.

11.1.6.2 The continued use of an existing storage building or structure not in strict conformity with this code shall be approved by the AHJ in cases where such continued use will not constitute a hazard to life or adjoining property.

11.1.6.3 Buildings and structures shall be dry and free from water intrusion through the roof, walls, and floors.

11.1.7 Electric Any heating source, including electric lamps, shall be located or guarded so as to preclude contact with bags or other combustible materials.

11.1.8 Bulk storage structures shall not exceed a height of 40 ft (12.2 m).

11.1.8.1 Where bulk storage structures are constructed of noncombustible material or facilities for fighting a roof fire are provided, the height of the storage building shall be limited by the building construction type as specified in the building code adopted by the jurisdiction.

11.1.9 Floors shall be in accordance with 6.2.1.10.

11.1.9.1 All floors in storage and handling areas shall be without open drains, traps, tunnels, pits, or pockets.

11.1.9.2 The noncombustible floor of the ammonium nitrate storage shall be sloped in a manner that promotes a positive drainage of liquids, whether water or molten material in the case of a fire.

11.1.9.3 The floor shall be at least 1 percent slope (0.16 in. (3.2 mm) for every linear foot of floor) to obtain this positive drainage.

11.1.10 Floors where ammonium nitrate solids or liquids are dispensed or used in open systems shall be in accordance with 6.3.2.2.3.

11.1.11 Protection of Existing Buildings.
The requirements of 11.1.5.1 through 11.1.5.4 shall apply retroactively to existing buildings of Type III, IV, or V construction or buildings with combustible content.

11.1.12 Automatic Sprinklers.
An automatic sprinkler system shall be provided in accordance with NFPA 13 for a minimum extra hazard (group 1).

11.1.13 Alarms.

Buildings shall be equipped throughout with an approved fire detection system, including, but not limited to, a smoke or heat detection system. Such a system shall be supervised in accordance with 6.2.1.11.
11.1.5.2.2 Audible or Visual Alarm

Any activation of the fire detection system shall also automatically initiate activation of a local audible and visual alarm system to notify occupants.

11.1.5.3 Public Notification/Alert System

An approved public notification/alert system capable of immediately notifying individuals located within 1 mile (1609 m) of the facility of the need to evacuate shall be provided. Where notification is provided through the personnel’s kit, the kit shall be equipped with a continuously audible and visual alarm. Where notification is provided through a personal communication system, the system shall be capable of simultaneously providing a continuously audible and visual alarm. Where notification is provided through a public address system, the system shall be capable of simultaneously providing a continuously audible and visual alarm.

11.1.5.4 Monitoring/Supervision

Supervision shall be provided for the alarm, detection, and automatic fire extinguishing system in accordance with 6.2.1.11.

11.2 General Requirements for Storage

11.2.1 Spill Control

Spill control shall be provided for ammonium nitrate solids in accordance with 11.2.1.1 and 11.2.1.2 and not 6.2.1.9.2.

11.2.1.1 If the contents of broken bags are uncontaminated, they shall be permitted to be salvaged by placing the damaged bag inside a clean, new slipover bag and closing it to prevent the discharge of contents.

11.2.1.2 Other spilled materials and discarded containers shall be gathered for disposal under the facility operating procedures for hazardous waste.

11.2.2 Drainage and Secondary Containment

Drainage shall be provided for ammonium nitrate liquids in accordance with 6.2.1.9.3.11.

11.2.2.1 For ammonium nitrate solids, the requirements of 6.2.1.9.3.11 shall not apply.

11.2.2.2 Secondary containment shall be provided for ammonium nitrate in accordance with 6.2.1.9.3.4.

11.2.3.1 Secondary containment shall be provided for ammonium nitrate in accordance with 6.2.1.9.3.5.

11.2.3.2 For ammonium nitrate solids, the requirements of 6.2.1.9.3.5 shall not apply.

11.2.3.3 Ventilation

The requirements of 6.2.1.5 shall apply.

11.2.3.4 The requirements of 6.2.1.6 shall not apply.

11.2.4.1 Storage buildings shall have ventilation or be of a construction that will be self-ventilating in the event of fire.

11.2.4 Treatment Systems

Treatment systems are not required for ammonium nitrate.

11.2.5 Fire Protection Systems

An automatic fire sprinkler system shall be provided in accordance with 6.2.2.4 NFPA 13 for a minimum extra hazard (group 1).

11.2.5.1 Automatic Sprinklers

6.2.1.11 Bagged in Bags

Not more than 2500 tons (2268 metric tons) of bagged ammonium nitrate shall be stored in a building or structure not equipped with an automatic sprinkler system.

6.2.1.11.1 When approved by the AHJ, a quantity of bagged ammonium nitrate greater than 2500 tons (2268 metric tons) shall be permitted to be stored in a building or structure not equipped with an automatic sprinkler system.

6.2.1.11.2 Sprinkler protection shall be permitted to be required by the AHJ for the storage of less than 2500 tons (2268 metric tons) of ammonium nitrate where the location of the building or the presence of other stored materials can present a special hazard.

6.2.1.11.3 Sprinkler systems shall be of the approved type and designed and installed in accordance with NFPA 13 and the following:

- Ammonium nitrate in noncombustible or combustible containers (paper bags or noncombustible containers with removable combustible liners) shall be designated as a Class I commodity.
- Where contained in plastic containers, ammonium nitrate shall be designated as a Class II commodity.
- Where contained in fiber packs or noncombustible containers in combustible packaging, ammonium nitrate shall be designated as a Class III commodity.

6.2.1.11.4 When small hose systems are used, they shall be in accordance with NFPA 14.

11.2.5.2 Fire Detection Systems

Buildings shall be equipped throughout with an approved fire detection system, including, but not limited to, a smoke or heat detection system. Such a system shall be supervised in accordance with 6.2.1.11.

11.2.5.2.1 Any activation of the fire detection system shall also automatically initiate activation of a local audible and visual alarm system to notify occupants.

11.2.5.2.2 Extinguishing Devices

Portable extinguishers shall be provided throughout the storage area, use, and in the loading and unloading handling areas in accordance with the fire prevention code adopted by the jurisdiction and NFPA 10.

11.2.5.2.2.1 Only water-based portable fire extinguishers shall be used on incipient fires involving ammonium nitrate.

11.2.5.2.3 All other types of extinguishers except dry-chemical extinguishers per 11.2.7.1.3 shall be prohibited from the ammonium nitrate building.

11.2.5.2.4 Water supplies and fire hydrants shall be provided for the protection of the ammonium nitrate storage by hose streams and automatic sprinklers in accordance with the fire prevention code adopted by the jurisdiction and as required by the AHJ.

11.2.5.2.5 When small hose systems are used, they shall be in accordance with NFPA 14.

11.2.8 Fire Protection Water Supplies

Water supplies and fire hydrants shall be provided in accordance with the fire prevention code adopted by the jurisdiction and as required by the AHJ.

11.2.8.1 Water supplies and fire hydrants shall be provided for the protection of the ammonium nitrate storage by hose streams and automatic sprinklers in accordance with the fire prevention code adopted by the jurisdiction and as required by the AHJ.

11.2.8.2 The requirements for automatic sprinkler systems per 11.2.2.2 and 11.2.8 supply shall be permitted to be waived by the AHJ where storage facilities are located in remote areas a minimum of 2 hours.

11.2.8.3 The requirements for automatic sprinkler systems per 11.2.2.2 and 11.2.8 supply shall be permitted to be waived by the AHJ where storage facilities are located in remote areas.
11.2.9* Explosion Control.
The requirements of 6.2.1.6 shall not apply.

11.2.10 Emergency and Standby Power.
Standby power shall be provided where required by 6.2.1.8.

11.2.11 Limit Controls.
Limit controls shall be provided where required by 6.2.1.7.

11.2.12 Alarms.
A fire alarm system shall be provided to monitor the fire sprinkler system and provide notification in accordance with 6.2.1.1.3 and NFPA 72.

11.2.12.2 Public Notification/Alert System.
Facilities storing ammonium nitrate that can detonate when exposed to fire conditions in quantities in excess of 1000 lb (453 kg) shall comply with 11.1.5.2.2 and 11.1.5.3.

11.2.13 Monitoring/Supervision.
Supervision shall be provided in accordance with 6.2.1.11.

11.2.14 Special Requirements.

11.2.14.1 Separation.
Ammonium nitrate shall be isolated in a separate room by fire barrier walls of not less than 1-hour fire resistance rating of one hour and extending from the floor to the underside of the roof above, or located in a separate building from the storage of any of the following:

(1) Organic chemicals, acids, or other corrosive materials
(2) Compressed flammable gases
(3) Pyrophoric materials
(4) Combustible materials
(5) Flammable and combustible liquids
(6) Other contaminating substances, including the following:
   (a) Wood chips
   (b) Organic materials
   (c) Chlorides
   (d) Phosphorus
   (e) Finely divided metals
   (f) Charcoals
   (g) Diesel fuels and oils
   (h) Animal fats
   (i) Baled cotton
   (j) Baled rags
   (k) Baled scrap paper
   (l) Bleaching powder
   (m) Burlap or cotton bags
   (n) Caustic soda
   (o) Coal
   (p) Coke
   (q) Charcoal
   (r) Cork
   (s) Camphor
   (t) Excelsior
   (u) Fibers of any kind
   (v) Fish oils
   (w) Fish meal
   (x) Foam rubber
   (y) Hay
   (z) Lubricating oil
   (aa) Linseed oil or other oxidizable or drying oils
   (ab) Naphthalene
   (ac) Oakum
   (ad) Oiled clothing
   (ae) Oiled paper
   (af) Oiled textiles
   (ag) Paint
   (ah) Straw
   (ai) Sawdust
   (aj) Wood shavings
   (ak) Vegetable oil

11.2.14.1.2 Walls referred to in 11.2.10.1.1 shall extend from the floor to the underside of the roof above.

11.2.14.1.3 In lieu of fire barrier walls, ammonium nitrate shall be permitted to be separated from the materials referred to in 11.2.10.1.1 by a space of at least 10.8 (3.1 m) or more, as required by the AHJ, and sills or curbs shall be provided to prevent mixing during fire conditions.

11.2.14.2 Incompatible Materials.
11.3.1.2.3 Storage of combustibles shall be prohibited in or around ammonium nitrate storage areas.

11.3.1.2.4 Storage or operations on the premises of makers, distributors, and user agents, they shall be separated from the ammonium nitrate by the distances or barricades specified in NFPA 495.

11.3.1.2.5 Explosives and blasting agents shall not be stored in the same building with ammonium nitrates, unless otherwise permitted by NFPA 495.

11.3.1.2.6 Storage of combustibles shall be prohibited in or around ammonium nitrate storage areas. In areas where lightning storms are prevalent, lightning protection shall be provided in accordance with NFPA 780.

11.3.1.2.7 The storage conforms to NEPA 30.

11.3.1.2.8 Walls and floors of storage shall be of noncombustible construction.

11.3.1.2.9 Containers for ammonium nitrate shall be of noncombustible construction.

11.3.1.2.10 Flammable liquids, such as gasoline, kerosene, solvents, and light fuel oils, shall not be stored on the premises, unless the following criteria are met:

- The storage conforms to NEPA 30.
- Walls and floors of storage shall be of noncombustible construction. 11.3.1.2.8 through 11.3.1.2.9.

11.3.1.2.11 Bins shall be of noncombustible construction.
11.3.2.3  Bins shall be clean and free of materials that can contaminate ammonium nitrate.

11.3.2.4  Bins shall be designed so that in the event of an external fire or self-accelerated decomposition, molten ammonium nitrate can flow away from the storage area to an open, unconfined area free from contamination with incompatible materials, except where such bins are protected against impregnation by contact with incompatible materials.

11.3.2.5  Aluminized [uncoated aluminum, brass, and wooden bins protected against impregnation by ammonium nitrate, shall not be permitted.

11.3.2.6  The warehouse shall be permitted to be subdivided into any desired number of ammonium nitrate storage compartments or bins provided the design does not allow molten ammonium nitrate to accumulate in the storage area and become confined.

11.3.2.7  The ammonium nitrate storage bins or piles shall be clearly identified by signs reading AMMONIUM NITRATE with letters at least 2 in. (50.8 mm) high.

11.3.2.8  Piles or bins shall be sized and arranged so that all material in the pile is able to be moved out in order to minimize possible caking of the stored ammonium nitrate.

11.3.2.9  The height or depth of piles shall be limited by the pressure-setting tendency of the product; however, in no case shall the ammonium nitrate be piled higher at any point than 3 ft (0.9 m) below the roof or its supporting and overhead structure.

11.3.2.10  Ammonium nitrate shall not be placed into storage where the temperature of the product exceeds 130°F (54.4°C).

11.3.2.11  Dynamite, other explosives, and blasting agents shall not be used to break up or loosen caked ammonium nitrate.

11.3.3  Warehouses.

11.3.3.1  Warehouses shall have ventilation, or be capable of ventilation in case of fire, that will, in the event of a fire, prevent the explosive decomposition of ammonium nitrate.

11.3.3.2  Buildings shall be ventilated so as to prevent confinement of decomposition gases.

11.3.3.3  Bulk storage structures shall not exceed a height of 40 ft (12.2 m).

11.3.3.4  Outdoor storage in enclosed hoppers or bins shall be permitted.

11.3.3.5  The warehouse shall be permitted to be subdivided into any desired number of ammonium nitrate storage compartments or bins.

11.3.3.6  The partitions dividing the ammonium nitrate storage from the storage of other products that would contaminate the ammonium nitrate shall be constructed to prevent the entrance of these products into the ammonium nitrate storage area.

11.3.3.7  The ammonium nitrate storage bins or piles shall be clearly identified by signs reading AMMONIUM NITRATE with letters at least 2 in. (50.8 mm) high.

11.3.3.8  Piles or bins shall be sized and arranged so that all material in the pile is able to be moved out in order to minimize possible caking of the stored ammonium nitrate.

11.3.3.9  The height or depth of piles shall be limited by the pressure-setting tendency of the product; however, in no case shall the ammonium nitrate be piled higher at any point than 3 ft (0.9 m) below the roof or its supporting and overhead structure.

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11.3.3.11  Dynamite, other explosives, and blasting agents shall not be used to break up or loosen caked ammonium nitrate.
11.4.1 Special Requirements — Outdoor Storage.
11.5 General Requirements for Use.
11.5.1 Spill Control.
Spill control shall be provided for ammonium nitrate liquids in accordance with 6.3.2.1.
11.5.1.1 Spilled ammonium nitrate and leaking or broken containers shall be removed immediately by a competent individual to a safe, secure, dry outside area or to a location designated by the competent individual to await disposal in conformance with applicable regulations.

11.5.2 Drainage.
11.5.2.1 Drainage shall be provided for ammonium nitrate liquids in accordance with 6.3.1.4.2.10.
11.5.2.2 For ammonium nitrate solids, the requirements of 6.3.1.4.2.10 shall not apply.
11.5.3 Secondary Containment.
11.5.3.1 Secondary containment shall be provided for ammonium nitrate solids or liquids in accordance with 6.3.1.4.2.
11.5.3.2 For ammonium nitrate solids, the requirements of 6.3.1.4.2 shall not apply.
11.5.4 Ventilation.
The requirements of 6.3.2.1.3 shall apply.
11.5.5 Fire Protection Systems.
An automatic fire sprinkler system shall be provided in accordance with 6.3.2.1.4 11.2.6.
11.5.5.1* Alternative automatic fire extinguishing systems using foam, dry-chemical or gaseous agents, or steam extinguishing systems shall not be allowed. Only water-based suppression systems shall be permitted.

11.5.5.2 Portable extinguishers shall be provided in accordance with 11.2.8.
11.5.6 Explosion Control.
The requirements of 6.3.2.1.4 shall not apply.
11.5.7 Emergency and Standby Power.
The requirements of 6.3.2.1.3 shall not apply.
11.5.8 Limit Controls.
Limit controls shall be provided in accordance with 6.3.1.2.
11.5.9 Alarms.
Alarms shall be provided in accordance with 11.2.13.
11.5.10 Monitoring/Supervision.
Supervision shall be provided in accordance with 6.3.1.8.
11.5.11 Floors.
Floors where ammonium nitrate solids or liquids are dispensed or used in open systems shall be in accordance with 6.3.2.2.3.
11.5.11.1 System Design.
System design shall be in accordance with 6.3.1.6.
11.5.12 Liquid Transfer.
Liquid transfer shall be in accordance with 6.3.1.7.
11.5.13 Indoor Use.
11.6 Open Systems.
11.6.1.1 Ventilation.
The requirements of 6.3.2.1.3 shall apply.
11.6.1.2 Explosion Control.
The requirements of 6.3.2.1.4 shall not apply.
11.6.1.3 Spill Control, Drainage, and Containment.
Secondary containment shall be provided for ammonium nitrate liquids in accordance with 6.3.2.2.4.
11.6.1.4* Closed Systems.
11.6.2.1 Ventilation.
The requirements of 6.3.2.1.3 shall apply.
11.6.2.2 Explosion Control.
The requirements of 6.3.2.1.4 shall not apply.
11.6.2.3 Spill Control, Drainage, and Containment.
Spill control and secondary containment shall be provided for ammonium nitrate liquids in accordance with 6.3.2.3.3.
11.7 Outdoor Use.
11.7.1 Open Systems.
11.7.1.1 Location.
Outdoor use and dispensing shall be located in accordance with 6.3.3.1.1.
11.7.1.2 Spill Control, Drainage, and Containment.
Spill control and secondary containment shall be provided for ammonium nitrate liquids in accordance with 6.3.3.2.2.
11.7.1.3 Clearance from Combustibles.
For outdoor use the requirements of 11.4.1 shall apply.
11.7.2 Closed Systems.
11.7.2.1 Location.
Outdoor use and dispensing shall be located in accordance with 6.3.3.1.1.
11.7.2.2 Spill Control, Drainage, and Containment.
Spill control and secondary containment shall be provided for ammonium nitrate liquids in accordance with 6.3.3.2.
11.8 Handling.
11.8.1 Handling.
Handling shall be in accordance with 6.3.4 and 11.8.1.
11.8.1.1 Vehicles and Lift Trucks.
11.8.1.1.1* Powered vehicles of any type shall not be stored or left unattended in a building storing ammonium nitrate. Vehicles shall not be refueled or recharged within 50 ft (15 m) of the ammonium nitrate storage.
11.8.1.1.2* Handling Equipment.
Powered vehicles used in ammonium nitrate storage facilities shall not be refueled within 50 ft (15 m) of the facility.
11.8.1.1.3 Fork trucks, tractors, platform lift trucks, and other specialized industrial trucks used within the warehouse shall be maintained so that fuels or hydraulic fluids do not contaminate the ammonium nitrate.
11.8.1.2 Handling Equipment.
Hollow spaces in nitrate-handling equipment, where nitrate is able to collect and be confined under high pressure, to become a source of explosion in the event of fire, shall be avoided.
Ammonium nitrate, originally covered by NFPA 490, was incorporated into NFPA 400 when the document was first published in 2010. Since NFPA 400 covers classes of hazardous materials and not specific hazardous materials, ammonium nitrate was “unique” in its incorporation into the document. The Committee saw value in retaining the document structure and requirements for hazard classes but also in identifying material (not hazard classification) specific requirements for common formulations of AN. As a result, in the 2013 edition ammonium nitrate requirements are determined initially by classifying the material in accordance with Chapter 4 and then applying the appropriate MAQs for that class of material in Chapter 5. Since different formulations of ammonium nitrate may be classified differently, the document user would have to classify the ammonium nitrate in order to determine the MAQ. When MAQs are exceeded, then the requirements of Chapter 11 also apply. The revision now requires compliance with Chapter 11 as well as Chapter 5 but contains a new specific reference to the Chapter 11 requirements in Section 5.2.1.3.1 to ensure that the applicable requirements of both Chapter 5 and Chapter 11 and not Chapters 15 and 19 are utilized for AN.

The Committee had extensive discussions over the classification of AN, whether it is an oxidizer or unstable reactive or both and the committee determined ultimately that agreement over the actual classification was less important for AN than compliance with the requirements in Chapter 11. Further, that Chapter 11 would apply to formulations of AN that meet the requirements of Section 11.1.1 which addresses the most common hazardous formulations of AN. For any AN formulations that do not meet the requirements of Section 11.1.1, the requirements of Chapter 5 and the balance of the document will apply if the particular formulation is a hazardous material.

Background.

Ammonium nitrate, originally covered by NFPA 490, was incorporated into NFPA 400 when the document was first published in 2010. Since NFPA 400 covers classes of hazardous materials and not specific hazardous materials, ammonium nitrate was “unique” in its incorporation into the document. The Committee saw value in retaining the document structure and requirements for hazard classes but also in identifying material (not hazard classification) specific requirements for common formulations of AN. As a result, in the 2013 edition ammonium nitrate requirements are determined initially by classifying the material in accordance with Chapter 4 and then applying the appropriate MAQs for that class of material in Chapter 5. Since different formulations of ammonium nitrate may be classified differently, the document user would have to classify the ammonium nitrate in order to determine the MAQ. When MAQs are exceeded, then the requirements of Chapter 11 also apply. The revision now requires compliance with Chapter 11 as well as Chapter 5 but contains a new specific reference to the Chapter 11 requirements in Section 5.2.1.3.1 to ensure that the applicable requirements of both Chapter 5 and Chapter 11 and not Chapters 15 and 19 are utilized for AN.

The Committee had extensive discussions over the classification of AN, whether it is an oxidizer or unstable reactive or both and the committee determined ultimately that agreement over the actual classification was less important for AN than compliance with the requirements in Chapter 11. Further, that Chapter 11 would apply to formulations of AN that meet the requirements of Section 11.1.1 which addresses the most common hazardous formulations of AN. For any AN formulations that do not meet the requirements of Section 11.1.1, the requirements of Chapter 5 and the balance of the document will apply if the particular formulation is a hazardous material.

Scope.

The scope of Chapter 11 was to clarify to cover the common hazardous formulations of AN and to clarify the concentrations of AN that are covered by the Chapter by providing percentages for solid or liquid forms of AN (60% by weight for solids, 70% by weight for liquids). The TIC determined that AN formulations less than these concentrations do not need regulation per Chapter 11 because the fire hazard is significantly reduced.

The amount of AN that triggers requirements in the chapter was set at 1000 pounds. The 1000 pound threshold matched the previous threshold for the permit requirement. The quantity selected was the subject of debate with amounts proposed ranging from 5 pounds, for an unstable reactive, to 50 tons. The larger amounts were considered to correlate with the amount expected in one or two typical delivery weights for full trailer loads of AN. However, since it is estimated that only 30 tons of AN was involved in the West Texas incident the Committee chose to go with a more conservative value.

Construction and Sprinkler Requirements

Most of the ammonium nitrate explosions on record involve the contamination of AN with a contaminant of some form. The committee recognized the serious hazard created by the presence of combustible materials in contact with ammonium nitrate and modified requirements to include non-combustible construction and to prohibit the use of wooden or other combustible bins for storage of AN.

The Committee recognized that many existing facilities are of combustible construction. The hazard of combustible materials in the presence of AN was considered to be of such significance that the committee added a requirement for sprinklers retroactively to facilities that are of combustible construction. New construction, regardless of type, will also be required to be sprinklered. The Committee reviewed and accepted test data on industrial grade AN. The prill form of AN has been assigned to Class 2 oxidizer, therefore, the sprinklers must meet the requirements of Extra Hazard (Group 1) per NFPA 13.

The Committee clarified that only water based suppression systems are allowed for AN since the purpose of the water is to both suppress an exposure fire and cool the ammonium nitrate, thereby reducing decomposition and reducing the possibility of forming molten AN. The requirement for a 2 hour water supply was added to mirror sprinkler water supply requirements for oxidizers established in Chapter 15.

Separation from combustibles

Recognizing how critical it is to keep AN from combustibles, the requirement for a separate room of concrete block construction with a 1 hour fire barrier extending from the floor to the roof is now the only option for indoor bulk storage, instead of the allowance for a 30 foot radiation that was allowed in lieu of the fire walls. The committee also modified the outdoor storage requirements to prevent the storage of combustibles within 30 feet of the AN to provide additional clearance rather than the 15 foot separation required in Chapter 6. The committee added the original list of common combustibles from the annex of NFPA 490 to the current list of incompatible materials to emphasize the broad range of materials that should not be stored near AN. In addition, the Committee modified the spill requirements that previously pointed to Chapter 6 to clarify that ammonium nitrate should not be confined. Housekeeping requirements were added to the document to minimize the potential for contamination of AN with combustibles.

Emergency Response

Since it was recognized that fires at AN facilities may pose a hazard to emergency responders and the surrounding community in the event of a fire, a section on emergency planning, that includes an alert system, was added for AN facilities covered by the standard. (Annex E was also revised to provide additional guidance to emergency responders.)

The Committee recognized the need for the local responders to be aware of the location of facilities storing ammonium nitrate and to be involved in pre-incident planning. Requirements for both pre-incident and emergency action planning were added to the chapter.

Another key change was the addition of a fire alarm system with fire detection in the AN storage area. Oxidizers can cause the growth phase of a fire to be greatly accelerated (shorter) than fires involving ordinary combustibles. For this reason, there is increased urgency associated with providing notification to building occupants of a need to evacuate...
Recognizing that freely vented fires involving AN do not present an explosion hazard, the requirement for ventilation in accordance with Chapter 6 was added. The Committee was

The exception for sprinklered detached storage is warranted because these facilities are dedicated ONLY to storage of the HAZMAT requiring detached storage (oxidizers in this

Since the safe evacuation distance is dependent on the amount and configuration of AN in a facility, an analysis may be provided to the AHJ or in the absence of analysis a 1 mile evacuation distance is the default. A one mile evacuation distance was selected based on information provided by the Institute Manufacturers of Explosives (IME) where an analysis was done looking at the debris pattern of a storage facility storing 1,000,000 and 50,000 pounds of AN. The estimates were made using IMESAFR, a probabilistic risk assessment tool which is used to calculate risk to personnel from explosives facilities. The evacuation distance was based on the normal or the greatest debris throw from the faces of the storage facility where the probability of anyone being killed from an event would be less that one in a million. A TNT equivalent of 0.42 was used in the model. This 1 mile estimate was also considered sufficiently conservative as supported by the “Baker Report” done by the Fertilizer Institute in which the worst-case explosion scenario of solid fertilizer grade ammonium nitrate storage based on endpoint distance to 1 psi overpressure (as used by EPA RMP for explosions from flammable substances) was determined for 30 to 50 tons in a single bulk storage pile at a retail facility, and 6,000 to 10,000 tons in a single bulk storage pile at a warehouse/manufacturing storage facility.

The importance of notifying the first responders by the use of improved signs was discussed, however the committee recognized the balance between providing signage for emergency responders and facility security and homeland security issues. The added signage provides information on the explosion hazard to emergency responders in a fire situation without compromising security. The required pre-incident planning also serves to notify emergency responders of the hazard of AN.

Other key changes to storage requirements

The temperature limit for placing AN in storage was changed from 130 oF to 140 oF based on a review of literature. The only known scientific study on the maximum product storage temperature was done by the Bureau of Mines during the investigation of the Texas City incidents in 1948 where the guidance for maximum product storage temperature (in paper bags) was 140 oF. It is believed that the change from 140 to 130 came about in 1950, when the Manufacturing Chemists Association published recommendations for packaging, handling, transportation and storage of ammonium nitrate. In that guide, MCA stated that as a matter of “good practice,”

“Ammunition storage facilities are not required to maintain equipment in such a condition as to prevent buildup of decomposition gases. The building shall be of fire resistance not less than that required for a one-hour fire rating. All openings shall be sealed, and only doors and windows shall be provided. A detector shall be provided which will automatically signal the presence of smoke or fire within the storage area and shall be interconnected with a fire alarm signaling system which shall be connected to the fire department. An automatic sprinkler system shall be provided in the building. The sprinkler system shall be designed and installed in accordance with NFPA 13, Standard for the Installation of Sprinkler Systems. Smoke detectors shall be provided in the building. The detector shall be of the type approved by the AHJ. The building shall be equipped with an automatic fire alarm system which shall be interconnected with a fire alarm signaling system which shall be connected to the fire department. The building shall be equipped with automatic fire alarm systems and smoke detectors.

The term “fire detection systems” is more generic (includes heat, smoke, rate of rise, beam, detectors etc.) than smoke detector and provides latitude for the developer to design an appropriate form of fire detection based on the specific requirements for a given installation. The definition of “fire detection systems” from NFPA 72 is provided for convenience below:

2010 NFPA 72: 3.3.59.2 Automatic Fire Detector. A device designed to detect the presence of a fire signature and to initiate action. For the purpose of this Code, automatic fire detectors are classified as follows: Automatic Fire Extinguishing or Suppression System Operation Detector, Fire–Gas Detector, Heat Detector, Other Fire Detectors, Radiant Energy–Sensing Fire Detector, Smoke Detector. (SIG-IDS)

The temperature limit for placing AN in storage was changed from 130 oF to 140 oF based on a review of literature. The only known scientific study on the maximum product storage temperature was done by the Bureau of Mines during the investigation of the Texas City incidents in 1948 where the guidance for maximum product storage temperature (in paper bags) was 140 oF. It is believed that the change from 140 to 130 came about in 1950, when the Manufacturing Chemists Association published recommendations for packaging, handling, transportation and storage of ammonium nitrate. In that guide, MCA stated that as a matter of “good practice,”

“Ammonium nitrate offered for loading aboard ship should be at a reasonably low temperature, normally not exceeding the temperature of the surrounding air. The temperature of the material in bags should not exceed 130 oF. This temperature (130 oF) is that commonly used as a control point for the loading of certain gases and liquids in the regulations of the Interstate Commerce Commission.”

Therefore the Committee revised the temperature recommendation to 140 oF to align with the only known documented source of data.

In addition to requiring that bulk storage bins be of non-combustible construction, a requirement was added to design the bins such that molten AN flows away from the storage area into an unconfined area. Molten AN that is confined can create an explosion hazard. The new text requires sloping of floors to be at least 1% so molten AN flows away from storage area. For positive floor drainage the committee reviewed a recommendation from the Professional Handbook of Building Construction which provided two possible slopes, 1% and 2%. It was felt that the 1% 1/8 inch per foot) would be sufficient and more workable than a 2% drainage which would be better suited for roof drainage.

Ventilation

Recognizing that freely vented fires involving AN do not present an explosion hazard, the requirement for ventilation in accordance with Chapter 6 was added. The Committee was unable to determine specific ventilation requirements for this revision cycle but plans to review this and provide further guidance on what constitutes “adequate ventilation” for the next revision cycle. Some of the questions to be considered are whether or not any type of natural ventilation configuration can prevent the buildup of decomposition gases and the release of heat sufficient to prevent an explosion or if mechanical or emergency “self-ventilation” would be required. Outdoor hoppers are now required to have a venting device to prevent buildup of decomposition gases.

Response

Message:

Public Comment No. 44-NFPA 400-2014 [New Section after 11.2.10.5]
Public Comment No. 21-NFPA 400-2014 [Section No. 11.1.1 (Excluding any Sub-Sections)]
Public Comment No. 23-NFPA 400-2014 [Section No. 11.1.1.1]
Public Comment No. 25-NFPA 400-2014 [Section No. 11.1.4.5]
Public Comment No. 27-NFPA 400-2014 [New Section after 11.1.4.7]
Public Comment No. 22-NFPA 400-2014 [Section No. 11.1.1]
Public Comment No. 31-NFPA 400-2014 [Sections 11.2.5.1.2, 11.2.5.1.3]
Public Comment No. 32-NFPA 400-2014 [Section No. 11.2.5.2.2]
Public Comment No. 24-NFPA 400-2014 [Section No. 11.1.3]
Public Comment No. 28-NFPA 400-2014 [Section No. 11.2.5 (Excluding any Sub-Sections)]
Public Comment No. 29-NFPA 400-2014 [New Section after 11.2.9]
Public Comment No. 45-NFPA 400-2014 [New Section after 11.2.10.5]
Public Comment No. 30-NFPA 400-2014 [Section No. 11.2.5.1.1]
Chapter 11  Ammonium Nitrate Solids and Liquids

11.1  General.

See Also Annex E.

11.1.1* Scope. The requirements of this chapter shall apply to the storage, use, and handling of solid and liquid ammonium nitrate in quantities greater than 1,000 lbs.

11.1.1.1 The storage, use, and handling of ammonium nitrate shall comply with the requirements of Chapters 1 through 4.

11.1.1.1.1 Chapters 6 through 10 shall apply unless otherwise indicated in this Chapter.

11.1.1.2 This chapter shall apply to solid ammonium nitrate in the form of crystals, flakes, grains or prills including fertilizer grade and industrial grade or other mixtures containing 60% or more by weight of ammonium nitrate.

11.1.1.3 This chapter shall apply to liquid ammonium nitrate solutions containing 70% or more by weight of ammonium nitrate.

11.1.1.4 This chapter shall not apply to liquid ammonium nitrate solutions used as fertilizers unless classified as a hazardous material by DOT.

11.1.1.5* This chapter shall not apply to ammonium nitrate and ammonium nitrate mixtures that are DOT Hazard Class 1 explosives.

11.1.1.6* The agricultural application of ammonium nitrate and ammonium nitrate–based fertilizers in outdoor agricultural uses is not regulated by this code.

11.1.1.7 Where Chapter 11 is applicable Chapter 15 Oxidizers and Chapter 19 Unstable Reactives shall not apply.

11.1.2 Sources of Ignition. Open flames and smoking shall be prohibited in buildings that store use and handle ammonium nitrate.

11.1.3 General Requirements for Storage. The quantity and arrangement limits in this chapter shall not apply to the transient storage of ammonium nitrate in process areas at plants where ammonium nitrate is manufactured.

11.1.4 Construction Requirements. Buildings, or portions thereof, in which ammonium nitrate is stored, handled, or used shall be constructed in accordance with the building code.
11.1.4.1 Buildings used for the storage and handling of ammonium nitrate in bulk, bags or other combustible containers shall be of non-combustible (Type I or II) construction.

11.1.4.2 Bins or compartments used for the storage of bulk ammonium nitrate shall be constructed of non-combustible materials that are compatible with ammonium nitrate. (See 11.3.2.3.2)

11.1.4.3 Storage buildings shall not have basements unless the basements are open on at least one side. Buildings over one story in height shall not be used for storage, unless approved for such use.

11.1.4.4 The exterior wall on the exposed side of a storage building within 50 ft (15.2 m) of a combustible building, forest, piles of combustible materials, and exposure hazards by ordinary combustible materials shall be a fire barrier wall with a minimum fire resistance rating of 2 hours in accordance with the building code.

11.1.4.5 In lieu of the fire barrier wall specified in 11.1.5.4 a means of exposure protection, such as a freestanding fire barrier wall, shall be permitted to be used when approved by the AHJ.

11.1.4.6 Buildings and structures shall be dry and free from water intrusion through the roof, walls, and floors.

11.1.4.7 Any heating source including electric lamps shall be located or guarded so as to preclude contact with bags or other combustible materials.

11.1.4.8 Bulk storage structures shall not exceed a height of 40 ft (12.2 m).

11.1.4.8.1 Where bulk storage structures are constructed of noncombustible material or facilities for fighting a roof fire are provided, the height of the storage building shall only be limited by the building construction type as specified in the building code adopted by the jurisdiction.

11.1.4.9 Floors.

11.1.4.9.1 Floors shall be in accordance with 6.2.1.10.

11.1.4.9.2* All flooring in storage and handling areas shall be without open drains, traps, tunnels, pits, or pockets.

11.1.4.9.3*The non-combustible floor of the ammonium nitrate storage shall be sloped in a manner that promotes a positive drainage of liquids, whether water or molten material in the case of a fire.

11.1.4.9.4 The floor shall be at least a 1% slope (1/8 inch for every linear foot of floor) to obtain this positive drainage.

11.1.4.9.5 Floors where ammonium nitrate solids or liquids are dispensed or used in open systems shall be in accordance with 6.3.2.2.3.
11.1.5* Protection of Existing Buildings. The requirements in this section shall apply retroactively to existing buildings of Type III, IV, or V construction or buildings with combustible content.

11.1.5.1 Automatic Sprinklers. An automatic fire sprinkler system shall be provided in accordance with NFPA 13 for a minimum Extra Hazard (Group 1).

11.1.5.2 Alarms.

11.1.5.2.1 Fire Detection Systems. Buildings shall be equipped throughout with an approved fire detection system, including but not limited to, a smoke or heat detection system. Such system shall be supervised in accordance with Section 6.2.1.11.

11.1.5.2.2 Audible or Visual Alarm. Any activation of the fire detection system shall also automatically initiate activation of a local audible and visual alarm system to notify occupants.

11.1.5.3 Public Notification/Alert System. An approved public notification/alert system capable of immediately notifying individuals located within 1 mile of the facility of the need to evacuate shall be provided.

11.1.5.4 Monitoring/Supervision. Supervision shall be provided for the alarm, detection, automatic fire extinguishing system in accordance with 6.2.1.11.

11.2 General Requirements for Storage.

11.2.1* Spill Control. Spill control for ammonium nitrate solids shall be in accordance with 11.2.1.1. and 11.2.1.2 and not 6.2.1.9.2.

11.2.1.1 If the contents of broken bags are uncontaminated, they shall be permitted to be salvaged by placing the damaged bag inside a clean, new slipover bag and closing it to prevent the discharge of contents.

11.2.1.2 Other spilled materials and discarded containers shall be gathered for disposal under the facility operating procedures for hazardous waste.

11.2.2 Drainage and Secondary Containment.

11.2.2.1 Drainage and secondary containment shall be provided for ammonium nitrate in accordance with 6.2.1.9.3.4(4).

11.2.3* Ventilation. The requirements of 6.2.1.5 shall apply.

11.2.4 Treatment Systems. Treatment systems are not required for ammonium nitrate.

11.2.5 Fire Protection Systems. An automatic fire sprinkler system shall be provided in accordance with NFPA 13 for a minimum Extra Hazard (Group 1).

11.2.5.1* Alternative automatic fire extinguishing systems using foam, dry chemical or gaseous agents or steam extinguishing systems shall not be allowed. Only water based suppression systems shall be permitted.
11.2.6 **Fire Detection Systems.** Buildings shall be equipped throughout with an approved fire detection system, including but not limited to, a smoke or heat detection system. Such system shall be supervised in accordance with Section 6.2.1.11.

11.2.6.1 Any activation of the fire detection system shall also automatically initiate activation of a local audible and visual alarm system to notify occupants.

11.2.7 **Extinguishing Devices.**

11.2.7.1 Portable extinguishers shall be provided throughout the storage, use and handling areas in accordance with the fire prevention code adopted by the jurisdiction and NFPA 10.

11.2.7.1.1 Only water based portable fire extinguishers shall be used on incipient fires involving ammonium nitrate.

11.2.7.1.2 All other type of extinguishers except dry chemical extinguishers per 11.2.7.1.3 shall be prohibited from the ammonium nitrate building

11.2.7.1.3 Where required by NFPA 10 for protection of combustibles, dry chemical extinguishers shall be permitted for use on incipient fires that do not involve ammonium nitrate.

11.2.8 **Fire Protection Water Supplies.**

11.2.8.1 Water supplies shall be provided for the protection of the ammonium nitrate storage by hose streams and automatic sprinklers in accordance with the fire code adopted by the AHJ.

11.2.8.2. The duration of the water supply shall be a minimum of 2 hours.

11.2.9* **Explosion Control.** The requirements of 6.2.1.6 shall not apply.

11.2.10 **Emergency and Standby Power.** Standby power shall be provided when required by 6.2.1.8.

11.2.11 **Limit Controls.** Limit controls, when required, shall be in accordance with 6.2.1.7.

11.2.12 **Alarms.**

11.2.12.1 A fire alarm system shall be provided to monitor the fire sprinkler system and provide notification in accordance with NFPA 72 and 6.2.1.1.3.

11.2.12.2 Public Notification/Alert System. Facilities storing ammonium nitrate that can detonate when exposed to fire conditions in quantities in excess of 1000 pounds shall comply with Section 11.2.12.2.1 and 11.2.12.2.2.

11.2.13 **Monitoring/Supervision.** Supervision shall be provided for the alarm, detection, automatic fire extinguishing system in accordance with 6.2.1.11.

11.2.14 **Special Requirements.**

11.2.14.1 **Separation.**
11.2.14.1.1*  Ammonium nitrate shall be isolated in a separate room by fire barrier walls constructed of concrete block having a minimum fire resistance rating of one hour and extending from the floor to the underside of the roof above or located in a separate building from the storage of any of the following:

(1) Organic chemicals, acids, or other corrosive materials
(2) Compressed flammable gases
(3) Pyrophoric materials
(4) Combustible materials
(5) Flammable and combustible liquids.
(6) Other contaminating substances, including the following:
   (a) Wood chips
   (b) Organic materials
   (c) Chlorides
   (d) Phosphorus
   (e) Finely divided metals
   (f) Charcoals
   (g) Diesel fuels and oils
   (h) Animal fats
   (i) Baled cotton
   (j) Baled rags
   (k) Baled scrap paper
   (l) Bleaching powder
   (m) Burlap or cotton bags
   (n) Caustic soda
   (o) Coal
   (p) Coke
   (q) Charcoal
   (r) Cork
   (s) Camphor
(t) Excelsior
(u) Fibers of any kind
(v) Fish oils
(w) Fish meal
(x) Foam rubber
(y) Hay
(z) Lubricating oil
(aa) Linseed oil or other oxidizable or drying oils
(bb) Naphthalene
(cc) Oakum
(dd) Oiled clothing
(ee) Oiled paper
(ff) Oiled textiles
(gg) Paint
(hh) Straw
(ii) Sawdust
(jj) Wood shavings
(kk) Vegetable oil

11.2.14.2 Prohibited Articles.

11.2.14.2.1 Sulfur, materials that require blasting during processing or handling, and finely divided metals shall not be stored in the same building with ammonium nitrate, unless such storage conforms to NFPA 495.

11.2.14.2.2 Explosives and blasting agents shall not be stored in the same building with ammonium nitrate, unless otherwise permitted by NFPA 495.

11.2.14.2.3 Explosives and blasting agents shall be permitted to be stored in the same building with ammonium nitrate on the premises of makers, distributors, and user–compounders of explosives or blasting agents.

11.2.14.2.4 Where explosives or blasting agents are stored in separate buildings, other than on the premises of makers, distributors, and user–compounders of explosives or blasting agents,
they shall be separated from the ammonium nitrate by the distances or barricades specified in NFPA 495.

11.2.14.2.5 Storage or operations on the premises of makers, distributors, and user–compounders of explosives or blasting agents shall conform to NFPA 495.

11.2.14.3 Lightning. In areas where lightning storms are prevalent, lightning protection shall be provided in accordance with NFPA 780.

11.2.14.4 Security (Control of Access). Provisions shall be made to prevent unauthorized personnel from entering the ammonium nitrate storage area.

11.2.15* Emergency Planning

11.2.15.1 Emergency Action Plans. Emergency Action Plans for facilities that store, use, or handle ammonium nitrate shall comply with the requirements of Chapter 7, and comply with the requirements of 11.2.15.2.1-11.2.15.2.4.

11.2.15.2.1 The emergency action plan shall clearly state that fires potentially affecting ammonium nitrate storage beyond the initial (incipient) stage shall not be approached by facility personnel.

11.2.15.2.2 The emergency action plan shall state whether the ammonium nitrate storage building has an automatic sprinkler system and if the building storing ammonium nitrate is of combustible construction.

11.2.15.2.3* The emergency action plan shall establish a safe evacuation distance based on an approved analysis of the permitted quantity and configuration of ammonium nitrate. Where no such analysis exists, a distance of at least 1 mile (5,280 feet) shall be used.

11.2.15.2.4 The emergency action plan shall be approved by the AHJ and updated and re-approved when conditions change and at least annually.

11.2.16* Signage In addition to the NFPA 704 placards required in 6.1.8.2.1, signs shall be conspicuously posted on the ammonium nitrate storage building stating: DO NOT FIGHT FIRE. EXPLOSION HAZARD. The sign shall be visible from 100 feet away with 6 inch red block lettering on a white reflective background.

11.3 Indoor Storage.

11.3.1 Housekeeping. Storage shall be arranged to facilitate manual access and handling, to maintain pile stability, to minimize breakage and spillage, and to promote good housekeeping.

11.3.1.1 All personnel that handle ammonium nitrate shall be trained on the general safety, regulatory controls, and industry standards on how to safely store, use and handle ammonium nitrate.

11.3.1.2* Good housekeeping shall be maintained at all times where ammonium nitrate is used, handled or stored and the following housekeeping rules shall be followed:

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11.3.2 Storage Conditions/Arrangement. Storage arrangement shall be in accordance with 11.3.2.1 through 11.3.2.3.

11.3.2.1 Containers. Bags and containers used for ammonium nitrate shall comply with the specifications and standards established by the U.S. Department of Transportation (DOT).

11.3.2.2 Piles of Bags, Drums, or Other Containers.

11.3.2.2.1 Solid ammonium nitrate shall not be placed into containers when the temperature of the ammonium nitrate exceeds 140°F (60°C).

11.3.2.2.2 Bags of ammonium nitrate shall not be stored within 30 in. (762 mm) of the walls and partitions of the storage building.

11.3.2.2.3 Piles shall comply with the following dimensions:

(1) The height of piles shall not exceed 20 ft (6.1 m).

(2) The width of piles shall not exceed 20 ft (6.1 m).

(3) The length of piles shall not exceed 50 ft (15.2 m), unless otherwise permitted by 11.3.2.2.3(4).

(4) Where the building is of noncombustible construction, or is protected by automatic sprinklers, the length of piles shall not be limited.

11.3.2.2.4 In no case shall the ammonium nitrate be stacked closer than 3 ft (0.9 m) below the roof or its supporting overhead structure.

11.3.2.2.5 Aisles shall be provided to separate piles by a clear space of not less than 3 ft (0.9 m) in width, with at least one service or main aisle in the storage area not less than 4 ft (1.2 m) in width.

11.3.2.3 Piles and Compartments for Bulk Solid Storage.

11.3.2.3.1* Bins shall be of non-combustible construction.

11.3.2.3.2 Bins shall be clean and free of materials that can contaminate ammonium nitrate.

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11.3.2.3.3 Bins shall be designed so that in the event of an external fire or self-accelerated decomposition, molten ammonium nitrate can flow away from the storage area to an open, unconfined area free from contamination with incompatible materials. (See 11.2.14.1.1 for list of incompatibles)

11.3.2.3.4* Due to the corrosive and reactive properties of ammonium nitrate, and to avoid contamination, galvanized iron, copper, alloys of copper, lead, and zinc shall not be used in bin construction, except where such bins are protected against contact with the ammonium nitrate.

11.3.2.3.5* Uncoated aluminum bins shall not be permitted.

11.3.2.3.6 The warehouse shall be permitted to be subdivided into any desired number of ammonium nitrate storage compartments or bins provided the design does not allow molten ammonium nitrate to accumulate in the storage area and become confined.

11.3.2.3.7 The ammonium nitrate storage bins or piles shall be clearly identified by signs reading AMMONIUM NITRATE with letters at least 2 in. (50.8 mm) high.

11.3.2.3.8 Piles or bins shall be sized and arranged so that all material is accessible to a mechanical means to minimize caking of the stored ammonium nitrate.

11.3.2.3.9* The height or depth of piles shall be limited by the caking tendency of the product; however, in no case shall the ammonium nitrate be piled higher at any point than 3 ft (0.9 m) below the roof or its supporting and overhead structure.

11.3.2.3.10 Ammonium nitrate shall not be placed into storage when the temperature of the product exceeds 140°F (60°C).

11.3.2.3.11 Explosives and blasting agents shall not be used to break up or loosen caked ammonium nitrate.

11.3.3 Detached Storage. The requirements of 6.2.3.4 shall apply.

11.4 Outdoor Storage.

11.4.1 Clearance from Combustibles.

11.4.1.1. Outdoor storage and use areas and the area surrounding shall be kept clear of weeds, debris, and common combustible materials not necessary to the storage or use of hazard materials for a minimum distance of 30 ft (9.0m).

11.4.1.2 Outdoor storage and use areas for ammonium nitrate shall be located not closer than 30 ft (9 m) from a property line that can be built upon, a street, an alley, or a public way, except that a 2 hour fire barrier wall, without openings and extending no less than 30 in. (762 mm) above and to the sides of the storage area, shall be permitted in lieu of such distance.
11.4.2 **Weather Protection.** When provided, weather protection shall be in accordance with 6.2.7.2.

11.4.3 **Outdoor Storage in Enclosed Hoppers or Bins.** In addition to the other requirements of 11.4, this section applies to outdoor storage of ammonium nitrate in quantities exceeding 1000 lbs.

11.4.3.1 All hoppers and bins in which bulk ammonium nitrate is stored, shall be constructed of non-combustible materials.

11.4.3.2 Enclosed hoppers or bins shall be provided with a venting device to enable the discharge of gases generated in the event of a fire.

11.4.3.* Parking of any vehicles or industrial trucks shall be prohibited within 30 ft. of the hoppers/bins.

11.4.4* **Special Requirements — Outdoor Storage.**

11.5 **General Requirements for Use.**

11.5.1 **Spill Control.**

Spill control shall be provided for ammonium nitrate liquids in accordance with 11.2.1.

11.5.1.1 Spilled ammonium nitrate, and leaking or broken containers shall be removed immediately by a competent individual to a safe, secure, dry outside area or to a location designated by the competent individual to await disposal, in conformance with applicable regulations.

11.5.2 **Drainage.**

11.5.2.1 Drainage shall be provided for ammonium nitrate liquids in accordance with 6.3.1.4.2.10.

11.5.2.2 For ammonium nitrate solids, the requirements of 6.3.1.4.2.10 shall not apply.

11.5.3 **Secondary Containment.**

11.5.3.1 Secondary containment shall be provided for ammonium nitrate solids or liquids in accordance with 6.3.1.4.2.

11.5.3.2 For ammonium nitrate solids, the requirements of 6.3.1.4.2 shall not apply.

11.5.4 **Ventilation.** The requirements of 6.3.2.1.3 shall apply.

11.5.6 **Fire Protection Systems.** An automatic fire sprinkler system shall be provided in accordance with 11.2.6.

11.5.6.1* Alternative automatic fire extinguishing systems using foam, dry chemical or gaseous agents or steam extinguishing systems shall not be allowed. Only water based suppression systems shall be permitted.

11.5.6.2 Portable extinguishers shall be provided in accordance with 11.2.8.

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11.5.7 **Explosion Control.** The requirements of 6.3.2.1.4 shall not apply.

11.5.8 **Emergency and Standby Power.** The requirements of 6.3.2.1.3.3 shall apply.

11.5.9 **Limit Controls.** Limit controls shall be provided in accordance with 6.3.1.2.

11.5.10 **Alarms.** Alarms shall be provided in accordance with 11.2.13.

11.5.11 **Monitoring/Supervision.** Supervision shall be provided in accordance with 6.3.1.8.

11.5.12 **System Design.** System design shall be in accordance with 6.3.1.6.

11.5.13 **Liquid Transfer.** Liquid transfer shall be in accordance with 6.3.1.7.

11.6 **Indoor Use.**

11.6.1 **Open Systems.**

11.6.1.1 **Ventilation.** The requirements of 6.3.2.1.3 shall apply.

11.6.1.2 **Explosion Control.** The requirements of 6.3.2.1.4 shall not apply.

11.6.1.3 **Spill Control, Drainage, and Containment.** Secondary containment shall be provided for ammonium nitrate liquids in accordance with 6.3.2.2.4.

11.7 **Outdoor Use.**

11.7.1 **Open Systems.**

11.7.1.1 **Location.** Outdoor use and dispensing shall be located in accordance with 6.3.3.1.1.

11.7.1.2 **Spill Control, Drainage, and Containment.** Spill control and secondary containment shall be provided for ammonium nitrate liquids in accordance with 6.3.3.2.2.

11.7.1.3 **Clearance from Combustibles.** For outdoor use the requirements of 11.4.1 shall apply.

11.8 **Handling.**

11.8.1 **Handling.** Handling shall be in accordance with 6.3.4 and 11.8.1.

11.8.1.1 **Vehicles and Lift Trucks.**

11.8.1.1.1* Powered vehicles of any type shall not be stored or left unattended in a building storing ammonium nitrate.

11.8.1.1.2 Powered vehicles used in ammonium nitrate storage facilities shall not be refueled within 50 feet of the facility.

11.8.1.1.3 Fork trucks, tractors, platform lift trucks, and other specialized industrial trucks used within the warehouse shall be maintained so that fuels or hydraulic fluids do not contaminate the ammonium nitrate.
**11.8.1.2** Handling Equipment. Hollow spaces in nitrate-handling equipment, where nitrate is able to collect and be confined to become a source of explosion in the event of fire, shall be avoided.
A.11.1.1 Determine the classification of ammonium nitrate in accordance with Chapter 4. Chapter 11 takes precedence to address the specific requirements for solid and liquid ammonium nitrate, when 1,000 pounds is exceeded. The physical hazards of ammonium nitrate are dependent on the properties of the specific material or mixture of materials as a whole. When used as a fertilizer, it is common for ammonium nitrate to exist as a component of a chemical mixture. It is not uncommon for the user to describe the mixture as ammonium nitrate when in reality the mixture can contain components that contribute to altering the end classification of the material. The manufacturer’s safety data sheet (SDS) should be used to assess the overall hazards of these materials. The user is cautioned that the DOT shipping classification for transportation purposes alone is not a sufficient means by which to determine the storage and use hazards of these materials. Ammonium nitrate in the undiluted or pure form has a higher degree of overall hazard than does ammonium nitrate when mixed or blended with compatible materials that can reduce the concentration. The tables in Chapter 5 are hazard-specific; they are not “chemical-specific.” Ammonium nitrate as such is not included in the tables, because the actual hazard classification varies with the material under consideration. The question must be answered as to whether the material is an oxidizer, and if so what Class; whether it is an unstable reactive, and if so what Class; or whether there are other physical or health hazards attendant to the mixture under evaluation. (See Annex E for additional information)

A.11.1.1.5 Ammonium nitrate and ammonium nitrate–based materials that are DOT Hazard Class 1 explosive should be stored in accordance with the requirements of NFPA 495, Explosive Materials Code. Sensitivity is determined by the application of the UN Test Series 1, which includes testing to determine impact sensitivity, friction sensitivity, sensitivity to electrostatic discharge, and thermal stability.

A.11.1.6 Agricultural application refers to the actual transporting and spreading of the fertilizers in fields. Storage in a building for eventual agricultural use is not an agricultural application.

A.11.1.4.9.2 This requirement is intended to prohibit floor drains, traps, tunnels, pits, or pockets into which any molten ammonium nitrate is able to flow and be confined in the event of fire.

A.11.1.4.9.3 The slope of the storage floor should be pitched in such a manner that it drains away from the ammonium nitrate pile and towards a containment area. As noted in other sections, no drainage pits, sumps or confined piping should be designed into this drainage plan.

A.11.15 Where a documented risk analysis demonstrates to the AHJ that an equivalent level of fire safety can be achieved using alternatives to the requirements of this section such an approach is an acceptable alternative. The risk analysis should be submitted to the AHJ in accordance with the requirements of Section 1.5.3. A risk analysis report should demonstrate equivalent fire safety by addressing relevant topics including but not limited to:

1. Location of the facility
2. Distance to exposed structures and population density of public areas and other areas associated with the ammonium nitrate facility.
3. Construction type
4. Storage configuration
5. Exposing combustible materials
6. Emergency response capability
7. Water supply
8. Ammonium Nitrate mixture, blends and use.
9. Fire protection features provided (fire barriers, fire detection and alarm, etc.)

A.11.2.1 Sumps and collection systems as required by 6.2.1.9.2 create confinement conditions and should be avoided with molten ammonium nitrate which could be created in a fire.

A.11.2.3 Buildings intended for the storage of ammonium nitrate should have not less than 0.007 ft\(^2\) of vent area for each square feet of ammonium nitrate storage area, unless mechanical ventilation is provided. Vent areas for exhaust and inlet air intake areas should not be less than 0.007 ft\(^2\)/ft\(^2\) of storage area. Buildings should be sufficiently ventilated to prevent the confinement of gases generated from the decomposition of ammonium nitrate. As stated in the Summary Report from the European Commission, Joint Research Center workshop on ammonium nitrate:

“Pure ammonium nitrate can undergo thermal decomposition if it receives enough energy. Gases are then emitted, especially nitrogen oxides and ammonia, both toxic. With proper ventilation, the decomposition stops as soon as the energy flow stops. The decomposition rate is not dangerously high at moderate temperatures, and the overall thermal effect is not significant since the exothermic reactions are accompanied by endothermic disassociation, which can in turn give rise to a steady state reaction provided the gases produced can escape freely and the system is adiabatic. The decomposition is catalysed by a number of substances such as chlorides, which can affect the above balance.”

A.11.2.5.1 Foam, dry chemical or gaseous extinguishing systems are ineffective in controlling fires involving ammonium nitrate, an oxidizer that supplies its own oxygen. Steam is similarly ineffective and should not be used due to the addition of heat to the decomposing mass. Water cools the AN, reducing molten AN formation and decomposition.

A.11.2.9 Explosion control methods required by section 6.2.1.6 are not warranted for ammonium nitrate regulated by this chapter. Deflagration control methods described in NFPA 69 (primarily deflagration venting) are not effective for the detonations that can sometimes result from ammonium nitrate that is involved in a fire situation. In Chapter 11 the emphasis is on explosion prevention but using methods that will be effective on ammonium nitrate and not those required by NFPA 69 namely – combustible concentration reduction, oxidant concentration reduction, or deflagration control. The other requirements of Chapter 11 are intended to prevent ammonium nitrate explosions and are more effective than the requirements of 6.2.1.6 for this material. Ammonium nitrate that is formulated to be an explosive is regulated in accordance with NFPA 495 and not this chapter.

A.11.2.14.1.1 Provisions should be made to avoid the following conditions with ammonium nitrate:

1.) heating in a confined space
2.) localized heating potentially leading to development of high temperature areas
3.) exposure to strong shock waves
4.) contamination with combustible materials, incompatible inorganic and organic substances that can result in sensitivity to explosion.
5.) low pH or acidic conditions

A.11.2.15. A pre-incident best practices plan should be developed by the local fire department in conjunction with any facility that stores, uses or handles ammonium nitrate. NFPA 1620 can be used for further guidance.
A.11.2.15.2.3 A one mile public evacuation distance has been recommended in the rare event of a facility containing ammonium nitrate becoming involved in a fire. This evacuation distance is recommended since the exact conditions of a facility during the emergency may not be known to the emergency response personnel. Under these potentially unknown conditions a worst-case scenario is assumed to ensure the public is evacuated to a safe distance.

The unknowns include:

1. The condition of the AN involved in the fire. For example contamination from a material that can behave as a fuel could potentially lead to a more violent release of energy than uncontaminated AN.
2. Presence of a burning structure.
3. The quantity of ammonium nitrate involved in the fire.

Over pressure calculations alone are not adequate to determine evacuation distances and debris field modeling is necessary to help ensure public safety. The one mile distance is based on a quantitative risk analysis of a scenario that involves AN mixed with a fuel source and the presence of a burning structure. Quantities up to one million pounds of ammonium nitrate were used in the determination based on projectile travel distance.

A.11.2.16 The NFPA 704 Fire Protection Guide to Hazardous Materials, Hazardous Chemicals Data Compilation currently lists ammonium nitrate, under emergency conditions as Health=0, Flammability=0, Instability=3 and Other=OX (oxidizer). Safety Data Sheets that provide NFPA 704 ratings typically agree with all ratings except Health where ratings of 0, 1 or 2 are reported by different manufacturers. Because decomposition products include various nitrogen oxides (NOx) and nitric acid, the minimum health rating should be considered 1.


A.11.3.2.3.1 Wood impregnated with ammonium nitrate is a fire hazard. It can be ignited by a low energy source with a vigorous fire.

A.11.3.2.3.4 Metal bins can be protected by special coatings such as sodium silicate, epoxy coatings, or polyvinyl chloride (PVC) coatings.

A.11.3.2.3.5 Storage in aluminum transport vehicles is not recommended.

A.11.3.2.3.9 Bulk and bagged ammonium nitrate can become caked and degrade in storage. This is a factor affected by humidity and temperature in the storage space and by prill quality. Temperature cycles through 90°F (32°C) and high atmospheric humidity are undesirable for storage in depth.

A.11.4.3.3 Active loading or unloading of vehicles with ammonium nitrate from the hoppers/bins is not considered parking and is permitted. The vehicle operator should remain within 25 feet of the vehicle during loading or unloading operations. Immediately upon completion of the loading/unloading activity, the vehicle should be moved at least 30 feet away from the hopper/bins.
A.11.4.4 Many of the general principles for the storage of ammonium nitrate–based fertilizers apply equally to fertilizers stored in the open and those stored in a building. It is generally recommended that bagged ammonium nitrate fertilizers should not be stored in large piles outdoors.

It should be noted that repeated temperature cycles can cause physical deterioration of some products. Physical deterioration can result in the breakdown of the fertilizer particles and damage to packages. The product should be protected from direct sunlight. Due note should be taken of ground conditions when storing outdoors to avoid damage to the product. Outdoor storage areas should be protected against unauthorized access, for example, by means of a fence. Warnings against unauthorized entry should be posted.

A.11.5.6.1 Foam, dry chemical or gaseous extinguishing systems are ineffective in controlling fires involving ammonium nitrate, an oxidizer that supplies its own oxygen. Steam is similarly ineffective.

A.11.8.1.1 This includes battery powered vehicles and vehicles powered by internal combustion engines such as motor vehicles, lift trucks and cargo conveyors. It is recommended that electric or LP-Gas powered trucks be employed rather than gasoline or diesel to reduce the potential for contamination to ammonium nitrate. Also see A.11.4.3.3.

A.11.8.1.2 Examples of hollow spaces include hollow conveyor rollers and hollow screw conveyor shafts.
Chapter 11  Ammonium Nitrate Solids and Liquids

11.1  General.

See also Annex E.

11.1.1  Scope. The requirements of this chapter shall apply to the storage, use, and handling of ammonium nitrate unless specified in Chapter 5 quantities greater than 1,000 lbs.

11.1.1.1  The storage of ammonium nitrate shall comply with the requirements of Chapters 1 through 4.

11.1.1.2  This chapter shall apply to solid ammonium nitrate in the form of crystals, flakes, grains or prills including fertilizer grade and industrial grade or other mixtures containing 60% or more by weight of ammonium nitrate.

11.1.1.3  This chapter shall apply to liquid ammonium nitrate solutions containing 70% or more by weight of ammonium nitrate.

11.1.1.4  This chapter shall not apply to liquid ammonium nitrate solutions used as fertilizers unless classified as a hazardous material by DOT.

11.1.1.5  This chapter shall not apply to ammonium nitrate and ammonium nitrate mixtures that are DOT Hazard Class 1 sensitive shall not be permitted by this code except on the specific approval of the authority having jurisdiction.

11.1.1.6  The agricultural application of ammonium nitrate and ammonium nitrate--based fertilizers in outdoor agricultural uses is not regulated by this code.

11.1.1.7  Where Chapter 11 is applicable Chapter 15 Oxidizers and Chapter 19 Unstable Reactives shall not apply.

11.2  Ignition.

The storage, use, and handling Sources of Ignition. Open flames and smoking shall be prohibited in buildings that store use and handle ammonium nitrate in any quantity shall also see also Annex E.
11.1.2—

General Requirements for Storage. The quantity and arrangement limits in this code shall not apply to the transient storage of ammonium nitrate in process areas at plants where ammonium nitrate is manufactured.

11.1.4—Construction Requirements.

Buildings, or portions thereof, in which ammonium nitrate is stored, handled, or used shall be constructed in accordance with the building code.

11.1.4.1—

The construction requirements of this code shall not apply retroactively to Buildings used for the storage and handling of ammonium nitrate in existing buildings at manufacturing plants. Bulk, bags or other combustible containers shall be of non-combustible (Type I or II) construction.

11.1.4.2 Bins or compartments used for the storage of bulk ammonium nitrate shall be constructed of non-combustible materials that are compatible with ammonium nitrate. (See 11.3.2.3.2)

11.1.4.2

11.1.4.3 Storage buildings shall not have basements unless the basements are open on at least one side. Buildings over one story in height shall not be used for storage, unless approved for such use.

11.1.4.4 The exterior wall on the exposed side of a storage building within 50 ft (15.2 m) of a combustible building, forest, piles of combustible materials, and exposure hazards by ordinary combustible materials shall be of Type I construction fire barrier wall with a minimum fire resistance rating of 2 hours in accordance with the building code.

11.1.4.5 In lieu of the Type I fire barrier wall specified in 11.1.4.3, 11.1.4.4, a means of exposure protection, such as a freestanding fire barrier wall, shall be permitted to be used when approved by the AHJ.

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The continued use of an existing storage building or structure not in strict conformity with this code shall be approved by the AHJ in cases where such continued use will not constitute a hazard to life or adjoining property.

11.1.4.6

Buildings and structures shall be dry and free from water intrusion through the roof, walls, and floors.

11.1.4.7

Electric. Any heating source including electric lamps shall be located or guarded so as to preclude contact with bags or other combustible materials.

11.1.4.8 Bulk storage structures shall not exceed a height of 40 ft (12.2 m).

11.1.4.8.1 Where bulk storage structures are constructed of noncombustible material or facilities for fighting a roof fire are provided, the height of the storage building shall only be limited by the building construction type as specified in the building code adopted by the jurisdiction.

11.1.4.9 Floors.

11.1.4.9.1 Floors shall be in accordance with 6.2.10.

11.1.4.9.2* All flooring in storage and handling areas shall be without open drains, traps, tunnels, pits, or pockets.

11.1.4.9.3* The non-combustible floor of the ammonium nitrate storage shall be sloped in a manner that promotes a positive drainage of liquids, whether water or molten material in the case of a fire.

11.1.4.9.4 The floor shall be at least a 1% slope (1/8 inch for every linear foot of floor) to obtain this positive drainage.

11.1.4.9.5 Floors where ammonium nitrate solids or liquids are dispensed or used in open systems shall be in accordance with 6.3.2.2.3.

11.1.5 Protection of Existing Buildings. The requirements in this section shall apply retroactively to existing buildings of Type III, IV, or V construction or buildings with combustible content.

11.1.5.1 Automatic Sprinklers. An automatic fire sprinkler system shall be provided in accordance with NFPA 13 for a minimum Extra Hazard (Group 1).

11.1.5.2 Alarms.

11.1.5.2.1 Fire Detection Systems. Buildings shall be equipped throughout with an approved fire detection system, including but not limited to, a smoke or heat detection system. Such system shall be supervised in accordance with Section 6.2.1.11.
11.1.5.2 Audible or Visual Alarm. Any activation of the fire detection system shall also automatically initiate activation of a local audible and visual alarm system to notify occupants.

11.1.5.3 Public Notification/Alert System. An approved public notification/alert system capable of immediately notifying individuals located within 1 mile of the facility of the need to evacuate shall be provided.

11.1.5.4 Monitoring/Supervision. Supervision shall be provided for the alarm, detection, automatic fire extinguishing system in accordance with 6.2.1.11.

11.2 General Requirements for Storage.

11.2.1 Spill Control.

Spill control shall be provided for ammonium nitrate solids shall be in accordance with 11.2.1.1, and 11.2.1.2 and not 6.2.1.9.2.

11.2.1.1 If the contents of broken bags are uncontaminated, they shall be permitted to be salvaged by placing the damaged bag inside a clean, new slipover bag and closing it to prevent the discharge of contents.

11.2.1.2 Other spilled materials and discarded containers shall be gathered for disposal under the facility operating procedures for hazardous waste.

11.2.2 Drainage.

11.2.2.1 Drainage shall be provided for ammonium nitrate liquids in accordance with 6.2.1.9.3.11.

11.2.2.2 For ammonium nitrate solids the requirements of 6.2.1.9.3.11 shall not apply.

11.2.3 and Secondary Containment.

11.2.3.1 Secondary Drainage and secondary containment shall be provided for ammonium nitrate in accordance with 6.2.1.9.3.6.2.1.9.3.

11.2.3.2 For ammonium nitrate solids, the requirements of 6.2.1.9.3 shall not apply.

11.2.4(4).

11.2.5* Ventilation.

11.2.5.1 The requirements of 6.2.1.56.2.1.5 shall not apply.

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11.2.4.2 Storage buildings shall have ventilation or be of a construction that will be self-ventilating in the event of fire.

11.2.4 Treatment Systems. Treatment systems are not required for ammonium nitrate.

11.2.5 Fire Protection Systems.

An automatic fire sprinkler system shall be provided in accordance with 6.2.1.1 NFPA 13 for a minimum Extra Hazard (Group 1).

11.2.5.1 Automatic Sprinklers.

11.2.5.1.1 Packaged in Bags.

Not more than 2500 tons (2268 metric tons) of bagged ammonium nitrate shall be stored in a building or structure not equipped with an Alternative automatic sprinkler system.

11.2.5.1.1.1 When approved by the AHJ, a quantity of bagged ammonium nitrate greater than 2500 tons (2268 metric tons) automatically extinguishing systems using foam, dry chemical or gaseous agents or steam extinguishing systems shall not be allowed. Only water based suppression systems shall be permitted to be stored in a building or structure.

11.2.6 Fire Detection Systems. Buildings shall be equipped throughout with an approved fire detection system, including but not limited to, a smoke or heat detection system.

11.2.5.1.2 Sprinkler protection Such system shall be permitted to be required by the AHJ for the storage of less than 2500 tons (2268 metric tons) of ammonium nitrate where the location of the building or the presence of other stored materials can present a special hazard.

11.2.5.1.3 Sprinklers shall be of the approved type and designed and installed in accordance with NFPA 13 and the following Section 6.2.1.11:

1. Ammonium nitrate in noncombustible or combustible containers (paper bags or noncombustible containers with removable combustible liners) shall be designated as a Class I commodity.

2. Where contained in plastic containers, ammonium nitrate shall be designated as a Class II commodity.

3. Where contained in fiber packs or noncombustible containers in combustible packaging, ammonium nitrate shall be designated as a Class III commodity.

11.2.6.1 Any activation of the fire detection system shall also automatically initiate activation of a local audible and visual alarm system to notify occupants.
11.2.5.2.7 Extinguishing Devices.

Portables shall be provided throughout the storage, use, and in the loading and unloading areas in accordance with the fire prevention code adopted by the jurisdiction and NFPA 10.

11.2.5.2.2 When small hose systems are provided, they shall be in accordance with NFPA 14.

11.2.5.3-11.2.7.1.1 Only water based portable fire extinguishers shall be used on incipient fires involving ammonium nitrate.

11.2.7.1.2 All other type of extinguishers except dry chemical extinguishers per 11.2.7.1.3 shall be prohibited from the ammonium nitrate building.

11.2.7.1.3 Where required by NFPA 10 for protection of combustibles, dry chemical extinguishers shall be permitted for use on incipient fires that do not involve ammonium nitrate.

11.2.8 Fire Protection Water Supplies.

11.2.8.1 Water supplies and fire hydrants shall be provided for the protection of the ammonium nitrate storage by hose streams and automatic sprinklers in accordance with the fire prevention code adopted by the jurisdiction and as required by the AHJ.

11.2.5.4 Remote Areas.

The requirements for automatic sprinklers, duration of the water supplies, and fire hydrants set forth in 11.2.5.2 and 11.2.5.3 supply shall be permitted to be waived by the AHJ where storage facilities are located in remote areas a minimum of 2 hours.

11.2.6.9 Explosion Control.

The requirements of 6.2.1.6 shall not apply.

11.2.7-10 Emergency and Standby Power.

Standby power shall be provided when required by 6.2.1.8.

11.2.8-11 Limit Controls.

Limit controls shall be provided when required by 6.2.1.7, shall be in accordance with 6.2.1.7.

11.2.9-12 Alarms.

11.2.12.1 A fire alarm system shall be provided to monitor the fire sprinkler system and provide notification in accordance with NFPA 72 and 6.2.1.1.3.

11.2.12.2 Public Notification/Alert System. Facilities storing ammonium nitrate that can detonate when exposed to fire conditions in quantities in excess of 1000 pounds shall comply with Section 11.2.12.2.1 and 11.2.12.2.2.
11.2.13 Monitoring/Supervision.

Supervision shall be provided in accordance with 6.2.1.11 for the alarm, detection, automatic fire extinguishing system in accordance with 6.2.1.11.

11.2.14 Special Requirements.

11.2.14.1 Separation.

11.2.14.1.1 Ammonium nitrate shall be separated isolated in a separate room by fire barrier walls of not less than 1-hour constructed of concrete block having a minimum fire resistance rating of one hour and extending from the floor to the underside of the roof above or located in a separate building from the storage of any of the following:

1. Organic chemicals, acids, or other corrosive materials
2. Compressed flammable gases
3. Pyrophoric materials
4. Combustible materials
5. Flammable and combustible materials, solids or liquids
6. Other contaminating substances, including the following:
   a. Wood chips
   b. Organic materials
   c. Chlorides
   d. Phosphorus
   e. Finely divided metals
   f. Charcoals
   g. Diesel fuels and oils

11.2.10.2 Incompatible Materials.

Walls referred to in 11.2.10.1.1 shall extend from the floor to the underside of the roof above.

11.2.10.1.3 In lieu of fire barrier walls, ammonium nitrate shall be permitted to be separated from the materials referred to in 11.2.10.1.1 by a space of at least 30 ft (9.1 m) or more, as required by the AHJ, and sills or curbs shall be provided to prevent mixing during fire conditions.
Flammable liquids, such as gasoline, kerosene, solvents, and light fuel oils, shall not be stored on the premises, unless the following criteria are met:

1. The storage conforms to NFPA 30.
2. Walls and sills or curbs are provided in accordance with 11.2.10.1.1 through 11.2.10.1.3.

11.2.10.2.2
LP-Gas shall not be stored on the premises, unless such storage conforms to NFPA 58.

11.2.10.3 (h) Animal fats
(i) Baled cotton
(j) Baled rags
(k) Baled scrap paper
(l) Bleaching powder
(m) Burlap or cotton bags
(n) Caustic soda
(o) Coal
(p) Coke
(q) Charcoal
(r) Cork
(s) Camphor
(t) Excelsior
(u) Fibers of any kind
(v) Fish oils
(w) Fish meal
(x) Foam rubber
(y) Hay
(z) Lubricating oil
(aa) Linseed oil or other oxidizable or drying oils
(bb) Naphthalene
(cc) Oakum
(dd) Oiled clothing
(ee) Oiled paper
(ff) Oiled textiles
(gg) Paint
(hh) Straw
(ii) Sawdust
(jj) Wood shavings
(kk) Vegetable oil

11.2.14.2 Prohibited Articles,

11.2.10.314.2.1

Sulfur, materials that require blasting during processing or handling, and finely divided metals shall not be stored in the same building with ammonium nitrate, unless such storage conforms to NFPA 495.

11.2.10.314.2.2

Explosives and blasting agents shall not be stored in the same building with ammonium nitrate, unless otherwise permitted by NFPA 495.

11.2.10.314.2.3

Explosives and blasting agents shall be permitted to be stored in the same building with ammonium nitrate on the premises of makers, distributors, and user–compounders of explosives or blasting agents.

11.2.10.314.2.4

Where explosives or blasting agents are stored in separate buildings, other than on the premises of makers, distributors, and user–compounders of explosives or blasting agents, they shall be separated from the ammonium nitrate by the distances or barricades specified in NFPA 495.

11.2.10.314.2.5

Storage or operations on the premises of makers, distributors, and user–compounders of explosives or blasting agents shall conform to NFPA 495.

11.2.10.4–11.2.14.3 Lightning.

In areas where lightning storms are prevalent, lightning protection shall be provided. in accordance with NFPA 780.

11.2.10.5–14.4 Security (Control of Access).
11.2.15* Emergency Planning

11.2.15.1 Emergency Action Plans. Emergency Action Plans for facilities that store, use, or handle ammonium nitrate shall comply with the requirements of Chapter 7, and comply with the requirements of 11.2.15.2.1-11.2.15.2.4.

11.2.15.2.1 The emergency action plan shall clearly state that fires potentially affecting ammonium nitrate storage beyond the initial (incipient) stage shall not be approached by facility personnel.

11.2.15.2.2 The emergency action plan shall state whether the ammonium nitrate storage building has an automatic sprinkler system and if the building storing ammonium nitrate is of combustible construction.

11.2.15.2.3* The emergency action plan shall establish a safe evacuation distance based on an approved analysis of the permitted quantity and configuration of ammonium nitrate. Where no such analysis exists, a distance of at least 1 mile (5,280 feet) shall be used.

11.2.15.2.4 The emergency action plan shall be approved by the AHJ and updated and re-approved when conditions change and at least annually.

11.2.16* Signage In addition to the NFPA 704 placards required in 6.1.8.2.1, signs shall be conspicuously posted on the ammonium nitrate storage building stating: DO NOT FIGHT FIRE. EXPLOSION HAZARD. The sign shall be visible from 100 feet away with 6 inch red block lettering on a white reflective background.

11.3 Indoor Storage.

11.3.1 Housekeeping. Storage shall be arranged to facilitate manual access and handling, to maintain pile stability, to minimize breakage and spillage, and to promote good housekeeping.

11.3.1.1 All personnel that handle ammonium nitrate shall be trained on the general safety, regulatory controls, and industry standards on how to safely store, use and handle ammonium nitrate.

11.3.1.2* Good housekeeping shall be maintained at all times where ammonium nitrate is used, handled or stored and the following housekeeping rules shall be followed:

1. Floors and storage area shall be free of any clutter and debris.
2. All spills shall be contained and properly disposed of immediately.
3. Any damaged container and/or waste shall be immediately and properly removed from the area to a safe location.
4. Policy, procedures and practice shall be in place to ensure separation of incompatible materials is maintained at all times.
(5) Storage of combustibles shall be prohibited in or around ammonium nitrate storage areas.

11.3.2 Storage Conditions/Arrangement.

Storage arrangement shall be in accordance with 11.3.1.1 through 11.3.1.2.

11.3.2.1 Containers.

Bags and containers used for ammonium nitrate shall comply with the specifications and standards established by the U.S. Department of Transportation (DOT).

11.3.2.2 Piles of Bags, Drums, or Other Containers.

Containers of solid ammonium nitrate shall not be placed into storage containers when the temperature of the ammonium nitrate exceeds 120°F (48.9°C).

11.3.2.2.1 Bags of ammonium nitrate shall not be stored within 30 in. (762 mm) of the walls and partitions of the storage building.

11.3.2.2.2 Piles shall comply with the following dimensions:

(1) The height of piles shall not exceed 20 ft (6.1 m).

(2) The length of piles shall not exceed 20 ft (6.1 m).

(3) The length of piles shall not exceed 50 ft (15.2 m), unless otherwise permitted by 11.3.2.2.3.

(4) Where the building is of noncombustible construction, or is protected by automatic sprinklers, the length of piles shall not be limited.

11.3.2.2.3 In no case shall the ammonium nitrate be stacked closer than 3 ft (0.9 m) below the roof or its supporting overhead structure.

11.3.2.2.5 Aisles shall be provided to separate piles by a clear space of not less than 3 ft (0.9 m) in width, with at least one service or main aisle in the storage area not less than 4 ft (1.2 m) in width.

11.3.2.2.6
Where storage facilities are located in remote areas, the requirements for pile sizes and aisles, as set forth in 11.2.1.2, shall be permitted to be waived by the AHJ.

11.3.2.3.1. Piles and Compartments for Bulk Solid Storage.

11.3.2.3.1.1. Bins shall be of non-combustible construction.

11.3.12.3.1. Warehouses shall have ventilation, or be capable of ventilation in case of fire, that will, in the event of fire, prevent the explosive decomposition of ammonium nitrate.

11.3.12.3.2.1. Where bulk storage structures are constructed of noncombustible material and facilities for fighting a roof fire are provided, the height of the storage building shall only be limited by the building construction type as specified in the building code adopted by the jurisdiction.

11.3.12.3.3. Compartments.

11.3.12.3.3.1. Bins shall be clean and free of materials that can contaminate ammonium nitrate.

11.3.12.3.2.2. Bins shall be designed so that in the event of an external fire or self-accelerated decomposition, molten ammonium nitrate can flow away from the storage area to an open, unconfined area free from contamination with incompatible materials. (See 11.2.14.1.1 for list of incompatibles)

11.3.12.3.4. Due to the corrosive and reactive properties of ammonium nitrate, and to avoid contamination, galvanized iron, copper, alloys of copper, lead, and zinc shall not be used in bin construction, except where such bins are protected against impregnation by contact with the ammonium nitrate.

11.3.12.3.2.3. Aluminum. Uncoated aluminum bins, and wooden bins protected against impregnation by ammonium nitrate, shall not be permitted.

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6. The warehouse shall be permitted to be subdivided into any desired number of ammonium nitrate storage compartments or bins provided the design does not allow molten ammonium nitrate to accumulate in the storage area and become confined.

11.3.12.3.5.

floors shall be in accordance with 6.2.1.10.

11.3.2.2.

All flooring in storage and handling areas shall be without open drains, traps, tunnels, pits, or pockets into which any molten ammonium nitrate is able to flow and be confined in the event of fire.

11.3.3. Detached Storage.

The requirements of 6.2.3.4 shall apply.

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11.4. Outdoor Storage.

11.4.1 Exposures. Clearance from Combustibles.

11.4.1.1 Outdoor storage and use areas and the area surrounding shall be kept clear of weeds, debris, and common combustible materials not necessary to the storage or use of hazard materials for a minimum distance of 30 ft (9.0m).

11.4.1.2 Outdoor storage and use areas for ammonium nitrate solids or liquids shall be separated located not closer than 30 ft (9.0 m) from exposure hazards a property line that can be built upon, a street, an alley, or a public way, except that a 2 hour fire barrier wall, without openings and extending no less than 30 in. (762 mm) above and to the sides of the storage area, shall be permitted in lieu of such distance.

11.4.1.1 Clearance from Combustibles.

Clearance from combustible materials shall be in accordance with 6.2.7.1.

11.4.2 Weather Protection.

When provided, weather protection shall be in accordance with 5.1.2 and 6.2.7.2, 6.2.7.2.

11.4.2.11.4.3 Outdoor Storage in Enclosed Hoppers or Bins. In addition to the other requirements of 11.4, this section applies to outdoor storage of ammonium nitrate in quantities exceeding 1000 lbs.

11.4.3.1 All hoppers and bins in which bulk ammonium nitrate is stored, shall be constructed of non-combustible materials.

11.4.3.2 Enclosed hoppers or bins shall be provided with a venting device to enable the discharge of gases generated in the event of a fire.

11.4.3.3 Parking of any vehicles or industrial trucks shall be prohibited within 30 ft. of the hoppers/bins.

11.4.4 Special Requirements — Outdoor Storage.

11.5 General Requirements for Use.

11.5.1 Spill Control.

Spill control shall be provided for ammonium nitrate liquids in accordance with 6.2.11.2.14.

11.5.1.1 Spilled ammonium nitrate, and leaking or broken containers shall be removed immediately by a competent individual to a safe, secure, dry outside area or to a location designated by the competent individual to await disposal, in conformance with applicable regulations.

11.5.2 Drainage.

11.5.2.1...
Drainage shall be provided for ammonium nitrate liquids in accordance with 6.3.1.4.2.10.

11.5.2.2. For ammonium nitrate solids, the requirements of 6.3.1.4.2.10 shall not apply.

11.5.3. Secondary Containment.

11.5.3.1. Secondary containment shall be provided for ammonium nitrate solids or liquids in accordance with 6.3.1.4.2.

11.5.3.2. For ammonium nitrate solids, the requirements of 6.3.1.4.2 shall not apply.

11.5.4. Ventilation.

The requirements of 6.3.2.1.3 shall apply.

11.5.6. Fire Protection System.

11.5.6.1. Alternative automatic fire extinguishing systems using foam, dry chemical or gaseous agents or steam extinguishing systems shall not be allowed. Only water based suppression systems shall be permitted.

11.5.6.2. Portable extinguishers shall be provided in accordance with 11.2.8.

11.5.7. Explosion Control.

The requirements of 6.3.2.1.4 shall not apply.

11.5.8. Emergency and Standby Power. The requirements of 6.3.2.1.3 shall apply.

The requirements of 6.3.2.1.3 shall not apply.

11.5.9. Limit Controls.

Limit controls shall be provided in accordance with 6.3.1.2.

11.5.10 Alarms. Alarms shall be provided in accordance with 11.2.13.

11.5.11 Monitoring/Supervision.

Supervision shall be provided in accordance with 6.3.1.8.

11.5.12 Floors.

Floors where ammonium nitrate solids or liquids are dispensed or used in open systems shall be in accordance with 6.3.2.1.3.
11.5.11-12  System Design.
System design shall be in accordance with 6.3.1.6.6.3.1.6.

11.5-12  Liquid Transfer.
Liquid transfer shall be in accordance with 6.3.1.7.6.3.1.7.

11.6  Indoor Use.

11.6.1  Open Systems.

11.6.1.1  Ventilation.
The requirements of 6.3.2.1.3 shall apply.

11.6.1.2  Explosion Control.
The requirements of 6.3.2.1.4 shall not apply.

11.6.1.3  Explosion Control. The requirements of 6.3.2.1.4 shall not apply

11.6.1.3  Spill Control, Drainage, and Containment.
Secondary containment shall be provided for ammonium nitrate liquids in accordance with 6.3.2.2.4.6.3.2.2.4.

11.6.2  Closed  Outdoor Use.

11.7  Open Systems.

11.6.2.1  Ventilation.
The requirements of 6.3.2.3.2 shall apply.

11.6.2.2  Explosion Control.
The requirements of 6.3.2.1.4 shall not apply.

11.7.1  Location.
Outdoor use and dispensing shall be located in accordance with 6.3.3.1.1.

11.6.7.1.2  Spill Control, Drainage, and Containment.
Spill control and secondary containment shall be provided for ammonium nitrate liquids in accordance with 6.3.2.3.6.3.3.2.2.

11.7.1  Outdoor Use.

11.7.1.1  Location.

11.6.7.1  Clearance from Combustibles. For outdoor use and dispensing, the requirements of 11.4.1 shall be located in accordance with 6.3.3.1.1.

11.7.1.2  Spill Control, Drainage, and Containment.
Spill control and secondary containment shall be provided for ammonium nitrate liquids in accordance with 6.3.3.2.2.

11.7.2. Closed Systems.

11.7.2.1. Location.
Outdoor use and dispensing shall be located in accordance with 6.3.3.1.1.

11.7.2.2. Spill Control, Drainage, and Containment.
Spill control and secondary containment shall be provided for ammonium nitrate liquids in accordance with 6.3.3.3.2.

11.8. Handling.

11.8.1. Handling.
Handling shall be in accordance with 6.3.4 and 11.8.1.6. 3.4 and 11.8.1.

11.8.1.1. Vehicles and Lift Trucks.

11.8.1.1.1.* Powered vehicles of any type shall not be stored or left unattended in a building storing ammonium nitrate. Vehicles shall not be refueled or recharged within 50 ft (15 m) of the ammonium nitrate storage.

11.8.1.1.2.* Powered vehicles used in ammonium nitrate storage facilities shall not be refueled within 50 feet of the facility.

11.8.1.1.3 Fork trucks, tractors, platform lift trucks, and other specialized industrial trucks used within the warehouse shall be maintained so that fuels or hydraulic fluids do not contaminate the ammonium nitrate.

11.8.1.2. Handling Equipment.

11.8.1.2.1* Hollow spaces in nitrate-handling equipment, where nitrate is able to collect and be confined under high pressure to become a source of explosion in the event of fire, shall be avoided.
Annex Chapter 11

A.11.1.1. Determine the classification of ammonium nitrate in accordance with Chapter 4 and then apply the appropriate MAQs in Chapter 5 tables 4. Chapter 11 will then take precedence to address the specific requirements for solid and liquid ammonium nitrate, if the MAQ when 1,000 pounds is exceeded. The classification or physical hazards of ammonium nitrate is dependent on the properties of the specific material or mixture of materials as a whole. When used as a fertilizer, it is common for ammonium nitrate to exist as a component of a chemical mixture. It is not uncommon for the user to describe the mixture as ammonium nitrate when in reality the mixture can contain components that contribute to altering the end classification of the material. The manufacturer’s safety data sheet (SDS) must be used to assess the overall hazards of these materials within the context of the classification scheme integral to Chapter 4. The user is cautioned that the DOT shipping classification for transportation purposes alone is not a sufficient means by which to determine the storage and use hazards of these materials. Ammonium nitrate in the undiluted or pure form has a higher degree of overall hazard than does ammonium nitrate when mixed or blended with compatible materials that can reduce the concentration. However, the materials with which it is blended cannot be inert materials, and the effects of the added components can only be determined by careful review of the SDS. The tables in Chapter 5 are hazard-specific; they are not “chemical-specific.” Ammonium nitrate as such is not included in the tables, because the actual hazard classification varies with the material under consideration. The question must be answered as to whether the material is an oxidizer, and if so what Class; whether it is an unstable reactive, and if so what Class; or whether there are other physical or health hazards attendant to the mixture under evaluation. (See Annex E for additional information).

A.11.1.1.5 Ammonium nitrate and ammonium nitrate–based materials that are DOT Hazard Class 1 sensitive explosive should be stored in accordance with the requirements of NFPA 495, Explosive Materials Code. Sensitivity is determined by the application of the UN Test Series 1 test, which includes testing to determine impact sensitivity, friction sensitivity, sensitivity to electrostatic discharge, and thermal stability.

A.11.1.3 Ammonium nitrate is capable of detonating with the blast effect of about half the quantity of explosives if heated under confinement that permits high-pressure buildup or if subjected to strong shocks, such as those from an explosive. The sensitivity of ammonium nitrate to detonation is increased by elevated temperatures or by contamination. (See Chapter 7.)

A.11.2.5.1.1 When determining whether greater quantities should be permitted without sprinkler protection, the AHJ should take into consideration proximity of the storage building to congested areas and the potential for presence of contaminants in the storage building.

A.11.2.10.2.2 It is recommended that electric or LP-Gas–powered trucks be employed, rather than gasoline- or diesel-powered trucks, to reduce the potential for contamination to ammonium nitrate.

A.11.2.10.4 See NFPA 780.

A.11.3.1.3.1.1

A.11.1.4.9.2 Agricultural application refers to the actual transporting and spreading of the fertilizers in fields. Storage in a building for eventual agricultural use is not an agricultural application.

A.11.1.4.9.2 This requirement is intended to prohibit floor drains, traps, tunnels, pits, or pockets into which any molten ammonium nitrate is able to flow and be confined in the event of fire.
A.11.1.4.9.3 The slope of the storage floor should be pitched in such a manner that it drains away from the ammonium nitrate pile and towards a containment area. As noted in other sections, no drainage pits, sumps or confined piping should be designed into this drainage plan.

A.11.1.5 Where a documented risk analysis demonstrates to the AHJ that an equivalent level of fire safety can be achieved using alternatives to the requirements of this section such an approach is an acceptable alternative. The risk analysis should be submitted to the AHJ in accordance with the requirements of Section 1.5.3. A risk analysis report should demonstrate equivalent fire safety by addressing relevant topics including but not limited to:

1. Location of the facility
2. Distance to exposed structures and population density of public areas and other areas associated with the ammonium nitrate facility.
3. Construction type
4. Storage configuration
5. Exposing combustible materials
6. Emergency response capability
7. Water supply
8. Ammonium Nitrate mixture, blends and use
9. Fire protection features provided (fire barriers, fire detection and alarm, etc.)

A.11.2.1 Sumps and collection systems as required by 6.2.1.9.2 create confinement conditions and should be avoided with molten ammonium nitrate which could be created in a fire.

A.11.2.3 Buildings intended for the storage of ammonium nitrate should have not less than 0.007 ft² of vent area for each square feet of ammonium nitrate storage area, unless mechanical ventilation is provided. Vent areas for exhaust and inlet air intake areas should not be less than 0.007 ft²/ft² of storage area. Buildings should be sufficiently ventilated to prevent the confinement of gases generated from the decomposition of ammonium nitrate. As stated in the Summary Report from the European Commission, Joint Research Center workshop on ammonium nitrate:

“Pure ammonium nitrate can undergo thermal decomposition if it receives enough energy. Gases are then emitted, especially nitrogen oxides and ammonia, both toxic. With adequate proper ventilation, the decomposition stops as soon as the energy flow stops. The decomposition rate is not dangerously high at moderate temperatures, and the overall thermal effect is not significant since the exothermic reactions are accompanied by endothermic disassociation, which can in turn give rise to a steady state reaction provided the gases produced can escape freely and the system is adiabatic. The decomposition is catalysed by a number of substances such as chlorides, which can affect the above balance.”

A.11.3.1.3.2 Bulk material refers to material that is in the unpackaged state.
A.11.3.1.3.3.2 Steel or wood

A.11.2.5.1 Foam, dry chemical or gaseous extinguishing systems are ineffective in controlling fires involving ammonium nitrate, an oxidizer that supplies its own oxygen. Steam is similarly ineffective and should not be used due to the addition of heat to the decomposing mass. Water cools the AN, reducing molten AN formation and decomposition.
Explosion control methods required by section 6.2.1.6 are not warranted for ammonium nitrate regulated by this chapter. Deflagration control methods described in NFPA 69 (primarily deflagration venting) are not effective for the detonations that can sometimes result from ammonium nitrate that is involved in a fire situation. In Chapter 11 the emphasis is on explosion prevention but using methods that will be effective on ammonium nitrate and not those required by NFPA 69 namely – combustible concentration reduction, oxidant concentration reduction, or deflagration control. The other requirements of Chapter 11 are intended to prevent ammonium nitrate explosions and are more effective than the requirements of 6.2.1.6 for this material. Ammonium nitrate that is formulated to be an explosive is regulated in accordance with NFPA 495 and not this chapter.

Provisions should be made to avoid the following conditions with ammonium nitrate:

1.) heating in a confined space
2.) localized heating potentially leading to development of high temperature areas
3.) exposure to strong shock waves
4.) contamination with combustible materials, incompatible inorganic and organic substances that can result in sensitivity to explosion.
5.) low pH or acidic conditions

A pre-incident best practices plan should be developed by the local fire department in conjunction with any facility that stores, uses or handles ammonium nitrate. NFPA 1620 can be used for further guidance.

A one mile public evacuation distance has been recommended in the rare event of a facility containing ammonium nitrate becoming involved in a fire. This evacuation distance is recommended since the exact conditions of a facility during the emergency may not be known to the emergency response personnel. Under these potentially unknown conditions a worst-case scenario is assumed to ensure the public is evacuated to a safe distance.

The unknowns include:

1. The condition of the AN involved in the fire. For example contamination from a material that can behave as a fuel could potentially lead to a more violent release of energy than uncontaminated AN.
2. Presence of a burning structure.
3. The quantity of ammonium nitrate involved in the fire.

Over pressure calculations alone are not adequate to determine evacuation distances and debris field modeling is necessary to help ensure public safety. The one mile distance is based on a quantitative risk analysis of a scenario that involves AN mixed with a fuel source and the presence of a burning structure. Quantities up to one million pounds of ammonium nitrate were used in the determination based on projectile travel distance.

The NFPA 704 Fire Protection Guide to Hazardous Materials, Hazardous Chemicals Data Compilation currently lists ammonium nitrate, under emergency conditions as Health=0, Flammability=0, Instability=3 and Other=OX (oxidizer). Safety Data Sheets that provide NFPA 704 ratings typically agree with all ratings except Health where ratings of 0, 1 or 2 are reported by different manufacturers. Because decomposition products include various nitrogen oxides (NOx) and nitric acid, the minimum health rating should be considered 1.

Housekeeping information can be found in Safety and Security Guidelines for the Storage and Transportation of Fertilizer Grade Ammonium Nitrate at Fertilizer Retail Facilities. Feb 2014, ARA and TFI
A.11.3.2.3.1 Wood impregnated with ammonium nitrate is a fire hazard. It can be ignited by a low energy source with a vigorous fire.

A.11.3.2.3.4 Metal bins can be protected by special coatings such as sodium silicate, epoxy coatings, or polyvinyl chloride (PVC) coatings.

A.11.3.2.3.5 Storage in aluminum transport vehicles is not recommended.

A.11.3.8.1

2.3.9 Bulk and bagged ammonium nitrate can become caked and degrade in storage. This is a factor affected by humidity and temperature in the storage space and by pelleted quality. Temperature cycles through 90°F (32°C) and high atmospheric humidity are undesirable for storage in depth.

A.11.4.3.3 Active loading or unloading of vehicles with ammonium nitrate from the hoppers/bins is not considered parking and is permitted. The vehicle operator should remain within 25 feet of the vehicle during loading or unloading operations. Immediately upon completion of the loading/unloading activity, the vehicle should be moved at least 30 feet away from the hopper/bins.

A.11.4.4 Many of the general principles for the storage of ammonium nitrate-based fertilizers apply equally to fertilizers stored in the open and those stored in a building. It is generally recommended that bagged ammonium nitrate fertilizers should not be stored in large piles outdoors.

It should be noted that repeated temperature cycles can cause physical deterioration of some products. Physical deterioration can result in the breakdown of the fertilizer particles and damage to packages. The product should be protected from direct sunlight. Due note should be taken of ground conditions when storing outdoors to avoid damage to the product. Outdoor storage areas should be protected against unauthorized access, for example, by means of a fence. Warnings against unauthorized entry should be posted.

A.11.5.6.1 Foam, dry chemical or gaseous extinguishing systems are ineffective in controlling fires involving ammonium nitrate, an oxidizer that supplies its own oxygen. Steam is similarly ineffective.

A.11.8.1.1.2 This includes battery powered vehicles and vehicles powered by internal combustion engines such as motor vehicles, lift trucks and cargo conveyors. It is recommended that electric or LP-Gas powered trucks be employed rather than gasoline, or diesel powered trucks, to reduce the potential for contamination to ammonium nitrate. Also see A.11.4.3.3.

A.11.8.1.2 Examples of hollow spaces include hollow conveyor rollers and hollow screw conveyor shafts.

Annex Chapter 11

A.11.1

Determine the classification of ammonium nitrate in accordance with Chapter 4. Chapter 11 takes precedence to address the specific requirements for solid and liquid ammonium nitrate, when 1,000 pounds is exceeded. The physical hazards of ammonium nitrate are dependent on the properties of the specific material or mixture of materials as a whole. When used as a fertilizer, it is common for ammonium nitrate to exist as a component of a chemical mixture. It is not uncommon for the user to describe the mixture as ammonium nitrate when in reality the mixture can contain components that contribute to altering the end classification of the material. The manufacturer’s safety data sheet (SDS) should be used to assess the overall hazards of these materials. The user is cautioned that the DOT shipping classification for transportation purposes alone is not a sufficient means by which to determine the storage and use hazards of these materials. Ammonium nitrate in the undiluted or pure form has a higher degree of overall hazard than does ammonium nitrate when mixed or blended with compatible materials that can reduce the concentration. The tables in Chapter 5 are hazard-specific; they are not chemical-specific. Ammonium nitrate as such is not included in the tables, because the actual hazard classification varies with the material under consideration. The question must be answered as to whether the material is an oxidizer, and, if so, what Class; whether it is an unstable reactive, and, if so, what Class; or whether there are other physical or health hazards attendant to the mixture under evaluation. (See Annex E for additional information.)

A.11.1.1

Ammonium nitrate and ammonium nitrate–based materials that are DOT Hazard Class 1 explosives should be stored in accordance with the requirements of NFPA 495, Explosive Materials Code. Sensitivity is determined by the application of the UN Test Series 1, which includes testing to determine impact sensitivity, friction sensitivity, sensitivity to electrostatic discharge, and thermal stability.

A.11.1.6

Agricultural application refers to the actual transporting and spreading of the fertilizers in fields. Storage in a building for eventual agricultural use is not an agricultural application.

A.11.1.4.9.2-1

This requirement is intended to prohibit floor drains, traps, tunnels, pits, or pockets into which any molten ammonium nitrate is able to flow and be confined in the event of fire.

A.11.1.4.9.3-2

The slope of the storage floor should be pitched in such a manner that it drains away from the ammonium nitrate pile and towards a containment area. As noted in other sections, no drainage pits, sumps, or confined piping should be designed into this drainage plan.

A.11.5

Where a documented risk analysis demonstrates to the AHJ that an equivalent level of fire safety can be achieved using alternatives to the requirements of this section, such an approach is an acceptable alternative. The risk analysis should be submitted to the AHJ in accordance with the requirements of Section.
1.5.3. A risk analysis report should demonstrate equivalent fire safety by addressing relevant topics, including, but not limited to, the following:

1. Location of the facility
2. Distance to exposed structures and population density of public areas and other areas associated with the ammonium nitrate facility.
3. Construction type
4. Storage configuration
5. Exposing combustible materials
6. Emergency response capability
7. Water supply
8. Ammonium Nitrate mixture, blends, and uses.
9. Fire protection features provided (fire barriers, fire detection and alarm, etc. and so on)

A.11.2.1

Sumps and collection systems as required by 6.2.1.9.2 create confinement conditions and should be avoided with molten ammonium nitrate, which could be created in a fire.

A.11.2.3

Buildings intended for the storage of ammonium nitrate should have not less than 0.007 ft² of vent area for each square foot of ammonium nitrate storage area, unless mechanical ventilation is provided. Vent areas for exhaust and inlet air intake areas should not be less than 0.007 ft³/ft² of storage area. Buildings should be sufficiently ventilated to prevent the confinement of gases generated from the decomposition of ammonium nitrate. As stated in the Summary Report from the European Commission, Joint Research Center workshop on ammonium nitrate:

“Pure ammonium nitrate can undergo thermal decomposition if it receives enough energy. Gases are then emitted, especially nitrogen oxides and ammonia, both toxic. With proper ventilation, the decomposition stops as soon as the energy flow stops. The decomposition rate is not dangerously high at moderate temperatures, and the overall thermal effect is not significant since the exothermic reactions are accompanied by endothermic disassociation, which can in turn give rise to a steady state reaction provided the gases produced can escape freely and the system is adiabatic. The decomposition is catalysed by a number of substances such as chlorides, which can affect the above balance.”

A.11.2.5.1

Foam, dry-chemical, or gaseous extinguishing systems are ineffective in controlling fires involving ammonium nitrate, an oxidizer that supplies its own oxygen. Steam is similarly ineffective and should not be used due to the addition of heat to the decomposing mass. Water cools the ammonium nitrate, reducing molten ammonium nitrate formation and decomposition.

A.11.2.9

Explosion control methods required by section 6.2.1.6 are not warranted for ammonium nitrate regulated by this chapter. Deflagration control methods described in NFPA 69 (primarily deflagration venting) are not effective for the detonations that can sometimes result from ammonium nitrate that is involved in a fire situation. In Chapter 11, the emphasis is on explosion prevention, but using methods that will be effective on ammonium...
A.11.2.14.1.1

Provisions should be made to avoid the following conditions with ammonium nitrate:

1. heating \(H\) in a confined space
2. localized \(L\) heating potentially leading to development of high-temperature areas
3. exposure \(E\) to strong shock waves
4. contamination \(C\) with combustible materials or incompatible inorganic and organic substances that can result in sensitivity to explosion
5. low \(P\) \(pH\) or acidic conditions

A.11.2.15

A pre-incident best practices plan should be developed by the local fire department in conjunction with any facility that stores, uses, or handles ammonium nitrate. NFPA 1620 can be used for further guidance.

A.11.2.15.1 A one-mile (1.6 km) public evacuation distance has been recommended in the rare event of a facility containing ammonium nitrate becoming involved in a fire. This evacuation distance is recommended since the exact conditions of a facility during the emergency may not be known to the emergency response personnel. Under these potentially unknown conditions a worst-case scenario is assumed to ensure the public is evacuated to a safe distance. These unknown conditions can include the following:

1. The condition of the ammonium nitrate involved in the fire. For example, contamination from a material that can behave as a fuel could potentially lead to a more violent release of energy than uncontaminated ammonium nitrate.
2. Presence of a burning structure.
3. The quantity of ammonium nitrate involved in the fire.

Over-pressure calculations alone are not adequate to determine evacuation distances and debris field modeling is necessary to help ensure public safety. The one-mile (1.6 km) distance is based on a quantitative risk analysis of a scenario that involves ammonium nitrate mixed with a fuel source and the presence of a burning structure. Quantities up to one million pounds (453,592 kg) of ammonium nitrate were used in the determination based on projectile travel distance.

A.11.2.16

The NFPA 704 Fire Protection Guide to Hazardous Materials, Hazardous Chemicals Data Compilation currently lists ammonium nitrate, under emergency conditions as Health = 0, Flammability = 0, Instability = 3, and Other = OX (oxidizer). Safety Data Sheets sheets that provide NFPA 704 ratings typically agree with all ratings except Health where ratings of 0, 1, or 2 are reported by different manufacturers. Because decomposition products include various nitrogen oxides (NOx) and nitric acid, the minimum health rating should be considered 1.
Housekeeping information can be found in Safety and Security Guidelines for the Storage and Transportation of Fertilizer Grade Ammonium Nitrate at Fertilizer Retail Facilities, Feb 2014, ARA and TFI

Chemical advisory: Safe Storage, Handling and Management of Ammonium Nitrate, August 2013

A.11.3.2.3.1
Wood impregnated with ammonium nitrate is a fire hazard. It can be ignited by a low-energy source with a vigorous fire.

A.11.3.2.3.4
Metal bins can be protected by special coatings such as sodium silicate, epoxy coatings, or polyvinyl chloride (PVC) coatings.

A.11.3.2.3.5
Storage in aluminum transport vehicles is not recommended.

A.11.3.2.3.9
Bulk and bagged ammonium nitrate can become caked and degrade in storage. This is a factor affected by humidity and temperature in the storage space and by prill quality. Temperature cycles through 90°F (32°C) and high atmospheric humidity are undesirable for storage in depth.

A.11.4.3.3
Active loading or unloading of vehicles with ammonium nitrate from the hoppers/bins is not considered parking and is permitted. The vehicle operator should remain within 25 feet of the vehicle during loading or unloading operations. Immediately upon completion of the loading/unloading activity, the vehicle should be moved at least 30 feet away from the hopper/bins.

A.11.4.4
Many of the general principles for the storage of ammonium nitrate–based fertilizers apply equally to fertilizers stored in the open and those stored in a building. It is generally recommended that bagged ammonium nitrate fertilizers should not be stored in large piles outdoors.

It should be noted that repeated temperature cycles can cause physical deterioration of some products. Physical deterioration can result in the breakdown of the fertilizer particles and damage to packages. The product should be protected from direct sunlight. Due note should be taken of ground conditions when storing outdoors to avoid damage to the product. Outdoor storage areas should be protected against unauthorized access, for example, by means of a fence. Warnings against unauthorized entry should be posted.

A.11.5.65.1
Foam, dry-chemical, or gaseous extinguishing systems are ineffective in controlling fires involving ammonium nitrate, an oxidizer that supplies its own oxygen. Steam is similarly ineffective.

A.11.8.1.1.1
This includes battery-powered vehicles and vehicles powered by internal combustion engines such as motor vehicles, lift trucks, and cargo conveyors. It is recommended that electric or LP-Gas-powered trucks be employed rather than gasoline or diesel to reduce the potential for contamination to ammonium nitrate. Also (See A.11.4.3.3.)

A.11.8.1.2

Examples of hollow spaces include hollow conveyor rollers and hollow screw conveyor shafts.
### Chapter 11  Ammonium Nitrate Solids and Liquids

#### 11.1  General.

See Also-also, Annex E.

#### 11.1.1  Scope.

The requirements of this chapter shall apply to the storage, use, and handling of solid and liquid ammonium nitrate in quantities greater than 1,000 lbs.

#### 11.1.1.1

The storage, use, and handling of ammonium nitrate shall comply with the requirements of Chapters 1 through and 4.

#### 11.1.1.2

Chapters 6 through 10 shall apply in this chapter unless otherwise indicated in this chapter.

#### 11.1.1.3

This chapter shall apply to 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.

#### 11.1.1.4

This chapter shall apply to liquid ammonium nitrate solutions containing 70% percent or more by weight of ammonium nitrate.

#### 11.1.1.5

This chapter shall not apply to liquid ammonium nitrate solutions used as fertilizers unless classified as a hazardous material by the U.S. Department of Transportation (DOT).

#### 11.1.1.6

This chapter shall not apply to ammonium nitrate and ammonium nitrate mixtures that are DOT Hazard Class 1 explosives.

#### 11.1.1.7

The agricultural application of ammonium nitrate and ammonium nitrate–based fertilizers in outdoor agricultural uses is not regulated by this code.

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Where Chapter 11 is applicable, Chapter 15 *Oxidizers* and Chapter 19 *Unstable Reactives* shall not apply.

### 11.1.2 Sources of Ignition.
Open flames and smoking shall be prohibited in buildings that store, use, and handle ammonium nitrate.

### 11.1.3 General Requirements for Storage
The quantity and arrangement limits in this chapter shall not apply to the transient storage of ammonium nitrate in process areas at plants where ammonium nitrate is manufactured.

### 11.1.4 Construction Requirements
Buildings, or portions thereof, in which ammonium nitrate is stored, used, or handled, or used shall be constructed in accordance with [the building code](#).

#### 11.1.4.1
Buildings used for the storage and handling of ammonium nitrate in bulk, bags, or other combustible containers shall be of non-combustible (Type I or II) construction.

#### 11.1.4.2
Bins or compartments used for the storage of bulk ammonium nitrate shall be constructed of non-combustible materials that are compatible with ammonium nitrate. *(See 11.3.2.3.2.)*

#### 11.1.4.3
Storage buildings shall not have basements unless the basements are open on at least one side.

##### 11.1.4.3.1
Buildings over one story in height shall not be used for storage, unless approved for such use.

##### 11.1.4.4
The exterior wall on the exposed side of a storage building within 50 ft (15.2 m) of a combustible building, a forest, piles of combustible materials, and/or exposure hazards by ordinary combustible materials shall be a fire barrier wall with a minimum fire resistance rating of 2 hours in accordance with [the building code](#).

##### 11.1.4.5
In lieu of the fire barrier wall specified in 11.1.4.4, a means of exposure protection, such as a freestanding fire barrier wall, shall be permitted to be used when approved by the AHJ.

##### 11.1.4.6
Buildings and structures shall be dry and free from water intrusion through the roof, walls, and floors.

##### 11.1.4.7
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Any heating source, including electric lamps, shall be located or guarded so as to preclude contact with bags or other combustible materials.

11.1.4.8
Bulk storage structures shall not exceed a height of 40 ft (12.2 m).

11.1.4.8.1
Where bulk storage structures are constructed of noncombustible material or facilities for fighting a roof fire are provided, the height of the storage building shall only—be limited by the building construction type as specified in the building code adopted by the jurisdiction.

11.1.4.9 Floors

Floors shall be in accordance with 6.2.1.10.

11.1.4.9.1
All flooring in storage and handling areas shall be without open drains, traps, tunnels, pits, or pockets.

11.1.4.9.2
The non-combustible floor of the ammonium nitrate storage shall be sloped in a manner that promotes a positive drainage of liquids, whether water or molten material in the case of a fire.

11.1.4.9.3
The floor shall be at least a 14% percent slope (1/8 inch-in for every linear foot of floor) to obtain this positive drainage.

11.1.4.9.4
Floors where ammonium nitrate solids or liquids are dispensed or used in open systems shall be in accordance with 6.3.2.2.3.

11.1.5 Protection of Existing Buildings.

The requirements in 11.1.5.1–through 11.1.5.4 shall apply retroactively to existing buildings of Type III, IV, or V construction or buildings with combustible content.

11.1.5.1 Automatic Sprinklers.

An automatic fire sprinkler system shall be provided in accordance with NFPA 13 for a minimum Extra Hazard (Group 1).

11.1.5.2 Alarms.

11.1.5.2.1 Fire Detection Systems.
Buildings shall be equipped throughout with an approved fire detection system, including, but not limited to, a smoke or heat detection system. Such a system shall be supervised in accordance with Section 6.2.1.11.

11.1.5.2.2 Audible or Visual Alarm.

Any activation of the fire detection system shall also automatically initiate activation of a local audible and visual alarm system to notify occupants.

11.1.5.3 Public Notification/Alert System.

An approved public notification/alert system capable of immediately notifying individuals located within 1 mile of the facility of the need to evacuate shall be provided.

11.1.5.4 Monitoring/Supervision.

Supervision shall be provided for the alarm, detection, and automatic fire extinguishing system in accordance with 6.2.1.11.

11.2 General Requirements for Storage.

11.2.1* Spill Control.

Spill control for ammonium nitrate solids shall be in accordance with 11.2.1.1 and 11.2.1.2 and not 6.2.1.9.2.

11.2.1.1

If the contents of broken bags are uncontaminated, they shall be permitted to be salvaged by placing the damaged bag inside a clean, new slipover bag and closing it to prevent the discharge of contents.

11.2.1.2

Other spilled materials and discarded containers shall be gathered for disposal under the facility operating procedures for hazardous waste.

11.2.2 Drainage and Secondary Containment.

11.2.2.1

Drainage and secondary containment shall be provided for ammonium nitrate in accordance with 6.2.1.9.3.4(4).

11.2.3* Ventilation.

The requirements of 6.2.1.5 shall apply.

11.2.4 Treatment Systems.

Treatment systems are not required for ammonium nitrate.

11.2.5 Fire Protection Systems.

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An automatic fire sprinkler system shall be provided in accordance with NFPA 13 for a minimum Extra Hazard (Group 1).

11.2.5.1* Alternative automatic fire extinguishing systems using foam, dry-chemical or gaseous agents, or steam extinguishing systems shall not be allowed. Only water-based suppression systems shall be permitted.

11.2.6 Fire Detection Systems.

Buildings shall be equipped throughout with an approved fire detection system, including, but not limited to, a smoke or heat detection system. Such a system shall be supervised in accordance with Section 6.2.1.11.

11.2.6.1 Any activation of the fire detection system shall also automatically initiate activation of a local audible and visual alarm system to notify occupants.

11.2.7* Extinguishing Devices.

11.2.7.1 Portable extinguishers shall be provided throughout the storage, use, and handling areas in accordance with the fire prevention code adopted by the jurisdiction and NFPA 10.

11.2.7.1.1 Only water-based portable fire extinguishers shall be used on incipient fires involving ammonium nitrate.

11.2.7.1.2 All other types of extinguishers except dry-chemical extinguishers per 11.2.7.1.3 shall be prohibited from the ammonium nitrate building.

11.2.7.1.3 Where required by NFPA 10 for protection of combustibles, dry-chemical extinguishers shall be permitted for use on incipient fires that do not involve ammonium nitrate.

11.2.8 Fire Protection Water Supplies.

11.2.8.1 Water supplies shall be provided for the protection of the ammonium nitrate storage by hose streams and automatic sprinklers in accordance with the fire code adopted by the AHJ.

11.2.8.2 The duration of the water supply shall be a minimum of 2 hours.

11.2.9* Explosion Control.

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The requirements of 6.2.1.6 shall not apply.

11.2.10 Emergency and Standby Power.

Standby power shall be provided when required by 6.2.1.8.

11.2.11 Limit Controls.

Limit controls, when required, shall be in accordance with 6.2.1.7.

11.2.12 Alarms.

11.2.12.1

A fire alarm system shall be provided to monitor the fire sprinkler system and provide notification in accordance with 6.2.1.1.3 NFPA 72 and 6.2.1.1.3 NFPA 72.

11.2.12.2 Public Notification/Alert System.

Facilities storing ammonium nitrate that can detonate when exposed to fire conditions in quantities in excess of 1000 pounds shall comply with Section 11.2.12.2.1 and 11.2.12.2.2.

11.2.13 Monitoring/Supervision.

Supervision shall be provided for the alarm, detection, and automatic fire extinguishing system in accordance with 6.2.1.11.

11.2.14 Special Requirements.

11.2.14.1 Separation.

11.2.14.1.1 Ammonium nitrate shall be isolated in a separate room by fire barrier walls constructed of concrete block having a minimum fire resistance rating of one hour and extending from the floor to the underside of the roof above or located in a separate building from the storage of any of the following:

1. Organic chemicals, acids, or other corrosive materials
2. Compressed flammable gases
3. Pyrophoric materials
4. Combustible materials
5. Flammable and combustible liquids.
6. Other contaminating substances, including the following:
   1. Wood chips
   2. Organic materials
(c) Chlorides
(d) Phosphorus
(e) Finely divided metals
(f) Charcoals
(g) Diesel fuels and oils
(h) Animal fats
(i) Baled cotton
(j) Baled rags
(k) Baled scrap paper
(l) Bleaching powder
(m) Burlap or cotton bags
(n) Caustic soda
(o) Coal
(p) Coke
(q) Charcoal
(r) Cork
(s) Camphor
(t) Excelsior
(u) Fibers of any kind
(v) Fish oils
(w) Fish meal
(x) Foam rubber
(y) Hay
(z) Lubricating oil
(aa) Linseed oil or other oxidizable or drying oils
(bb) Naphthalene
(cc) Oakum
(dd) Oiled clothing
(ee) Oiled paper
(ff) Oiled textiles
(gg) Paint
(hh) Straw
(ii) Sawdust
(jj) Wood shavings
(kk) Vegetable oil

11.2.14.2 Prohibited Articles.

11.2.14.2.1
Sulfur, materials that require blasting during processing or handling, and finely divided metals shall not be stored in the same building with ammonium nitrate, unless such storage conforms to NFPA 495.

11.2.14.2.2
Explosives and blasting agents shall not be stored in the same building with ammonium nitrate, unless otherwise permitted by NFPA 495.

11.2.14.2.3
Explosives and blasting agents shall be permitted to be stored in the same building with ammonium nitrate on the premises of makers, distributors, and users/compounders of explosives or blasting agents.

11.2.14.2.4
Where explosives or blasting agents are stored in separate buildings, other than on the premises of makers, distributors, and users/compounders of explosives or blasting agents, they shall be separated from the ammonium nitrate by the distances or barricades specified in NFPA 495.

11.2.14.2.5
Storage or operations on the premises of makers, distributors, and users/compounders of explosives or blasting agents shall conform to NFPA 495.

11.2.14.3 Lightning.

In areas where lightning storms are prevalent, lightning protection shall be provided in accordance with NFPA 780.

11.2.14.4 Security (Control of Access).
Provisions shall be made to prevent unauthorized personnel from entering the ammonium nitrate storage area.

11.2.15* Emergency Planning

11.2.15.1 Emergency Action Plans

Emergency Action Plans for facilities that store, use, or handle ammonium nitrate shall comply with the requirements of Chapter 7, and comply with the requirements of 11.2.15.1.1 through 11.2.15.31.4.

11.2.15.2

The emergency action plan shall clearly state that fires potentially affecting ammonium nitrate storage beyond the initial (incipient) stage shall not be approached by facility personnel.

11.2.15.2.1

The emergency action plan shall state whether the ammonium nitrate storage building has an automatic sprinkler system and if the building storing ammonium nitrate is of combustible construction.

11.2.15.2.4

The emergency action plan shall be approved by the AHJ and updated and re-approved at least annually or when conditions change and at least annually.

11.2.16* Signage

In addition to the NFPA 704 placards required in 6.1.8.2.1, signs shall be conspicuously posted on the ammonium nitrate storage building stating: DO NOT FIGHT FIRE. EXPLOSION HAZARD. The sign shall be visible from 100 feet (30 m) away and shall have 6 inch (15 cm) red block lettering on a white reflective background.

11.3 Indoor Storage

11.3.1 Housekeeping

Storage shall be arranged to facilitate manual access and handling, to maintain pile stability, to minimize breakage and spillage, and to promote good housekeeping.

11.3.1.1

All personnel that handle ammonium nitrate shall be trained on the general safety, regulatory controls, and industry standards on how to safely store, use, and handle ammonium nitrate.

11.3.1.2*

Good housekeeping shall be maintained at all times where ammonium nitrate is stored, used, or handled or stored and the following housekeeping rules shall be followed:

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Floors and storage areas shall be free of any clutter and debris.
All spills shall be contained and properly disposed of immediately.
Any damaged container and/or waste shall be immediately and properly removed from the area to a safe location.
Policy, procedures, and practice shall be in place to ensure separation of incompatible materials is maintained at all times.
Storage of combustibles shall be prohibited in or around ammonium nitrate storage areas.

11.3.2 Storage Conditions/Arrangement.

Storage arrangement shall be in accordance with 11.3.2.1 through 11.3.2.3.

11.3.2.1 Containers.

Bags and containers used for ammonium nitrate shall comply with the specifications and standards established by the U.S. Department of Transportation (DOT).

11.3.2.2 Piles of Bags, Drums, or Other Containers.

11.3.2.2.1 Solid ammonium nitrate shall not be placed into containers where the temperature of the ammonium nitrate exceeds 140°F (60°C).

11.3.2.2.2 Bags of ammonium nitrate shall not be stored within 30 in. (762 mm) of the walls and partitions of the storage building.

11.3.2.2.3 Piles shall comply with the following dimensions:

1. The height of piles shall not exceed 20 ft (6.1 m).
2. The width of piles shall not exceed 20 ft (6.1 m).
3. The length of piles shall not exceed 50 ft (15.2 m), unless otherwise permitted by 11.3.2.2.3(4).
4. Where the building is of noncombustible construction, or is protected by automatic sprinklers, the length of piles shall not be limited.

11.3.2.2.4
In no case shall the ammonium nitrate be stacked closer than 3 ft (0.9 m) below the roof or its supporting overhead structure.

11.3.2.2.5

Aisles shall be provided to separate piles by a clear space of not less than 3 ft (0.9 m) in width, with at least one service or main aisle in the storage area not less than 4 ft (1.2 m) in width.

11.3.2.3 Piles and Compartments for Bulk Solid Storage.

11.3.2.3.1*

Bins shall be of non-combustible construction.

11.3.2.3.2

Bins shall be clean and free of materials that can contaminate ammonium nitrate.

11.3.2.3.3

Bins shall be designed so that in the event of an external fire or self-accelerated decomposition, molten ammonium nitrate can flow away from the storage area to an open, unconfined area free from contamination with incompatible materials. (*See 11.2.14.1.1 for a list of incompatibles.*)

11.3.2.3.4*

Due to the corrosive and reactive properties of ammonium nitrate, and to avoid contamination, galvanized iron, copper, alloys of copper, lead, and zinc shall not be used in bin construction, except where such bins are protected against contact with the ammonium nitrate.

11.3.2.3.5*

Uncoated aluminum bins shall not be permitted.

11.3.2.3.6

The warehouse shall be permitted to be subdivided into any desired number of ammonium nitrate storage compartments or bins provided the design does not allow molten ammonium nitrate to accumulate in the storage area and become confined.

11.3.2.3.7

The ammonium nitrate storage bins or piles shall be clearly identified by signs reading AMMONIUM NITRATE with letters at least 2 in. (50.8 mm) high.
11.3.2.3.8

Piles or bins shall be sized and arranged so that all material is accessible to a mechanical means to minimize caking of the stored ammonium nitrate.

11.3.2.3.9*

The height or depth of piles shall be limited by the caking tendency of the product; however, in no case shall the ammonium nitrate be piled higher at any point than 3 ft (0.9 m) below the roof or its supporting and overhead structure.

11.3.2.3.10

Ammonium nitrate shall not be placed into storage when the temperature of the product exceeds 140°F (60°C).

11.3.2.3.11

Explosives and blasting agents shall not be used to break up or loosen caked ammonium nitrate.

11.3.3 Detached Storage.

The requirements of 6.2.3.4 shall apply.

11.4 Outdoor Storage.

11.4.1 Clearance from Combustibles.

11.4.1.1

Outdoor storage and use areas and the area surrounding shall be kept clear of weeds, debris, and common combustible materials not necessary to the storage or use of hazardous materials for a minimum distance of 30 ft (9.0 m).

11.4.1.2

Outdoor storage and use areas for ammonium nitrate shall be located not closer than 30 ft (9 m) from a property line that can be built upon, a street, an alley, or a public way, except that a 2 hour fire barrier wall, without openings and extending no less than 30 in. (762 mm) above and to the sides of the storage area, shall be permitted in lieu of such distance.

11.4.2 Weather Protection.

When provided, weather protection shall be in accordance with 6.2.7.2.

11.4.3 Outdoor Storage in Enclosed Hoppers or Bins.

In addition to the other requirements of 11.4, this section applies to outdoor storage of ammonium nitrate in quantities exceeding 1000 lb (453 kg).

Commented [BM48]: Change to ‘hazardous’?
Commented [PN49R48]: Yes

Commented [PN50]: 453 kg
11.4.3.1
All hoppers and bins in which bulk ammonium nitrate is stored shall be constructed of non-combustible materials.

11.4.3.2
Enclosed hoppers or bins shall be provided with a venting device to enable the discharge of gases generated in the event of a fire.

11.4.3.3*
Parking of any vehicles or industrial trucks shall be prohibited within 30 ft. (9.1 m) of the hoppers/bins.

11.4.4* Special Requirements — Outdoor Storage.

11.5 General Requirements for Use.

11.5.1 Spill Control.
Spill control shall be provided for ammonium nitrate liquids in accordance with 11.2.1.

11.5.1.1
Spilled ammonium nitrate, and leaking or broken containers shall be removed immediately by a competent individual to a safe, secure, dry outside area or to a location designated by the competent individual to await disposal, in conformance with applicable regulations.

11.5.2 Drainage.

11.5.2.1
Drainage shall be provided for ammonium nitrate liquids in accordance with 6.3.1.4.2.10.

11.5.2.2
For ammonium nitrate solids, the requirements of 6.3.1.4.2.10 shall not apply.

11.5.3 Secondary Containment.

11.5.3.1
Secondary containment shall be provided for ammonium nitrate solids or liquids in accordance with 6.3.1.4.2.

11.5.3.2
For ammonium nitrate solids, the requirements of 6.3.1.4.2 shall not apply.

11.5.4 Ventilation.
The requirements of 6.3.2.1.3 shall apply.
11.5.65 Fire Protection Systems.

An automatic fire sprinkler system shall be provided in accordance with 11.2.6.

11.5.65.1* Alternative automatic fire extinguishing systems using foam, dry chemical or gaseous agents, or steam extinguishing systems shall not be allowed. Only water-based suppression systems shall be permitted.

11.5.65.2 Portable extinguishers shall be provided in accordance with 11.2.8.

11.5.76 Explosion Control.

The requirements of 6.3.2.1.4 shall not apply.

11.5.87 Emergency and Standby Power.

The requirements of 6.3.2.1.3.3 shall apply.

11.5.98 Limit Controls.

Limit controls shall be provided in accordance with 6.3.1.2.

11.5.10-11.5.9 Alarms.

Alarms shall be provided in accordance with 11.2.13.

11.5.110 Monitoring/Supervision.

Supervision shall be provided in accordance with 6.3.1.8.

11.5.121 System Design.

System design shall be in accordance with 6.3.1.6.

11.5.132 Liquid Transfer.

Liquid transfer shall be in accordance with 6.3.1.7.

11.6 Indoor Use.

11.6.1 Open Systems.

11.6.1.1 Ventilation.

The requirements of 6.3.2.1.3 shall apply.

11.6.1.2 Explosion Control.

The requirements of 6.3.2.1.4 shall not apply.

11.6.1.3 Spill Control, Drainage, and Containment.

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Secondary containment shall be provided for ammonium nitrate liquids in accordance with 6.3.2.2.4.

11.7 Outdoor Use.

11.7.1 Open Systems.

11.7.1.1 Location.
Outdoor use and dispensing shall be located in accordance with 6.3.3.1.1.

11.7.1.2 Spill Control, Drainage, and Containment.
Spill control and secondary containment shall be provided for ammonium nitrate liquids in accordance with 6.3.3.2.2.

11.7.1.3 Clearance from Combustibles.
For outdoor use the requirements of 11.4.1 shall apply.

11.8 Handling.

11.8.1 Handling.
Handling shall be in accordance with 6.3.4 and 11.8.1.

11.8.1.1 Vehicles and Lift Trucks.

11.8.1.1.1 Powered vehicles of any type shall not be stored or left unattended in a building storing ammonium nitrate.

11.8.1.2
Powered vehicles used in ammonium nitrate storage facilities shall not be refueled within 50 feet (15 m) of the facility.

11.8.1.3 Fork trucks, tractors, platform lift trucks, and other specialized industrial trucks used within the warehouse shall be maintained so that fuels or hydraulic fluids do not contaminate the ammonium nitrate.

11.8.1.2 Handling Equipment.
Hollow spaces in nitrate-handling equipment, where nitrate is able to collect and be confined to become a source of explosion in the event of fire, shall be avoided.
### 15.2.10 Detection Systems

15.2.10.1 A fire detection system shall be provided in accordance with Section 6.2 and 15.3.1 in indoor storage areas for liquid and solid oxidizers.

15.2.10.2 A fire detection system shall not be required for detached storage buildings protected by an automatic sprinkler system.

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**Submitter Information Verification**

- **Submitter Full Name:** [Not Specified]
- **Organization:** [Not Specified]
- **Street Address:**
- **City:**
- **State:**
- **Zip:**
- **Submittal Date:** Thu Aug 07 10:34:06 EDT 2014

**Committee Statement**

- **Committee Statement:**

  In the public input stage section 15.2.10 was deleted. It was previously listed as "Reserved". Instead of deleting this section a requirement for automatic fire detection should be added. Oxidizers can cause the growth phase of a fire to be greatly accelerated (shorter) than fires involving ordinary combustibles. For this reason, there is increased urgency associated with providing notification to building occupants of a need to evacuate the building faster than with ordinary combustible fires. For this reason, fire detection is warranted for both storage and use areas with ≥MAQ quantities of oxidizer solids and liquids. The term "fire detection systems" is more generic (includes heat, smoke, rate of rise, beam detectors etc.) than smoke detector and provides latitude for the designer to develop an appropriate form of fire detection based on specific of a given installation (corrosive, cold, non-smooth ceiling etc.). The definition of "fire detection systems" from NFPA 72 is provided for convenience below:

  2010 NFPA 72: 3.3.59.2 Automatic Fire Detector. A device designed to detect the presence of a fire signature and to initiate action.

  For the purpose of this Code, automatic fire detectors are classified as follows: Automatic Fire Extinguishing or Suppression System Operation Detector, Fire-Gas Detector, Heat Detector, Other Fire Detectors, Radiant Energy Sensing Fire Detector, Smoke Detector. (SIG-IDS)

  The exception for sprinklered detached storage is warranted because these facilities are dedicated ONLY to storage of the HAZMAT requiring detached storage (oxidizers in this case). As a result, there are no separated occupancies allowed (such as business, industrial etc.) so a strong argument can be made that all occupants of a detached storage buildings can reasonable be expected to self notify and evacuate prior to conditions becoming untenable. For sprinklered detached storage buildings - fire detection is therefore not warranted.

  These changes have the additional benefit of correlating NFPA 400 with the IFC.

**Response Message:** Public Comment No. 2-NFPA 400-2014 [New Section after 15.2.9]
15.3.1 Detection Systems.

15.3.1.1 A fire detection system shall be provided in indoor storage areas for liquid and solid oxidizers.

15.3.1.2 A fire detection system shall not be required for detached storage buildings protected by an automatic sprinkler system.

Committee Statement:

In the public input stage section 15.3.1 was deleted. It was previously listed as "Reserved". Instead of deleting this section a requirement for automatic fire detection should be added. Oxidizers can cause the growth phase of a fire to be greatly accelerated (shorter) than fires involving ordinary combustibles. For this reason, there is increased urgency associated with providing notification to building occupants of a need to evacuate the building faster than with ordinary combustible fires. For this reason, fire detection is warranted for both storage and use areas with >MAQ quantities of oxidizer solids and liquids. The term "fire detection systems" is more generic (includes heat, smoke, rate of rise, beam, detectors etc.) than smoke detector and provides latitude for the designer to develop an appropriate form of fire detection based on specific of a given installation. (corrosive, cold, non-smooth ceiling etc.) The definition of "fire detection systems" from NFPA 72 is provided for convenience below:

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These changes have the additional benefit of correlating NFPA 400 with the IFC.
For protection-level storage or detached storage, no minimum separation distance shall be required between oxidizer storage of less than 2300 lb (1043 kg) (total weight in the storage area) and any wall.

Committee Statement
In first draft Table 5.2.1.13.3(a) was changed from 1150 pounds to 1350 pounds to reflect one-pallet load of Class 3 oxidizer product thus 2300 pounds needs to be changed to 2700 pounds to reflect two pallet loads of product, which is the intent of the code.
15.3.2.4.13.1 Class 3 Oxidizers Less than 2300 lb (1043 kg)

(A) Sprinkler design criteria for buildings that require sprinkler protection and contain total quantities of Class 3 oxidizers less than 2300 lb (1043 kg) shall be in accordance with the requirements of 15.3.2.4.13.1(B)

(B) Facilities that require sprinkler protection and contain total quantities of Class 3 oxidizers greater than 200 lb (91 kg), but less than 2300 lb (1043 kg), shall follow the sprinkler design criteria in Table 15.3.2.4.13.1(B)

Table 15.3.2.4.13.1(B) Sprinkler Protection of Class 3 Oxidizers Stored in Total Quantities Greater than 200 lb (91 kg) but Less than 2300 lb (1043 kg)

<table>
<thead>
<tr>
<th>Storage Parameters</th>
<th>Shelf</th>
<th>Bulk or Pile</th>
<th>Bulk or Pile</th>
<th>Rack</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum storage height</td>
<td>6 ft (1.8 m)</td>
<td>5 ft (1.5 m)</td>
<td>10 ft (3 m)</td>
<td>10 ft (3 m)</td>
</tr>
<tr>
<td>Maximum ceiling height</td>
<td>25 ft (7.6 m)</td>
<td>25 ft (7.6 m)</td>
<td>25 ft (7.6 m)</td>
<td>NA</td>
</tr>
<tr>
<td>Aisles — pile separation</td>
<td>4 ft (1.2 m) min. clear aisles</td>
<td>4 ft (1.2 m) min. clear aisles</td>
<td>8 ft (2.4 m) min. clear aisles</td>
<td>8 ft (2.4 m) min. clear aisles</td>
</tr>
<tr>
<td>Ceiling design criteria</td>
<td>0.45 gpm/ft²/2000 ft²</td>
<td>0.35 gpm/ft²/5000 ft² or 0.6 gpm/2000 ft²</td>
<td>0.65 gpm/ft²/5000 ft² or 0.6 gpm/2000 ft²</td>
<td>0.35 gpm/ft²/5000 ft² or 0.6 gpm/2000 ft²</td>
</tr>
<tr>
<td>In-rack sprinklers</td>
<td>NP</td>
<td>NP</td>
<td>NA</td>
<td>See 15.3.2.4.12.2.</td>
</tr>
<tr>
<td>Hose stream demand</td>
<td>500 gpm</td>
<td>500 gpm</td>
<td>500 gpm</td>
<td>500 gpm</td>
</tr>
<tr>
<td>Duration</td>
<td>120 minutes</td>
<td>120 minutes</td>
<td>120 minutes</td>
<td>120 minutes</td>
</tr>
</tbody>
</table>

For SI units, 1 gal = 3.79 L. NA: Not applicable. NP: Not permitted.
### Second Revision No. 148-NFPA 400-2014 [Section No. 15.3.1.4.13.4]

**15.3.2.4.13.4** Class 3 Oxidizers Greater than or Equal to 2300 lb (1043 kg). 

**A**
Facilities containing total quantities of Class 3 oxidizers equal to or greater than the threshold limits of 2300 lb (1043 kg) shall be protected in accordance with the requirements of **15.3.2.4.13.5(B)**.

**B**
The sprinkler protection required by **15.3.2.4.13.4** shall be in accordance with Table **15.3.2.4.13.4(B)**.

### Table 15.3.2.4.13.4(B)

<table>
<thead>
<tr>
<th>Storage Parameters</th>
<th>Bulk or Pile</th>
<th>Bulk or Pile</th>
<th>Rack</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum storage height</td>
<td>5 ft (1.5 m)</td>
<td>10 ft (3 m)</td>
<td>10 ft (3 m)</td>
</tr>
<tr>
<td>Maximum ceiling height</td>
<td>25 ft (7.6 m)</td>
<td>25 ft (7.6 m)</td>
<td>NA</td>
</tr>
<tr>
<td>Aisles — pile separation</td>
<td>8 ft (2.4 m) min. clear aisles</td>
<td>8 ft (2.4 m) min. clear aisles</td>
<td>8 ft (2.4 m) min. clear aisles</td>
</tr>
<tr>
<td>Ceiling design criteria</td>
<td>0.35 gpm/ft²/5000 ft² (1.32 L/min/m²/464.5 m²)</td>
<td>0.65 gpm/ft²/5000 ft² (5.3 L/min/m²/1000 m²)</td>
<td>Predominant for other commodities but not less than ordinary hazard Group II</td>
</tr>
<tr>
<td>In-rack sprinklers</td>
<td>NP</td>
<td>NP</td>
<td>See 15.3.2.4.13.5(K)</td>
</tr>
<tr>
<td>Hose stream demand</td>
<td>500 gpm (1893 L/min)</td>
<td>500 gpm (1893 L/min)</td>
<td>500 gpm (1893 L/min)</td>
</tr>
<tr>
<td>Duration</td>
<td>120 minutes</td>
<td>120 minutes</td>
<td>120 minutes</td>
</tr>
</tbody>
</table>

NA: Not applicable.  
NP: Not permitted.

### Committe Statement

**Committee Statement:** In the First Draft, Table 5.2.1.13.3(a) was changed from 1150 pounds to 1350 pounds to reflect one-pallet load of Class 3 oxidizer product thus 2300 pounds needs to be changed to 2700 pounds to reflect two pallet loads of product, which is the intent of the code.  

Because of re-ordering the list under 15.3.2.4.13.5 the reference in the Rack column of the In-rack sprinkler row needs to be changed from "K" to "L"
15.3.2.4.13.5 Special In-Rack Sprinkler Protection for Class 3 Oxidizers Stored in Total Quantities Greater Than or Equal to 2700 lb (1225 kg).

Where required by Table 15.3.2.4.13.4(B), special in-rack sprinkler protection, which is required by 15.3.1.4.13.5(B) and 15.3.1.4.13.5(L), shall be as shown in Figure 15.3.2.4.13.5(A).

Figure 15.3.2.4.13.5(A) Arrangement of Barriers and In-Rack Sprinklers for Special Fire Protection Provisions.

(B) Racks shall be arranged in accordance with 15.3.2.4.13.5(C) and 15.3.2.4.13.5(L) through 15.3.2.4.13.5(T).
(C) Racks shall be of steel construction.
(D) Racks shall have vertical supports spaced no more than 10 ft (3.1 m) apart.
(E) Horizontal rack members shall be spaced no more than 6 ft (1.8 m) apart vertically.
(F) Display or storage shall be limited in height to two protected tiers.
(G) Horizontal barriers constructed of plywood at least \(\frac{3}{8}\) in. (9.5 mm) thick shall be provided above each level of oxidizing material storage, and the following criteria also shall be met:
(1) The barriers shall extend from rack face to rack face and shall be tight to the vertical barriers described in 15.3.2.4.13.5(H) and 15.3.2.4.13.5(I).
(2) The barriers shall be supported by horizontal rack members.
(H) Transverse vertical barriers constructed of plywood at least \(\frac{3}{8}\) in. (9.5 mm) thick shall be provided at the rack uprights extending from rack face to rack face.
(I) For double-row racks, longitudinal vertical barriers constructed of plywood at least \(\frac{3}{8}\) in. (9.5 mm) thick shall be provided at the rack uprights in the center of the rack.
(J) If intermediate shelves are used between the horizontal barriers, the shelves shall be constructed of open wire mesh or steel grating.
(K) Pallets, if used, shall be of the solid-deck type.
(L) In-rack automatic sprinklers shall be provided under each horizontal barrier and arranged in accordance with 15.3.2.4.13.5(M) through 15.3.2.4.13.5(T).
(M) For double-row racks, two lines of in-rack sprinklers shall be provided between the face of the rack and the longitudinal vertical barrier located in the center of the rack.
(N) For single-row racks, two lines of in-rack sprinklers shall be provided between each rack face.
Three in-rack sprinklers shall be provided on each in-rack sprinkler line as follows:

1. Two sprinklers on each line shall be spaced approximately 1 1/2 in. (38.1 mm) from each transverse vertical barrier.
2. One in-rack sprinkler on each in-rack sprinkler line shall be located approximately equidistant between the transverse vertical barriers.

In-rack sprinklers shall be of the upright or pendent type, with the fusible element located no more than 6 in. (152.4 mm) from the horizontal barrier.

The stock shall be maintained at least 6 in. (152.4 mm) below the sprinkler deflector.

In-rack sprinklers shall be K = 8.0, quick-response, ordinary-temperature-rated sprinklers.

The in-rack sprinkler system shall be designed to supply 6 sprinklers on each line, with a total of 12 sprinklers operating at gauge pressure of 25 psi (172 kPa).

The design of the in-rack sprinkler system shall be independent of, and shall not be required to be balanced with, ceiling sprinkler systems.
Facilities that require sprinkler protection having total quantities of Class 3 oxidizers greater than 200 lb (91 kg), but less than 2300 lb (1043 kg), shall comply with 15.3.2.4.13.1(B).

Submitter Information Verification

Submitter Full Name: [Not Specified]
Organization: [Not Specified]
Street Address: [Not Specified]
City: [Not Specified]
State: [Not Specified]
Zip: [Not Specified]
Submittal Date: Fri Aug 29 07:46:56 EDT 2014

Committee Statement

Committee Statement: In first draft Table 5.2.1.13.3(a) was changed from 1150 pounds to 1350 pounds to reflect one-pallet load of Class 3 oxidizer product thus 2300 pounds needs to be changed to 2700 pounds to reflect two pallet loads of product, which is the intent of the code.
### Committee Statement

Committee Statement:

In the public input stage section 15.5.10 was deleted. It was previously listed as "Reserved". Instead of deleting this section a requirement for automatic fire detection should be added. Oxidizers can cause the growth phase of a fire to be greatly accelerated (shorter) than fires involving ordinary combustibles. For this reason, there is increased urgency associated with providing notification to building occupants of a need to evacuate the building faster than with ordinary combustible fires. For this reason, fire detection is warranted for both storage and use areas with >MAQ quantities of oxidizer solids and liquids. The term "fire detection systems" is more generic (includes heat, smoke, rate of rise, beam, detectors etc.) than smoke detector and provides latitude for the designer to develop an appropriate form of fire detection based on specific of a given installation. (corrosive, cold, non-smooth ceiling etc.)

The definition of "fire detection systems" from NFPA 72 is provided for convenience below: 2010 NFPA 72: 3.3.59.2 Automatic Fire Detector. A device designed to detect the presence of a fire signature and to initiate action. For the purpose of this Code, automatic fire detectors are classified as follows: Automatic Fire Extinguishing or Suppression System Operation Detector, Fire–Gas Detector, Heat Detector, Other Fire Detectors, Radiant Energy– Sensing Fire Detector, Smoke Detector. (SIG-iDS)

### Response Message:

Public Comment No. 5-NFPA 400-2014 [New Section after 15.5.9]

---

<table>
<thead>
<tr>
<th>15.5.10</th>
<th>Alarms</th>
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<tbody>
<tr>
<td>A fire detection system shall be required in accordance with Section 6.2 and 15.6.2 for indoor use.</td>
<td></td>
</tr>
</tbody>
</table>

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Submitter Information Verification

Submitter Full Name: [Not Specified]
Organization: [Not Specified]
Street Address: 
City: 
State: 
Zip: 
Submittal Date: Thu Aug 07 10:46:19 EDT 2014
Committee Statement:

Committee Statement: Title changed to match text in current edition of NFPA 55.

Response Message:
Toxicity.
The toxicity of gas mixtures shall be classified in accordance with CGA P-20, Standard for the Classification of Toxic Gas Mixtures, or by testing in accordance with the requirements of 29 CFR 1910.1000 or DOT 49 CFR 173 or ISO 10298, Determination of Toxicity of a Gas or Gas Mixture. [55.5.1.4.1]
Where the quantities of compressed gases or cryogenic fluids stored or used within an indoor control area exceed those shown in Table 5.2.1.4 through Table 5.2.1.10.1, the area shall meet the requirements for Protection Level 1 through 5 in accordance with the building code, based on the requirements of 21.2.3.2. [§§6.3.1.1]
Where a gas room is used to increase the threshold quantity for a gas requiring special provisions or where otherwise required by the material or application-specific requirements of Chapters 7 through 15 of NFPA 55, the room shall meet the requirements of 21.2.4.1 through 21.2.4.5 (§5.6.4).

Submitter Information Verification

Submitter Full Name: [Not Specified]
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submit Date: Sat Aug 02 15:40:34 EDT 2014

Committee Statement

Committee Statement: Modified to match current edition text.
Response Message:
21.2.7.1.2
The requirements of 21.2.7.1 shall not apply where emergency power is provided in accordance with 21.2.7.2 and NFPA 70. \([55:6.7.1.2]\)

Submitter Information Verification

Submitter Full Name: [Not Specified]
Organization: [Not Specified]
Street Address: 
City: 
State: 
Zip: 
Submit Date: Sat Aug 02 15:42:25 EDT 2014

Committee Statement

Committee Statement: Modified to match current edition text.
Response Message:
<table>
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<th>Section No. 21.2.10.2</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>21.2.10.2 Sprinkler System Design.</strong></td>
</tr>
<tr>
<td><strong>When</strong> sprinkler protection is <strong>required</strong>, the area in which compressed gases or cryogenic fluids are stored or used shall be protected with a sprinkler system designed to be not less than that required by 11.2.3.1.1 of NFPA 13 for the Ordinary Hazard Group 2 density/area curve. (<a href="#">55:6.10.2.1</a>)</td>
</tr>
<tr>
<td><strong>21.2.10.2.1</strong></td>
</tr>
<tr>
<td><strong>When</strong> sprinkler protection is <strong>required</strong>, the area in which the flammable or pyrophoric compressed gases or cryogenic fluids are stored or used shall be protected with a sprinkler system designed to be not less than that required by 11.2.3.1.1 of NFPA 13 for the Extra Hazard Group 1 density/area curve. (<a href="#">55:6.10.2.2</a>)</td>
</tr>
</tbody>
</table>

**Submitter Information Verification**

- **Submitter Full Name:** [Not Specified]
- **Organization:** [Not Specified]
- **Street Address:**
- **City:**
- **State:**
- **Zip:**
- **Submittal Date:** Sat Aug 02 15:45:10 EDT 2014

**Committee Statement**

- **Committee Statement:** Modified to match current edition text.
21.2.11 Lighting.
Approved lighting by natural or artificial means shall be provided for the areas of storage or use. [55.6.11]
21.2.12.1.3
The authority having jurisdiction shall be permitted to waive the signage requirements 21.2.12.1 where consistent with safety. [55:6.12.1.2]
Indoor storage and use areas and storage buildings for compressed gases and cryogenic fluids shall be provided with mechanical exhaust ventilation or fixed natural ventilation, where natural ventilation is shown to be acceptable for the material as stored. [§§6.16]
21.2.16.1  Compressed Air.

Subsection  The requirements of 21.2.16 shall not apply to cylinders, containers, and tanks containing compressed air. [§6.16.2]

Submitter Information Verification

Submitter Full Name: [Not Specified]
Organization: [Not Specified]
Street Address: 
City: 
State: 
Zip: 
Submittal Date: Sat Aug 02 15:57:52 EDT 2014

Committee Statement

Committee Statement: Modified to match current edition text.
Response Message: N
21.2.16.4 Recirculation of Exhaust.

Exhaust ventilation shall not be recirculated within the room or building if the cylinders, containers, or tanks stored are capable of releasing hazardous gases. [55:6.16.5]

Committee Statement

Committee Statement: Modified text to match current edition of NFPA 55.

21.2.16.5 Ventilation Discharge.
Ventilation discharge systems shall terminate at a point not less than 50 ft (15 m) from intakes of air-handling systems, air-conditioning equipment, and air compressors. [§§6.16.6]

Submitter Information Verification

Submitter Full Name: [Not Specified]
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submit Date: Sat Aug 02 15:58:55 EDT 2014

Committee Statement

Committee Statement: Modified to match current edition text.
Response Message:
Section 21.3.1.2 Listed and Approved Hydrogen Equipment

Listed and approved hydrogen generating and consuming equipment shall be in accordance with the listing requirements and manufacturers' instructions. \[55: 7.1.4, 7.1.4.1\]

21.3.1.2.1 Such equipment shall not be required to meet the requirements of Section 21.3. \[55: 7.1.4.2\]

Submitter Information Verification

Submitter Full Name: [Not Specified]
Organization: [Not Specified]
Street Address: 
City: 
State: 
Zip: 
Submittal Date: Mon Aug 18 12:08:15 EDT 2014

Committee Statement

Committee Statement: This text will be moved to Chapter 10 in NFPA 55 and will be referenced in 21.6 in NFPA 400.
Response Message: http://submittals.nfpa.org/TerraViewWeb/ContentFetcher?commentPara...
21.3.1.3 Metal Hydride Storage Systems.

[§§ 7.1.5.1.3.1, 7.1.5.1.3.2]

21.3.1.3.1 General Requirements.

[§§ 7.1.5.1.3.1.1, 7.1.5.1.3.1.2]

21.3.1.3.1.1 Metal Hydride Storage System Requirements.

The storage and use of metal hydride storage systems shall be in accordance with 21.3.1.3.1.1 through 21.3.1.3.1.10 as applicable. [§§ 7.1.5.1.3.1.1.1 through 7.1.5.1.3.1.10.10]

21.3.1.3.1.2 Metal Hydride Storage System Requirements, Storing or Supplying Hydrogen.

Those portions of the system that are used as a means to store or supply hydrogen shall also comply with Sections 21.3.1.3.1.8 through 21.3.1.3.1.10 as applicable. [§§ 7.1.5.1.3.1.2.1 through 7.1.5.1.3.1.2.10.]

21.3.1.3.1.3 Classification.

The hazard classification of the metal hydride storage system, as required by Section 4.1, shall be based on the hydrogen stored without regard to the metal hydride content. [§§ 7.1.5.1.3.1.3.1 through 7.1.5.1.3.1.3.3]

21.3.1.3.1.4 Listed or Approved Systems.

Metal hydride storage systems shall be listed or approved for the application and designed in a manner that prevents the addition or removal of the metal hydride by other than the original equipment manufacturer. [§§ 7.1.5.1.3.1.4.1 through 7.1.5.1.3.1.4.5]

21.3.1.3.1.5 Compressed Gas Cylinders, Containers, and Tanks.

Compressed gas cylinders, containers, and tanks shall be designed and constructed in accordance with 21.3.1.3.1.5.1 through 21.3.1.3.1.5.5 as applicable. [§§ 7.1.5.1.3.1.5.1 through 7.1.5.1.3.1.5.5.5]

21.3.1.3.1.6 Service Life and Inspection of Containers.

Metal hydride storage systems, cylinders, containers or tanks shall be inspected, tested, and requalified for service at not less than five year intervals. [§§ 7.1.5.1.3.1.6.1 through 7.1.5.1.3.1.6.5]

21.3.1.3.1.7 Marking and Labeling.

Marking and labeling of cylinders, containers, tanks, and systems shall be in accordance with 21.3.1.3.1.7.1 through 21.3.1.3.1.7.8 as applicable. [§§ 7.1.5.1.3.1.7.1 through 7.1.5.1.3.1.7.8.8]

(A) System Marking.

Metal hydride storage systems shall be marked with the following:

- Manufacturer's name
- Service life indicating the last date the system can be used
- A unique code or serial number specific to the unit
- System name or product code that identifies the system by the type of chemistry used in the system
- Emergency contact name, telephone number, or other contact information
- Limitations on refilling of containers to include rated charging pressure and capacity.

[§§ 7.1.5.1.3.1.7.1 through 7.1.5.1.3.1.7.1.5]

(B) Valve Marking.

Metal hydride storage system valves shall be marked with the following:

- Manufacturer's name
- Service life indicating the last date the valve can be used
- Metal hydride service in which the valve can be used, or a product code that is traceable to this information.

[§§ 7.1.5.1.3.1.7.1.6 through 7.1.5.1.3.1.7.1.6.5]

(C) Pressure Relief Device Marking.

Metal hydride storage system pressure relief devices shall be marked with the following:

- Manufacturer's name
- Metal hydride service in which the device can be used, or a product code that is traceable to this information
- Activation parameters to include temperature, pressure, or both

[§§ 7.1.5.1.3.1.7.1.7 through 7.1.5.1.3.1.7.1.7.9]

(D) Pressure Vessel Markings.

Cylinders, containers, and tanks used in metal hydride storage systems shall be marked with the following:

- Manufacturer's name
- Design specification to which the vessel was manufactured
- Authorized body approving the design and initial inspection and test of the vessel
- Manufacturer's original test date
- Unique serial number for the vessel
- Service life indicating the last date the vessel can be used
- System name or product code that identifies the system by the type of chemistry used in the system

[§§ 7.1.5.1.3.1.7.1.8 through 7.1.5.1.3.1.7.1.8.9]

21.3.1.3.1.8 Temperature Extremes.

Metal hydride storage systems, whether full or partially full, shall not be exposed to artificially created high temperatures exceeding 122°F (50°C) or subambient (low) temperatures unless designed for use under the exposed conditions. [§§ 7.1.5.1.3.1.8.1 through 7.1.5.1.3.1.8.8]

21.3.1.3.1.9 Falling Objects.

Metal hydride storage systems shall not be placed in areas where they are capable of being damaged by falling objects. [§§ 7.1.5.1.3.1.9.1 through 7.1.5.1.3.1.9.5]

21.3.1.3.1.10 Piping Systems.

Piping, including tubing, valves, fittings and pressure regulators, serving metal hydride storage systems shall be maintained gas tight to prevent leakage. [§§ 7.1.5.1.3.1.10.1 through 7.1.5.1.3.1.10.10]

(A) Leaking Systems.

Leaking systems shall be removed from service. [§§ 7.1.5.1.10.1 through 7.1.5.1.10.10]

21.3.1.3.1.11 Refilling of Containers.

The refilling of listed or approved metal hydride storage systems shall be in accordance with the listing requirements and manufacturer's instructions. [§§ 7.1.5.1.11.1 through 7.1.5.1.11.10]

(A) Industrial Trucks.

The refilling of metal hydride storage systems shall be in accordance with NFPA 2. [§§ 7.1.5.1.11.1.1 through 7.1.5.1.11.1.10]

(B) Hydrogen Purify.

The purity of hydrogen used for the purpose of refilling containers shall be in accordance with the listing and the manufacturer's instructions. [§§ 7.1.5.1.11.2 through 7.1.5.1.11.2.10]
Electrical components for metal hydride storage systems shall be designed, constructed, and installed in accordance with NFPA 70 [55: 7.1.5.1.2].

Portable Containers or Systems.

Securing Containers.

Containers, cylinders, and tanks shall be secured in accordance with 21.3.1.7.4 [55: 7.1.5.2.1].

(A) Use on Mobile Equipment.

When a metal hydride storage system is used on mobile equipment, the equipment shall be designed to restrain containers, cylinders, or tanks from dislodgement, slipping, or rotating when the equipment is in motion [55: 7.1.5.2.1].

(B) Motorized Equipment.

Metal hydride storage systems used on motorized equipment shall be installed in a manner that protects valves, pressure regulators, fittings, and controls against accidental impact.

Metal hydride storage systems including cylinders, containers, tanks, and fittings shall not extend beyond the platform of the mobile equipment.

Valves.

Valves on containers, cylinders, and tanks shall remain closed except when containers are connected to closed systems and ready for use [55: 7.1.6.2].

Submitter Information Verification

Submitter Full Name: [Not Specified]
Organization: [Not Specified]
Street Address: 
City: 
State: 
Zip: 
Submittal Date: Fri Aug 15 16:34:18 EDT 2014

Committee Statement

Committee Statement: This material has been moved to chapter 10 of NFPA 55 and is referenced in NFPA 400 in 21.6.

Response Message:
Suppliers shall **either** repair the cylinders, containers, cylinders, and tanks, remove them from service, or dispose of them in an approved manner. [55:7.1.6.2.2 7.1.7.2.2]
21.3.1.2.4 Cylinders, Containers, and Tanks Containing Residual Gas. Compressed gas cylinders, containers, and tanks containing residual product shall be treated as full except when being examined, serviced, or refilled by a gas manufacturer, authorized cylinder requalifier, or distributor. [Section 21.3.1.4.4]

Submitter Information Verification

Submitter Full Name: [Not Specified]
Organization: [Not Specified]
Street Address: [Not Specified]
City: [Not Specified]
State: [Not Specified]
Zip: [Not Specified]
Submittal Date: Sat Aug 02 16:06:26 EDT 2014

Committee Statement

Committee Statement: Modified to match current edition text.
Response Message:
### Incompatible Materials

Gas cylinders, containers, and tanks shall be separated in accordance with Table 21.3.1.7.2 when incompatible materials are stored. See Table 21.3.1.9.2 for annex from 21.3.1.5.2 to be relocated to this section.

#### Table 21.3.1.7.2

<table>
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<th>Gas Category</th>
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<th>Pyrophoric</th>
<th>Flammable</th>
<th>Oxidizing</th>
<th>Corrosive</th>
<th>Unstable Reactive Class 2, 3, or Class 4</th>
<th>Toxic or Highly Toxic</th>
<th>Pyrophoric</th>
<th>Flammable</th>
<th>Oxidizing</th>
<th>Corrosive</th>
<th>Unstable Reactive Class 2, 3, or Class 4</th>
<th>Toxic or Highly Toxic</th>
<th>Pyrophoric</th>
<th>Flammable</th>
<th>Oxidizing</th>
<th>Corrosive</th>
<th>Unstable Reactive Class 2, 3, or Class 4</th>
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<tr>
<td>Unstable reactive Class 2, 3, or Class 4</td>
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NR: No separation required.

### Committee Statement

**Committee Statement:** Modified to match current edition text. Asterisk placed at 21.3.1.9.2 and annex from 21.3.1.5.2 to be relocated to this section. Note that there is a new Figure in revised 2016 edition of NFPA 55 that should be used instead of current Figure. See also SR 119 and SR 20.
Combustible waste, vegetation, and similar materials shall be kept a minimum of 10 ft (3.1 m) from compressed gas cylinders, containers, tanks, and systems.

Submitter Information Verification

Submitter Full Name: Michael Beady
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Street Address:
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Submit Date: Fri Sep 26 12:51:08 EDT 2014

Committee Statement

Committee Statement: Updated text to match source
Response Message:
21.3.1.13 Storage Area Temperature.
Storage area temperatures shall not exceed 52°C (125°F). [55.7.1.17.1 7.1.16]  
21.3.1.13.1 Compressed Gas Containers.
Storage area temperatures shall not exceed 52°C (125°F) (52°C). [55.7.1.17.1 7.1.16.1]
21.3.1.14.2 Contact with Earth.

Gas piping in contact with earth or other material that could corrode the piping shall be protected against corrosion in an approved manner. [55:7.1.18.2, 7.1.17.2]

21.3.1.14.2.1

When cathodic protection is provided, it shall be in accordance with 21.3.1.3. [55:7.1.18.2.1, 7.1.17.2.1]

Submitter Information Verification

Submitter Full Name: [Not Specified]
Organization: [Not Specified]
Street Address: [Not Specified]
City: [Not Specified]
State: [Not Specified]
Zip: [Not Specified]
Submittal Date: Sun Aug 17 20:07:16 EDT 2014

Committee Statement

Committee Statement: Modified text to match current edition of NFPA 55.
Response Message:
21.3.1.14.4
In areas subject to vehicle traffic, the pipe trench shall be of sufficient depth to permit a cover of at least 18 in. (450 mm) of well-compacted backfill material and pavement. In paved areas where a minimum 4 in. (100 mm) of reinforced concrete is used, backfill between the pipe and the asphalt shall be permitted to be reduced to 4 in. (100 mm) minimum. In paved areas where a minimum 2 in. (50 mm) of asphalt is used, backfill between the pipe and the asphalt shall be permitted to be reduced to 8 in. (200 mm) minimum. In paved areas where a minimum 4 in. (100 mm) of reinforced concrete is used, backfill between the pipe and the asphalt shall be permitted to be reduced to 4 in. (100 mm) minimum. [30: 5.5.5.2; 27.6.5.2; 27.6.5.3; 27.6.5.4; 30: 7.1.17.4; 55: 7.1.18.6; 7.1.18.7]

21.3.1.14.5
In paved areas where a minimum 2 in. (50 mm) of asphalt is used, backfill between the pipe and the asphalt shall be permitted to be reduced to 8 in. (200 mm) minimum. [55: 7.1.17.5]

21.3.1.14.6
In paved areas where a minimum 4 in. (100 mm) of reinforced concrete is used, backfill between the pipe and the asphalt shall be permitted to be reduced to 4 in. (100 mm) minimum. [55: 7.1.17.6]

21.3.1.14.7
In areas not subject to vehicle traffic, the pipe trench shall be of sufficient depth to permit a cover of at least 12 in. (300 mm) of well-compacted backfill material. A greater burial depth shall be provided when required by the manufacturer’s instructions or where frost conditions are present. [30: 27.6.5.5; 27.6.5.6; 55: 7.1.18.7; 55: 7.1.18.8; 7.1.17.7]

21.3.1.14.8
A greater burial depth shall be provided when required by the manufacturer’s instructions or where frost conditions are present. [55: 7.1.17.8]
21.3.1.14.10
Two or more levels of piping within the same trench shall be separated vertically by a minimum 6 in. (150 mm) of well-compacted backfill. [Ref: 27.6.5.8, 95.7.1.18.10, 7.1.17.10]
Second Revision No. 125-NFPA 400-2014 [ Section No. 21.3.3.1.3 [Excluding any Sub-Sections] ]

Piping, tubing, fittings, and related components shall be designed, fabricated, and tested in accordance with the requirements of the applicable parts of ASME B31.3, Process Piping, or other approved standards. [55:7.3.1.3]

Submitter Information Verification

Submitter Full Name: [Not Specified]
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Zip: [Not Specified]
Submittal Date: Mon Aug 18 13:26:21 EDT 2014

Committee Statement

Committee Statement: Modified text to match current edition of NFPA 55.
Response Message:
Second Revision No. 121-NFPA 400-2014 [Section No. 21.3.3.1.12]

21.3.3.1.12 Excess Flow Control

Where compressed gases having a hazard ranking in one or more of the following hazard classes in accordance with NFPA 704 are carried in pressurized piping above a gauge pressure of 15 psi (103 kPa), an approved method of either leak detection with emergency shutoff or excess flow control shall be provided:

1. Health hazard Class 3 or Class 4
2. Flammability Class 4
3. Reactivity/Instability Class 3 or Class 4

(A) Excess Flow Control Location with Hazardous Material Storage.
Where the piping originates from within a hazardous material storage room or area, the excess flow control shall be located within the storage room or area. [55: 7.3.1.12.1]

(B) Excess Flow Control Location with Bulk Storage.
Where the piping originates from a bulk source, the excess flow control shall be located at the bulk source at a point immediately downstream of the source valve. [55: 7.3.1.12.1.2]

21.3.3.1.12.2

Approved means of meeting the requirements for emergency isolation shall include any of the following:

1. Automatic shutoff valves located as close to the bulk source as practical, tied to leak detection systems
2. Attended control stations where trained personnel can monitor alarms or supervisory signals and can trigger emergency responses
3. A constantly monitored control station with an alarm and remote shutoff of the gas supply system
4. Excess flow valves at the bulk source

21.3.3.1.12.3

The controls required by the requirements of 21.3.3.1.12 shall not be required for the following:

1. Piping for inlet connections designed to prevent backflow at the source
2. Piping for pressure relief devices
3. Where the source of the gas is not in excess of the quantity threshold indicated in Table 5.2.1.4 through Table 5.2.1.10.1

21.3.3.1.12.4 Location Exemptions.

The requirements of 21.3.3.1.12 shall not apply to the following:

1. Piping for inlet connections designed to prevent backflow
2. Piping for pressure-relief devices
3. Systems containing 450 scf (12.7 Nm³) or less of flammable gas

Supplemental Information

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Submitter Information Verification

Submitter Full Name: [Not Specified]
Organization: [Not Specified]
Street Address: 
City: 
State: 
Zip: 
Submittal Date: Sun Aug 17 20:22:44 EDT 2014

Committee Statement

Committee Statement: Modified to match current NFPA 55 edition text. Add attached annex.

Response Message:
Sections A.7.3.1.12.1...from NFPA 55

A.21.3.1.12.1
Bulk cryogenic fluids are not subject to the requirements for excess flow control based on a health hazard ranking due to cold temperature when installed in accordance with the requirements of Chapter 8 or Chapter 9 of NFPA 55. Bulk cryogenic fluids that are vaporized and distributed as a compressed gas downstream of the source valve are subject to the requirements for excess flow control if the gas has either a health hazard rating of Class 3 or 4 based on corrosivity or toxicity or a reactivity ranking of Class 3 or 4. [55:A.7.3.1.12.1]
21.3.6.2.1
Bulk hydrogen gas installations shall be in accordance with Section 21.6. [55: 7.6.2.1]

21.3.6.2.1.1
Where a fire barrier is used to protect compressed gas systems, the system shall terminate downstream of the source valve.

21.3.6.2.1.2
The fire barrier wall shall be either an independent structure or the exterior wall of the building adjacent to the storage or use area. [55: 7.6.2.1.2]
21.3.6.1 Bulk gas systems for flammable gases other than hydrogen shall be in accordance with Section 21.6 Table 10.3.2.1(a), Table 10.3.2.1(b), or Table 3.2.1(c) of NFPA 55 where the quantity of flammable compressed gas exceeds 5000 scf (141.6 Nm$^3$). [55: 7.6.2.2]

21.3.6.2.1 Where fire barriers are used as a means of distance reduction, fire barriers shall be in accordance with 10.3.2.4 of NFPA 55. [55: 7.6.2.2.1]

21.3.6.2.2 Mobile acetylene trailer systems (MATS) shall be located in accordance with 15.2.3 of NFPA 55. [55: 7.6.2.2.2]

Submitter Information Verification

Submitter Full Name: [Not Specified]
Organization: [Not Specified]
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Submit Date: Mon Aug 18 14:25:37 EDT 2014

Committee Statement

Committee Statement: Text modified to match current NFPA 55 edition text.
Response Message:

Submitter Information Verification

Submitter Full Name: [Not Specified]
Organization: [Not Specified]
Street Address: 
City: 
State: 
Zip: 
Submital Date: Fri Aug 15 16:35:15 EDT 2014

Committee Statement

Committee Statement: This material has been moved to chapter 10 of NFPA 55 and is referenced in NFPA 400 in 21.6. Chapter 10 now covers gas hydrogen in bulk and non-bulk quantities.

Response Message: 

http://submittals.nfpa.org/TerraViewWeb/ContentFetcher?commentPara...
Second Revision No. 118-NFPA 400-2014 [ New Section after 21.11 ]

Submitter Information Verification

Submitter Full Name: [ Not Specified ]
Organization: [ Not Specified ]
Street Address:
City:
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Zip:
Submittal Date: Fri Aug 15 16:37:15 EDT 2014

Committee Statement

Committee Statement: New Chapter 16 has been added to NFPA 55.
Response Message:

http://submittals.nfpa.org/TerraViewWeb/ContentFetcher?commentPara...
A.3.3.1 Absolute Pressure (Gas)

Measured from this reference point, the standard atmospheric pressure at sea level is an absolute pressure of 101.3 kPa (14.7 psi). Absolute pressure in the inch-pound system is commonly denoted in terms of pounds per square inch absolute (psia) [14.7 psi (101.3 kPa) [NFPA 2016]].

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Committee Statement:

Change to current edition extracted text.
A.3.3.16 Combustible Dust

Dusts traditionally have been defined as a material 420 µm or smaller (capable of passing through a U.S. No. 40 standard sieve). 

**Combustible particulates with an effective diameter of less than 420 µm should be defined to fulfill the criteria for dust definition.** However, for consistency with other standards, 500 µm (capable of passing through a U.S. No. 35 standard sieve) is now considered an appropriate size criterion. Particle surface area-to-volume ratio is a key factor in determining the rate of combustion. 

**Combustible particulates with minimum dimension more than 500 µm generally have a surface-to-volume ratio that is too small to pose a deflagration hazard.** Flat, needle-shaped particles, flakes, or particles of fibers with lengths that are large compared to their diameter usually do not pass through a 420 500 µm sieve yet could still pose a deflagration hazard. 

**Furthermore, many particulates accumulate electrostatic charge in handling, causing them to attract each other, forming agglomerates. Often, agglomerates behave as if they were larger particles, yet when they are dispersed they present a significant hazard.** Consequently, it can be inferred that any particle that has a surface area-to-volume ratio greater than that of a 420 500 µm diameter sphere should also be defined to behave as a combustible dust. 

**Minimum dimension less than or equal to 500 µm could behave as a combustible dust if suspended in air or the process-specific oxidizer.** If the minimum dimension of the particulate is greater than 500 µm, it is unlikely that the material would be a combustible dust as determined by the test. 

The determination of whether a sample of combustible dust material is a combustible dust cannot present a false fire or explosion hazard could be based on a screening test methodology such as is provided in ASTM E1226, Standard Test Method for Explosibility of Dust Clouds—screening method. 

Alternatively, a standardized test method such as ASTM E1515, Standard Test Method for Minimum Explosible Concentration of Combustible Dusts; or ASTM E1226 can be used for this determination could be used to determine dust explosibility. [654, 2013]

There is some possibility that a sample will result in a false positive in the 20 L sphere when tested by the ASTM E1226 screening test or the ASTM E1515 test. When the lowest ignition energy allowed by either method still results in a positive result, the owner/operator can elect to determine whether the sample is a combustible dust with screening tests performed in a larger scale (1 m³) enclosure, which is less susceptible to overdriving and thus will provide more realistic results. [654, 2013]

This possibility for false positives has been known for quite some time and is attributed to “overdriven” conditions that exist in the 20 L chamber due to the use of strong pyrotechnic igniters. For that reason, the reference method for explosibility testing is based on a 1 m³ chamber, and the 20 L chamber test method is calibrated to produce results comparable to those from the 1 m³ chamber for most dusts. In fact, the U.S. standard for 20 L testing (ASTM E1226) states, “The objective of this test method is to develop data that can be correlated to those from the 1 m³ chamber (described in ISO 6184-1 and VDI 3673).” ASTM E1226 further states, “Because a number of factors (concentration, uniformity of dispersion, turbulence of ignition, sample age, etc.) can affect the test results, the test vessel to be used for routine work must be standardized using dust samples whose parameters are known in the 1 m³ chamber.” [654, 2013]

**NFPA 68** also recognizes this problem and addresses it stating that “the 20 L test apparatus is designed to simulate results of the 1 m³ chamber; however, the igniter discharge makes it problematic to determine values less than 50 bar·m/sec. Where the material is expected to yield, K values less than 50 bar·m/sec testing in a 1 m³ chamber might yield lower values.” [654, 2013]

Any time a combustible dust is processed or handled, a potential for deflagration exists. The degree of deflagration hazard varies, depending on the type of combustible dust and the processing methods used.

A dust explosion has the following four requirements:

1. **Combustible dust**
2. Dust dispersion in air or other oxidant at or exceeding the minimum explosible concentration (MEC)
3. Sufficient concentration at or exceeding the minimum explosible concentration (MEC) 
4. Ignition source such as an electrostatic discharge, an electric current arc, a glowing ember, a hot surface, welding slag, frictional heat, or a flame

While the deflagration is confined and produces a pressure sufficient to rupture the confining enclosure, the event is, by definition, an “explosion.” [654, 2013]

Evaluation of the hazard of a combustible dust should be determined by the means of actual test data. Each situation should be evaluated and applicable tests selected. The following list represents the factors that are sometimes used in determining the deflagration hazard of a dust:

1. Minimum explosible concentration (MEC)
2. Minimum ignition energy (MIE)
3. Particle size distribution
4. Moisture content as received and as tested
5. Maximum explosion pressure at optimum concentration
6. Maximum rate of pressure rise at optimum concentration
7. Kₜₜ (normalized rate of pressure rise) as defined in ASTM E1226, Standard Test Method for Explosibility of Dust Clouds
8. Layer ignition temperature
9. Dust cloud ignition temperature
10. Limiting oxidant concentration (LOC) to prevent ignition
11. Electrical volume resistivity
12. Charge relaxation time
13. Chargeability

It is important to keep in mind that as a particulate is processed, handled, or transported, the particle size generally decreases due to particle attrition. Consequently, it is often necessary to evaluate the explosibility of the particulate at multiple points along the process. Where process conditions dictate the use of oxidizing media other than air (nominally taken as 21 percent oxygen and 79 percent nitrogen), the applicable tests should be conducted in the appropriate process-specific medium. [654, 2013]
A.3.3.19.6 Nonmetallic Container ([Solid, Flammable and Combustible Liquid]).
Permissible nonmetallic containers for shipping Class I, Class II, and Class IIIA liquids are governed by the hazardous materials transportation regulations promulgated by the United Nations publication Recommendations on the Transport of Dangerous Goods, Model Regulations, and the U.S. Department of Transportation's Hazardous Materials Regulations, Title 49, Code of Federal Regulations. Small tanks for Class IIIB liquids are not governed by these regulations. Fiber portable tanks for Class IIIB liquids include composite designs consisting of a multi-ply cardboard box with a rigid or flexible plastic bladder. [30, 2012 2014]
A.3.3.19.10.1 Atmospheric Tank (Flammable and Combustible Liquid).

Older-style flat roof tanks were designed to operate at pressures of atmospheric through a gauge pressure of 0.5 psi (3.5 kPa) measured at the top of the tank. This limitation was established to avoid continuous stress on the roof plates of the tank.

Submitter Information Verification
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Submittal Date: Tue Sep 23 15:00:44 EDT 2014

Committee Statement
Committee Statement: Updated text to match extract source
Response Message:
A.3.3.19.11.2 Nonmetallic Portable Tank (Flammable and Combustible Liquid).
Permissible nonmetallic portable tanks for shipping Class I, Class II, and Class IIIA liquids are governed by the hazardous materials transportation regulations promulgated by the United Nations publication, Recommendations on the Transport of Dangerous Goods (UN) and the U.S. Department of Transportation’s Hazardous Materials Transportation (DOT). Small tanks for Class IIIB liquids are not governed by either UN or DOT hazardous materials regulations. Fiber portable tanks for Class IIIB liquids include composite designs consisting of a multi-ply corrugated cardboard box with a rigid or flexible inner plastic bladder.

Submitter Information Verification
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Street Address:
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Submit Date: Wed Jul 30 11:06:54 EDT 2014

Committee Statement
Committee Statement: Modified to current edition extracted text.
Response Message:
**A.3.3.26 Cylinder Pack (Gas)**

Six-packs and twelve-packs are terms used to further define cylinder packs with a specific number of cylinders involved. The characteristic internal water volume of individual cylinders in a cylinder pack ranges from 1.52 ft³ to 1.76 ft³ (43 L to 50 L) or a water capacity of from 95 lb to 110 lb (43 kg to 50 kg). [55,2013-2016]

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### Committee Statement

- **Committee Statement:** Modified to current edition extracted text.
- **Response Message:**

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**National Fire Protection Association Report**

http://submittals.nfpa.org/TerraViewWeb/ContentFetcher?commentPara...
A.3.3.37 Explosion Control (Gas)

NFPA 68 provides guidance on the use of deflagration venting systems for use in buildings and other enclosures. The primary purpose of a venting system is to relieve the overpressure produced in an explosion to limit the potential damage to the building where the explosion occurs. Although some structural damage can be anticipated, the use of relief venting is expected to prevent massive building failure and collapse. In cases where detonation is probable, venting is often used in conjunction with barricade construction where the pressure-resistant portions of the building have been constructed to resist the pressures anticipated should an explosive event occur. Design of barricade systems is highly specialized, and the subject of military standards applicable to the subject. NFPA 69 provides guidance on the use of suppression, ventilation systems, and the limiting of oxidants as a means to prevent the occurrence of an explosion. When relief vents are to be used as a means to provide explosion relief, the fundamental requirements of NFPA 5000, the building code, for structural elements including snow, wind, and seismic events should be considered. In some instances, the requirements for wind resistance can impose more rigorous requirements on the relief vents than required by the engineering analysis used to determine the relief pressure. In such cases, users must demonstrate that the relief vents will not become airborne or release in such a manner as to create secondary hazards within or external to the building in which they are installed. Specific designs may require approval by the AHJ. [55, 2013, 2016]
**A.3.3.50 Gas Room**

Gas rooms must be constructed and utilized in accordance with 21.2.4 [55, 2013].

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Committee Statement:

- **Committee Statement:** Removed extract tag. Annex no longer exists in NFPA 55 but definition remains in 55.
- **Response Message:**
A.3.3.55 Immediately Dangerous to Life and Health (IDLH) (Gas).

This level is established by the National Institute for Occupational Safety and Health (NIOSH). If adequate data do not exist for precise establishment of IDLH, an independent certified industrial hygienist, industrial toxicologist, or appropriate regulatory agency should make such determination. [55, 2013-2016]
A.3.3.56 ISO Module (Gas).

The characteristic internal water volume of individual tubular cylinders is 43 \text{ ft}^3 (1218 \text{ L}) or a water capacity of 2686 \text{ lb} (1218 \text{ kg}). The frame of an ISO container module and its corner castings are specially designed and dimensioned to be used in multi-modal transportation service on container ships, special highway chassis, and container-on-flatcar railroad equipment. [55, 2013]

Submitter Information Verification

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State: [Not Specified]
Zip: [Not Specified]
Submital Date: Thu Jul 31 15:47:39 EDT 2014

Committee Statement

Committee Statement: Modified to match existing edition text.
Response Message:
A.3.3.60.11 Water-Reactive Material.

**Class 1 Water-Reactive Materials.** Materials whose heat of mixing is at or above 30 cal/g and less than 100 cal/g.

**Class 2 Water-Reactive Materials.** Materials whose heat of mixing is at or above 100 cal/g and less than 600 cal/g.

**Class 3 Water-Reactive Materials.** Materials whose heat of mixing is greater or equal to 600 cal/g.

[Table F.2]
A.3.3.86 Tube Trailer (Gas).

The characteristic internal water volume of individual tubular cylinders ranges from 43 \text{ ft}^3 (1218 \text{ L}) to 93 \text{ ft}^3 (2632 \text{ L}) or a water capacity of 2686 lb (1218 kg) to 5803 lb (2632 kg). [55, 2013 2016]
A.4.1

The categorization and classification of hazardous materials enables 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 current definitions found in Chapter 3 have been developed using a compilation of criteria found in NFPA codes and standards, requirements of the U.S. Department of Transportation DOT, and in some cases definitions established by OSHA in 29 CFR.

A system known as the Globally Harmonized System of Classification and Labeling of Chemicals (GHS) has been developed based on standards for classification published by the United Nations (UN) Subcommittee of Experts on the GHS. The United States U.S. continues its efforts to incorporate the GHS in its federal regulatory scheme. OSHA plans to issue a final rule to harmonize its published its revised Hazard Communication Standard (29 CFR 1910.1200) to align with the GHS in March 2012. The revised standard became effective in May 2012.

It is anticipated by the Committee that over time, the GHS will be reviewed for applicability and possible integration into the regulatory scheme developed in NFPA 400 for hazardous materials storage, handling, and use. The evolution of this system of classification will be facilitated by the changes associated with classification, labeling, and Safety Data Sheets safety data sheets. It is not anticipated that the GHS will be fully implemented immediately within NFPA 400, recognizing the historical basis that exists for some of the classifications of materials, such as flammable and combustible liquids.
A.21.1.1.2.1(3) It is intended that installations of bulk oxygen systems regulated by NFPA 99 also comply with the requirements of Chapter 5 of NFPA 55. The bulk oxygen system terminates at the point where oxygen at service pressure first enters the supply line. Bulk compressed gas and cryogenic fluid system installations are intended to be covered by the requirements of this code. Instrumentation and alarms that are attendant to the system and designed to interface with the application in a health care facility are to be retained within the purview of NFPA 99. [55:A.1.1.2(3)]

Committee Statement

Committee Statement: Modified to match current edition text.

Response Message:
For information, see NFPA 52, or NFPA 58. [55: A.1.1.2(6)]

A.21.1.1.2.1(6)
The storage of compressed gases and cryogenic fluids, outside the boundaries of laboratory work areas is covered by this standard code. [55: A.1.1.2(6)]

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State: [Not Specified]
Zip: [Not Specified]
Submit Date: Fri Aug 01 15:34:05 EDT 2014

Committee Statement
Committee Statement: Modified to match current edition text.
Response Message:
A.21.2.9

See NFPA 55 provides for more information on this subject. [55: A.6.8]

Submitter Information Verification

Submitter Full Name: [Not Specified]
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submit Date: Fri Aug 01 15:38:19 EDT 2014

Committee Statement

Committee Statement: Deleted extract tag.
Response Message:
A.21.3.1.1
The equipment referenced is intended to include fuel cell applications, generation of hydrogen from portable or transportable hydrogen generation equipment, batteries, and similar devices and equipment that utilize hydrogen for the purpose of power generation. It does not include hydrogen production facilities intended to produce hydrogen used for distribution or repackaging operations operated by gas producers, distributors, and repackagers. [Rc. A.7.1.1]

Submitter Information Verification
Submitter Full Name: [Not Specified]
Organization: [Not Specified]
Street Address: 
City: 
State: 
Zip: 
Submittal Date: Fri Aug 01 15:40:27 EDT 2014

Committee Statement
Committee Statement: Deleted since annex text no longer exists in NFPA 55.
Response Message: 

National Fire Protection Association Report
http://submittals.nfpa.org/TerraViewWeb/ContentFetcher?commentPara...
A.21.3.1.7.2
Figure A.21.3.1.7.2 is a schematic showing the separation distances required under 21.3.1.7.2. Figure A.21.3.1.7.2 Separation of Gas Cylinders by Hazard.

Committee Statement
Annex was relocated to the correct section of code. Delete figure and replace with the figure that is in the current edition of NFPA 55. (A.7.1.12.2) See also SR 119 and SR 73.

Response Message:
Pressure vessels of any type may be subject to additional regulations imposed by various states or other legal jurisdictions. Users should be aware that compliance with DOT or ASME requirements might not satisfy all of the required regulations for the location in which the vessel is to be installed or used. Liquid oxygen containers should be fabricated from materials meeting the impact test requirements of paragraph UG-84 of the ASME, Boiler and Pressure Vessel Code - Section VIII, UG-A.8.2.
A.21.4.2.4.5.1
Pressure relief valves typically are spring-loaded valves where the relief pressure is set by adjustment of a spring. Valves should be sealed to prevent adjustment by other than authorized personnel typically found at a retest facility. An ASME pressure relief valve is designed to comply with the requirements of the ASME Boiler and Pressure Vessel Code and typically is equipped with a wire and lead seal to prevent tampering. [S5.A5.A.2.5.6.4 A.8.2.4.5.1]
Annex B Chemical Data

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

B.1 General.

The information provided in Annex B is not a part of the requirements of this document but is included for informational purposes.
B.2 Hazard Recognition.
Chapter 5 introduces the concepts of control areas and MAQs. The purpose is to permit limited amounts of hazardous materials in occupancies having minimum controls without triggering the more restrictive Protection Level 1 through Protection Level 5 building requirements. The allowable quantities in Table 5.2.1.1.3, Table 5.2.1.2 through Table 5.2.1.8, and Table 5.2.1.10.1 are based on demonstrated need and historical safe storage and use of hazardous contents. The preponderance of provisions contained in Chapter 6 and those of Chapters 11 through 21 establish additional controls for occupancies exceeding the hazardous materials limits (MAQs) prescribed for control areas.

Not all of the hazardous materials categories are placed into the high-hazard category, and some of these materials (contents) have been recognized as being of low or ordinary hazard, depending on their nature in a fire. For example, Class III combustible liquids, Class 1 unstable (reactive) materials, Class 1 water-reactive materials, Class 1 oxidizing solids and liquids, and Class IV and Class V organic peroxides are hazardous materials, which, in some cases, do not have an MAQ and, therefore, are not required to comply with the requirements for Protection Level 1 through Protection Level 5. Some materials, though classified as high-hazard, such as aerosols, are exempt from the requirements of NFPA 400, as they are regulated elsewhere within the regulatory scheme developed by NFPA in the code. For additional exceptions, see 1.1.2. (5000A.34.1.1)

Figure B.2 helps to illustrate the conditions under which the protection level requirements are applicable. (5000A.34.1.1)

Figure B.2 Flow Chart Illustrating Protection Level Applicability. (5000: Figure A.34.1.1)

Safety data sheets (SDS) are used as a primary means to assess the hazards of a specific material. In the U.S., the OSHA Hazard Communication Rule (29 CFR 1900.1200) prescribes what information is to be provided by SDS. Over the years, there have been a number of guidelines prepared that describe the information that is to be included. ANSI Z400.1, Hazardous Industrial Chemicals—Material Safety Data Sheets—Preparation, specifies the general form the SDS. The rule (29 CFR 1900.1200) also specifies the layout of SDS, including 5.46.16: headings section format, with standardized wording headings, the numbering and order of these headings, and the information required to complete as the SDS. The major headings of this standard include the following:

Section 1: Product and Company Identification
Section 2: Hazards Hazard(s): Identification
Section 3: Composition/Information on Ingredients
Section 4: First Aid: Aid Measures
Section 5: Fire, Fire-Fighting Measures
Section 6: Accidental Release Measures
Section 7: Handling and Storage
Section 8: Exposure Controls/Personal Protection
Section 9: Physical and Chemical Properties
Section 10: Stability and Reactivity
Section 11: Toxicological Information
Section 12: Ecological Information
Section 13: Disposal Considerations
Section 14: Transport Information
Section 15: Regulatory Information
Section 16: Other Information, including date of preparation or last revision.

The American Chemical Society publishes chemical abstracts as pointers to the chemical literature. Since 1907, their Chemical Abstracts Service (CAS) has indexed and summarized chemistry-related articles from more than 40,000 scientific journals, in addition to patents, conference proceedings, and other documents pertinent to chemistry, life sciences, and many other fields. In total, abstracts for more than 25 million documents are accessible online through CAS.

Substance identification is a special strength of CAS. It is widely known as the CAS Registry, the largest substance identification system in existence. When CAS processes a chemical substance newly encountered in the literature, its molecular structure diagram, systematic chemical name, molecular formula, and other identifying information are added to the Registry, and it is assigned a unique CAS Registry Number. The Registry now contains records for more than 30 million organic and inorganic substances and more than 58 million sequences.

Individual chemicals are identified through the use of a CAS registry number, commonly referred to as the CAS number or CASRN. The number, which has no chemical significance, is used to link the material through its molecular structure into an index system where the Chemical Abstracts name is provided.

The CAS number is unique for each given material; however, for few exceptions, mixtures of chemicals are not assigned a CAS number per se, since each individual component of the mixture has its own unique CAS number. For the purposes of hazard classification and the application of NFPA 400, there are three primary identifiers for each chemical that must be known:

1. CAS number (unless it is a chemical mixture)
2. Concentration (typically expressed in weight percent for solids or liquids and volume percent for gases)
3. Physical state (solid, liquid, or gas)
For example, consider the material hydrochloric acid, also called hydrogen chloride. It can exist in the anhydrous form (as a gas) or in a water solution as the aqueous liquid material of varying concentrations. The hazard properties of the material vary with the form. The regulatory approach used by NFPA 400 is based on hazard classification of the materials to be regulated. The materials under consideration must be evaluated to classify their hazards within the context of the code. The starting point begins with the SDS, where the material can be identified by name, and other information, such as CAS registry number and physical state, is provided. Although there are 16 different main headings in the SDS, the primary need for classification of materials rests with determining the physical and health hazards of the material or mixture in question.

Within the context of NFPA 400, the user must determine whether the physical and/or health hazards of the material place it into one or more of the following hazard categories:

1. Corrosive solids and liquids
2. Flammable solids
3. Organic peroxide formulations
4. Oxidizer solids and liquids
5. Pyrophoric solids and liquids
6. Toxic and highly toxic solids and liquids
7. Unstable (reactive) solids and liquids
8. Water-reactive solids and liquids

Each of the hazard categories can be further subdivided into subcategories, each with its attendant hazard properties. For example, oxidizer solids and liquids are subdivided into Class 4, Class 3, Class 2, and Class 1 subcategories commonly referred to as the hazard class.

Although it might be expected that the above nomenclature would appear on the SDS, this is not always the case. Appendices A and B of OSHA's Hazard Communication Rule (29 CFR 1900.1200) identify specific health and physical hazards that might differ from that of NFPA 400. Terms used in NFPA 400 are consistent with those used in other NFPA standards and codes. Please see Annex J of NFPA 400 for a comparison of these hazard definitions. Therefore, the user must review the physical and chemical properties, as well as the health hazard information provided, in order to make a determination as to the appropriate hazard category and class for the material to be regulated.

B.3 Chemical Family — A Pointer to Hazard Classification.

B.3.1 General.

It is quite common that preparers of SDSs indicate the chemical family to which a material belongs, that is, the group of chemical substances that have a similar molecular structure. For example, materials such as acetone, methyl ethyl ketone, and amyl ethyl ketone are members of the ketone family. While the properties of various hazardous materials within a chemical family may vary, the chemical family becomes a pointer to the more likely hazard categories of the material under consideration.

While hundreds of thousands of chemicals are in use, this annex categorizes the more commonly used industrial chemicals into chemical families or unique groupings that have similar properties. Materials and/or chemicals exhibit a wide range of properties, some of which are hazardous. This code provides guidance for known physical and health hazards of materials within its scope.

B.3.2 Chemical Families Related to Hazard Category.
Table B.3.2 provides a summary of chemical families with associated physical and health hazard properties, which are subdivided into specific categories. This table is for informational purposes only. The physical and health hazards indicated are broad representations for the various chemical families. These classifications are not intended to cover all the hazards of a material. A more detailed description of the chemical families, subfamilies, and chemical structure of specific hazards are contained in the explanatory material following the table. For specific information, the chemical-specific SDS must be consulted. Additional information can be obtained from the manufacturer.

### Table B.3.2 NFPA 400 Chemical Data

<table>
<thead>
<tr>
<th>CHEMICAL FAMILY</th>
<th>CHEMICAL STRUCTURE</th>
<th>PHYSICAL HAZARDS (a,b)</th>
<th>HEALTH HAZARDS (2,3)</th>
<th>EXAMPLES (CAS No.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acids</td>
<td>Carboxylic R-COOH, Ar-COOH</td>
<td>Unstable: (S, L, G)</td>
<td>Corrosive: (S, L, G)</td>
<td>Formic acid (64-18-6), acetic acid (64-19-7), benzoic acid (65-85-0), acryl acid (79-10-7), oxalic acid (144-62-7), propionic acid (79-09-4), 4-amino-3,5,6-trichloro-picolinic acid (1918-02-1), 2-hydroxybenzoic acid (69-72-7), citric acid (77-92-9), benzoic acid (65-85-0)</td>
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<tr>
<td>Peroxy</td>
<td>R-OOH, Ar-OOH</td>
<td>Unstable: (S, L, G)</td>
<td>Corrosive: (S, L, G)</td>
<td>Peroxyacetic acid (79-21-0), m-chloro perbenzoic acid (937-14-4), peroxymonsulfuric acid (7722-86-3)</td>
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<tr>
<td>Mineral</td>
<td></td>
<td>Unstable: (S, L, G)</td>
<td>Corrosive: (S, L, G)</td>
<td>Hydrochloric acid (7647-01-0), sulfuric acid (7664-93-9), phosphoric acid (7664-38-2)</td>
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<td>Gaseous</td>
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<td>Unstable: (S, L, G)</td>
<td>Corrosive: (S, L, G)</td>
<td>Hydrogen chloride (7647-01-0), hydrogen bromide (10035-10-6), hydrogen fluoride (7664-39-3), boron trichloride (10294-34-5), boron trifluoride (7637-07-2)</td>
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<tr>
<td>Oxidizing</td>
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<td>Unstable: (S, L, G)</td>
<td>Corrosive: (S, L, G)</td>
<td>Nitric acid (7697-37-2), chloric acid (7790-93-4), chlorosulfonic acid (7790-94-5)</td>
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<tr>
<td>Alcohols</td>
<td>Aliphatic R-OH</td>
<td>Flammable: (S, L, G)</td>
<td>Corrosive: (S, L, G)</td>
<td>Methanol (67-56-1), ethanol (64-17-5), isopropanol (87-63-2), butanol (75-65-0), glycerol (56-81-5), 1-hexanol (111-27-3), 2-octanol (123-96-6)</td>
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<tr>
<td>Aromatic</td>
<td>Ar-OH</td>
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<td>Corrosive: (S, L, G)</td>
<td>Phenol (108-95-2), 1,2-dihydroxybenzene (catechol) (120-80-9), 2-naphthol (135-19-3), 2,4-dichloro-phenol (120-83-2), 4-methylphenol (p-cresol) (106-44-5)</td>
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<tr>
<td>Alkyl halides</td>
<td>R-X</td>
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<td>Corrosive: (S, L, G)</td>
<td>Bromoform (75-25-2), chloroform (67-66-3), 1,2-dichloroethane (ethylene dichloride) (107-06-2), 1,2-dichlorotetrafluoroethane (76-14-2), 1,2-dibromoethane (ethylene dibromide) (106-93-4), methyl bromide (74-83-9), 1,2-dichloropropane (propylene dichloride) (78-87-5)</td>
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<tr>
<td>Amines</td>
<td>Aliphatic, organic R-NH_2, R-NH, R-N, R-NH_2, Ar(N)</td>
<td>Flammable: (S, L, G)</td>
<td>Corrosive: (S, L, G)</td>
<td>Ethylamine (75-04-7), ethylenediamine (107-15-3), pyridine (107-62-6), dimethylamine (75-50-3), hexylamine (111-26-2), isopropylamine (75-31-0), triethylamine (121-44-8), morpholine (110-91-8), butylamine (109-73-9)</td>
</tr>
<tr>
<td></td>
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<td></td>
<td>Diethylkarboxylin (88497-98-1), aniline (62-56-3), pyridine (100-51-7), N,N-diethyl aniline (91-66-7), 3-methylpyridine (3-pyridine) (108-99-6), 4-phenylenediamine (4-aminodiphenyl) (106-50-3), 4-aminoaniline (p-toluidine) (109-49-0), 2,4-diamino-toluene (TDA) (95-90-7)</td>
</tr>
<tr>
<td>CHEMICAL FAMILY</td>
<td>CHEMICAL STRUCTURE</td>
<td>PHYSICAL HAZARDS</td>
<td>HEALTH HAZARDS</td>
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<td><strong>Bases</strong></td>
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<td><strong>Toxic</strong></td>
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<tr>
<td></td>
<td></td>
<td><strong>Oxidizer</strong></td>
<td><strong>Highly</strong></td>
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<tr>
<td></td>
<td></td>
<td><strong>Pyrophoric</strong></td>
<td><strong>Toxic</strong></td>
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<tr>
<td></td>
<td></td>
<td><strong>Water</strong></td>
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<tr>
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<td></td>
<td><strong>Reactive</strong></td>
<td></td>
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<tr>
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<td><strong>Solid</strong></td>
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<td><strong>Organic Peroxide</strong></td>
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<td></td>
<td><strong>Flammable</strong></td>
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<td></td>
<td><strong>Flammable/ Combustible</strong></td>
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<td></td>
<td></td>
<td><strong>S</strong></td>
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<td><strong>L</strong></td>
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<td></td>
<td></td>
<td><strong>G</strong></td>
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<td><strong>✓✓✓</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Carbides / Nitrides</strong></td>
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<td><strong>✓</strong></td>
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<td><strong>Carbonyl compounds</strong></td>
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<td><strong>✓✓✓</strong></td>
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<tr>
<td><strong>Acid anhydrides</strong></td>
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<td><strong>✓✓✓</strong></td>
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<td><strong>Aldehydes</strong></td>
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<tr>
<td><strong>Esters</strong></td>
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<td><strong>Halides</strong></td>
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<td><strong>✓✓✓</strong></td>
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<td><strong>Ketones</strong></td>
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</table>

**Sodium hydroxide** (1310-73-2), potassium hydroxide (1310-58-3), sodium carbonate (467-19-8)

**Ammonia** (7664-41-7), methylamine (74-89-5), trimethylamine (75-50-3)

**Calcium carbide** (75-20-7), lithium nitride (26134-62-3), gallium nitride (25617-97-4), boron nitride (10643-11-5)

**Acetyl chloride** (75-36-5), sulfonyl chloride (7791-25-5), benzoyl chloride (98-88-4), methanesulfonyl chloride (124-63-0), p-toluene sulfonyl chloride (98-59-9), trichloroacetyl chloride (76-02-8), pivaloyl chloride (3268-49-3)

**Formaldehyde** (50-00-0), acetaldehyde (75-07-0), butyraldehyde (123-72-8), benzaldehyde (100-52-7), 2-butenal (crotonaldehyde) (4170-30-3), n-valeraldehyde (110-62-3), p-methoxybenzaldehyde (4-anisaldehyde) (123-11-5), 2-propenal (acrolein) (107-02-8)

**Methyl formate** (107-31-3), methyl acrylate (2-propenoic acid methyl ester), (96-33-3), benzenedicarboxylic acid dioctyl ester (117-84-0), ethyl ethanoate (ethyl acetate) (141-78-6), butanedioic acid dimethyl ester (dimethyl fumarate) (106-65-0), oleic acid methyl ester (112-62-9), n-butyl acetate (123-86-4)

**Phosgene** (74-90-8), carbonyl fluoride (263-50-4), thioformegone (463-71-8), oxalic chloride (79-37-8), trichloromethyl chlorofomate (diphosgene) (503-38-8), methyl chlorofomate (78-22-1)

**Methyl formate** (107-31-3), methyl acrylate (2-propenoic acid methyl ester), (96-33-3), benzenedicarboxylic acid dichloro ester (117-84-0), ethyl ethanoate (ethyl acetate) (141-78-8), butanedioic acid dimethyl ester (dimethyl fumarate) (106-65-0), cletic acid methyl ester (112-62-9), n-butyl acetate (123-86-4)

**Methyl propyl ketone** (107-87-9), methyl isovaleryl ketone (110-12-3), acetone (67-64-1), cyclohexanone (108-94-1), 1-chloro-2-propanone (chloroacetonone) (78-95-5), 2-butanone (methyl ethyl ketone) (78-93-3), cyclopentanone (120-62-3), acetonophene (98-86-2), methyl isobutyl ketone (108-10-1), limonene (138-86-3), 1,3-dichloroacetonone (334-07-6)

**Sodium cyanide** (143-33-9), trimethylsilyl cyanide (1310-87-5), potassium cyanide (1310-58-3), hydrogen cyanide (74-90-8), cyanogen chloride (506-77-4), inorganic cyanides (506-77-4)

**Sodium hydroxide** (1310-73-2), potassium hydroxide (1310-58-3), sodium carbonate (467-19-8)

**Ammonia** (7664-41-7), methylamine (74-89-5), trimethylamine (75-50-3)

**Calcium carbide** (75-20-7), lithium nitride (26134-62-3), gallium nitride (25617-97-4), boron nitride (10643-11-5)

**Acetyl chloride** (75-36-5), sulfonyl chloride (7791-25-5), benzoyl chloride (98-88-4), methanesulfonyl chloride (124-63-0), p-toluene sulfonyl chloride (98-59-9), trichloroacetyl chloride (76-02-8), pivaloyl chloride (3268-49-3)

**Formaldehyde** (50-00-0), acetaldehyde (75-07-0), butyraldehyde (123-72-8), benzaldehyde (100-52-7), 2-butenal (crotonaldehyde) (4170-30-3), n-valeraldehyde (110-62-3), p-methoxybenzaldehyde (4-anisaldehyde) (123-11-5), 2-propenal (acrolein) (107-02-8)

**Methyl formate** (107-31-3), methyl acrylate (2-propenoic acid methyl ester), (96-33-3), benzenedicarboxylic acid dichloro ester (117-84-0), ethyl ethanoate (ethyl acetate) (141-78-8), butanedioic acid dimethyl ester (dimethyl fumarate) (106-65-0), cletic acid methyl ester (112-62-9), n-butyl acetate (123-86-4)

**Phosgene** (74-90-8), carbonyl fluoride (263-50-4), thioformegone (463-71-8), oxalic chloride (79-37-8), trichloromethyl chlorofomate (diphosgene) (503-38-8), methyl chlorofomate (78-22-1)

**Methyl propyl ketone** (107-87-9), methyl isovaleryl ketone (110-12-3), acetone (67-64-1), cyclohexanone (108-94-1), 1-chloro-2-propanone (chloroacetonone) (78-95-5), 2-butanone (methyl ethyl ketone) (78-93-3), cyclopentanone (120-62-3), acetonophene (98-86-2), methyl isobutyl ketone (108-10-1), limonene (138-86-3), 1,3-dichloroacetonone (334-07-6)
<table>
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<tr>
<th>CHEMICAL FAMILY (1)</th>
<th>CHEMICAL STRUCTURE</th>
<th>Unstable Reactive</th>
<th>Water Reactive</th>
<th>Oxidizer</th>
<th>Pyrophoric</th>
<th>Flammable</th>
<th>Organic Peroxide (4)</th>
<th>Flammable/ Combustible (5)</th>
<th>Corrosive</th>
<th>Toxic</th>
<th>Highly Toxic</th>
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<td>(S, L, G)</td>
<td>(S, L, G)</td>
<td>(S, L, G)</td>
<td>(S, L, G)</td>
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<td>Organic (nitriles)</td>
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<td>Epoxides</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Oxidizing</td>
<td></td>
<td>-</td>
<td>-</td>
<td>✓</td>
<td>✓</td>
<td>-</td>
<td>-</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Pyrophoric</td>
<td></td>
<td>-</td>
<td>-</td>
<td></td>
<td>✓</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sulfur Gases</td>
<td>R-SH</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hydrocarbons</td>
<td></td>
<td>-</td>
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<td>-</td>
<td>-</td>
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<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Aliphatic</td>
<td></td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
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<td>✓</td>
<td>✓</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Alkenes</td>
<td>R₂CH=CHR₂</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alkynes</td>
<td>R₂C≡CR₂, R-CN=CH</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aromatic</td>
<td>Ar</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**EXAMPLES (CAS No.)**

The following examples and their classifications represent neat, undiluted, commercially available products:

- Cyanide (151-50-8)
- Acetonitrile (75-05-8), benzonitrile (100-47-0), chloroacetonitrile (107-14-2), 2-propanenitrile (acylonitrile) (107-13-1), butyronitrile (109-74-0)
- Ethylene oxide (75-21-8), propylene oxide (75-56-9), 1,2-epoxybutane (106-88-7), 1-chloro-2, 3-epoxypropane (epichlorohydrin) (158-89-6)
- 1,2-Dimethoxyethane (glyme) (110-71-4), diethyl ether (60-29-7), furan (110-00-9), tetrahydrofuran (THF) (109-99-9), polyethylene glycol (25322-88-3), 1,4-dioxane (109-98-6), methyl vinyl ether (107-25-6), ethylene glycol monomethyl ether (EGME, 2-methoxyethanol) (34590-94-8)
- Acetylene (74-86-2), hydrogen (1333-74-0), methane (74-82-8), propane (74-98-6)
- Chlorine (7782-50-5), fluorine (7782-41-4), bromine (7787-71-5), chlorine trifluoride (7790-91-2), bromine pentafluoride (7789-30-2)
- Carbon dioxide (124-38-9), helium (7440-59-7), argon (7440-37-1)
- Oxygen (7782-44-7)
- Silane (7803-62-5), methyl silane (992-94-9), disilane (1590-87-0)
- Hydrogen sulfide (7783-08-4), methyl mercaptan (74-93-1), sulfur dioxide (7446-08-5)
- Cyclopentane (287-92-3), hexane (110-64-3), dodecane (112-40-3), butane (106-97-8)
- Benzene (71-43-2), toluene (108-88-3), cumene (98-82-8), naphthalene (91-20-3), chlorobenzene (108-90-7), 1,2,3-trichlorobenzene (87-61-6), 3,4-dichloro-trifluoro toluene (328-84-7), 1,2-dimethyl benzene (o-xylene) (95-47-6), 1,4-dichlorobenzene (p-dichlorobenzene) (106-46-7), ethylbenzene (100-41-4)
### PHYSICAL HAZARDS

<table>
<thead>
<tr>
<th>CHEMICAL FAMILY</th>
<th>CHEMICAL STRUCTURE</th>
<th>Unstable</th>
<th>Reactive</th>
<th>Water Reactive</th>
<th>Oxidizer</th>
<th>Pyrophoric</th>
<th>Flammable</th>
<th>Organic Peroxide</th>
<th>Combustible</th>
</tr>
</thead>
<tbody>
<tr>
<td>Isocyanates</td>
<td>R-N=C=O, Ar-N=C=O</td>
<td>✓✓✓✓✓</td>
<td>✔️</td>
<td>✓✓✓</td>
<td>✔️</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✔️</td>
</tr>
<tr>
<td>Metals</td>
<td>Metal Alkyls</td>
<td>M-R</td>
<td>✓✓✓✓✓</td>
<td>✓✓✓✓</td>
<td>✔️</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✔️</td>
</tr>
<tr>
<td>Metal Halides</td>
<td>M-X</td>
<td>✓✓✓✓✓</td>
<td>✓✓✓✓✓</td>
<td>✓✓✓✓</td>
<td>✔️</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✔️</td>
</tr>
<tr>
<td>Metal Hydrides</td>
<td>(solids)</td>
<td>M-H</td>
<td>✓✓✓✓✓</td>
<td>✓✓✓✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✔️</td>
</tr>
<tr>
<td>Metal Hydrides</td>
<td>(gases)</td>
<td>M-H</td>
<td>✓✓✓✓✓</td>
<td>✓✓✓✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✔️</td>
</tr>
<tr>
<td>Metals (alkali)</td>
<td>M</td>
<td>✓✓✓✓✓</td>
<td>✓✓✓✓✓</td>
<td>✓✓✓✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✔️</td>
</tr>
<tr>
<td>Metals (powdered)</td>
<td>M</td>
<td>✓✓✓✓✓</td>
<td>✓✓✓✓✓</td>
<td>✓✓✓✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✔️</td>
</tr>
<tr>
<td>Nitrated</td>
<td>Nitro</td>
<td>R, Ar-NO₂</td>
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<td>✓✓✓✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✔️</td>
</tr>
<tr>
<td>Azo (aliphatic)</td>
<td>R-N=N-R</td>
<td>✓✓✓✓✓</td>
<td>✓✓✓✓✓</td>
<td>✓✓✓✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✔️</td>
</tr>
<tr>
<td>Azo (aromatic)</td>
<td>Ar-N=N-Ar</td>
<td>✓✓✓✓✓</td>
<td>✓✓✓✓✓</td>
<td>✓✓✓✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✔️</td>
</tr>
<tr>
<td>Azides</td>
<td>R, Ar-N₃</td>
<td>✓✓✓✓✓</td>
<td>✓✓✓✓✓</td>
<td>✓✓✓✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✔️</td>
</tr>
<tr>
<td>Inorganic Nitrites</td>
<td>M-NO₂</td>
<td>✓✓✓✓✓</td>
<td>✓✓✓✓✓</td>
<td>✓✓✓✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✔️</td>
</tr>
</tbody>
</table>

### HEALTH HAZARDS

<table>
<thead>
<tr>
<th></th>
<th>Corrosive</th>
<th>Toxic</th>
<th>Highly Toxic</th>
</tr>
</thead>
<tbody>
<tr>
<td>EXAMPLES (CAS No.)The following examples and their classifications represent neat, undiluted, commercially available products</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Isocyanates</td>
<td>✓✓✓✓✓</td>
<td>✓✓✓✓✓</td>
<td>✓✓✓✓✓</td>
</tr>
<tr>
<td>Metals</td>
<td>✓✓✓✓✓</td>
<td>✓✓✓✓✓</td>
<td>✓✓✓✓✓</td>
</tr>
<tr>
<td>Metal Halides</td>
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<td>✓✓✓✓✓</td>
<td>✓✓✓✓✓</td>
</tr>
<tr>
<td>Metal Hydrides</td>
<td>✓✓✓✓✓</td>
<td>✓✓✓✓✓</td>
<td>✓✓✓✓✓</td>
</tr>
<tr>
<td>Metals (alkali)</td>
<td>✓✓✓✓✓</td>
<td>✓✓✓✓✓</td>
<td>✓✓✓✓✓</td>
</tr>
<tr>
<td>Metals (powdered)</td>
<td>✓✓✓✓✓</td>
<td>✓✓✓✓✓</td>
<td>✓✓✓✓✓</td>
</tr>
</tbody>
</table>

### Examples:
- **Isocyanates**: Unstable, reactive, water reactive, oxidizer, pyrophoric, flammable, organic peroxide, combustible.
- **Metals**: Potentially reactive, water reactive, oxidizer, pyrophoric, flammable, solid, organic peroxide, combustible.
- **Metal Halides**: Unstable, reactive, water reactive, oxidizer, pyrophoric, flammable, solid, organic peroxide, combustible.
- **Metal Hydrides (solids)**: Unstable, reactive, water reactive, oxidizer, pyrophoric, flammable, solid, organic peroxide, combustible.
- **Metal Hydrides (gases)**: Unstable, reactive, water reactive, oxidizer, pyrophoric, flammable, solid, organic peroxide, combustible.
- **Metals (alkali)**: Unstable, reactive, water reactive, oxidizer, pyrophoric, flammable, solid, organic peroxide, combustible.
- **Metals (powdered)**: Unstable, reactive, water reactive, oxidizer, pyrophoric, flammable, solid, organic peroxide, combustible.
- **Nitrated compounds**: Nitro, unstable, reactive, water reactive, oxidizer, pyrophoric, flammable, organic peroxide, combustible.
- **Azo (aliphatic)**: Unstable, reactive, water reactive, oxidizer, pyrophoric, flammable, solid, organic peroxide, combustible.
- **Azo (aromatic)**: Unstable, reactive, water reactive, oxidizer, pyrophoric, flammable, solid, organic peroxide, combustible.
- **Azides**: Unstable, reactive, water reactive, oxidizer, pyrophoric, flammable, solid, organic peroxide, combustible.
- **Inorganic Nitrites**: Unstable, reactive, water reactive, oxidizer, pyrophoric, flammable, solid, organic peroxide, combustible.
Source material for the chemical families includes (S, L, G)  

<table>
<thead>
<tr>
<th>CHEMICAL FAMILY</th>
<th>CHEMICAL STRUCTURE</th>
<th>Unstable Reactive</th>
<th>Water Reactive</th>
<th>Oxidizer</th>
<th>Flammable Solid</th>
<th>Organic Peroxide</th>
<th>Flammable/ Combustible</th>
<th>HEALTH HAZARDS</th>
<th>PHYSICAL HAZARDS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inorganic Nitrites</td>
<td>M-NO₃</td>
<td>✓✓✓</td>
<td>✓✓✓</td>
<td>✓✓✓</td>
<td>✓✓✓</td>
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<td>✓✓✓</td>
<td>✓✓✓</td>
<td>✓✓✓</td>
</tr>
<tr>
<td>Nitrogen-Halogen compounds</td>
<td>R-N-X</td>
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<td>✓✓✓</td>
<td>✓✓✓</td>
<td>✓✓✓</td>
<td>✓✓✓</td>
<td>✓✓✓</td>
<td>✓✓✓</td>
<td>✓✓✓</td>
</tr>
<tr>
<td>Oxyanion</td>
<td>M-ClO₃, M-ClO₄⁻</td>
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<td>✓✓✓</td>
<td>✓✓✓</td>
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<td>✓✓✓</td>
<td>✓✓✓</td>
</tr>
<tr>
<td>Peroxides Organic</td>
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<td>✓✓✓</td>
<td>✓✓✓</td>
<td>✓✓✓</td>
<td>✓✓✓</td>
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<td>✓✓✓</td>
<td>✓✓✓</td>
</tr>
<tr>
<td>Metal / Inorganic</td>
<td>M-O-O</td>
<td>✓✓✓</td>
<td>✓✓✓</td>
<td>✓✓✓</td>
<td>✓✓✓</td>
<td>✓✓✓</td>
<td>✓✓✓</td>
<td>✓✓✓</td>
<td>✓✓✓</td>
</tr>
<tr>
<td>Phosphorus-Halogen Compounds</td>
<td>O=P-X₃, P-X</td>
<td>✓✓✓</td>
<td>✓✓✓</td>
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<td>✓✓✓</td>
<td>✓✓✓</td>
<td>✓✓✓</td>
<td>✓✓✓</td>
<td>✓✓✓</td>
</tr>
</tbody>
</table>

Notes:  
(1) *(S, L, G)* refers to whether hazards apply to "Solid," "Liquid," and/or "Gaseous" physical forms.  
(2) ✓✓✓ Indicates that most or all of the chemicals within the family or sub-family have the indicated physical and health hazards.  
(3) ✓✓ Indicates that some of the chemicals in the family may have this additional physical and health hazards.  
(4) ✓ Indicates that only a select few chemicals within a specific family display the relevant physical and health hazards.  
* Ar = phenyl ring; X = halogen (i.e., fluorine, chlorine, bromine, iodine); R = organic; M = metal.

Additional Source Material:  
http://www.epa.gov/oppt/chemrtk/pubs/update/hpvchmlt.htm  
http://www.epa.gov/oppt/chemrtk/  
## Table Descriptions

Nineteen general chemical families are listed in the first column of Table B.3.2. The chemical families include organic chemicals, inorganic chemicals, gases, and metals. Some of the general chemical families are further divided into subfamilies if one or more hazard category or categories further depend on chemical structure. The second column, Chemical Structure, shows the basic chemical formula or structure representing the chemical family and/or subfamilies.

The next several columns list the seven physical hazard categories and three health hazard categories. The specific hazard categories are defined in Chapter 3. The physical hazard categories include the following:

1. Unstable Reactive
2. Water Reactive
3. Oxidizer
4. Pyrophoric
5. Flammable Solid
6. Organic Peroxide
7. Flammable/Combustible

### Hazards of Materials

The health hazards include the following:

1. Corrosive
2. Toxic
3. Highly Toxic

Hazards categories are defined by the following symbols. A triple check mark (✓✓✓) is used to indicate that most or all of the chemicals within the family or subfamily have the indicated physical or health hazard. A double check mark (✓✓) is used to identify that some of the chemicals in the family might have this additional hazard. A single check mark (✓) indicates that only a select few chemicals within a specific family display the relevant physical and health hazard(s).

The check marks are provided to inform the user as to the likely property of materials in each of the hazard categories listed. However, it must be recognized that the ultimate classification of a material is dependent on the application of the definitions found in Chapter 3 and the interpretation of the information provided relative to tests conducted by authoritative entities within the framework established by the definitions.

The last column provides examples of chemicals with the indicated hazards. The examples illustrate materials in the concentrated or undiluted state. Concentration-specific hazards for common materials are provided in the explanatory material following the table (see Section B.5).

### Multiple Hazard Materials

A specific chemical can exhibit multiple hazard categories. In other words, there could be materials with more than one physical hazard property that also have one or more health hazard properties. The regulatory controls integral to NFPA 400 require that all hazards be addressed. It is incumbent on the code user to identify each applicable hazard property of a chemical to properly classify the hazards of the material. It should also be recognized that each of the hazards considered could be concentration dependent.

To illustrate the utility of Table B.3.2, consider the chemical family of mineral acids, listed in column 1 of Table B.3.2. Specific examples of mineral acids are listed in the last column of Table B.3.2. Well-known mineral acids are hydrochloric acid and sulfuric acid. The row entries with dashes (—) under the physical hazard categories indicate that, in general, mineral acids are not considered to have the physical hazards of being unstable/reactive, oxidizer, pyrophoric, flammable solids, organic peroxides, or flammable/combustible. Specified mineral acids are not reactive (✓) based on concentration and the specific mineral acid itself. The row entries show the principal hazard properties of mineral acids. Aromatic acids, especially Corrosive (✓✓✓), are highly reactive, highly corrosive, and toxic. The check marks under Toxic (✓) indicates that a small few of the chemicals in the mineral acid family have this additional health hazard. The one checkmark under Toxic (✓) indicates that a select few of the chemicals in the mineral acid family have this additional health hazard. The check marks under Toxic (✓) indicate that a select few of the chemicals in the mineral acid family have this additional health hazard.

Well-known mineral acids are hydrochloric acid and sulfuric acid. The row entries with dashes (—) under the physical hazard categories indicate that, in general, mineral acids are not considered to have the physical hazards of being unstable/reactive, oxidizer, pyrophoric, flammable solids, organic peroxides, or flammable/combustible. Specified mineral acids are not reactive (✓) based on concentration and the specific mineral acid itself. The row entries show the principal hazard properties of mineral acids. Aromatic acids, especially Corrosive (✓✓✓), are highly reactive, highly corrosive, and toxic. The check marks under Toxic (✓) indicates that a small few of the chemicals in the mineral acid family have this additional health hazard. The one checkmark under Toxic (✓) indicates that a select few of the chemicals in the mineral acid family have this additional health hazard. The check marks under Toxic (✓) indicate that a select few of the chemicals in the mineral acid family have this additional health hazard.

Specific examples of mineral acids are listed in the last column

### Additional Source Material


The EPA's OPPT/ChemRTK provides additional information at [http://www.epa.gov/oppt/chemrtk/pubs/update/hpvcintro.htm](http://www.epa.gov/oppt/chemrtk/pubs/update/hpvcintro.htm)

The OSHA guidance can be found at [http://www.osha.gov/SLTC/emergencypreparedness/guides/chemical.html](http://www.osha.gov/SLTC/emergencypreparedness/guides/chemical.html)

## Description of Chemical Families

### General

Dilution can cause the hazard characteristics of an individual chemical to diminish until the property is no longer pertinent. Each chemical must be individually reviewed by the manufacturer to provide the data to assess the physical and health hazards. For compressed gases, there are accepted standards that can be used to estimate both the flammability and toxicity without actual test data.

### Acids

**B.4.1.1** Acids (Carboxylic) (R-COOH, Ar-COOH).

Carboxylic acids are weak acids. Unlike mineral acids, such as hydrochloric acid. Most are readily soluble in water. Physical and health properties vary significantly based on molecular weight and the number of carboxyl groups. Smaller molecular weight aliphatic carboxylic acids (such as formic and acetic acid) are liquids and are flammable and corrosive. Larger chain, higher molecular weight carboxylic acids are often solids with minimal hazards (such as citric acid). Aromatic acids are sometimes corrosive.

**B.4.1.2** Acids (Peroxy) (R-OHO, Ar-OOH).

All peroxy acids are classified as organic peroxides and are classified as oxidizers and corrosive. Aromatic peroxy acids (such as perbenzoic acid) are solids and are unstable reactive and toxic. Most are pastes or liquids and require refrigeration. Some forms of this acid family are often found as their sodium, potassium, or ammonium salts.

**B.4.1.3** Acids (Mineral).

These are all strong acids, are liquids, and are corrosive, even in dilute solutions. These include hydrofluoric acid (HF), hydrochloric acid (HCl), hydrobromic acid (HBr), phosphoric acid (H₃PO₄), and sulfuric acid (H₂SO₄). In some cases they are toxic and water reactive depending on acid and concentration.

**B.4.1.4** Acidic (Gaseous).

The common acid gases, which include hydrogen bromide (HBr), hydrogen chloride (HCl), hydrogen fluoride (HF), and hydrogen iodide (HI), are corrosive and in some cases toxic. They are highly soluble in water, forming the corresponding aqueous acid and are packaged as liquefied compressed gases. Other acid gases include boron trifluoride (BCl₃), boron trifluoride (BF₃), and silicon tetrafluoride (SiF₄).

**B.4.1.5** Acidic (Oxidizing).

Some strong acids are also oxidizing acids, most commonly nitric acid (HNO₃). As oxidizers, they are also corrosive and toxic. These physical and health properties are exhibited even in dilute solutions.

**B.4.1.6** Alcohols.

**B.4.1.2.1** Aliphatic Alcohols (R-OH).

The category includes primary (1°), secondary (2°), and tertiary (3°) branched and cyclic alcohols. Most common alcohols include methanol, ethanol, isopropyl alcohol, 2-propanol (2-methyl-1-propanol), isobutanol (2-methyl-1-butanol), cyclohexanol. Many alcohols, especially smaller chain alcohols, are highly flammable even in dilute solutions. This generally does not hold true for the small chain glycols (or polyglycolated compounds), such as propylene glycol, which have significantly higher boiling points. Most smaller chain aliphatic alcohols are readily soluble in water. Longer chain alcohols "fatty alcohols" (e.g., dodecanol, hexadecanol and octadecanol) are solids, are not flammable, and are not miscible with water.

**B.4.1.2.2** Aromatic Alcohols (Ar-OH).

The most common aromatic alcohol is phenol (hydroxybenzene). Others include the hydroxybenzenes (e.g., catechol) and hydroxytoluenes (e.g., o-cresol). Most phenols are usually solids or high boiling point liquids and readily soluble in water. Phenol and p-cresol are highly corrosive and toxic. Functionalized phenol derivatives (e.g., 2,4-dichlorophenol), while also soluble in water, are not flammable and can be toxic. Higher molecular weight phenolics such as hydroxynaphthalenes (e.g., naphthol) can also be toxic but are not corrosive. The chemical and physical properties of aliphatic and aromatic alcohols vary significantly depending on the structure of the alcohol and other functional groups.
B.4.1.3 Alkyl Halides (R-X). This chemical family includes halogenated alkyl analogues, such as methylene chloride, chloroform, carbon tetrachloride, bromoform, dichloroethane, perchloroethylene, methyl bromide and methyl iodide, fluorothane, and Freon® derivatives. Often these chemicals are nonflammable gases and liquids, used as fire extinguishers, refrigerants, and solvents. The most widely known category is the chlorofluorocarbons (CFCs). Nonflammable gases include dichlorodifluoromethane (Freon-12). Some chemicals in this family are flammable. Highly substituted alkyl halides (i.e., those chemicals with many halogen atoms present in a molecule) such as 1,2-dichloroethane and 1,1,2,2-tetrachloroethane are liquids and toxic.

B.4.1.4 Amines.

B.4.1.4.1 Amines (Aliphatic) (R-NH₂ or R₂NH, R₃N). The aliphatic amines consist of primary (1°), secondary (2°), and tertiary (3°) branched compounds. Lower molecular weight amines such as ethylamine, propylamine, butylamine, and triethylamine are highly flammable liquids, corrosive and readily soluble in water. Some are toxic. Many amines, such as methylamine, are sold in diluted aqueous solutions, and are typically flammable. (For ammonia, see B.4.1.5.2.)

B.4.1.4.2 Amines (Aromatic) (Ar-NH₂ or Ar(N)). This family includes substituted aromatic amines, such as benzene derivatives (e.g., aniline, and o-aminophenol) and heteroaromatics (e.g., pyridine and pyrrolidine). Most of these chemicals are solids or liquids and may be readily soluble in water and are toxic. Some are flammable. Health hazards associated with these chemicals depend heavily on the ring structure, degree of substitution, and location of the nitrogen(s) within the heteroaromatic ring.

B.4.1.5 Bases.

B.4.1.5.1 Alkalis. Bases are found either as solids or as concentrated aqueous solutions. Most bases are highly corrosive with all tissues with which they come in contact. Bases, such as sodium carbonate (Na₂CO₃), sodium hydroxide (NaOH), and potassium hydroxide (KOH), readily absorb moisture from the air. When dissolved in water, these chemicals often liberate substantial heat and form corrosive solutions in concentrated form. The corrosiveness and toxicity of these chemicals decreases with dilution.

B.4.1.5.2 Carbides/Nitrides. The common basic gases, ammonia (NH₃) and the lower molecular weight amines (methylamine, dimethylamine, and trimethylamine), are all corrosive but not toxic. They are highly soluble in water and are liquefied compressed gases. The common bases are flammable gases with a narrow flammability range. They are often sold commercially as aqueous solutions, which are also flammable.

B.4.1.6 Carbides/Nitrides. Carbides have varying degrees of physical hazards. Carbides, such as calcium carbide (CaC₂) and sodium carbide (Na₂C₂), react violently with water, are flammable in the presence of moisture, and could be corrosive. Other carbides, such as zirconium carbide (ZrC), tungsten carbide (WC), and silicon carbide (SiC), have little reactivity. Nitrides, such as boron nitride (BN), are usually stable.

B.4.1.7 Carbonyl Compounds.

B.4.1.7.1 Carbonyl Compounds (Acid Anhydrides) (R₂C=O)₂. These chemicals, often referred to as simply “anhydrides,” are more reactive than their corresponding carboxylic acids. Anhydrides react with water to form the corresponding acid or acid, and are often good dehydrating agents. Lower molecular weight anhydrides, such as acetic anhydride, propionic anhydride, and isobutyric anhydride, are most often corrosive, flammable, and could react violently with water. Functionalized anhydrides such as trifluoroacetic anhydride are highly corrosive and highly water reactive. Aromatic anhydrides, such as phthalic anhydride, are also corrosive but not water reactive.

B.4.1.7.2 Carbonyl Compounds (Acid Halides) (R₂C(O)X). Lower molecular weight alkyl esters, such as methyl formate, ethyl acetate, and n-butyl acetate, are flammable liquids.

B.4.1.7.3 Carbonyl Compounds (Aldehydes) (R-CH=O, Ar-CH=O). Most aldehydes are volatile organic compounds. Simple, lower molecular weight aliphatic aldehydes, such as acetaldehyde, propionaldehyde (methylacetaldehyde), butyraldehyde, and 2-butanalddehyde (crotonaldehyde), for example, exist as liquids, and are mostly highly flammable. Formaldehyde is known to be toxic. Many aromatic aldehydes, such as benzaldehyde, have limited flammability.

B.4.1.7.4 Carbonyl Compounds (Esters) (R₂C=O)₂R₂. In general, the category possesses few physical or health hazards. Aliphatic and aromatic esters are significantly more stable than the acid anhydrides and are not water reactive. Lower molecular weight aliphatic esters, such as methyl formate, ethyl acetate, and n-butyl acetate, are flammable liquids.

B.4.1.7.5 Carbonyl Compounds (Halides) (ClO(C=O)X, C(S)X₂). These compounds are very reactive chemicals and are considered highly toxic, highly water reactive, and corrosive. Phosgene is a nonflammable gas, while thiophosgene and oxalyl chloride are liquids. Trichloromethyl chloroformate (diphosgene) and methyl chloroformate are liquids and less reactive but still water reactive.

B.4.1.7.6 Carbonyl Compounds (Ketones) (R₂C=O). Similar to aldehydes, most ketones are volatile organic compounds. Many ketones are also flammable liquids. Simple, low molecular weight ketones, such as acetone, cyclohexanone, methyl ethyl ketone (MEK), and methyl isobutyl ketone (MIBK), for example, are liquids and highly flammable. Common functionalized ketones, such as chloroacetone, 1,3-dichloro-2-propanone, and chloroacetylphene (chloroethyl phenyl ketone), while not flammable, are toxic. Many aromatic ketones have limited flammability.

B.4.1.8 Cyanides.

B.4.1.8.1 Cyanides (Gaseous). The common cyanide gases, hydrogen cyanide (HCN), cyanogen chloride (CINO), and cyanogen (C₂N₂), are highly toxic. Hydrogen cyanide is a liquid, but is treated and packaged as a gas. Cyanogen and hydrogen cyanide are flammable, while cyanogen chloride is corrosive.

B.4.1.8.2 Cyanides (Inorganic) (M-CN). Common inorganic cyanides include sodium cyanide (NaCN) and trimethylsilyl cyanide (TMSCN). This family is characterized as highly toxic. Cyanide salts are readily soluble in water and highly toxic. Trimethylsilyl cyanide is water reactive. The family does not include the many organic compounds that contain the CN group (called nitriles). Nitriles do not display the toxicity of the inorganic cyanides such as sodium and potassium cyanide.

B.4.1.8.3 Nitriles (Organic). Common, lower molecular weight nitriles, including acetonitrile and 2-propenenitrile (acrylonitrile), are highly flammable liquids and toxic. Many aromatic nitriles (benzonitriles) are solids and often toxic, depending on substituents. Benzonitriles have limited flammability.

B.4.1.9 Epoxides.

B.4.1.9.1 Epoxides are generally composed of ethylene oxide, which is a gas, and propylene oxide and 1-chloro-2,3-epoxypropane (epichlorohydrin), which are liquids. These chemicals most often have flammable, toxic, water-reactive, and unstable reactive hazard characteristics.

B.4.1.10 Ethers/Glycols (R-O-R). This broad category includes both simple alcohol ethers and polyhydroxylated glycol ethers. Simple, low molecular weight ethers such as diethyl ether or vinyl ether are low boiling, low-boiling liquids or compressed gases and highly flammable. Cyclic ethers, such as tetrahydrofuran (THF) and 1,4-dioxane, are highly flammable liquids while slightly toxic. Common higher molecular weight glycol ethers, such as 1,2-dimethoxyethane (glyme), ethylene glycol monomethyl ether (EGME), 2-methoxyethanol, dipropylene glycol monomethyl ether (DPM, 1-(2-methoxy-2-methylethoxy)-2-propanol), propylene glycol monomethyl ether (PGME, 1-methoxy-2-propanol), diethyylene glycol monomethyl ether (DEGME), and dipropylene glycol monomethyl ether (DPGME), are often water soluble liquids and combustible. Lower molecular weight ethers are often highly flammable and toxic. Many are high-boiling, high-boiling point liquids.
Cryogenic fluids are refrigerated liquefied gases with a boiling point lower than −130°F (−90°C) at an atmospheric pressure of an absolute pressure of 14.7 psi (101.3 kPa, absolute). They are maintained in the cryogenic (super-cooled) state by artificial means.

B.4.1.11.1 Gases (Flammable).

Common nonliquefied flammable compressed gases include carbon monoxide and hydrogen. Other flammable gases are hydrocarbon gases. The alkanes include methane (CH₄), ethane (C₂H₆), and propane (C₃H₈). Ethane and propane are liquefied compressed gases at ambient temperature. The alkenes include ethylene (C₂H₄) and propylene (C₃H₆), both liquefied compressed gases, and the alkynes include acetylene (C₂H₂). Acetylene is an unstable reactive gas; it is found in cylinders, packaged as a compressed gas dissolved in a solution of acetone or dimethyl formamide. While acetylene can be liquefied at ambient temperatures, for safety reasons it is shipped as a nonliquefied compressed gas.

B.4.1.11.2 Gases (Halogen).

The pure halogen gases, fluorine (F₂), chlorine (Cl₂), bromine (Br₂), and iodine (I₂), are extremely powerful oxidizers, and are corrosive and toxic. Fluorine and chlorine are only slightly soluble in water, while bromine triﬂuoride and chlorine triﬂuoride are extremely water reactive. Bromine triﬂuoride is explosive in contact with water. Fluorine is a compressed gas while chlorine, bromine triﬂuoride, and chlorine triﬂuoride are liquefied compressed gases.

Gases that are fully halogenated, such as hexaﬂuoroethane (C₂F₆), carbon tetraﬂuoride (CF₄), and sulfur hexaﬂuoride (SF₆), are inert and nonreactive.

B.4.1.11.3 Gases (Inert).

The atmospheric gases, with the exception of oxygen, have limited chemical reactivity, and are not corrosive, ﬂammable, or toxic. These gases include nitrogen, argon, and carbon dioxide. Their greatest hazard is asphyxiation. The rare gases, such as helium, neon, krypton, xenon, and argon, were once thought to be inert (having no chemical activity at all); however, with the last 20 years the compounds have been made through the use of strong oxidizer gases, such as ﬂuorine, to form nitrogen oxides.

B.4.1.11.4 Gases (Oxidizing).

The more common oxidizing gases are oxygen, nitrous oxide, and nitrogen trifluoride. Oxygen and nitrogen trifluoride are liquefied compressed gases, while nitrous oxide is a liqueﬁed compressed gas.

B.4.1.11.5 Gases (Pyrophoric).

Gases with a autoignition temperature below 130°F (54°C) are considered pyrophoric. Silane (SiH₄) is probably one of the most common pyrophoric gases found in use today. Other pyrophoric gases include methanesilane (CH₃SiH₃) and disilane (Si₂H₆). Silane and methanesilane are compressed gases, whereas disilane is a liquefied compressed gas. Some pyrophoric gases, such as phosphine (PH₃) and diborane (B₂H₆), are also highly toxic. Although all pyrophoric gases are flammable by nature, they are regulated as pyrophoric gases within the context of the model codes.

B.4.1.11.6 Gases (Sulfur Gases) (R-SH).

The common sulfur gases are hydrogen sulfide (H₂S), methyl mercaptan (CH₃SH), and carbonyl sulfide (COS) and are toxic and ﬂammable. They are all liquefied compressed gases.

B.4.1.12 Hydrocarbons.

B.4.1.12.1 Hydrocarbons (Aliphatic) (R). Commonly referred to as saturated hydrocarbons, alkanes as a whole are unreactive chemicals. The aliphatic hydrocarbons appear in decane, and cyclohexane are flammable liquids. Lower molecular weight hydrocarbons such as methane, ethane, propane, and butane are flammable compressed gases.

B.4.1.12.2 Hydrocarbons (Alkenes) (R-CR=CHR). Alkenes are a very broad category of hydrocarbons and are commonly referred to as unsaturated hydrocarbons, olefins, or vinyl compounds. Alkenes are relatively stable compounds, but are more reactive than alkanes. Smaller chain alkenes, such as ethylene, propylene, and butene, are all flammable gases and readily form explosive mixtures with air. Common derivatized alkenes, such as dicyclopentadiene, vinyl chloride (monochloroethylene), vinyl acetate, and 1,4-dichloro-2-butene, are toxic. Some are flammable liquids. They also readily polymerize (without inhibitors), which leads to unstable reactive characteristics.

B.4.1.12.3 Hydrocarbons (Alkynes) (R-CR=CHR). Of all the aliphatic hydrocarbons, alkenes are the most reactive. Many alkenes are highly reactive and considered unstable reactive, especially as molecular weights increase. Many halogenated alkenes are components of halogenated hydrocarbons. They are unstable reactive materials. The most common alkenes are gases, including acetylene (ethylene — see Flammable Gases) and methyl acetylene (propynyl). They can form explosive mixtures with air. The most common dervitized alkene is propargyl alcohol (2-propyn-1-ol), which is flammable, corrosive, and toxic.

B.4.1.12.4 Hydrocarbons (Aromatic) (R-Ar). This family is very broad and derived from such compounds as benzene and toluene and have limited alkyl (methyl, ethyl, etc.) substitution on the ring. Smaller aromatic hydrocarbons (benzene, toluene (methyl benzene), ethyl benzene, and xylenes) are flammable liquids and are sometimes toxic.

B.4.1.13 Isocyanates (R-In=C=O). Isocyanates are aliphatic isocyanates, and are toxic. They are sometimes toxic. Telene isocyanate, and isocyanate (MDI) are liquids and are typically unstable reactive, water-reactive, corrosive, and toxic. Some are highly toxic. Some are violently water reactive.

B.4.1.14 Metals.

B.4.1.14.1 Metal Alloys (M-R). Physical and health hazards of this chemical family vary significantly based on the corresponding metal. Most metal alldes are typically inert (such as sodium chloride [table salt], calcium chloride, magnesium fluoride, aluminum chloride, and palladium (II) chloride), while some have a much higher reactivity (such as silver bromide and chromium (III) chloride) and are strong oxidizers. The chemical and physical properties vary significantly depending on the metal. If a metal halide contains a heavy metal, such as lead, chromium, thallium, and mercury, it is assumed to be highly toxic. Fluoride and bromide salts are more toxic than the corresponding chloride salts.

B.4.1.14.2 Metal Hydrides (Solids). Compounds such as lithium aluminum hydride (LiAlH₄), sodium borohydride (NaBH₄), and sodium hydride (NaH) are flammable solids, water-reactive, and corrosive. Metal hydrides react violently with water.

B.4.1.14.4 Metal Hydrides (Gaseous). The more common metal hydride gases are arsine (arsenic hydride, AsH₃), diborane (boron hydride, B₂H₆), hydrogen selenide (selenium hydride, H₂Se), and phosphine (phosphorus hydride, PH₃). In general, these chemicals are toxic, liquefied compressed gases, with many being highly toxic. They are flammable and some have autodetonation temperatures low enough to start them pyrophoric, such as diborane and phospine. The key exception is silane (SiH₄), which is not toxic. Silane is a liquefied gas rather than a liquefied compressed gas.

B.4.1.14.5 Metals (Alkalis). This category includes sodium, potassium, and lithium. All are highly corrosive and can often explode if they are exposed to water. They are all flammable solids as well.
B.4.1.14.6 Metals (Powdered).
Metals, especially those in a finely divided state, are usually categorized as flammable solids, such as aluminum, magnesium, sodium, and potassium. Some, but not all, react violently and are water-reactive. Some are also toxic.

B.4.1.15 Nitrated Organic Compounds.

B.4.1.15.1 Organic Nitro Compounds (R, Ar-NO2).

Most often, smaller alkyl nitro compounds, such as nitromethane, are flammable, unstable reactive, and often toxic. Aromatic nitro analogues are toxic or highly toxic and unstable reactive, the latter being dependent on the amount of ring substitution.

B.4.1.15.2 Azido (Aliphatic) (R-N=N-R).

Aliphatic azo derivatives are inherently unstable and readily decompose, often violently, upon the application of heat. Aliphatic azo compounds are characterized as unstable reactive, flammable solids and are often toxic.

B.4.1.15.3 Azo (Aromatic) (R-N=N-N=N-Ar).

Aromatic azo derivatives have superior thermal stability properties compared to aliphatic azo derivatives. Many aromatic azo derivatives are quite stable and often used as dyes. They have a wide array of chemical and physical properties depending on the substituents on the aromatic ring and the number of azo groups present in the molecule (mono-, di-, tri-, tetra-, etc.). Most exhibit low to moderate toxicity.

B.4.1.15.4 Azoxy (R, Ar-NO3).

The most common chemicals of this family are the metal azides, including sodium and lithium azide. All the compounds in this family are unstable reactive and highly toxic.

B.4.1.15.5 Nitrates (Inorganic) (M-NO3).

The most common nitrates are sodium and potassium nitrate. All are strong oxidizers and toxic.

B.4.1.15.6 Nitrates (Inorganic) (M-NO2).

Examples of inorganic nitrates include sodium nitrate, silver nitrate, zinc nitrate, lithium nitrate, and lead nitrate. While all inorganic nitrates are strong oxidizers, the physical and health properties vary significantly depending on the metal. Many of these compounds are corrosive and may have unstable reactive properties. Toxicity varies with the associated metal.

B.4.1.16 Nitrogen-Halogen compounds Compounds (R-N-X).

This chemical family includes chlorinated isocyanurates (trichloroisocyanuric acid, sodium dichloroisocyanurate), halogenated succinimides (N-bromosuccinimide), and halogenated hydantoin (e.g., 1-bromo-3-chloro-5,5-dimethylhydantoin). Some are strong oxidizers and corrosive in their pure states, with varying properties of unstable reactive, water-reactive, and toxicity hazards. Specially formulated chlorinated isocyanurate products have been shown to reduce oxidizer properties.

B.4.1.17 Oxynitrogen (M-ClO2, M-CO2, M-Cl, M-O).

This chemical family includes chlorates, chlorites, perchlorates, bromates, and hypochlorites. The most common chemicals are sodium chlorite (NaClO2), sodium chlorate (NaClO3), ammonium perchlorate (NH4ClO4), potassium bromate (KBrO3), and calcium hypochlorite (Ca(OCl)2). Most are strong oxidizers and corrosive in their pure states with varying properties of unstable reactive, water reactive, and toxicity hazards. Chlorites and chlorates are most commonly found as dilute solutions that reduce toxicity and oxidizing properties. Specially formulated calcium hypochlorite products have been shown to reduce their oxidizing properties. Sodium hypochlorite (liquid bleach) is too unstable in solid form and is found only in dilute solutions that are corrosive.

B.4.1.18 Peroxides.

B.4.1.18.1 Peroxides (Organic) (R-O-O-R).

The common organic peroxides include such chemicals as t-amyl hydroperoxide, dibenzyl peroxide, di-tert-butyl peroxide, diacetyl peroxide, methyl ethyl ketone peroxide, diisopropyl peroxypivalonate, and cumyl hydroperoxide. Organic peroxides possess a wide range of properties based on the many physical forms and concentrations and have a large range of safety-related properties, including physical as well as health hazards. Organic peroxides are either used as the technically pure compound or as formulations where the peroxide might be found in a diluted form, such as solutions, pastes, or solid granules. Organic peroxide formulations vary in reactivity hazard from self-extinguishing to the potential for a violent deflagration or detonation. Decomposition can be initiated by heat, friction, mechanical shock, or contamination, though sensitivity to these stimuli varies greatly. Dilution with water or other solvents is used as a means to reduce the level of sensitivity to outside stimuli and the potential for decomposition. Refrigeration is also used as a means to reduce the potential for decomposition. The health hazards of these materials as provided in commerce vary greatly depending on concentration and formulation itself.

B.4.1.18.2 Metal Peroxides (Inorganic) (M-O-O).

Metal peroxides, such as sodium peroxide and calcium peroxide, are all oxidizers. Some are corrosive and water reactive. Reaction with water can be explosive in some instances.

B.4.1.19 Phosphorus-Halogen Compounds (Dihalogen monoxide).

These phosphorus analogues are corrosive and often react violently with water and include such chemicals as phosphorus oxychloride (POCl3), phosphorus trichloride (PCl3), and phosphorus pentachloride (PCl5). They are water reactive, corrosive, and toxic.

B.5 Hazard Category Based on Concentration.

B.5.1 General.

Some chemicals exhibit different physical and/or health hazards based on the concentration. Some pertinent examples of concentration-dependent hazards of specific chemicals are provided in the following list. Additional information on concentration-dependent hazards should be contained in the SDS.

(1) Acetic Acid (64-19-7).
Concentration: 100 percent — corrosive, flammable/combustible; 36 percent aqueous — corrosive; <5 percent aqueous — not corrosive.

(2) Ammonia (7664-41-7).
Concentration: anhydrous — corrosive, flammable gas; <50 percent aqueous — not corrosive.

(3) Formaldehyde (50-00-0).
Concentration: anhydrous — corrosive, highly toxic; 37 percent aqueous — combustible, highly toxic; 10 percent aqueous — combustible.

Concentration: anhydrous — corrosive, water reactive, toxic; 10–48 percent — corrosive, toxic; 2–10 percent aqueous — corrosive.

(5) Nitric Acid (7697-32-7).
Concentration: 7–40 percent aqueous — oxidizer, corrosive; 1–6 percent aqueous — not oxidizer, not corrosive.

(6) Phosphine (CAS numbers based on concentration).
Concentration: 5 percent phosphine, 95 percent nitrogen — pyrophoric; toxic; phosphine: 2 percent phosphine, 98 percent nitrogen — toxic.

(7) Phosphoric Acid (7664-38-2).
Concentration: 85–98 percent aqueous — corrosive; <80 percent aqueous — not corrosive.

Concentration: 100 percent — corrosive, water reactive, toxic; 45 percent aqueous — corrosive, water reactive; 5 percent aqueous — corrosive.

(9) 2-Propanone (Isopropanol) (67-63-0).
Concentration: >91 percent aqueous — flammable; 20–50 percent aqueous — combustible.

(10) Sodium chlorate (7775-09-9).
Concentration: 100 percent — corrosive, oxidizer, unstable reactive; 40–50 percent aqueous — corrosive, oxidizer.

(11) Sodium hydroxide (1310-73-2).
Concentration: 100 percent — corrosive, water reactive, toxic; 1–50 percent aqueous — corrosive.

(12) Sulfuric Acid (7694-32-0).
Concentration: 92–98 percent aqueous — corrosive, water reactive, toxic; 12.7–50 percent aqueous — corrosive, water reactive, toxic; 4–12.6 percent aqueous — corrosive.

(13) Sodium Hypochlorite (7087-52-9).
Concentration: 12–15 percent aqueous — corrosive; 3–5 percent aqueous — not corrosive.

B.6 Safety Data Sheets (SDS).

B.6.1 General.

Safety data sheets (SDS) have been established as a primary means of hazard identification under OSHA’s Hazard Communication program. SDSs are provided by manufacturers or importers as a means to communicate hazards within a set of standardized terms and elements or bodies of information.
In 2012, OSHA revised its Hazard Communication Standard to align with the United Nations Globally Harmonized System of Classification and Labelling of Chemicals (GHS). The Hazard Communication Standards require the use of a 16-section format for SDSs, similar to that of the ANSI format. As manufacturers and distributors transition to the 16-section SDS format, they will include information in the sections referenced in B.2. In order to classify the hazards of a given material, users should refer to key sections of the SDS that contain the following information:

1. **Product identification** (SDS Section 1)
2. **Hazard (hazards) identification** (SDS Section 2)
3. **Composition/information on ingredients** (SDS Section 3)
4. **Physical and chemical properties** (SDS Section 9)
5. **Stability and reactivity** (SDS Section 10)
6. **Toxicological information** (SDS Section 11)
7. **Transportation transport information** (SDS Section 14)

Each section should contain relevant information that can be used in the hazard classification process. The following paragraphs subsections provide useful information to help the user with these required SDS sections.

**B.6.2.1 Product identification.**

**Product identification** will typically include the chemical name, common name, and synonyms. Pure materials, sometimes referred to as “neat” to indicate that they are in an undiluted form, are typically referred to by their chemical name. However, it is not uncommon to find that the manufacturer has identified the material under a trade name chosen by that particular manufacturer. Chemical synonyms will frequently be shown; however, it should be expected that the list of synonyms may vary or be an abbreviated listing and that there may be other names that are not listed.

For chemical mixtures the material will typically be identified by its trade name. Some confusion can be created when a material in its “neat” form is further identified in the Hazard Identification section as containing other constituents. Commercially available materials even in the pure or neat form contain impurities from the manufacturing process. Although there is no hard-and-fast rule, materials in concentrations of 95 percent or greater are generally considered to be in the pure form and are referred to by the CASRN for the major component. The impurities from manufacturing are generally not considered for the purposes of material identification and such materials are not considered to be “mixtures” of chemicals per se.

The product identification section provides additional information, including the identification of the manufacturer of the material and nomenclature intended to link the SDS to the label, labeler, and even the container as furnished by the manufacturer.

The composition of the material or information on ingredients is either incorporated into or follows the material and company identification. The composition section typically lists the material as components as identified by OSHA, and not those categories used by NFPA. Although the OSHA hazard categories have been incorporated into the regulatory scheme used by NFPA, there are differences and the converse is not true. For example, OSHA does not incorporate the traditional NFPA hazard class.

In addition to the product identifier, Section 1 of the SDS will list the chemical name, and the name, address, and phone number of the responsible party.

The primary differences center on the use of types of hazards that are not included in the OSHA approach. For example, similar to NFPA, the Hazard Communication Standard requires that hazardous chemicals be classified according to the severity of hazard presented by the chemical. However, the hazard categories defined and assigned by the Hazard Communication Standard are different than those used by NFPA. For example, the Hazard Communication Standard defines oxidents differently than the NFPA (see Annex 1 for a comparison of these definitions). Within the hazard category of oxidizer, there are four subcategories orClasses of hazards recognized under the NFPA system, namely, Class 1, Class 2, Class 3, and Class 4 materials. Hazard classes are used to describe a range of hazards within a given hazard category, and the class system is used for materials that are oxidizers other than oxidizing gases, organic peroxides, unstable reactives, and water reactives. Although not subject of regulation by NFPA 400, flammable liquids are further subdivided into Class I, Class II, Class III, and combustible liquids are further subdivided into Class IIA, IIB, and IIC liquids.

The composition section is required to list components of a material that are present in concentrations of 1 percent or more. For materials that are identified as carcinogens under the OSHA definition, the material must be listed if its concentration exceeds 0.1 percent. The SDS may also list components that are nonhazardous. The CASRN for each component is typically listed in this section of the SDS.

**B.6.2.2 Hazards Identification.**

Section 2 of the SDS lists the hazard identification of the chemical, including the classification of the chemical, signal word, the pictogram(s), hazard statement(s), description of hazard(s), and precautionary statements. SDS Section 2 also describes hazards that are not otherwise classified.

The hazard identification section of the SDS is used to provide complete overview of the material to include a description of its physical properties, including its physical state (solid, liquid, gas). The matrix typically provides general information on significant physical hazards (e.g., fire, explosion, and reactivity), as well as information on potential health effects that can result from exposure to the material. While the information is useful in terms of a gross assessment of hazards, additional information found elsewhere in the SDS is needed in order to properly classify the material, and includes information on health and physical hazards that can result from exposure to the material.

**B.6.2.3 Composition/information on ingredients.**

The composition section is required to list hazardous components of a material and are themselves classified and contribute to the classification of the chemical. For mixtures, the composition section must also list the chemical name and concentration of all ingredients classified as health hazards and that are present above their cut-off concentration limits or present a health risk below the cut-off concentration limits. The SDS can also list components that are nonhazardous. The CASRN for each component is typically listed in this section of the SDS.
Section 9 of the SDS lists the physical and chemical properties of the materials. A description of its physical properties, including its physical state (i.e., solid, liquid, gas), is required. It is typical to find a wide array of physical and chemical properties listed. Examples of some of the physical and chemical properties of interest include, but are not limited to required in SDS Section 9 include the following:

1. Appearance (color, physical form, state, shape, color, and so on)
2. Odor
3. Odor threshold
4. pH
5. Melting/freezing point (specify which)
6. Initial boiling point and boiling range
7. Flash point
8. Evaporation rate
9. Flammability (solid, gas)
10. Upper/lower flammability or explosive limits
11. Vapor pressure
12. Vapor density
13. Specific gravity or relative density
14. Solubility (specify solvent, e.g., water)
15. Partition coefficient n-octanol/water
16. Auto-ignition temperature
17. Decomposition temperature
18. Viscosity

Section 11 of the SDS lists information about the stability and reactivity of materials. This section typically describes conditions under which affect the intrinsic stability of a material. An intrinsic property is a property that is inherent in the material in and of itself, as compared to its properties under conditions that are brought about by the environment in which it is located. Environmental conditions can be described as extrinsic conditions, such as when the material is exposed to heat, fire, shock, or other effects.

This section of the SDs is used as a means to assess its nature within the context of the unstable reactive hazard category. While many materials have an intrinsic stability, they can become unstable when exposed to high temperatures or mechanical or physical shock. Therefore, the information found on an SDS might have to be supplemented by referring to other authoritative sources regarding the reactivity of the material.

Section 14 of the SDS lists the toxicity information. The section on toxicological properties contains information on the health effects of the material or its components. It typically supports the detail provided in the section on hazards identification in the SDS. The information provided is written for use by health care professionals and those that have the technical training and experience in the safety and toxicology aspects of interface with materials from a toxicological perspective.

However, this section of the SDS contains information that is used to establish the approach to control integral to NFPA 400 with respect to toxicity and corrosivity. Data including the effects of acute exposure to mammals and other life forms or information regarding the irreversible destruction of tissue at the site of contact will be found in this section of the SDS.

There may also be other information relating to the toxicological effects resulting in, but not limited to, irritation, sensitization, carcinogenicity, reproductive effects, and genetic and target organ effects, none of which fall under the scope of NFPA 400.

Transportation.

The Section 14 of the SDS lists the system of classification used by the Department of Transportation (DOT), to classify materials for shipment purposes, which is not compatible with the system used to classify materials within the context of NFPA 400. With the alignment to the United Nations Globally Harmonized System of Classification and Labeling of Chemicals (GHS), it is required that although the DOT Department of Transportation (DOT), it must be recognized that although the OSHA OSHA’s system of hazard communication has some similarity but may become harmonized with the system used by the DOT Department of Transportation, it is not fully compatible. The OSHA OSHA’s system used SDS, correlates with the DOT regulations for transporting hazardous chemicals, located in 49 CFR as developed for transportation purposes. The OSHA system contemplates that users and producers of hazardous materials will encounter these materials in their unpackaged state where the materials are reasonably foreseeable to have a potential for bodily contact or use within the work environment on a regular basis. On the other hand, the DOT system of control views the materials in their final packaging as required for transportation where the materials are not subject to exposure to personnel except under upset conditions. However, with the effort to implement the United Nations Globally Harmonized System of Classification and Labelling of Chemicals, this may change.

These differences aside, Because OSHA does not enforce the contents of Section 14 of the SDS, users may find additional information in the section for transportation on the SDS, which may or may not be further explained in preceding sections. It is important to recognize that the classification for the purposes of transportation will not suffice as a means to assign the material to a given hazard category under the requirements of NFPA 400, and the user must carefully apply the material specific definitions found in Chapter 3 along with the criteria obtained from the SDS and other resources to determine the appropriate classification of a given material.

Supplemental Information

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Submitter Information Verification

Submitter Full Name: [Not Specified ]
Organization: [Not Specified ]
Street Address: [Not Specified ]
City: [Not Specified ]
State: [Not Specified ]
Zip: [Not Specified ]
Submit Date: Tue Aug 05 15:47:29 EDT 2014

Committee Statement

Committee Statement: Changes made to B.2 to match extracted text from current edition of NFPA 5000.

Changes to the text in Annex B are proposed because OSHA updated its Hazard Communication Standard (29 CFR 1910.1200) to align with the GHS.

See attached document for full Annex B Revision.

Response Message:
Annex B  Chemical Data

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

B.1 General.

The information provided in Annex B is not a part of the requirements of this document but is included for informational purposes.

B.2 Hazard Recognition.

Chapter 5 introduces the concepts of control areas and MAQs. The purpose is to permit limited amounts of hazardous materials in occupancies having minimum controls without triggering the more restrictive Protection Level 1 through Protection Level 5 building requirements. The allowable quantities in Table 5.2.1.1, Table 5.2.1.2 through Table 5.2.1.8, and Table 5.2.1.10 are based on demonstrated need and historical safe storage and use of hazardous contents. The preponderance of provisions contained in Chapter 6 and those of Chapters 11 through 21 establish additional controls for occupancies exceeding the hazardous materials limits (MAQs) prescribed for control areas.

Not all of the hazardous materials categories are placed into the high hazard category, and some of these materials (contents) have been recognized as being of low or ordinary hazards, depending on their nature in a fire. For example, Class IIIB combustible liquids, Class 1 unstable (reactive) materials, Class 1 oxidizing solids and liquids, and Class IV and Class V organic peroxides are hazardous materials, which, in some cases, do not have a MAQ and, therefore, are not required to comply with the requirements for Protection Level 1 through Protection Level 5. Some materials, though classified as high hazard, such as aerosols, are exempt from the requirements of NFPA 400, as they are regulated elsewhere within the regulatory scheme developed by NFPA in the code. For additional exceptions, see 1.1.2.

Figure B.2 helps to illustrate the conditions under which the protection level requirements are applicable. [5000: A.34.1.1]

****INSERT FIGURE HERE****

FIGURE B.2  Flow Chart Illustrating Protection Level Applicability. [5000:Figure A.34.1.1]

Material safety data sheets (MSDS) are used as a primary means to assess the hazards of a specific material. In the U.S., the OSHA Hazard Communication Rule (29 CFR 1900.1200)
prescribes what information is to be provided by the MSDS. Over the years, there have been a number of guidelines prepared that describe the information that is to be included. ANSI Z400.1, Hazardous Industrial Chemicals—Material Safety Data Sheets—Preparation, specifies the general layout of the MSDS, including 16-section headings format with standardized wording, headings, the numbering and order of these headings, and the information required to complete the an-MSDS. The major headings of this standard include:

Section 1: Product and Company Identification

Section 2: Hazard(s) Identification

Section 3: Composition/Information on Ingredients

Section 4: First-Aid Measures

Section 5: Fire-Fighting Measures

Section 6: Accidental Release Measures

Section 7: Handling and Storage

Section 8: Exposure Controls/Personal Protection

Section 9: Physical and Chemical Properties

Section 10: Stability and Reactivity

Section 11: Toxicological Information

Section 12: Ecological Information

Section 13: Disposal Considerations

Section 14: Transport Information

Section 15: Regulatory Information

Section 16: Other Information, including date of preparation or last revision

The American Chemical Society publishes chemical abstracts as pointers to the chemical literature. Since 1907, their Chemical Abstracts Service (CAS) has indexed and summarized chemistry-related articles from more than 40,000 scientific journals, in addition to patents, conference proceedings, and other documents pertinent to chemistry, life sciences, and many other fields. In total, abstracts for more than 25 million documents are accessible online through CAS.

Substance identification is a special strength of CAS. It is widely known as the CAS Registry, the largest substance identification system in existence. When CAS processes a chemical substance newly encountered in the literature, its molecular structure diagram, systematic chemical name, molecular formula, and other identifying information are added to the Registry, and it is assigned a unique CAS Registry Number. The Registry now contains records for more than 30 million organic and inorganic substances and more than 58 million sequences.
Individual chemicals are identified through the use of a CAS registry number, commonly referred to as the CAS number or CASRN. The number, which has no chemical significance, is used to link the material through its molecular structure into an index system where the Chemical Abstracts name is provided.

The CAS number is unique for each given material; however, with few exceptions, mixtures of chemicals are not assigned a CAS number per se, since each individual component of the mixture has its own unique CAS number. For the purposes of hazard classification and the application of NFPA 400, there are three primary identifiers for each chemical that must be known:

1. CAS number (unless it is a chemical mixture)
2. Concentration (typically expressed in weight percent for solids or liquids and volume percent for gases)
3. Physical state (solid, liquid, or gas)

For example, consider the material hydrochloric acid, also called hydrogen chloride. It can exist in the anhydrous form (as a gas) or in a water solution as the aqueous liquid material of varying concentrations. The hazard properties of the material vary with the form.

The regulatory approach used by NFPA 400 is based on hazard classification of the materials to be regulated. The materials under consideration must be evaluated to classify their hazards within the context of the code. The starting point begins with the MSDS, where the material can be identified by name, and other information, such as CAS registry number and physical state, is provided. Although there are 16 different main headings in the MSDS, the primary need for classification of materials rests with determining the physical and health hazards of the material or mixture in question.

Within the context of NFPA 400, the user must determine whether the physical and/or health hazards of the material place it into one or more of the following hazard categories:

1. Corrosive solids and liquids
2. Flammable solids
3. Organic peroxide formulations
4. Oxidizer solids and liquids
5. Pyrophoric solids and liquids
6. Toxic and highly toxic solids and liquids
7. Unstable (reactive) solids and liquids
8. Water-reactive solids and liquids

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Each of the hazard categories can be further subdivided into subcategories, each with its attendant hazard properties. For example, oxidizer solids and liquids are subdivided into Class 4, Class 3, Class 2, and Class 1 subcategories commonly referred to as the hazard class.

Although it might be expected that the above nomenclature would appear on the MSDS, this is not always the case. Appendices A and B of OSHA’s Hazard Communication Rule (29 CFR 1900.1200) identify specific health and physical hazards that may differ from that of NFPA 400. Terms used in NFPA 400 are consistent with those used in other NFPA standards and codes. Please see Annex J of NFPA 400 for a comparison of these hazard definitions. Therefore, the user must review the physical and chemical properties, as well as the health hazard information provided, in order to make a determination as to the appropriate hazard category and class for the material being regulated.

### B.3 Chemical Family — A Pointer to Hazard Classification.

#### B.3.1 General.

It is quite common that preparers of MSDS indicate the chemical family to which a material belongs, that is, the group of chemical substances that have a similar molecular structure. For example, materials such as acetone, methyl ethyl ketone, and amyl ethyl ketone are members of the ketone family. While the properties of various hazardous materials within a chemical family may vary, the chemical family becomes a pointer to the more likely hazard categories of the material under consideration.

While hundreds of thousands of chemicals are in use, this annex categorizes the more commonly used industrial chemicals into chemical families or unique groupings that have similar properties. Materials and/or chemicals exhibit a wide range of properties, some of which are hazardous. This code provides guidance for known physical and health hazards of materials within its scope.

#### B.3.2 Chemical Families Related to Hazard Category.

Table B.3.2 provides a summary of chemical families with associated physical and health hazard properties, which are subdivided into specific categories. This table is for informational purposes only. The physical and health hazards indicated are broad representations for the various chemical families. These classifications are not intended to cover all the hazards of a material. A more detailed description of the chemical families, subfamilies, and chemical structure of specific hazards are contained in the explanatory material following the table. For specific information, the chemical-specific MSDS must be consulted. Additional information can be obtained from the manufacturer.

<table>
<thead>
<tr>
<th>CHEMICAL FAMILY(1)</th>
<th>CHEMICAL STRUCTURE</th>
<th>PHYSICAL HAZARDS (2,3)</th>
<th>HEALTH HAZARDS (2,3)</th>
<th>EXAMPLES (CAS No.) The following examples and their</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Unstable</td>
<td>Water React</td>
<td>Oxidizer</td>
</tr>
<tr>
<td></td>
<td></td>
<td>React</td>
<td>React</td>
<td>Oxidizer</td>
</tr>
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### Acids

<table>
<thead>
<tr>
<th>Classification</th>
<th>Example Products</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carboxylic (R-COOH, Ar-COOH)</td>
<td>Formic acid (64-18-6), acetic acid (64-19-7), benzoic acid (65-85-0), acrylic acid (79-10-7), oxalic acid (144-62-7), propanoic acid (79-09-4), 4-amino-3,5,6-trichloropicolinic acid (1918-02-1), 2-hydroxybenzoic acid (69-72-7), citric acid (77-92-9), benzoic acid (65-85-0)</td>
</tr>
<tr>
<td>Peroxy (R-OOH, Ar-OOH)</td>
<td>Peroxyacetic acid (79-21-0), m-chloro perbenzoic acid (937-14-4), peroxymonosulfuric acid (7722-86-3)</td>
</tr>
<tr>
<td>Mineral</td>
<td>Hydrochloric acid (7647-01-0), sulfuric acid (7664-93-9), phosphoric acid (7664-38-2)</td>
</tr>
<tr>
<td>Gaseous</td>
<td>Hydrogen chloride (7647-01-0), hydrogen bromide (10035-10-6), hydrogen fluoride (7664-39-3), boron trifluoride (10294-34-5), boron trifluoride (7637-07-2)</td>
</tr>
<tr>
<td>Oxidizing</td>
<td>Nitric acid (7697-37-2), chloric acid (7790-93-4), chlorosulfonic acid (7790-94-5)</td>
</tr>
</tbody>
</table>

### Alcohols

<table>
<thead>
<tr>
<th>Classification</th>
<th>Example Products</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aliphatic (R-OH)</td>
<td>Methanol (67-56-1), ethanol (64-17-5), isopropanol (67-63-0), t-butanol (75-65-0), glycerol (56-81-5), 1-hexanol (111-27-3), 2-octanol (123-96-6)</td>
</tr>
<tr>
<td>Aromatic (Ar-OH)</td>
<td>Phenol (108-95-2), 1,2-dihydroxybenzene (catechol) (120-80-4)</td>
</tr>
<tr>
<td>Alkyl halides</td>
<td>R-X</td>
</tr>
<tr>
<td>--------------</td>
<td>-----</td>
</tr>
<tr>
<td>Amines</td>
<td>Aliphatic, organic</td>
</tr>
<tr>
<td>Aromatic</td>
<td>Ar-NH₂, Ar(N)</td>
</tr>
<tr>
<td>Bases</td>
<td>Alkalis</td>
</tr>
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</table>

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<table>
<thead>
<tr>
<th>Gaseous</th>
<th>hydroxide (1310-58-3), sodium carbonate (497-19-8)</th>
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</thead>
<tbody>
<tr>
<td>Ammonia (7664-41-7),</td>
<td></td>
</tr>
<tr>
<td>methylamine (74-89-5),</td>
<td></td>
</tr>
<tr>
<td>trimethylamine (75-50-3)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Carbides / Nitrides</th>
<th>Calcium carbide (75-20-7), lithium nitride (26134-62-3), gallium nitride (25617-97-4), boron nitride (10643-11-5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>M-C₂, M-N</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Carbonyl compound s</th>
<th>Acid anhydride</th>
<th>R₁ C(O)OC( O)-R₂</th>
<th>n-Butyric anhydride (106-31-0), maleic anhydride (108-31-6), propionic anhydride (123-62-6), isobutyric anhydride (97-72-3), phthalic anhydride (85-44-9), acetic anhydride (108-24-7), trifluoroacetic anhydride (407-25-0)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acyl halides</td>
<td>R, Ar C(O)X,</td>
<td></td>
<td>Acetyl chloride (75-36-5), sulfonyl chloride (7791-25-5), benzyol chloride (98-88-4), methanesulfonyl chloride (124-63-0), p-toluene sulfonyl chloride (98-59-9), trichloroacetyl chloride (76-02-8), pivaloyl chloride (3266-49-3)</td>
</tr>
<tr>
<td>Aldehydes</td>
<td>RCH=O, Ar-CH=O</td>
<td></td>
<td>Formaldehyde (50-00-0), acetaldehyde (75-07-0), butyraldehyde (123-72-8), benzaldehyde (100-52-7), 2-butenal (crotonaldehyde) (4170-30-3), n-valeraldehyde (110-62-3), p-methoxybenzaldehyde (4-anisaldehyde) (123-11-5), 2-</td>
</tr>
</tbody>
</table>
| Esters | $R_1(C=O)\text{OR}_2$ | - | - | - | - | - | ✓ | - | - | propenal (acrolein) (107-02-8)  
| | | | | | | | | | Methyl formate (107-31-3), methyl acrylate (2-propenoic acid methyl ester), (96-33-3), benzenedicarboxylic acid dioctyl ester (117-84-0), ethyl ethanoate (ethyl acetate) (141-78-6), butanedioic acid dimethyl ester (dimethyl fumarate) (106-65-0), oleic acid methyl ester (112-62-9), n-butyl acetate (123-86-4) |
| Halides | $C(O)X_2$, $C(S)X_2$ | ✓ | ✓✓✓ | - | - | - | ✓ | ✓✓ | ✓ | Phosgene (75-44-5), carbonyl fluoride (353-50-4), thiophosgene (463-71-8), oxalyl chloride (79-37-8), trichloromethyl chloroformate (diphosgene) (503-38-8), methyl chloroformate (79-22-1) |
| Ketones | $R_1R_2C=O$ | - | - | - | - | - | ✓✓✓ | - | ✓ | Methyl propyl ketone (107-87-9), methyl isovalyl ketone (110-12-3), acetone (67-64-1), cyclohexanone (108-94-1), 1-chloro-2-propanone (chloroacetone) (78-95-5), 2-butane (methyl ethyl ketone) (78-93-3), cyclopentanone (120-92-3), acetonophenone (98-86-2), methyl isobutyl ketone (108-10-1), limonene (138-86-3), 1,3-dichloroacetone (534-07-6) |
| Cyanides | Gaseous | - | - | - | - | - | ✓ | ✓ | - | Hydrogen cyanide (74-90-8), cyanogen chloride (506-77-4), cyanogen (460-19-5) |
| Inorganic | M-CN | - | ✓ | - | - | - | - | - | ✓ | Sodium cyanide (143-33-9) |
### Organic (nitriles)

<table>
<thead>
<tr>
<th>R, Ar-CN</th>
<th>Acetonitrile (75-05-8), benzonitrile (100-47-0), chloroacetonitrile (107-14-2), 2-propenenitrile (acrylonitrile) (107-13-1), butyronitrile (109-74-0)</th>
</tr>
</thead>
</table>

### Epoxides

| Ethylene oxide (75-21-8), propylene oxide (75-56-9), 1,2-epoxybutane (106-88-7), 1-chloro-2,3-epoxypropane (epichlorohydrin) (106-89-8) |

### Ethers/glycols

| 1,2-Dimethoxyethane (glyme) (110-71-4), diethyl ether (60-29-7), furan (110-00-9), tetrahydrofuran (THF) (109-99-9), polyethylene glycol (25322-68-3), 1,4-dioxane (123-91-1), 1,3-butylene glycol (107-88-0), methyl vinyl ether (107-25-5), ethylene glycol monomethyl ether (EGME, 2-methoxyethanol) (109-86-4), dipropylene glycol monomethyl ether (DPM, 1-(2-methoxy-2-methylethoxy)-2-propanol) (34590-94-8) |

### Gases

| Acetylene (74-86-2), hydrogen (1333-74-0), methane (74-82-8), propane (74-98-6) |

### Halogens

<p>| Chlorine (7782-50-5), fluorine (7782-41-4), bromine trifluoride (7787-71-5), chlorine trifluoride (7790-39-6) |</p>
<table>
<thead>
<tr>
<th>Nonflammable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon dioxide</td>
</tr>
<tr>
<td>Helium</td>
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<td>Argon</td>
</tr>
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<td>Bromine pentafluoride</td>
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<tr>
<td>Oxygen</td>
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<tr>
<td>Silane</td>
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<tr>
<td>Methyl silane</td>
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<td>Disilane</td>
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<th>Sulfur Gases</th>
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<tbody>
<tr>
<td>Hydrogen sulfide</td>
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<tr>
<td>Cyclopentane</td>
</tr>
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<td>Hexane</td>
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<tr>
<td>Dodecane</td>
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<td>Butane</td>
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<table>
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<th>Alkenes</th>
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<tbody>
<tr>
<td>Vinyl acetate</td>
</tr>
<tr>
<td>Vinyl benzene (styrene)</td>
</tr>
<tr>
<td>Vinyl chloride</td>
</tr>
<tr>
<td>Ketene</td>
</tr>
<tr>
<td>1-butene</td>
</tr>
<tr>
<td>2-methylbutene</td>
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<tr>
<td>1,1,1,4,4,4-hexafluoro-2-</td>
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<tr>
<td>butyne</td>
</tr>
<tr>
<td>2-butyne</td>
</tr>
<tr>
<td>1,4-diol</td>
</tr>
<tr>
<td>1-propyne</td>
</tr>
<tr>
<td>2-propyn-1-ol</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Aromatic Ar</th>
</tr>
</thead>
<tbody>
<tr>
<td>Benzene</td>
</tr>
<tr>
<td>Toluene</td>
</tr>
<tr>
<td>Cumene</td>
</tr>
<tr>
<td>Naphthalene</td>
</tr>
<tr>
<td>Chlorobenzene</td>
</tr>
<tr>
<td>1,2,3-trichlorobenzene</td>
</tr>
</tbody>
</table>

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<table>
<thead>
<tr>
<th>Isocyanates</th>
<th>R-</th>
<th>N=C=O,</th>
<th>Ar-</th>
<th>N=C=O</th>
<th>Toluene diisocyanate (TDI) (584-84-9), methylene bisphenyl isocyanate (MDI) (101-68-8), hexamethylene diisocyanate (HDI) (822-06-0), p-toluenesulfonyl isocyanate (4083-64-1), methyl isocyanate (624-83-9)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Metals</td>
<td>M-R</td>
<td>-</td>
<td>✓✓✓</td>
<td>-</td>
<td>✓✓✓</td>
</tr>
<tr>
<td>Metal</td>
<td>M-X</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
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<tr>
<td>Metal</td>
<td>M-H</td>
<td>-</td>
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</tr>
<tr>
<td>Metal</td>
<td>M-H</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>
**Metals (alkali)**
|   | M     | - | - | - | - | - | - | - | - | Sodium (7440-23-5), lithium (7439-93-2), potassium (7440-09-7) |

**Metals (powdered)**
|   | M     | - | - | - | - | - | - | - | - | Aluminum (7429-90-5), magnesium (7439-95-4), titanium (7440-32-6), zirconium (7440-67-7) |

**Nitrate compounds**
| Nitro compounds | R, Ar-NO₂ | ✓ | ✓ | ✓ | ✓ | - | - | - | - | Nitromethane (75-52-5), o-nitroaniline (88-74-4), dinitrotoluene (25321-14-6), p-dinitrobenzene (100-25-4), m-nitrotoluene (99-08-1), 1-chloro-4-nitro-benzene (100-00-5), p-nitrophenol (100-02-7), nitro-p-nitroaniline (100-01-6), 1,4-diamino-2-nitrobenzene (5307-14-2), 1-nitropropane (108-03-2) |

**Azo (aliphatic)**
| R-N=N-R | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | Diethyl azodicarboxylate (197228-7), 1,1'-azobis(cyanocyclohexane) (209498-6), 2,2'-azobis(2-methylbutyronitrile) (1347208-7), azoisobutyronitrile (AIBN) (78-67-1), 2,2'-azobis(2,4-dimethylvaleronitri le) (441911-8) |

**Azo (aromatic)**
<p>| Ar-N=N-Ar | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | Azobenzene (10333-3), p-aminoazobenzene (Aniline Yellow) (60-09-3), p-dimethylaminooz benzene-sulfonic acid (Methyl Orange) (54758-0), 1-(2-methoxyphenylazo)-2-naphthol (Sudan Red G) (122955-6), 4-acetamido-2'-hydroxy-5'-methylazobenzene (Disperse Yellow 3) (283240-8), 4-[N-(2-cyanethyl)-N-ethylamino]-4'-nitroazobenzene |</p>
<table>
<thead>
<tr>
<th><strong>Azides</strong></th>
<th>R, Ar-N₃</th>
<th>✓ ✓ ✓ - - - - - - ✓ ✓ ✓</th>
<th>Sodium azide (26628-22-8)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Inorganic Nitrates</strong></td>
<td>M-NO₂</td>
<td>- - ✓ ✓ ✓ - - - ✓ ✓ ✓ ✓ -</td>
<td>Sodium nitrite (7632-00-0), potassium nitrite (7758-09-0)</td>
</tr>
<tr>
<td><strong>Inorganic Nitrates</strong></td>
<td>M-NO₃</td>
<td>✓ - ✓ ✓ ✓ - - - ✓ ✓ ✓ ✓ ✓</td>
<td>Sodium nitrate (7631-99-4), silver nitrate (7761-88-8), zinc nitrate (7779-88-6), lithium nitrate (7790-69-4), lead nitrate (10099-74-8), potassium nitrate (7757-79-1)</td>
</tr>
<tr>
<td><strong>Nitrogen-Halogen compounds</strong></td>
<td>R-N-X</td>
<td>✓ ✓ ✓ ✓ ✓ - - - ✓ ✓ ✓ ✓ ✓</td>
<td>Trichloroisocyanuric acid (87-90-1), sodium dichloroisocyanuric acid (2893-78-9), N-bromosuccinimide (128-08-5), 1-bromo-3-chloro-5,5-dimethylhydantoin (BCDMH) (126-06-7)</td>
</tr>
<tr>
<td><strong>Oxyanion</strong></td>
<td>M-ClO₃⁻, M-ClO₂⁻, M-ClO₄⁻, M-OCl⁻</td>
<td>✓ ✓ ✓ ✓ ✓ - - - ✓ ✓ ✓ ✓ ✓</td>
<td>Sodium chlorite (7758-19-2), sodium chlorate (7775-09-9), sodium perchlorate (7601-89-0), ammonium perchlorate (7790-98-9), calcium hypochlorite (7778-54-3), potassium bromate (7758-01-2), lithium hypochlorite (13840-33-0)</td>
</tr>
<tr>
<td><strong>Peroxides</strong></td>
<td>Organic R-O-O-R</td>
<td>✓ ✓ ✓ - ✓ - - ✓ ✓ ✓ ✓ ✓</td>
<td>Benzoyl peroxide (94-36-0), diacetyl peroxide (&gt;70%) (110-22-5), dibenzoyl peroxide (94-36-0), methyl ethyl ketone peroxide (&gt;60%) (97-02-9), di-t-butyl peroxide (110-05-4), γ-amy1 hydroperoxide (3425-61-4), cumene hydroperoxide (80-)</td>
</tr>
</tbody>
</table>
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<table>
<thead>
<tr>
<th>Metal / Inorganic</th>
<th>O=P-X₃</th>
<th>P-X</th>
<th>M-O-O</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sodium perborate</td>
<td><img src="image1" alt="Chemical Formula" /></td>
<td><img src="image2" alt="Chemical Formula" /></td>
<td><img src="image3" alt="Chemical Formula" /></td>
</tr>
<tr>
<td>(10486-00-7)</td>
<td>(1335-26-8)</td>
<td>(1313-60-6)</td>
<td></td>
</tr>
</tbody>
</table>

*Ar* = phenyl ring; *X* = halogen (i.e., fluorine, chlorine, bromine, iodine); *R* = organic; *M* = metal.

**Footnotes to Table B.3.2:**


2. The physical and health hazards are BROAD representations for the various classes of chemicals. These classifications are NOT intended to cover all hazards of a material. For specific information, the chemical-specific MSDS MUST be consulted. Additional information can be obtained from the manufacturer.

3. For additional concentration dependent hazard categories, see B.5.

Additional Source Material:

- [http://www.epa.gov/oppt/chemrtk/](http://www.epa.gov/oppt/chemrtk/)
- [http://www.epa.gov/oppt/chemrtk/pubs/update/hpvcmlit.htm](http://www.epa.gov/oppt/chemrtk/pubs/update/hpvcmlit.htm)

*S, L, G* refers to whether hazards apply to “Solid,” “Liquid,” and/or “Gaseous” physical forms.

- Indicates that most or all of the chemicals within the family or sub-family have the indicated physical and health hazards.

- Indicates that some of the chemicals in the family may have this additional physical and health hazards.

- Indicates that only a select few chemicals within a specific family display the relevant physical and health hazards.

"-" = Not applicable for the specific chemical category.

5. The “flammable or combustible” hazard categories are NOT regulated under NFPA 400. However, many chemicals exhibit the hazard properties of flammability or combustibility.

6. “Peroxide” is not a hazard characteristic but a unique chemical family with a range of properties listed as a specific physical hazard under NFPA 400.

B.3.2.1 Table Descriptions. Nineteen general chemical families are listed in the first column of Table B.3.2. The chemical families include organic chemicals, inorganic chemicals, gases, and metals. Some of the general chemical families are further divided into subfamilies if one or more hazard category or categories further depend on chemical structure. The second column, Chemical Structure, shows the basic chemical formula or structure representing the chemical family and/or subfamilies.

The next several columns list the seven physical hazard categories and three health hazard categories. The specific hazard categories are defined in Chapter 3. The physical hazard categories include the following:

1. Unstable Reactive
2. Water Reactive
3. Oxidizer
4. Pyrophoric
5. Flammable Solid
6. Organic Peroxide
7. Flammable/Combustible

The health hazards include the following:

1. Corrosive
2. Toxic
3. Highly Toxic

Hazard categories are defined by the following symbols. A triple check mark (✓✓✓) is used to indicate that most or all of the chemicals within the family or subfamily have the indicated physical or health hazard. A double check mark (✓✓) is used to identify that some of the chemicals in the family might have this additional hazard. A single check mark (✓) indicates that only a select few chemicals within a specific family display the relevant physical and health hazard(s). The check marks are provided to inform the user as to the likely property of materials in each of the hazard categories listed. However, it must be recognized that the ultimate
classification of a material is dependent on the application of the definitions found in Chapter 3 and the interpretation of the information provided relative to tests conducted by authoritative entities within the framework established by the definitions.

The last column provides examples of chemicals with the indicated hazards. The examples illustrate materials in the concentrated or undiluted state. Concentration-specific hazards for common materials are provided in the explanatory material following the table (see Section B.5).

**B.3.2.2 Multiple Hazard Materials.** A specific chemical can exhibit multiple hazard categories. In other words, there could be materials with more than one physical hazard property that also have one or more health hazard properties. The regulatory controls integral to NFPA 400 require that all hazards be addressed. It is incumbent on the code user to identify each applicable hazard property in order to properly classify the hazards of the material. It should also be recognized that each of the hazards considered could be concentration dependent.

**B.3.2.2.1 Illustration of Table B.3.2.** To illustrate the utility of Table B.3.2, consider the chemical family of mineral acids, listed in column 1 of Table B.3.2. Specific examples of mineral acids are listed in the last column of Table B.3.2. Well-known mineral acids are hydrochloric acid and sulfuric acid. The row entries with dashes (---) under the physical hazard categories indicate that, in general, mineral acids are not considered to have the physical hazards of being unstable/reactive, oxidizer, pyrophoric, flammable solids, organic peroxides, or flammable/combustible. Specific mineral acids are water reactive (✓) based on concentration and the specific mineral acid itself. The row entries show the principal hazard properties of mineral acids are Health Hazards, especially Corrosive (✓✓✓). The one checkmark under Toxic (✓) indicates that a select few of the chemicals in the mineral acid family have this additional health hazard. See B.4.1.1 for additional information on mineral acids. The MSDS for the specific mineral acid should be consulted for more detailed information relating to physical and health hazards.

**B.3.3 ADDITIONAL SOURCE MATERIAL:** [http://www.epa.gov/oppt/chemrtk/](http://www.epa.gov/oppt/chemrtk/)
[http://www.epa.gov/oppt/chemrtk/pubs/update/hpvchmlt.htm](http://www.epa.gov/oppt/chemrtk/pubs/update/hpvchmlt.htm)

**B.4 Description of Chemical Families.**

**B.4.1 General.** Dilution can cause the hazard characteristics of an individual chemical to diminish until the property is no longer pertinent. Each chemical must be individually reviewed by the manufacturer to provide the data to assess the physical and health hazards. For compressed gases, there are accepted standards that can be used to estimate both the flammability and toxicity without actual test data.

**B.4.1.1 Acids.**

**B.4.1.1.1 Acids (Carboxylic) (R-COOH, Ar-COOH).** Carboxylic acids are weak acids, unlike mineral acids, such as hydrochloric acid. Most are readily soluble in water. Physical and health
properties vary significantly based on molecular weight and the number of carboxylic acid groups. Smaller molecular weight aliphatic carboxylic acids (such as formic and acetic acid) are liquids and are flammable and corrosive. Larger chain, higher molecular weight carboxylic acids are often solids with minimal hazards (such as citric acid). Aromatic acids are sometimes corrosive.

B.4.1.1.2 Acids (Peroxy) (R-OOH, Ar-OOH). All peroxy acids are classified as organic peroxides and are classified as oxidizers and corrosive. Aromatic peroxy acids (such as perbenzoic acid) are solids and are unstable reactive and toxic. Most are pastes or liquids and require refrigeration. Some forms of this acid family are often found as their sodium, potassium, or ammonium salts.

B.4.1.1.3 Acids (Mineral). These are all strong acids, are liquids, and are corrosive, even in dilute solutions. These include hydrofluoric acid (HF), hydrochloric acid (HCl), hydrobromic acid (HBr), phosphoric acid (H₃PO₄), and sulfuric acid (H₂SO₄). In some cases they are toxic and water reactive depending on acid and concentration.

B.4.1.1.4 Acid (Gaseous). The common acid gases, which include hydrogen bromide (HBr), hydrogen chloride (HCl), hydrogen fluoride (HF), and hydrogen iodide (HI), are corrosive and in some cases toxic. They are highly soluble in water, forming the corresponding aqueous acid and are packaged as liquefied compressed gases. Other acid gases include boron trichloride (BCl₃), boron trifluoride (BF₃) and silicon tetrafluoride (SiF₄).

B.4.1.1.5 Acid (Oxidizing). Some strong acids are also oxidizing acids, most commonly nitric acid (HNO₃). As oxidizers, they are also corrosive and toxic. These physical and health properties are exhibited even in dilute solutions.

B.4.1.2 Alcohols.

B.4.1.2.1 Aliphatic Alcohols (R-OH). The category includes primary (1°), secondary (2°), and tertiary (3°) branched and cyclic alcohols. Most common alcohols include methanol, ethanol, isopropanol, t-butanol (2-methylpropan-2-ol), n-butanol (butan-1-ol) and cyclohexanol. Many alcohols, especially smaller chain alcohols, are highly flammable even in dilute solutions. This generally does not hold true for the small-chain glycols (or polyhydroxylated compounds), such as propylene glycol which have significantly higher boiling points. Most smaller chain aliphatic alcohols are readily soluble in water. Longer chain alcohols “fatty alcohols” (e.g., dodecanol, hexadecanol and octadecanol) are solids, are not flammable, and are not miscible with water.

B.4.1.2.2 Aromatic Alcohols (Ar-OH). The most common aromatic alcohol is phenol (hydroxybenzene). Others include the dihydroxybenzenes (e.g., catechol) and hydroxytoluenes (e.g., o-cresol). Most phenols are usually solids or high boiling point liquids and readily soluble in water. Phenol and p-cresol are highly corrosive and toxic. Functionalized phenol derivatives (e.g., 2,4-dichlorophenol), while also soluble in water, are not flammable and can be toxic. Higher molecular weight phenols such as hydroxynaphthalene (e.g., naphthol) can also be toxic but are not corrosive. The chemical and physical properties of aliphatic and aromatic alcohols vary significantly depending on the structure of the alcohol and other functional groups.
B.4.1.3 **Alkyl Halides (R-X).** This chemical family includes halogenated alkyl analogues, such as methylene chloride, chloroform, carbon tetrachloride, bromoform, dichloroethane, perchloroethylene, methyl bromide and methyl iodide, fluoroethane, and Freon® derivatives. Often these chemicals are nonflammable gases and liquids, used as fire extinguishers, refrigerants, and solvents. The most widely known category is the chlorofluorocarbons (CFCs). Nonflammable gases include bromochlorodifluoromethane (Halon 1211) and dichlorodifluoromethane (Freon-12). Some chemicals in this family are flammable. Highly substituted alkyl halides (i.e., those chemicals with many halogen atoms present in a molecule) such as 1,2-dichloroethane and 1,1,2,2-tetrachloroethane are liquids and toxic.

B.4.1.4 **Amines.**

B.4.1.4.1 **Amines (Aliphatic) (R-NH\(_2\), R\(_2\)NH, R\(_3\)N).** The aliphatic amines consist of primary (1°), secondary (2°), and tertiary (3°) branched compounds. Lower molecular weight amines such as ethylamine, propylamine, butylamine and triethylamine are highly flammable liquids, corrosive and readily soluble in water. Some are toxic. Many amines, such as methylamine, are sold in diluted aqueous solutions, and are typically flammable. (For ammonia, see [B.4.1.5.2](#).)

B.4.1.4.2 **Amines (Aromatic) (Ar-NH\(_2\), Ar(N)).** This family includes substituted aromatic amines, such as benzene derivatives (e.g., aniline, and \(o\)-aminoaniline) and heteroaromatics (e.g., pyridine and picoline). Most of these chemicals are solids or liquids and may be readily soluble in water and are toxic. Some are flammable. Health hazards associated with these chemicals depend heavily on the ring structure, degree of substitution, and location of the nitrogen(s) within the heteroaromatic ring.

B.4.1.5 **Bases.**

B.4.1.5.1 **Alkalis.** Bases are found either as solids or as concentrated aqueous solutions. Most bases are highly corrosive with all tissues with which they come in contact. Bases, such as sodium carbonate (\(Na_2CO_3\)), sodium hydroxide (\(NaOH\)), and potassium hydroxide (\(KOH\)), readily absorb moisture from the air. When dissolved in water, these chemicals often liberate substantial heat and form corrosive solutions in concentrated form. The corrosiveness and toxicity of these chemicals decreases with dilution.

B.4.1.5.2 **Gaseous.** The common basic gases, ammonia (\(NH_3\)) and the lower molecular weight amines (methylamine, dimethylamine, trimethylamine) are all are corrosive but not toxic. They are highly soluble in water and are liquefied compressed gases. The common bases are flammable gases with a narrow flammability range. They are often sold commercially as aqueous solutions, which are also flammable.

B.4.1.6 **Carbides/Nitrides.** Carbides have varying degrees of physical hazards. Carbides, such as calcium carbide (\(CaC_2\)) and sodium carbide (\(Na_2C_2\)), react violently with water, are flammable in the presence of moisture, and could be corrosive. Other carbides, such as zirconium carbide (\(ZrC\)), tungsten carbide (\(WC\)), and silicon carbide (\(SiC\)), have little reactivity. Nitrides, such as boron nitride (\(BN\)), are usually stable.

B.4.1.7 **Carbonyl Compounds.**
B.4.1.7.1 Carbonyl Compounds (Acid Anhydrides) (R₁-C(O)OC(O)-R₂). These chemicals, often referred to as simply “anhydrides,” are more reactive than their corresponding carboxylic acids. Anhydrides react with water to form the corresponding acid or base, and are often good dehydrating agents. Lower molecular weight anhydrides, such as acetic anhydride, propionic anhydride, and isobutyric anhydride, are most often corrosive, flammable, and could react violently with water. Functionalized anhydrides such as trifluoroacetic anhydride are highly corrosive and highly water reactive. Aromatic anhydrides, such as phthalic anhydride, are also corrosive but not water reactive.

B.4.1.7.2 Carbonyl Compounds (Acyl Halides) (R, Ar-C(O)X; R, Ar-SO₂-X). These chemicals include the most common acid halides and sulfonyl halides and are considerably more reactive than the corresponding anhydrides. Acyl halides are most often corrosive, water reactive, and volatile. Higher molecular weight aromatic acid halides, such as benzoyl chloride, are toxic and corrosive and have limited water solubility and lower water reactivity. Lower molecular weight acid halides such as acetyl chloride are flammable, highly corrosive, and react violently with water.

B.4.1.7.3 Carbonyl Compounds (Aldehydes) (R-CH=O, Ar-CH=O). Most aldehydes are volatile organic compounds. Simple, lower molecular weight alkyl aldehydes, such as acetaldehyde, propionaldehyde (methylacetaldehyde), butyraldehyde, and 2-butenaldehyde (crotonaldehyde), for example, exist as liquids, and are most often highly flammable. Formaldehyde is known to be toxic. Many aromatic aldehydes, such as benzaldehyde, have limited flammability.

B.4.1.7.4 Carbonyl Compounds (Esters) (R₁O(C=O)R₂). In general, the category possesses few physical or health hazards. Aliphatic and aromatic esters are significantly more stable than the acid anhydrides and are not water reactive. Lower molecular weight alkyl esters, such as methyl formate, ethyl acetate, and n-butyl acetate, are flammable liquids.

B.4.1.7.5 Carbonyl Compounds (Halides) (C(O)X₂, C(S)X₂). These compounds are very reactive chemicals and are considered highly toxic, highly water reactive, and corrosive. Phosgene is a nonflammable gas, while thiophosgene and oxalyl chloride are liquids. Trichloromethyl chloroformate (diphosgene) and methyl chloroformate are liquids and less reactive but still water reactive.

B.4.1.7.6 Carbonyl Compounds (Ketones) (R₁R₂C=O). Similar to aldehydes, most ketones are volatile organic compounds. Many ketones are also flammable liquids. Simple, low molecular weight ketones, such as acetone, cyclohexanone, methyl ethyl ketone (MEK), and methyl isobutyl ketone (MIBK), for example, are liquids and highly flammable. Common functionalized ketones, such as chloroacetone, 1,3-dichloro-2-propanone, and chloroacetophenone (chloromethyl phenyl ketone), while not flammable, are toxic. Many aromatic ketones have limited flammability.

B.4.1.8 Cyanides.

B.4.1.8.1 Cyanides (Gaseous). The common cyanide gases, hydrogen cyanide (HCN), cyanogen chloride (CICN), and cyanogen (C₂N₂), are highly toxic. Hydrogen cyanide is a liquid,
but is treated and packaged as a gas. Cyanogen and hydrogen cyanide are flammable, while cyanogen chloride is corrosive.

**B.4.1.8.2 Cyanides (Inorganic) (M-CN).** Common inorganic cyanides include sodium cyanide (NaCN) and trimethylsilyl cyanide (TMSCN). This family is characterized as highly toxic. Cyanide salts are readily soluble in water and highly toxic.

Trimethylsilyl cyanide is water reactive. The family does not include the many organic compounds that contain the CN group (called nitriles). Nitriles do not display the toxicity of the inorganic cyanides such as sodium and potassium cyanide.

**B.4.1.8.3 Nitriles (Organic).** Common, lower molecular weight nitriles, including acetonitrile and 2-propanenitrile (acrylonitrile), are highly flammable liquids and toxic. Many aromatic nitriles (benzonitriles) are solids and often toxic, depending on substituents. Benzonitriles have limited flammability.

**B.4.1.9 Epoxides.** Epoxides are very reactive chemicals. Common epoxides include ethylene oxide, which is a gas, and propylene oxide and 1-chloro-2,3-epoxypropane (epichlorohydrin), which are liquids. These chemicals most often have flammable, toxic, water-reactive, and unstable reactive hazard characteristics.

**B.4.1.10 Ethers/Glycols (R-O-R).** This broad category includes both simple alcohol ethers and polyhydroxylated glycol ethers. Simple, low molecular weight ethers such as diethyl ether or vinyl ether are low boiling liquids or compressed gases and highly flammable. Cyclic ethers, such as tetrahydrofuran (THF) and 1,4-dioxane, are highly flammable liquids while slightly toxic. Common higher molecular weight glycol ethers, such as 1,2-dimethoxyethane (glyme), ethylene glycol monomethyl ether (EGME, 2-methoxyethanol), dipropylene glycol monomethyl ether (DPM, 1-(2-methoxy-2-methylethoxy)-2-propanol), propylene glycol monomethyl ether (PGME, 1-methoxy-2-propanol), diethylene glycol monomethyl ether (DEGME), and dipropylene glycol monomethyl ether (DPGME), are often water soluble liquids and combustible. Lower molecular weight glycol ethers are flammable liquids. Many are high boiling point liquids.

**B.4.1.11 Gases.** Within the context of the model codes, gases are regulated as either compressed gases or as cryogenic fluids. Compressed gases can be found either in the nonliquefied or liquefied state. Any gas can be liquefied at a sufficiently low temperature by increasing its pressure through the use of compression. Gases that cannot be liquefied at normal ambient temperatures are called “permanent” gases. A permanent gas is able to be liquefied by reducing the temperature below ambient temperatures and increasing its pressure. However, at normal ambient temperatures of 68°F (20°C) these gases remain in a nonliquefied state.

The scientific explanation for this phenomenon is generally explained in the following discussion. There is a temperature for each gas at or below which it can be liquefied by pressure, but above which it is impossible to liquefy at any pressure. This temperature is called the critical temperature of the gas. At temperatures above the critical temperature, the substance can exist only in the gaseous state regardless of the pressure applied. The pressure that will just liquefy a gas at its critical temperature is called the critical pressure. In other words, the critical pressure of a gas is equal to the vapor pressure exerted by the liquefied gas at its critical temperature. All that is necessary to liquefy a gas is to cool it to its critical temperature and subject it to a pressure.
equal to or greater than its critical pressure. The farther below the critical temperature it is cooled, the less the pressure required for liquefaction. At the critical conditions of temperature and pressure the gaseous and liquid forms of the substance have the same density.

Atmospheric air is a mixture of permanent gases and principally composed of argon, oxygen, and nitrogen. Under normal ambient conditions it remains in the gaseous state. The critical temperature of air is −221.1°F (−140.6°C). The critical pressure is an absolute pressure of 547 psi (3771 kPa, absolute). To liquefy compressed air, the temperature must be reduced to −221.1°F or less with a commensurate increase in pressure above 547 psia. By comparison, liquefied petroleum gas (LP-Gas), is a mixture of hydrocarbon gases, principally propane and butane, which is found in the liquid form under ambient conditions. These gases have a critical temperature well in excess of 68°F (20°C), and as a result, they are found as liquefied compressed gases under ambient temperatures.

Cryogenic fluids are refrigerated liquefied gases with a boiling point lower than −130°F (−90°C) at an atmospheric pressure of an absolute pressure of 14.7 psi (101.3 kPa, absolute). They are maintained in the cryogenic (super-cooled) state by artificial means.

B.4.1.11.1 Gases (Flammable). Common nonliquefied flammable compressed gases include carbon monoxide and hydrogen. Other flammable gases are hydrocarbon gases. The alkanes include methane (CH₄), ethane (C₂H₆), and propane (C₃H₈). Ethane and propane are liquefied compressed gases at ambient temperature. The alkenes include ethylene (C₂H₄) and propylene (C₃H₆), both liquefied compressed gases, and the alkynes include acetylene (C₂H₂). Acetylene is an unstable reactive gas; it is found in cylinders, packaged as a compressed gas dissolved in a solution of acetone or dimethyl formamide. While acetylene can be liquefied at ambient temperatures, for safety reasons it is shipped as a nonliquefied compressed gas.

B.4.1.11.2 Gases (Halogens) (X-X). The pure halogen gases, fluorine (F₂), chlorine (Cl₂), bromine trifluoride (BrF₃), and chloride trifluoride (ClF₃), are extremely powerful oxidizers, and are corrosive and toxic. Fluorine and chlorine are only slightly soluble in water, while bromine trifluoride and chlorine trifluoride are extremely water reactive. Bromine trifluoride is explosive on contact with water. Fluorine is a compressed gas while chlorine, bromine trifluoride, and chlorine trifluoride are liquefied compressed gases.

Gases that are fully halogenated, such as hexafluoroethane (C₂F₆), carbon tetrafluoride (CF₄), and sulfur hexafluoride (SF₆), are inert and nonreactive.

B.4.1.11.3 Gases (Non-Flammable). The atmospheric gases, with the exception of oxygen, have limited chemical reactivity, and are not corrosive, flammable, or toxic. These gases include nitrogen, argon, and carbon dioxide. Their greatest hazard is asphyxiation. The rare gases, such as helium, neon, krypton, xenon, and argon, were once thought to be inert (having no chemical activity at all); however, within the last 20 years compounds have been made through the use of strong oxidizer gases, such as fluorine, to form nitrogen trifluoride.

B.4.1.11.4 Gases (Oxidizing). The more common oxidizing gases are oxygen, nitrous oxide, and nitrogen trifluoride. Oxygen and nitrogen trifluoride are compressed gases, while nitrous oxide is a liquefied compressed gas.
B.4.1.11.5 **Gases (Pyrophoric).** Gases with an autoignition temperature below 130°F (54°C) are classified as pyrophoric. Silane (SiH₄) is probably one of the most common pyrophoric gases found in use today. Other pyrophoric gases include methylsilane (CH₃SiH₃) and disilane (Si₂H₆). Silane and methylsilane are compressed gases, while disilane is a liquefied compressed gas. Some pyrophoric gases, such as phosphine (PH₃) and diborane (B₂H₆), are also highly toxic. Although all pyrophoric gases are flammable by nature, they are regulated as pyrophoric gases within the context of the model codes.

B.4.1.11.6 **Gases (Sulfur Gases) (R-SH).** The common sulfur gases are hydrogen sulfide (H₂S), methyl mercaptan (CH₃SH), and carbonyl sulfide (COS) and are toxic and flammable. They are all liquefied compressed gases.

B.4.1.12 **Hydrocarbons.**

B.4.1.12.1 **Hydrocarbons (Aliphatic) (R).** Commonly referred to as saturated hydrocarbons, alkanes as a whole are unreactive chemicals. The aliphatic hydrocarbons pentane, decane, and cyclohexane are flammable liquids. Lower molecular weight hydrocarbons such as methane, ethane, propane, and butane are flammable compressed gases.

B.4.1.12.2 **Hydrocarbons (Alkenes) (R₁CH=CHR₂).** Alkenes are a very broad category of hydrocarbons and are commonly referred to as unsaturated hydrocarbons, olefins, or vinyl compounds. Alkenes are relatively stable compounds, but are more reactive than alkanes. Smaller chain alkenes, such as ethylene, propylene, and butene, are all flammable gases and readily form explosive mixtures with air. Common derivatized alkenes, such as styrene (vinyl benzene), vinyl chloride (monochloroethylene), vinyl acetate, and 1,4-dichloro-2-butene, are toxic. Some are flammable liquids. They also readily polymerize (without inhibitors), which leads to unstable reactive characteristics.

B.4.1.12.3 **Hydrocarbons (Alkynes) (R₁C≡CR₂, R-C≡CH).** Of all the aliphatic hydrocarbons, alkynes are the most reactive. Many alkynes are highly reactive and considered unstable reactive, especially as molecular weights increase. Many halogenated alkynes and metal derivatives can be explosive. The most common alkynes are gases, including acetylene (ethyne — see Flammable Gases) and methyl acetylene (1-propyne), can form explosive mixtures with air. The most common derivitized alkyne is propargyl alcohol (2-propyn-1-ol), which is flammable, corrosive, and toxic.

B.4.1.12.4 **Hydrocarbons (Aromatic) (Ar).** This family is very broad and derived from such compounds as benzene and toluene and have limited alkyl (methyl, ethyl, etc.) substitution on the ring. Smaller aromatic hydrocarbons (benzene, toluene (methyl benzene), ethyl benzene, and xylene) are flammable liquids and are sometimes toxic. High molecular weight compounds with many aromatic rings (such as naphthalene and anthracene) are solids and are often toxic. Substituted analogues, such as dichlorobenzene, have varying degrees of toxicity based on the degree of substitution and arrangement on its ring structure. Many are also flammable solids.

B.4.1.13 **Isocyanates (R-N=C=O, Ar-N=C=O).** This family includes compounds such as toluene diisocyanate (TDI), p-toluenesulfonyl isocyanate, and methylene bisphenyl isocyanate (MDI). The chemicals are liquids and are typically unstable reactive, water-reactive, corrosive, and toxic. Some are highly toxic. Some are violently water reactive.
B.4.1.14 Metals.

B.4.1.14.1 Metal Alkyls (M-R). All metal alkyls are pyrophoric, corrosive, and highly reactive. The simple metal alkyls trimethylaluminum (TMAI), trimethylgallium (TMG), and trimethylindium (TMI) are pyrophoric liquids. They are also violently water reactive. Dimethylzinc and trimethylaluminum are also unstable reactive. Tetramethylditin is a flammable liquid.

B.4.1.14.2 Metal Halides (M-X). Physical and health hazards of this chemical family vary significantly based on the corresponding metal. Most metal halides are typically inert (such as sodium chloride [table salt], calcium chloride, magnesium fluoride, aluminum chloride, and palladium (II) chloride), while some have a much higher reactivity (such as silver bromide and chromium (III) chloride) and are strong oxidizers. The chemical and physical properties vary significantly depending on the metal. If a metal halide contains a heavy metal, such as lead, chromium, thallium, and mercury, it is assumed to be highly toxic. Fluoride and bromide salts are more toxic than the corresponding chloride salts.

B.4.1.14.3 Metal Hydrides (Solids). Compounds such as lithium aluminum hydride (LiAlH₃), sodium borohydride (NaBH₄), and sodium hydride (NaH) are flammable solids, water-reactive, and corrosive. Metal hydrides react violently with water.

B.4.1.14.4 Metal Hydrides (Gaseous). The more common metal hydride gases are arsine (arsenic hydride, AsH₃), diborane (boron hydride, B₂H₆), hydrogen selenide (selenium hydride, H₂Se), and phosphine (phosphorous hydride, PH₃). In general, these chemicals are toxic, liquefied compressed gases, with many being highly toxic. They are flammable and some have autoignition temperatures low enough to make them pyrophoric, such as diborane and phosphine. The key exception is silane (SiH₄), which is not toxic. Silane is a compressed gas rather than a liquefied compressed gas.

B.4.1.14.5 Metals (Alkali). This category includes sodium, potassium, and lithium. All are highly corrosive and can often explode if they are exposed to water. They are all flammable solids as well.

B.4.1.14.6 Metals (Powdered). Metals, especially those in a finely divided state, are usually categorized as flammable solids, such as aluminum, magnesium, sodium, and potassium. Some, but not all, react violently and are water-reactive. Some are also toxic.

B.4.1.15 Nitrated Organic Compounds.

B.4.1.15.1 Organic Nitro Compounds (R, Ar-NO₂). Most often, smaller alkyl nitro compounds, such as nitromethane, are flammable, unstable reactive, and often toxic. Aromatic nitro analogues are toxic or highly toxic and unstable reactive, the latter being dependent on the amount of ring substitution.

B.4.1.15.2 Azo (Aliphatic) (R-N=N-R). Aliphatic azo derivatives are inherently unstable and readily decompose, often violently, upon the application of heat. Aliphatic azo compounds are characterized as unstable reactive, flammable solids and are often toxic.
B.4.1.15.3 Azo (Aromatic) (Ar-N=N-Ar). Aromatic azo derivatives have superior thermal stability properties compared to aliphatic azo derivatives. Many aromatic azo derivatives are quite stable and often used as dyes. They have a wide array of chemical and physical properties depending on the substituents on the aromatic ring and the number of azo groups present in the molecule (mono-, dis-, tris-, tetrakis-, etc.). Most exhibit low to moderate toxicity.

B.4.1.15.4 Azides (R, Ar-N₃). The most common chemicals of this family are the metal azides, including sodium and lithium azide. All the compounds in this family are unstable reactive and highly toxic.

B.4.1.15.5 Nitrites (Inorganic) (M-NO₂). The most common nitrites are sodium and potassium nitrite. All are strong oxidizers and toxic.

B.4.1.15.6 Nitrates (Inorganic) (M-NO₃). Examples of inorganic nitrates include sodium nitrate, silver nitrate, zinc nitrate, lithium nitrate, and lead nitrate. While all inorganic nitrates are strong oxidizers, the physical and health properties vary significantly depending on the metal. Many of these compounds are corrosive and may have unstable reactive properties. Toxicity varies with the associated metal.

B.4.1.16 Nitrogen-Halogen compounds (R-N-X). This chemical family includes chlorinated isocyanurates (trichloroisocyanuric acid, sodium dichloroisocyanurate), halogenated succinimides (N-bromosuccinimide), and halogenated hydantoins (e.g. 1-bromo-3-chloro-5,5-dimethylhydantoin). Some are strong oxidizers and corrosive in their pure states, with varying properties of unstable reactive, water-reactive, and toxicity hazards. Specially formulated chlorinated isocyanurate products have been shown to reduce oxidizer properties.

B.4.1.17 Oxyanion (M-ClO₂, M-ClO₃, M-ClO₄, M-OCl). This chemical family includes chlorites, chlorates, perchlorates, bromates, and hypochlorites. The most common chemicals are sodium chlorite (NaClO₂), sodium chlorate (NaClO₃), ammonium perchlorate (NH₄ClO₄), potassium bromate (KBrO₃), and calcium hypochlorite (Ca(OCl)₂). Most are strong oxidizers and corrosive in their pure states with varying properties of unstable reactive, water reactive, and toxicity hazards. Chlorites and chlorates are most commonly found as diluted solutions that reduce toxicity and oxidizing properties. Specially formulated calcium hypochlorite products have been shown to reduce their oxidizing properties. Sodium hypochlorite (liquid bleach) is too unstable in solid form and is found only in dilute solutions that are corrosive.

B.4.1.18 Peroxides.

B.4.1.18.1 Peroxide (Organic) (R-O-O-R). The common organic peroxides include such chemicals as t-amyl hydroperoxide, dibenzoyl peroxide, di-t-butyl peroxide, diacetyl peroxide, methyl ethyl ketone peroxide, diisopropyl peroxydicarbonate, and cumyl hydroperoxide. Organic peroxides possess a wide range of properties based on the many physical forms and concentrations and have a large range of safety-related properties, including physical as well as health hazards. Organic peroxides are either used as the technically pure compound or as formulations where the peroxide might be found in a diluted form, such as solutions, pastes, or solid granules.
Organic peroxide formulations vary in reactivity hazard from self-extinguishing to the potential for a violent deflagration or detonation. Decomposition can be initiated by heat, friction, mechanical shock, or contamination, though sensitivity to these stimuli varies greatly. Dilution with water or other solvents is used as a means to reduce the level of sensitivity to outside stimuli and the potential for decomposition. Refrigeration is also used as a means to reduce the potential for decomposition. The health hazards of these materials as provided in commerce vary greatly depending on concentration and formulation itself.

B.4.1.18.2 Metal Peroxides (Inorganic) (M-O-O). Metal peroxides, such as sodium peroxide and calcium peroxide, are all oxidizers. Some are corrosive and water reactive. Reaction with water can be explosive in some instances.

B.4.1.19 Phosphorus-Halogen Compounds (O=P-X₃, P-X). These phosphorus analogues are corrosive and often react violently with water and include such chemicals as phosphorus oxychloride (POCl₃), phosphorus trichloride (PCl₃), and phosphorus pentachloride (PCl₅). They are water reactive, corrosive, and toxic.

B.5 Hazard Category Based on Concentration.

B.5.1 General. Some chemicals exhibit different physical and/or health hazards based on the concentration. Some pertinent examples of concentration-dependent hazards of specific chemicals are provided in the following list. Additional information on concentration-dependent hazards should be contained in the MSDS.

1) Acetic Acid (64-19-7). Concentration: 100 percent — corrosive, flammable/combustible; 36 percent aqueous — corrosive; <5 percent aqueous — not corrosive.


3) Formaldehyde (50-00-0). Concentration: anhydrous — flammable, corrosive, highly toxic; 37 percent aqueous — combustible, highly toxic 10 percent aqueous — combustible.


5) Nitric Acid (7697-37-2). Concentration: 7–40 percent aqueous — oxidizer, corrosive; 1–6 percent aqueous — not oxidizer, not corrosive.

6) Phosphine (CAS numbers based on concentration). Concentration: 5 percent phosphine, 95 percent nitrogen — pyrophoric, toxic; phosphine: 2 percent phosphine, 98 percent nitrogen — toxic.


8) Potassium Hydroxide (1310-58-3). Concentration: 100 percent — corrosive, water reactive, toxic; 45 percent aqueous — corrosive, water reactive; 5 percent aqueous — corrosive.

(10) Sodium chlorate (7775-09-9). Concentration: 100 percent — corrosive, oxidizer, unstable reactive; 40–50 percent aqueous — corrosive, oxidizer.

(11) Sodium hydroxide (1310-73-2). Concentration: 100 percent — corrosive, water reactive, toxic; 1–50 percent aqueous — corrosive.

(12) Sulfuric Acid (7664-93-9). Concentration: 92–98 percent aqueous — corrosive, water reactive, toxic; 12.7–50 percent aqueous — corrosive, water reactive, toxic; 4–12.6 percent aqueous — corrosive.


B.6 Material Safety Data Sheets (MSDSs) — A Starting Point for Hazards Identification.

B.6.1 Material safety data sheets (MSDSs) have been established as a primary means of hazard identification under OSHA’s Hazard Communication program. MSDSs are provided by manufacturers or importers as a means to communicate hazards within a set of standardized terms and elements or bodies of information.

B.6.2 In 2012, OSHA revised its Hazard Communication Standard to align with the United Nations Globally Harmonized System of Classification and Labelling of Chemicals (GHS). The Hazard Communication Standard specifies requires the use of a 16-section format for SDSs, similar to that of the ANSI format. The use of the ANSI format in the preparation of MSDS is not mandatory, however, most manufacturers As manufacturers and distributors transition to the 16-section SDS format, they will include information that relates to the sixteen sections referenced in B.2. In order to classify the hazards of a given material, users should refer to key sections of the MSDS that contain the following information:

(1) Product identification (SDS Section 1)
(2) Hazard(s) identification (SDS Section 2)
(3) Composition/information on ingredients (SDS Section 3)
(44) Physical and chemical properties (SDS Section 9)
(45) Stability and reactivity (SDS Section 10)
(56) Toxicological information (SDS Section 11)
(67) Transportation information (SDS Section 14)

Each section should contain relevant information that can be used in the hazard classification process. The following paragraphs provide useful information to help the user with these required MSDS sections.
**B.6.2.1 Product Identification.** Product identification will typically include the chemical name, common name, and synonyms. Pure materials, sometimes referred to as “neat” to indicate that they are in an undiluted form, are typically referred to by their chemical name. However, it is not uncommon to find that the manufacturer has identified the material under a trade name chosen by that particular manufacturer. Chemical synonyms will frequently be shown; however, it should be expected that the list of synonyms may be an abbreviated listing and that there may be other synonyms that are not listed.

For chemical mixtures the material will typically be identified by its trade name. Some confusion can be created when a material in its “neat” form is further identified in the Hazard Identification section as containing other constituents. Commercially available materials, even in the pure or neat form, contain impurities from the manufacturing process. Although there is no hard-and-fast rule, materials in concentrations of 95 percent or greater are generally considered to be in the pure form and are referred to by the CASRN for the major component. The impurities from manufacturing are generally not considered for the purposes of material identification and such materials are not considered to be “mixtures” of chemicals per se.

The product identification section provides additional information, including the identification of the manufacturer of the material and nomenclature intended to link the MSDS to the label provided on the material in the container(s) as furnished by the manufacturer.

The composition of the material or information on ingredients is listed in SDS Section 3, as defined in the OSHA Hazard Communication Standard. In addition to the product identifier, Section 1 of the SDS will list the chemical name, and the name, address and phone number of the responsible party, either incorporated into or follows the material and company identification. The composition section typically lists the hazardous components as identified by OSHA, and not those categories used by NFPA 400. Although the OSHA hazard categories have been incorporated into the regulatory scheme used by NFPA 400, there are differences and the converse is not true. For example, OSHA does not incorporate the traditional NFPA hazard ratings used in NFPA 704—class, although, in the The revised Hazard Communication Standard, OSHA allows the completed NFPA 704 diamond to be provided on the SDS, this information to be listed in Section 2 of the SDS. NFPA and OSHA developed a Quick Card to compare the classification and rating systems, located at www.nfpa.org/704.

Similar to NFPA, the Hazard Communication Standard requires that hazardous chemicals be classified according to the severity of hazard presented by the chemical. However, the hazard categories defined and assigned by the Hazard Communication Standard are different than those used by NFPA. For example, the Hazard Communication Standard defines oxidizers differently than the NFPA (see Annex J of NFPA 400 for a comparison of these definitions). The primary differences center on the use of subclasses of hazards that are not identified in the OSHA approach. For example, within the hazard category of oxidizer, there are four subcategories or Classes of hazards recognized under the NFPA system, e.g., Class 4, Class 3, Class 2, and Class 1 materials. Hazard classes are used to describe a range of hazards within a given hazard category, and the class system is used for materials that are oxidizers other than oxidizing gases, organic peroxides, unstable reactivities, and water reactivities. Although not the subject of regulation by NFPA 400, flammable liquids are further subdivided into Class I, Class II, and Class III, and combustible liquids are further subdivided into Class II, IIIA, and IIIB liquids.
The composition section is required to list components of a material that are present in concentrations of 1 percent or more. For materials that are identified as carcinogens under the OSHA definitions, the material must be listed if its concentration exceeds 0.1 percent. The MSDS may also list components that are nonhazardous. The CASRN for each component is typically listed in this section of the MSDS.

B.6.2.2 Hazards Identification. Section 2 of the SDS will list the hazard identification of the chemical, including the classification of the chemical, signal word, the pictogram(s), hazard statement(s), description of hazard(s), precautionary statements. Information such as the NFPA 704 diamond may be listed in this section as well, although it is not an OSHA requirement. The SDS Section 2 also describes hazards that are not otherwise classified.

The hazard identification section of the MSDS is used to provide an emergency overview of the material and includes a description of its physical properties, including its physical state (solid, liquid, gas). The overview typically provides general information on significant physical hazards (e.g., fire, explosion, and instability), as well as information on potential health and physical hazards effects that can result from exposure to the material. While the information is useful in terms of a gross assessment of hazards, additional information found elsewhere in the MSDS is needed in order to properly classify the material.

B.6.2.3 Composition/information on ingredients. The composition of the material or information on ingredients is listed in SDS Section 3, per the OSHA Hazard Communication Standard. The composition section typically lists the hazardous components as defined by OSHA, and not those categories used by NFPA 400. Although the OSHA hazard categories have been incorporated into the regulatory scheme used by NFPA 400, there are differences and the converse is not true. For example, OSHA does not incorporate the traditional NFPA hazard ratings used in NFPA 704. The revised Hazard Communication Standard, allows the completed NFPA 704 diamond to be provided on the SDS. NFPA and OSHA developed a Quick Card to compare the classification and rating systems, located at www.nfpa.org/704.

The composition section is required to list hazardous components of a material are themselves classified and contribute to the classification of the chemical. For mixtures, the composition section must also list the chemical name and concentration of all ingredients classified as health hazards and that are present above their cut-off/concentration limits or present a health risk below the cut-off/concentration limits. The SDS may also list components that are nonhazardous. The CASRN for each component is typically listed in this section of the SDS.

B.6.2.4 Physical and Chemical Properties. Section 9 of the SDS will list the physical and chemical properties of the materials, are included in this Section 9 of the MSDS. A description of its physical properties, including its physical state (solid, liquid, gas) are required. It is typical to find a wide array of physical and chemical properties listed. Examples of some of the physical and chemical properties required in SDS Section 9 of interest include, but are not limited to the following:

1. Appearance (physical state, color, etc.-physical form, shape)
2. Odor
3. Odor threshold
(4) Physical state
(45) pH
(56) Melting/freezing point (specify which)
(67) Initial boiling point and boiling range
(78) Flash point
(89) Evaporation rate
(949) Flammability (solid, gas)
(104) Upper/lower flammability or explosive limits
(112) Vapor pressure
(123) Vapor density
(134) Specific gravity or Relative density
(145) Solubility(ies) (specify solvent, e.g., water)
(15) Partition coefficient: n-octanol/water
(16) Auto-ignition temperature
(17) Decomposition temperature
(18) Viscosity

B.6.2.45 Stability and Reactivity. Section 10 of the SDS lists The section on information about the stability and reactivity of materials. Section 10 of the SDS, This section typically describes conditions which affect the intrinsic stability of a material. An intrinsic property is a property that is inherent in the material in and of itself, as compared to its properties under conditions that are brought about by the environment in which it is located. Environmental conditions can be described as extrinsic conditions, such as when the material is exposed to heat, fire, shock, or other effects.

This section of the MSDS is used as a means to assess its nature within the context of the unstable reactive hazard category. While many materials have an intrinsic stability, they can become unstable when exposed to high temperatures or mechanical or physical shock. Therefore, the information found on an MSDS might have to be supplemented by referring to other authoritative sources regarding the reactivity of the material.

B.6.2.56 Toxicological Properties Information. The section 11 of the SDS lists on toxicological information. Section 11 of the SDS contains information on the health effects of the material or its components. It typically supports the detail provided in the section on hazards identification in the MSDS. The information provided is written for use by healthcare professionals and those that have the technical training and experience in the safety and toxicology aspects of interface with materials from a toxicological perspective.
However, this section of the MSDS contains information that is used to establish the approach to control integral to NFPA 400 with respect to toxicity and corrosivity. Data including the effects of acute exposure to mammals and other life forms or information regarding the irreversible destruction of tissue at the site of contact will be found in this section of the MSDS.

There may be other information regarding the toxicological effects resulting in but not limited to irritation, sensitization, carcinogenicity, reproductive effects, and genetic and target organ effects, none of which fall under the scope of NFPA 400.

**B.6.2.67 Transportation.** Section 14 of the SDS lists the system of classification used by the Department of Transportation (DOT) to classify materials for shipment purposes, which is not compatible with the system used to classify materials within the context of NFPA 400. With the alignment to the United Nations Globally Harmonized System of Classification and Labeling of Chemicals (GHS), it must be recognized that although the OSHA’s system of hazard communication has now become harmonized with some similarity to the system used by the Department of Transportation, it is not wholly compatible. The OSHA’s hazard communication system, embodied in the MSDS, does not correlate with the DOT regulations for transporting hazardous chemicals, located system used in 49 CFR as developed for transportation purposes. The OSHA system contemplates that users and producers of hazardous materials will encounter these materials in their unpackaged state where the materials are reasonably foreseen to have a potential for bodily contact or use within the work environment on a regular basis. On the other hand, the DOT system of control views the materials in their final packaging as required for transportation where the materials are not subject to exposure to personnel except under upset conditions. However, with the effort to implement the United Nations Globally Harmonized System of Classification and Labeling of Chemicals, this may change.

These differences aside, because OSHA does not enforce the contents of Section 14 of the SDS, users may find additional information in the section for transportation on the MSDS, which may or may not be further explained in preceding sections. It is important to recognize that the classification for the purposes of transportation will not suffice as a means to assign the material to a given hazard category under the requirements of NFPA 400, and the user must carefully apply the material specific definitions found in Chapter 3 along with the criteria obtained from the MSDS and other resources in order to determine the appropriate classification of a given material.
Annex B  Chemical Data

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

B.1 General.

The information provided in Annex B is not a part of the requirements of this document but is included for informational purposes.

B.2 Hazard Recognition.

Chapter 5 introduces the concepts of control areas and MAQs. The purpose is to permit limited amounts of hazardous materials in occupancies having minimum controls without triggering the more restrictive Protection Level 1 through Protection Level 5 building requirements. The allowable quantities in Table 5.2.1.1.3, Table 5.2.1.2 through Table 5.2.1.8, and Table 5.2.1.10.1 are based on demonstrated need and historical safe storage and use of hazardous contents. The preponderance of provisions contained in Chapter 6 and those of Chapters 11 through 21 establish additional controls for occupancies exceeding the hazardous materials limits (MAQs) prescribed for control areas.

Not all of the hazardous materials categories are placed into the high hazard category, and some of these materials (contents) have been recognized as being of low or ordinary hazards, depending on their nature in a fire. Class IIIB combustible liquids, Class 1 unstable (reactive) materials, Class 1 water-reactive materials, Class 1 oxidizing solids and liquids, and Class IV and Class V organic peroxides are hazardous materials, which, in some cases, do not have a MAQ and, therefore, are not required to comply with the requirements for Protection Level 1 through Protection Level 5. Some materials, though classified as high hazard, such as aerosols, are exempt from the requirements of NFPA 400, as they are regulated in the code. For additional exceptions, see 1.1.2. [5000: A.34.1.1]

Figure B.2 helps to illustrate the conditions under which the protection level requirements are applicable. [5000: A.34.1.1]

****INSERT FIGURE HERE****

**FIGURE B.2  Flow Chart Illustrating Protection Level Applicability. [5000:Figure A.34.1.1]**

Safety data sheets (SDS) are used as a primary means to assess the hazards of a specific material. In the U.S., the OSHA Hazard Communication Rule (29 CFR 1900.1200) prescribes what information is to be provided by the SDS. The rule (29 CFR 1900.1200) also specifies the layout
of the SDS, including 16-section format with standardized headings, the numbering and order of these headings, and the information required to complete the SDS. The major headings of this standard include:

Section 1: Identification
Section 2: Hazard(s) Identification
Section 3: Composition/Information on Ingredients
Section 4: First-Aid Measures
Section 5: Fire-Fighting Measures
Section 6: Accidental Release Measures
Section 7: Handling and Storage
Section 8: Exposure Controls/Personal Protection
Section 9: Physical and Chemical Properties
Section 10: Stability and Reactivity
Section 11: Toxicological Information
Section 12: Ecological Information
Section 13: Disposal Considerations
Section 14: Transport Information
Section 15: Regulatory Information
Section 16: Other Information, including date of preparation or last revision

The American Chemical Society publishes chemical abstracts as pointers to the chemical literature. Since 1907, their Chemical Abstracts Service (CAS) has indexed and summarized chemistry-related articles from more than 40,000 scientific journals, in addition to patents, conference proceedings, and other documents pertinent to chemistry, life sciences, and many other fields. In total, abstracts for more than 25 million documents are accessible online through CAS.

Substance identification is a special strength of CAS. It is widely known as the CAS Registry, the largest substance identification system in existence. When CAS processes a chemical substance newly encountered in the literature, its molecular structure diagram, systematic chemical name, molecular formula, and other identifying information are added to the Registry, and it is assigned a unique CAS Registry Number. The Registry now contains records for more than 30 million organic and inorganic substances and more than 58 million sequences.

Individual chemicals are identified through the use of a CAS registry number, commonly referred to as the CAS number or CASRN. The number, which has no chemical significance,
used to link the material through its molecular structure into an index system where the Chemical Abstracts name is provided.

The CAS number is unique for each given material; however, with few exceptions, mixtures of chemicals are not assigned a CAS number per se, since each individual component of the mixture has its own unique CAS number. For the purposes of hazard classification and the application of NFPA 400, there are three primary identifiers for each chemical that must be known:

1. CAS number (unless it is a chemical mixture)
2. Concentration (typically expressed in weight percent for solids or liquids and volume percent for gases)
3. Physical state (solid, liquid, or gas)

For example, consider the material hydrochloric acid, also called hydrogen chloride. It can exist in the anhydrous form (as a gas) or in a water solution as the aqueous liquid material of varying concentrations. The hazard properties of the material vary with the form.

The regulatory approach used by NFPA 400 is based on hazard classification of the materials to be regulated. The materials under consideration must be evaluated to classify their hazards within the context of the code. The starting point begins with the SDS, where the material can be identified by name, and other information, such as CAS registry number and physical state, is provided. Although there are 16 different main headings in the SDS, the primary need for classification of materials rests with determining the physical and health hazards of the material or mixture in question.

Within the context of NFPA 400, the user must determine whether the physical and/or health hazards of the material place it into one or more of the following hazard categories:

1. Corrosive solids and liquids
2. Flammable solids
3. Organic peroxide formulations
4. Oxidizer solids and liquids
5. Pyrophoric solids and liquids
6. Toxic and highly toxic solids and liquids
7. Unstable (reactive) solids and liquids
8. Water-reactive solids and liquids

Each of the hazard categories can be further subdivided into subcategories, each with its attendant hazard properties. For example, oxidizer solids and liquids are subdivided into Class 4, Class 3, Class 2, and Class 1 subcategories commonly referred to as the hazard class.
Although it might be expected that the above nomenclature would appear on the SDS, this is not always the case. Appendices A and B of OSHA’s Hazard Communication Rule (29 CFR 1900.1200) identify specific health and physical hazards that may differ from that of NFPA 400. Terms used in NFPA 400 are consistent with those used in other NFPA standards and codes. Please see Annex J of NFPA 400 for a comparison of these hazard definitions. Therefore, the user must review the physical and chemical properties, as well as the health hazard information provided, in order to make a determination as to the appropriate hazard category and class for the material being regulated.

**B.3 Chemical Family — A Pointer to Hazard Classification.**

**B.3.1 General.** It is quite common that preparers of SDS indicate the chemical family to which a material belongs, that is, the group of chemical substances that have a similar molecular structure. For example, materials such as acetone, methyl ethyl ketone, and amyl ethyl ketone are members of the ketone family. While the properties of various hazardous materials within a chemical family may vary, the chemical family becomes a pointer to the more likely hazard categories of the material under consideration.

While hundreds of thousands of chemicals are in use, this annex categorizes the more commonly used industrial chemicals into chemical families or unique groupings that have similar properties. Materials and/or chemicals exhibit a wide range of properties, some of which are hazardous. This code provides guidance for known physical and health hazards of materials within its scope.

**B.3.2 Chemical Families Related to Hazard Category.** Table B.3.2 provides a summary of chemical families with associated physical and health hazard properties, which are subdivided into specific categories. This table is for informational purposes only. The physical and health hazards indicated are broad representations for the various chemical families. These classifications are not intended to cover all the hazards of a material. A more detailed description of the chemical families, subfamilies, and chemical structure of specific hazards are contained in the explanatory material following the table. For specific information, the chemical-specific SDS must be consulted. Additional information can be obtained from the manufacturer.

| CHEMICAL FAMILY(1) | CHEMICAL STRUCTURE | PHYSICAL HAZARDS(2,3) | HEALTH HAZARDS(2,3) | EXAMPLES (CAS No.) The following examples and their classifications represent neat, undiluted, commercially available materials.

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<table>
<thead>
<tr>
<th></th>
<th>Carboxylic</th>
<th>Acids</th>
<th>-</th>
<th>-</th>
<th>-</th>
<th>-</th>
<th>-</th>
<th>✓</th>
<th>✓</th>
<th>✓</th>
<th>-</th>
<th>Formic acid (64-18-6), acetic acid (64-19-7), benzoic acid (65-85-0), acrylic acid (79-10-7), oxalic acid (144-62-7), propanoic acid (79-99-4), 4-amino-3,5,6-trichloropicolinic acid (1918-02-1), 2-hydroxybenzoic acid (69-72-7), citric acid (77-92-9), benzoic acid (65-85-0)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peroxy</td>
<td>R-OOH,</td>
<td>Ar-OOH</td>
<td>✓ ✓ ✓</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>Peroxyacetic acid (79-21-0), m-chloro perbenzoic acid (937-14-4), peroxymonosulfuric acid (7722-86-3)</td>
</tr>
<tr>
<td>Mineral</td>
<td>-</td>
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<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>-</td>
<td>Hydrochloric acid (7647-01-0), sulfuric acid (7664-93-9), phosphoric acid (7664-38-2)</td>
</tr>
<tr>
<td>Gaseous</td>
<td>-</td>
<td>✓</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>Hydrogen chloride (7647-01-0), hydrogen bromide (10035-10-6), hydrogen fluoride (7664-39-3), boron trifluoride (10294-34-5), boron trifluoride (7637-07-2)</td>
</tr>
<tr>
<td>Oxidizing</td>
<td>-</td>
<td>✓</td>
<td>✓ ✓ ✓</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>Nitric acid (7697-37-2), chloric acid (7790-93-4), chlorosulfonic acid (7790-94-5)</td>
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<tr>
<td>Alcohols</td>
<td>Aliphatic</td>
<td>R-OH</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>-</td>
<td>Methanol (67-56-1), ethanol (64-17-5), isopropanol (67-63-0), t-butanol (75-65-0), glycerol (56-81-5), 1-hexanol (111-27-3), 2-octanol (123-96-6)</td>
</tr>
</tbody>
</table>
|          | Aromatic   | Ar-OH | - | - | - | ✓ | - | - | ✓ | ✓ | ✓ | Phenol (108-95-2), 1,2-dihydroxybenzene (catechol) (120-80-9), 2-naphthol (135-19-3), 2,4-dichloro-phenol (120-83-2), 4-
<p>| Alkyl halides | R-X | - | - | - | - | √ | √ | - | Bromoform (75-25-2), chloroform (67-66-3), 1,2-dichloroethane (ethylene dichloride) (107-06-2), 1,2-dichlorotetrafluoro ethane (76-14-2), 1,2-dibromoethane (ethylene dibromide) (106-93-4), methyl bromide (74-83-9), 1,2-dichloropropane (propylene dichloride) (78-87-5) |
| Amines | Aliphatic, organic | R-NH₂, R₂NH, R₃N | - | - | - | - | √√√ | √ | Ethylamine (75-04-7), ethylenediamine (107-15-3), pyrrolidine (123-75-1), trimethylamine (75-50-3), hexylamine (111-26-2), isopropylamine (75-31-0), triethylamine (121-44-8), morpholine (110-91-8), butylamine (109-73-9) |
| | Aromatic | Ar-NH₂, Ar(N) | - | - | - | - | √ | √√√ | √ | Diethyltoluenediamine (68479-98-1), aniline (62-53-3), pyridine (110-86-1), N,N-diethyl aniline (91-66-7), 3-methylpyridine (3-picoline) (108-99-6), p-phenylenediamine (4-aminodiamine) (106-50-3), 4-aminotoluene (p-toluidine) (106-49-0), 2,4-diaminotoluene (TDA) (95-80-7) |
| | Bases | - | √ | - | - | - | - | √√√ | √ | Sodium hydroxide (1310-73-2), potassium hydroxide (1310-58-3), sodium carbonate (497-19-8) |</p>
<table>
<thead>
<tr>
<th>Gaseous</th>
<th>-</th>
<th>-</th>
<th>-</th>
<th>-</th>
<th>-</th>
<th>✔✔✔</th>
<th>✔✔</th>
<th>-</th>
<th>Ammonia (7664-41-7), methylamine (74-89-5), trimethylamine (75-50-3)</th>
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<tr>
<td>Carbides / Nitrides</td>
<td>M-C₂, M-N</td>
<td>-</td>
<td>✔</td>
<td>-</td>
<td>-</td>
<td>✔</td>
<td>-</td>
<td>-</td>
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<tr>
<td>Carbonyl compound Acid anhydride</td>
<td>$R_1$-C(O)OC($\text{O}$)-$R_2$</td>
<td>-</td>
<td>✔</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>✔</td>
<td>✔✔</td>
<td>✔</td>
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<tr>
<td>Acyl halides</td>
<td>R, Ar-C(O)X, R,Ar-SO₂X</td>
<td>-</td>
<td>✔✔✔</td>
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<td>-</td>
<td>✔</td>
<td>✔✔</td>
<td>✔</td>
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<tr>
<td>Aldehydes</td>
<td>RCH=O, Ar-CH=O</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>✔✔</td>
<td>-</td>
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<tr>
<td>Esters</td>
<td>R(_1)(C=O)R(_2)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>✓</td>
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<td>Halides</td>
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<td>✓</td>
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<td>-</td>
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<tr>
<td></td>
<td>C(S)X(_2)</td>
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<tr>
<td>Ketones</td>
<td>R(_1)R(_2)C=O</td>
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<td>-</td>
<td>-</td>
<td>✓</td>
</tr>
<tr>
<td>Organic (nitriles)</td>
<td>R, Ar-CN</td>
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<td>-</td>
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<td>✓</td>
<td>✓</td>
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<tr>
<td>Ethers/glycols</td>
<td>R-O-R</td>
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<td>Gases Flammable</td>
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<td>✓</td>
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<td>-</td>
<td>-</td>
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</tbody>
</table>
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| Isocyanates | R- \( \text{N=O} \), \( \text{Ar-} \), \( \text{N=C=O} \) | Toluene diisocyanate (TDI) (584-84-9), methylene bisphenol isocyanate (MDI) (101-68-8), hexamethylene diisocyanate (HDI) (822-06-0), p-tolueneisulfonfyl isocyanate (4083-64-1), methyl isocyanate (624-83-9) |
| Metals | Metal Alkyls | M-R | Butyllithium (109-72-8), triethylaluminum (97-93-8), triethylborane (97-94-9), n-butylethylmagnesium (62202-86-2), diethyl zinc (557-20-0) |
| Metals Halides | M-X | Aluminum chloride (7446-70-0), chromium (III) chloride (10025-73-7), copper(I) chloride (7758-89-6), silver bromide (7785-23-1), ruthenium (II) chloride (10049-08-8), titanium tetrachloride (7550-45-0), tin chloride (7772-99-8), tungsten hexahalide (7783-82-6) |
| Metal Hydrides (gases) | M-H | Diborane (19287-45-7), hydrogen selenide (7783-07-5), phosphine (7803-51-2) |
| Metals (alkali) | M | - | ✓✓✓ | - | ✓✓✓ | - | ✓✓✓ | ✓✓✓ | - | Sodium (7440-23-5), lithium (7439-93-2), potassium (7440-09-7) |
| Metals (powdered) | M | - | ✓✓✓ | - | ✓✓✓ | - | ✓✓✓ | - | - | Aluminum (7429-90-5), magnesium (7439-95-4), titanium (7440-32-6), zirconium (7440-67-7) |

| Nitrate compounds | Nitro R, Ar-NO₂ | ✓✓ ✓ ✓ | - | - | - | - | ✓✓ | ✓✓ | ✓✓ | Nitromethane (75-52-5), o-nitroaniline (88-74-4), dinitrotoluene (25321-14-6), p-dinitrobenzene (100-25-4), m-nitrotoluene (99-08-1), 1-chloro-4-nitrobenzene (100-00-5), p-nitrophenol (100-02-7), nitro-p-nitroaniline (100-01-6), 1,4-diamino-2-nitrobenzene (5307-14-2), 1-nitropropane (108-03-2) |

| Azo (aliphatic) | R-N=N-R | ✓✓ ✓ ✓ | - | - | - | - | ✓✓ | ✓✓ | ✓✓ | Diethyl azodicarboxylate (1972-28-7), 1,1′-azobis(cyanocyclohexane) (2094-98-6), 2,2′-azobis(2-methylbutyronitrile) (13472-08-7), azoisobutyronitrile (AIBN) (78-67-1), 2,2′-azobis(2,4-dimethylvaleronitrile) (4419-11-8) |

<p>| Azo (aromatic) | Ar-N=N-Ar | - | - | - | - | - | - | ✓✓ | Azobenzene (103-33-3), p-aminoazobenzene (Aniline Yellow) (60-09-3), p-dimethylaminoozo benzene-sulfonic acid (Methyl Orange) (547-58-0), 1-(2-methoxyphenylazo)-2-naphthol (Sudan Red G) (1229-55-6), 4-acetamido-2′-hydroxy-5′-methylazobenzene (Disperse Yellow 3) (2832-40-8), 4-[N-(2-cyanethyl)-N-ethylamino]-4′-nitroazobenzene |</p>
<table>
<thead>
<tr>
<th>Azides</th>
<th>R, Ar-N₃</th>
<th>✓ ✓ ✓ - - - - - - ✓ ✓ ✓</th>
<th>Sodium azide (26628-22-8)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inorganic</td>
<td>M-NO₂</td>
<td>- ✓ ✓ ✓ - - - - ✓ ✓ - ✓ ✓</td>
<td>Sodium nitrite (7632-00-0), potassium nitrite (7758-09-0)</td>
</tr>
<tr>
<td>Nitrates</td>
<td>M-NO₃</td>
<td>✓ ✓ ✓ ✓ - - - - ✓ ✓ ✓ ✓ ✓</td>
<td>Sodium nitrate (7631-99-4), silver nitrate (7761-88-8), zinc nitrate (7779-88-6), lithium nitrate (7790-69-4), lead nitrate (10099-74-8), potassium nitrate (7757-79-1)</td>
</tr>
</tbody>
</table>

| Nitrogen-Halogen compounds | R-N-X | ✓ ✓ ✓ ✓ - - - - ✓ ✓ ✓ ✓ ✓ | Trichloroisocyanuric acid (87-90-1), sodium dichloroisocyanurate (2893-78-9), N-bromosuccinimide (128-08-5), 1-bromo-3-chloro-5,5-dimethylhydantoin (BCDMH) (126-06-7) |

| Oxyanion      | M-ClO₃, M-ClO₂, M-ClO₄, M-OCl | ✓ ✓ ✓ ✓ - - - - ✓ ✓ ✓ ✓ | Sodium chlorite (7758-19-2), sodium chlorate (7775-09-9), sodium perchlorate (7601-89-0), ammonium perchlorate (7790-98-9), calcium hypochlorite (7778-54-3), potassium bromate (7758-01-2), lithium hypochlorite (13840-33-0) |

| Peroxides     | Organic | R-O-O-R | ✓ ✓ ✓ ✓ - - - - ✓ ✓ ✓ ✓ ✓ | Benzoyl peroxide (94-36-0), diacetyl peroxide (>70%) (110-22-5), dibenzyol peroxide (94-36-0), methyl ethyl ketone peroxide (>60%) (97-02-9), di-tert-butyl peroxide (110-05-4), γ-amyl hydroperoxide (3425-61-4), cumene hydroperoxide (80-
### Table B.3.2

<table>
<thead>
<tr>
<th>Metal / Inorganic</th>
<th>M-O-O</th>
<th>Phosphorus Halogen Compounds</th>
<th>O=P-X_3, P-X</th>
<th><em>(S, L, G)</em> refers to whether hazards apply to “Solid,” “Liquid,” and/or “Gaseous” physical forms.</th>
</tr>
</thead>
<tbody>
<tr>
<td>-</td>
<td>-</td>
<td>-</td>
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<tr>
<td>✓</td>
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<tr>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
</tr>
</tbody>
</table>

15-9), 1-butyl peroxyacetate (107-71-1)
Sodium perborate (10486-00-7), sodium percarbonate (15630-89-4), magnesium peroxide (1335-26-8), sodium peroxide (1313-60-6)

*(S, L, G) refers to whether hazards apply to “Solid,” “Liquid,” and/or “Gaseous” physical forms.

✓✓✓ Indicates that most or all of the chemicals within the family or sub-family have the indicated physical and health hazards.

✓✓ Indicates that some of the chemicals in the family may have this additional physical and health hazards.

✓ Indicates that only a select few chemicals within a specific family display the relevant physical and health hazards.

"." = Not applicable for the specific chemical category.

Ar = phenyl ring; X = halogen (i.e., fluorine, chlorine, bromine, iodine); R = organic; M = metal.

Additional Source Material:

http://www.epa.gov/oppt/chemrtk/

http://www.epa.gov/oppt/chemrtk/pubs/update/hpvchmlt.htm


http://www.osha.gov/SLTC/emergencypreparedness/guides/chemical.html

**Footnotes to Table B.3.2:**


2. The physical and health hazards are BROAD representations for the various classes of chemicals. These classifications are NOT intended to cover all hazards of a material. For specific information, the chemical-specific SDS MUST be consulted. Additional information can be obtained from the manufacturer.

3. For additional concentration dependent hazard categories, see B.5.

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5. The “flammable or combustible” hazard categories are NOT regulated under NFPA 400. However, many chemicals exhibit the hazard properties of flammability or combustibility.

6. “Peroxide” is not a hazard characteristic but a unique chemical family with a range of properties listed as a specific physical hazard under NFPA 400.

### B.3.2.1 Table Descriptions.

Nineteen general chemical families are listed in the first column of Table B.3.2. The chemical families include organic chemicals, inorganic chemicals, gases, and metals. Some of the general chemical families are further divided into subfamilies if one or more hazard category or categories further depend on chemical structure. The second column, Chemical Structure, shows the basic chemical formula or structure representing the chemical family and/or subfamilies.

The next several columns list the seven physical hazard categories and three health hazard categories. The specific hazard categories are defined in Chapter 3. The physical hazard categories include the following:

1. Unstable Reactive
2. Water Reactive
3. Oxidizer
4. Pyrophoric
5. Flammable Solid
6. Organic Peroxide
7. Flammable/Combustible

The health hazards include the following:

1. Corrosive
2. Toxic
3. Highly Toxic

Hazard categories are defined by the following symbols. A triple check mark (✓✓✓) is used to indicate that most or all of the chemicals within the family or subfamily have the indicated physical or health hazard. A double check mark (✓✓) is used to identify that some of the chemicals in the family might have this additional hazard. A single check mark (✓) indicates that only a select few chemicals within a specific family display the relevant physical and health hazard(s). The check marks are provided to inform the user as to the likely property of materials in each of the hazard categories listed. However, it must be recognized that the ultimate
classification of a material is dependent on the application of the definitions found in Chapter 3 and the interpretation of the information provided relative to tests conducted by authoritative entities within the framework established by the definitions.

The last column provides examples of chemicals with the indicated hazards. The examples illustrate materials in the concentrated or undiluted state. Concentration-specific hazards for common materials are provided in the explanatory material following the table (see Section B.5).

B.3.2.2 Multiple Hazard Materials. A specific chemical can exhibit multiple hazard categories. In other words, there could be materials with more than one physical hazard property that also have one or more health hazard properties. The regulatory controls integral to NFPA 400 require that all hazards be addressed. It is incumbent on the code user to identify each applicable hazard property in order to properly classify the hazards of the material. It should also be recognized that each of the hazards considered could be concentration dependent.

B.3.2.2.1 Illustration of Table B.3.2. To illustrate the utility of Table B.3.2, consider the chemical family of mineral acids, listed in column 1 of Table B.3.2. Specific examples of mineral acids are listed in the last column of Table B.3.2. Well-known mineral acids are hydrochloric acid and sulfuric acid. The row entries with dashes (—) under the physical hazard categories indicate that, in general, mineral acids are not considered to have the physical hazards of being unstable/reactive, oxidizer, pyrophoric, flammable solids, organic peroxides, or flammable/combustible. Specific mineral acids are water reactive (✓) based on concentration and the specific mineral acid itself. The row entries show the principal hazard properties of mineral acids are Health Hazards, especially Corrosive (✓✓✓). The one checkmark under Toxic (✓) indicates that a select few of the chemicals in the mineral acid family have this additional health hazard. See B.4.1.1 for additional information on mineral acids. The SDS for the specific mineral acid should be consulted for more detailed information relating to physical and health hazards.

B.3.3 ADDITIONAL SOURCE MATERIAL: http://www.epa.gov/oppt/chemrtk/
http://www.epa.gov/oppt/chemrtk/pubs/update/hpvchmlt.htm
http://www.osha.gov/SLTC/emergencypreparedness/guides/chemical.html

B.4 Description of Chemical Families.

B.4.1 General. Dilution can cause the hazard characteristics of an individual chemical to diminish until the property is no longer pertinent. Each chemical must be individually reviewed by the manufacturer to provide the data to assess the physical and health hazards. For compressed gases, there are accepted standards that can be used to estimate both the flammability and toxicity without actual test data.

B.4.1.1 Acids. Carboxylic acids are weak acids, unlike mineral acids, such as hydrochloric acid. Most are readily soluble in water. Physical and health
properties vary significantly based on molecular weight and the number of carboxylic acid groups. Smaller molecular weight aliphatic carboxylic acids (such as formic and acetic acid) are liquids and are flammable and corrosive. Larger chain, higher molecular weight carboxylic acids are often solids with minimal hazards (such as citric acid). Aromatic acids are sometimes corrosive.

B.4.1.1.2 Acids (Peroxy) (R-OOH, Ar-OOH). All peroxy acids are classified as organic peroxides and are classified as oxidizers and corrosive. Aromatic peroxy acids (such as perbenzoic acid) are solids and are unstable reactive and toxic. Most are pastes or liquids and require refrigeration. Some forms of this acid family are often found as their sodium, potassium, or ammonium salts.

B.4.1.1.3 Acids (Mineral). These are all strong acids, are liquids, and are corrosive, even in dilute solutions. These include hydrofluoric acid (HF), hydrochloric acid (HCl), hydrobromic acid (HBr), phosphoric acid (H₃PO₄), and sulfuric acid (H₂SO₄). In some cases they are toxic and water reactive depending on acid and concentration.

B.4.1.1.4 Acid (Gaseous). The common acid gases, which include hydrogen bromide (HBr), hydrogen chloride (HCl), hydrogen fluoride (HF), and hydrogen iodide (HI), are corrosive and in some cases toxic. They are highly soluble in water, forming the corresponding aqueous acid and are packaged as liquefied compressed gases. Other acid gases include boron trichloride (BCl₃), boron trifluoride (BF₃) and silicon tetrafluoride (SiF₄).

B.4.1.1.5 Acid (Oxidizing). Some strong acids are also oxidizing acids, most commonly nitric acid (HNO₃). As oxidizers, they are also corrosive and toxic. These physical and health properties are exhibited even in dilute solutions.

B.4.1.2 Alcohols.

B.4.1.2.1 Aliphatic Alcohols (R-OH). The category includes primary (1°), secondary (2°), and tertiary (3°) branched and cyclic alcohols. Most common alcohols include methanol, ethanol, isopropanol, t-butanol (2-methylpropan-2-ol), n-butanol (butan-1-ol) and cyclohexanol. Many alcohols, especially smaller chain alcohols, are highly flammable even in dilute solutions. This generally does not hold true for the small-chain glycols (or polyhydroxylated compounds), such as propylene glycol which have significantly higher boiling points. Most smaller chain aliphatic alcohols are readily soluble in water. Longer chain alcohols “fatty alcohols” (e.g., dodecanol, hexadecanol and octadecanol) are solids, are not flammable, and are not miscible with water.

B.4.1.2.2 Aromatic Alcohols (Ar-OH). The most common aromatic alcohol is phenol (hydroxybenzene). Others include the dihydroxybenzenes (e.g., catechol) and hydroxytoluenes (e.g., o-cresol). Most phenols are usually solids or high boiling point liquids and readily soluble in water. Phenol and p-cresol are highly corrosive and toxic. Functionalized phenol derivatives (e.g., 2,4-dichlorophenol), while also soluble in water, are not flammable and can be toxic. Higher molecular weight phenols such as hydroxynaphthalene (e.g., naphthol) can also be toxic but are not corrosive. The chemical and physical properties of aliphatic and aromatic alcohols vary significantly depending on the structure of the alcohol and other functional groups.
B.4.1.3 Alkyl Halides (R-X). This chemical family includes halogenated alkyl analogues, such as methylene chloride, chloroform, carbon tetrachloride, bromoform, dichloroethane, perchloroethylene, methyl bromide and methyl iodide, fluoroethane, and Freon® derivatives. Often these chemicals are nonflammable gases and liquids, used as fire extinguishers, refrigerants, and solvents. The most widely known category is the chlorofluorocarbons (CFCs). Nonflammable gases include bromochlorodifluoromethane (Halon 1211) and dichlorodifluoromethane (Freon-12). Some chemicals in this family are flammable. Highly substituted alkyl halides (i.e., those chemicals with many halogen atoms present in a molecule) such as 1,2-dichloroethane and 1,1,2,2-tetrachloroethane are liquids and toxic.

B.4.1.4 Amines.

B.4.1.4.1 Amines (Aliphatic) (R-NH₂, R₂NH, R₃N). The aliphatic amines consist of primary (1°), secondary (2°), and tertiary (3°) branched compounds. Lower molecular weight amines such as ethylamine, propylamine, butylamine and triethylamine are highly flammable liquids, corrosive and readily soluble in water. Some are toxic. Many amines, such as methylamine, are sold in diluted aqueous solutions, and are typically flammable. (For ammonia, see B.4.1.5.2.)

B.4.1.4.2 Amines (Aromatic) (Ar-NH₂, Ar(N)). This family includes substituted aromatic amines, such as benzene derivatives (e.g., aniline, and o-aminoaniline) and heteroaromatics (e.g., pyridine and picoline). Most of these chemicals are solids or liquids and may be readily soluble in water and are toxic. Some are flammable. Health hazards associated with these chemicals depend heavily on the ring structure, degree of substitution, and location of the nitrogen(s) within the heteroaromatic ring.

B.4.1.5 Bases.

B.4.1.5.1 Alkalis. Bases are found either as solids or as concentrated aqueous solutions. Most bases are highly corrosive with all tissues with which they come in contact. Bases, such as sodium carbonate (Na₂CO₃), sodium hydroxide (NaOH), and potassium hydroxide (KOH), readily absorb moisture from the air. When dissolved in water, these chemicals often liberate substantial heat and form corrosive solutions in concentrated form. The corrosiveness and toxicity of these chemicals decreases with dilution.

B.4.1.5.2 Gaseous. The common basic gases, ammonia (NH₃) and the lower molecular weight amines (methylamine, dimethylamine, trimethylamine) are all are corrosive but not toxic. They are highly soluble in water and are liquefied compressed gases. The common bases are flammable gases with a narrow flammability range. They are often sold commercially as aqueous solutions, which are also flammable.

B.4.1.6 Carbides/Nitrides. Carbides have varying degrees of physical hazards. Carbides, such as calcium carbide (CaC₂) and sodium carbide (Na₂C₂), react violently with water, are flammable in the presence of moisture, and could be corrosive. Other carbides, such as zirconium carbide (ZrC), tungsten carbide (WC), and silicon carbide (SiC), have little reactivity. Nitrides, such as boron nitride (BN), are usually stable.

B.4.1.7 Carbonyl Compounds.
B.4.1.7.1 Carbonyl Compounds (Acid Anhydrides) (R_1-C(O)OC(O)-R_2). These chemicals, often referred to as simply “anhydrides,” are more reactive than their corresponding carboxylic acids. Anhydrides react with water to form the corresponding acid or base, and are often good dehydrating agents. Lower molecular weight anhydrides, such as acetic anhydride, propionic anhydride, and isobutyric anhydride, are most often corrosive, flammable, and could react violently with water. Functionalized anhydrides such as trifluoroacetic anhydride are highly corrosive and highly water reactive. Aromatic anhydrides, such as phthalic anhydride, are also corrosive but not water reactive.

B.4.1.7.2 Carbonyl Compounds (Acyl Halides) (R, Ar-C(O)X; R, Ar-SO_2-X). These chemicals include the most common acid halides and sulfonyl halides and are considerably more reactive than the corresponding anhydrides. Acyl halides are most often corrosive, water reactive, and volatile. Higher molecular weight aromatic acid halides, such as benzoyl chloride, are toxic and corrosive and have limited water solubility and lower water reactivity. Lower molecular weight acid halides such as acetyl chloride are flammable, highly corrosive, and react violently with water.

B.4.1.7.3 Carbonyl Compounds (Aldehydes) (R-CH=O, Ar-CH=O). Most aldehydes are volatile organic compounds. Simple, lower molecular weight alkyl aldehydes, such as acetaldehyde, propionaldehyde (methylacetaldehyde), butyaldehyde, and 2-butenaldehyde (crotonaldehyde), for example, exist as liquids, and are most often highly flammable. Formaldehyde is known to be toxic. Many aromatic aldehydes, such as benzaldehyde, have limited flammability.

B.4.1.7.4 Carbonyl Compounds (Esters) (R_1O(C=O)R_2). In general, the category possesses few physical or health hazards. Aliphatic and aromatic esters are significantly more stable than the acid anhydrides and are not water reactive. Lower molecular weight alkyl esters, such as methyl formate, ethyl acetate, and n-butyl acetate, are flammable liquids.

B.4.1.7.5 Carbonyl Compounds (Halides) (C(O)X_2, C(S)X_2). These compounds are very reactive chemicals and are considered highly toxic, highly water reactive, and corrosive. Phosgene is a nonflammable gas, while thiophosgene and oxalyl chloride are liquids. Trichloromethyl chloroformate (diphosgene) and methyl chloroformate are liquids and less reactive but still water reactive.

B.4.1.7.6 Carbonyl Compounds (Ketones) (R_1R_2C=O). Similar to aldehydes, most ketones are volatile organic compounds. Many ketones are also flammable liquids. Simple, low molecular weight ketones, such as acetone, cyclohexanone, methyl ethyl ketone (MEK), and methyl isobutyl ketone (MIBK), for example, are liquids and highly flammable. Common functionalized ketones, such as chloroacetone, 1,3-dichloro-2-propanone, and chloroacetophenone (chloromethyl phenyl ketone), while not flammable, are toxic. Many aromatic ketones have limited flammability.

B.4.1.8 Cyanides.

B.4.1.8.1 Cyanides (Gaseous). The common cyanide gases, hydrogen cyanide (HCN), cyanogen chloride (CICN), and cyanogen (C_2N_2), are highly toxic. Hydrogen cyanide is a liquid,
but is treated and packaged as a gas. Cyanogen and hydrogen cyanide are flammable, while cyanogen chloride is corrosive.

**B.4.1.8.2 Cyanides (Inorganic) (M-CN).** Common inorganic cyanides include sodium cyanide (NaCN) and trimethylsilyl cyanide (TMSCN). This family is characterized as highly toxic. Cyanide salts are readily soluble in water and highly toxic.

Trimethylsilyl cyanide is water reactive. The family does not include the many organic compounds that contain the CN group (called nitriles). Nitriles do not display the toxicity of the inorganic cyanides such as sodium and potassium cyanide.

**B.4.1.8.3 Nitriles (Organic).** Common, lower molecular weight nitriles, including acetonitrile and 2-propenenitrile (acrylonitrile), are highly flammable liquids and toxic. Many aromatic nitriles (benzonitriles) are solids and often toxic, depending on substituents. Benzonitriles have limited flammability.

**B.4.1.9 Epoxides.** Epoxides are very reactive chemicals. Common epoxides include ethylene oxide, which is a gas, and propylene oxide and 1-chloro-2,3-epoxypropane (epichlorohydrin), which are liquids. These chemicals most often have flammable, toxic, water-reactive, and unstable reactive hazard characteristics.

**B.4.1.10 Ethers/Glycols (R-O-R).** This broad category includes both simple alcohol ethers and polyhydroxylated glycol ethers. Simple, low molecular weight ethers such as diethyl ether or vinyl ether are low boiling liquids or compressed gases and highly flammable. Cyclic ethers, such as tetrahydrofuran (THF) and 1,4-dioxane, are highly flammable liquids while slightly toxic. Common higher molecular weight glycol ethers, such as 1,2-dimethoxyethane (glyme), ethylene glycol monomethyl ether (EGME, 2-methoxyethanol), dipropylene glycol monomethyl ether (DPM, 1-(2-methoxy-2-methylethoxy)-2-propanol), propylene glycol monomethyl ether (PGME, 1-methoxy-2-propanol), diethylene glycol monomethyl ether (DEGME), and dipropylene glycol monomethyl ether (DPGME), are often water soluble liquids and combustible. Lower molecular weight glycol ethers are flammable liquids. Many are high boiling point liquids.

**B.4.1.11 Gases.** Within the context of the model codes, gases are regulated as either compressed gases or cryogenic fluids. Compressed gases can be found either in the nonliquefied or liquefied state. Any gas can be liquefied at a sufficiently low temperature by increasing its pressure through the use of compression. Gases that cannot be liquefied at normal ambient temperatures are called “permanent” gases. A permanent gas is able to be liquefied by reducing the temperature below ambient temperatures and increasing its pressure. However, at normal ambient temperatures of 68°F (20°C) these gases remain in a nonliquefied state.

The scientific explanation for this phenomenon is generally explained in the following discussion. There is a temperature for each gas at or below which it can be liquefied by pressure, but above which it is impossible to liquefy at any pressure. This temperature is called the critical temperature of the gas. At temperatures above the critical temperature, the substance can exist only in the gaseous state regardless of the pressure applied. The pressure that will just liquefy a gas at its critical temperature is called the critical pressure. In other words, the critical pressure of a gas is equal to the vapor pressure exerted by the liquefied gas at its critical temperature. All that is necessary to liquefy a gas is to cool it to its critical temperature and subject it to a pressure
equal to or greater than its critical pressure. The farther below the critical temperature it is cooled, the less the pressure required for liquefaction. At the critical conditions of temperature and pressure the gaseous and liquid forms of the substance have the same density.

Atmospheric air is a mixture of permanent gases and principally composed of argon, oxygen, and nitrogen. Under normal ambient conditions it remains in the gaseous state. The critical temperature of air is −221.1°F (−140.6°C). The critical pressure is an absolute pressure of 547 psi (3771 kPa, absolute). To liquefy compressed air, the temperature must be reduced to −221.1°F or less with a commensurate increase in pressure above 547 psia. By comparison, liquefied petroleum gas (LP-Gas), is a mixture of hydrocarbon gases, principally propane and butane, which is found in the liquid form under ambient conditions. These gases have a critical temperature well in excess of 68°F (20°C), and as a result, they are found as liquefied compressed gases under ambient temperatures.

Cryogenic fluids are refrigerated liquefied gases with a boiling point lower than −130°F (−90°C) at an atmospheric pressure of an absolute pressure of 14.7 psi (101.3 kPa, absolute). They are maintained in the cryogenic (super-cooled) state by artificial means.

**B.4.1.11.1 Gases (Flammable).** Common nonliquefied flammable compressed gases include carbon monoxide and hydrogen. Other flammable gases are hydrocarbon gases. The alkanes include methane (CH\(_4\)), ethane (C\(_2\)H\(_6\)), and propane (C\(_3\)H\(_8\)). Ethane and propane are liquefied compressed gases at ambient temperature. The alkenes include ethylene (C\(_2\)H\(_4\)) and propylene (C\(_3\)H\(_6\)), both liquefied compressed gases, and the alkynes include acetylene (C\(_2\)H\(_2\)). Acetylene is an unstable reactive gas; it is found in cylinders, packaged as a compressed gas dissolved in a solution of acetone or dimethyl formamide. While acetylene can be liquefied at ambient temperatures, for safety reasons it is shipped as a nonliquefied compressed gas.

**B.4.1.11.2 Gases (Halogens) (X-X).** The pure halogen gases, fluorine (F\(_2\)), chlorine (Cl\(_2\)), bromine trifluoride (BrF\(_3\)), and chlorine trifluoride (ClF\(_3\)), are extremely powerful oxidizers, and are corrosive and toxic. Fluorine and chlorine are only slightly soluble in water, while bromine trifluoride and chlorine trifluoride are extremely water reactive. Bromine trifluoride is explosive on contact with water. Fluorine is a compressed gas while chlorine, bromine trifluoride, and chlorine trifluoride are liquefied compressed gases.

Gases that are fully halogenated, such as hexafluoroethane (C\(_2\)F\(_6\)), carbon tetrafluoride (CF\(_4\)), and sulfur hexafluoride (SF\(_6\)), are inert and nonreactive.

**B.4.1.11.3 Gases (Non-Flammable).** The atmospheric gases, with the exception of oxygen, have limited chemical reactivity, and are not corrosive, flammable, or toxic. These gases include nitrogen, argon, and carbon dioxide. Their greatest hazard is asphyxiation. The rare gases, such as helium, neon, krypton, xenon, and argon, were once thought to be inert (having no chemical activity at all); however, within the last 20 years compounds have been made through the use of strong oxidizer gases, such as fluorine, to form nitrogen trifluoride.

**B.4.1.11.4 Gases (Oxidizing).** The more common oxidizing gases are oxygen, nitrous oxide, and nitrogen trifluoride. Oxygen and nitrogen trifluoride are compressed gases, while nitrous oxide is a liquefied compressed gas.
B.4.1.11.5  **Gases (Pyrophoric).** Gases with an autoignition temperature below 130°F (54°C) are classified as pyrophoric. Silane (SiH₄) is probably one of the most common pyrophoric gases found in use today. Other pyrophoric gases include methylsilane (CH₃SiH₃) and disilane (Si₂H₆). Silane and methylsilane are compressed gases, while disilane is a liquefied compressed gas. Some pyrophoric gases, such as phosphine (PH₃) and diborane (B₂H₆), are also highly toxic. Although all pyrophoric gases are flammable by nature, they are regulated as pyrophoric gases within the context of the model codes.

B.4.1.11.6  **Gases (Sulfur Gases) (R-SH).** The common sulfur gases are hydrogen sulfide (H₂S), methyl mercaptan (CH₃SH), and carbonyl sulfide (COS) and are toxic and flammable. They are all liquefied compressed gases.

B.4.1.12  **Hydrocarbons.**

B.4.1.12.1  **Hydrocarbons (Aliphatic) (R).** Commonly referred to as saturated hydrocarbons, alkanes as a whole are unreactive chemicals. The aliphatic hydrocarbons pentane, decane, and cyclohexane are flammable liquids. Lower molecular weight hydrocarbons such as methane, ethane, propane, and butane are flammable compressed gases.

B.4.1.12.2  **Hydrocarbons (Alkenes) (R₁CH=CHR₂).** Alkenes are a very broad category of hydrocarbons and are commonly referred to as unsaturated hydrocarbons, olefins, or vinyl compounds. Alkenes are relatively stable compounds, but are more reactive than alkanes. Smaller chain alkenes, such as ethylene, propylene, and butene, are all flammable gases and readily form explosive mixtures with air. Common derivatized alkenes, such as styrene (vinyl benzene), vinyl chloride (monochloroethylene), vinyl acetate, and 1,4-dichloro-2-butene, are toxic. Some are flammable liquids. They also readily polymerize (without inhibitors), which leads to unstable reactive characteristics.

B.4.1.12.3  **Hydrocarbons (Alkynes) (R₁C≡CR₂, R-C≡C-H).** Of all the aliphatic hydrocarbons, alkynes are the most reactive. Many alkynes are highly reactive and considered unstable reactive, especially as molecular weights increase. Many halogenated alkynes and metal derivatives can be explosive. The most common alkynes are gases, including acetylene (ethyne — see Flammable Gases) and methyl acetylene (1-propyne), can form explosive mixtures with air. The most common derivitized alkyne is propargyl alcohol (2-propyn-1-ol), which is flammable, corrosive, and toxic.

B.4.1.12.4  **Hydrocarbons (Aromatic) (Ar).** This family is very broad and derived from such compounds as benzene and toluene and have limited alkyl (methyl, ethyl, etc.) substitution on the ring. Smaller aromatic hydrocarbons (benzene, toluene (methyl benzene), ethyl benzene, and xylene) are flammable liquids and are sometimes toxic. High molecular weight compounds with many aromatic rings (such as naphthalene and anthracene) are solids and are often toxic. Substituted analogues, such as dichlorobenzene, have varying degrees of toxicity based on the degree of substitution and arrangement on its ring structure. Many are also flammable solids.

B.4.1.13  **Isocyanates (R-N=C=O, Ar-N=C=O).** This family includes compounds such as toluene diisocyanate (TDI), p-toluenesulfonyl isocyanate, and methylene bisphenyl isocyanate (MDI). The chemicals are liquids and are typically unstable reactive, water-reactive, corrosive, and toxic. Some are highly toxic. Some are violently water reactive.
B.4.1.14  Metals.

B.4.1.14.1  Metal Alkyls (M-R). All metal alkyls are pyrophoric, corrosive, and highly reactive. The simple metal alkyls trimethylaluminum (TMAI), trimethylgallium (TMG), and trimethylindium (TMI) are pyrophoric liquids. They are also violently water reactive. Dimethylzinc and trimethylaluminum are also unstable reactive. Tetramethyltin is a flammable liquid.

B.4.1.14.2  Metal Halides (M-X). Physical and health hazards of this chemical family vary significantly based on the corresponding metal. Most metal halides are typically inert (such as sodium chloride [table salt], calcium chloride, magnesium fluoride, aluminum chloride, and palladium (II) chloride), while some have a much higher reactivity (such as silver bromide and chromium (III) chloride) and are strong oxidizers. The chemical and physical properties vary significantly depending on the metal. If a metal halide contains a heavy metal, such as lead, chromium, thallium, and mercury, it is assumed to be highly toxic. Fluoride and bromide salts are more toxic than the corresponding chloride salts.

B.4.1.14.3  Metal Hydrides (Solids). Compounds such as lithium aluminum hydride (LiAlH₃), sodium borohydride (NaBH₄), and sodium hydride (NaH) are flammable solids, water-reactive, and corrosive. Metal hydrides react violently with water.

B.4.1.14.4  Metal Hydrides (Gaseous). The more common metal hydride gases are arsine (arsenic hydride, AsH₃), diborane (boron hydride, B₂H₆), hydrogen selenide (selenium hydride, H₂Se), and phosphine (phosphorous hydride, PH₃). In general, these chemicals are toxic, liquefied compressed gases, with many being highly toxic. They are flammable and some have autoignition temperatures low enough to make them pyrophoric, such as diborane and phosphine. The key exception is silane (SiH₄), which is not toxic. Silane is a compressed gas rather than a liquefied compressed gas.

B.4.1.14.5  Metals (Alkali). This category includes sodium, potassium, and lithium. All are highly corrosive and can often explode if they are exposed to water. They are all flammable solids as well.

B.4.1.14.6  Metals (Powdered). Metals, especially those in a finely divided state, are usually categorized as flammable solids, such as aluminum, magnesium, sodium, and potassium. Some, but not all, react violently and are water-reactive. Some are also toxic.

B.4.1.15  Nitrated Organic Compounds.

B.4.1.15.1  Organic Nitro Compounds (R, Ar-NO₂). Most often, smaller alkyl nitro compounds, such as nitromethane, are flammable, unstable reactive, and often toxic. Aromatic nitro analogues are toxic or highly toxic and unstable reactive, the latter being dependent on the amount of ring substitution.

B.4.1.15.2  Azo (Aliphatic) (R-N=N-R). Aliphatic azo derivatives are inherently unstable and readily decompose, often violently, upon the application of heat. Aliphatic azo compounds are characterized as unstable reactive, flammable solids and are often toxic.
B.4.1.15.3  **Azo (Aromatic) (Ar-N=N-Ar).** Aromatic azo derivatives have superior thermal stability properties compared to aliphatic azo derivatives. Many aromatic azo derivatives are quite stable and often used as dyes. They have a wide array of chemical and physical properties depending on the substituents on the aromatic ring and the number of azo groups present in the molecule (mono-, di-, tri-, tetrakis-, etc.). Most exhibit low to moderate toxicity.

B.4.1.15.4  **Azides (R, Ar-N₃).** The most common chemicals of this family are the metal azides, including sodium and lithium azide. All the compounds in this family are unstable reactive and highly toxic.

B.4.1.15.5  **Nitrates (Inorganic) (M-NO₂).** The most common nitrates are sodium and potassium nitrite. All are strong oxidizers and toxic.

B.4.1.15.6  **Nitrites (Inorganic) (M-NO₃).** Examples of inorganic nitrates include sodium nitrate, silver nitrate, zinc nitrate, lithium nitrate, and lead nitrate. While all inorganic nitrates are strong oxidizers, the physical and health properties vary significantly depending on the metal. Many of these compounds are corrosive and may have unstable reactive properties. Toxicity varies with the associated metal.

B.4.1.16  **Nitrogen-Halogen compounds (R-N-X).** This chemical family includes chlorinated isocyanurates (trichloroisocyanuric acid, sodium dichloroisocyanurate), halogenated succinimides (N-bromosuccinimide), and halogenated hydantoins (e.g. 1-bromo-3-chloro-5,5-dimethylhydantoin). Some are strong oxidizers and corrosive in their pure states, with varying properties of unstable reactive, water-reactive, and toxicity hazards. Specially formulated chlorinated isocyanurate products have been shown to reduce oxidizer properties.

B.4.1.17  **Oxyanion (M-ClO₂, M-ClO₃, M-ClO₄, M-OCl).** This chemical family includes chlorites, chlorates, perchlorates, bromates, and hypochlorites. The most common chemicals are sodium chlorite (NaClO₂), sodium chlorate (NaClO₃), ammonium perchlorate (NH₄ClO₄), potassium bromate (KBrO₃), and calcium hypochlorite (Ca(OCl)₂). Most are strong oxidizers and corrosive in their pure states with varying properties of unstable reactive, water reactive, and toxicity hazards. Chlorites and chlorates are most commonly found as diluted solutions that reduce toxicity and oxidizing properties. Specially formulated calcium hypochlorite products have been shown to reduce their oxidizing properties. Sodium hypochlorite (liquid bleach) is too unstable in solid form and is found only in dilute solutions that are corrosive.

B.4.1.18  **Peroxides.**

B.4.1.18.1  **Peroxide (Organic) (R-O-O-R).** The common organic peroxides include such chemicals as t-amyl hydroperoxide, dibenzoyl peroxide, di-t-butyl peroxide, diacetyl peroxide, methyl ethyl ketone peroxide, diisopropyl peroxydicarbonate, and cumyl hydroperoxide. Organic peroxides possess a wide range of properties based on the many physical forms and concentrations and have a large range of safety-related properties, including physical as well as health hazards. Organic peroxides are either used as the technically pure compound or as formulations where the peroxide might be found in a diluted form, such as solutions, pastes, or solid granules.
Organic peroxide formulations vary in reactivity hazard from self-extinguishing to the potential for a violent deflagration or detonation. Decomposition can be initiated by heat, friction, mechanical shock, or contamination, though sensitivity to these stimuli varies greatly. Dilution with water or other solvents is used as a means to reduce the level of sensitivity to outside stimuli and the potential for decomposition. Refrigeration is also used as a means to reduce the potential for decomposition. The health hazards of these materials as provided in commerce vary greatly depending on concentration and formulation itself.

B.4.1.18.2 Metal Peroxides (Inorganic) (M-O-O). Metal peroxides, such as sodium peroxide and calcium peroxide, are all oxidizers. Some are corrosive and water reactive. Reaction with water can be explosive in some instances.

B.4.1.19 Phosphorus-Halogen Compounds (O=P-X₃, P-X). These phosphorus analogues are corrosive and often react violently with water and include such chemicals as phosphorus oxychloride (POCl₃), phosphorus trichloride (PCl₃), and phosphorus pentachloride (PCl₅). They are water reactive, corrosive, and toxic.

B.5 Hazard Category Based on Concentration.

B.5.1 General. Some chemicals exhibit different physical and/or health hazards based on the concentration. Some pertinent examples of concentration-dependent hazards of specific chemicals are provided in the following list. Additional information on concentration-dependent hazards should be contained in the SDS.

1. Acetic Acid (64-19-7). Concentration: 100 percent — corrosive, flammable/combustible; 36 percent aqueous — corrosive; <5 percent aqueous — not corrosive.


3. Formaldehyde (50-00-0). Concentration: anhydrous — flammable, corrosive, highly toxic; 37 percent aqueous — combustible, highly toxic 10 percent aqueous — combustible.


5. Nitric Acid (7697-37-2). Concentration: 7–40 percent aqueous — oxidizer, corrosive; 1–6 percent aqueous — not oxidizer, not corrosive.

6. Phosphine (CAS numbers based on concentration). Concentration: 5 percent phosphine, 95 percent nitrogen — pyrophoric, toxic; phosphine: 2 percent phosphine, 98 percent nitrogen — toxic.


8. Potassium Hydroxide (1310-58-3). Concentration: 100 percent — corrosive, water reactive, toxic; 45 percent aqueous — corrosive, water reactive; 5 percent aqueous — corrosive.

(10) Sodium chlorate (7775-09-9). Concentration: 100 percent — corrosive, oxidizer, unstable reactive; 40–50 percent aqueous — corrosive, oxidizer.

(11) Sodium hydroxide (1310-73-2). Concentration: 100 percent — corrosive, water reactive, toxic; 1–50 percent aqueous — corrosive.

(12) Sulfuric Acid (7664-93-9). Concentration: 92–98 percent aqueous — corrosive, water reactive, toxic; 12.7–50 percent aqueous — corrosive, water reactive, toxic; 4–12.6 percent aqueous — corrosive.


B.6 Safety Data Sheets (SDSs) — A Starting Point for Hazards Identification.

B.6.1 Safety data sheets (SDSs) have been established as a primary means of hazard identification under OSHA’s Hazard Communication program. SDSs are provided by manufacturers or importers as a means to communicate hazards within a set of standardized terms and elements or bodies of information.

B.6.2 In 2012, OSHA revised its Hazard Communication Standard to align with the United Nations Globally Harmonized System of Classification and Labelling of Chemicals (GHS). The Hazard Communication Standard requires the use of a 16-section format for SDSs, similar to that of the ANSI format. As manufacturers and distributors transition to the 16-section SDS format, they will include information in the sixteen sections referenced in B.2. In order to classify the hazards of a given material, users should refer to key sections of the SDS that contain the following information:

(1) Identification (SDS Section 1)
(2) Hazard(s) identification (SDS Section 2)
(3) Composition/information on ingredients (SDS Section 3)
(4) Physical and chemical properties (SDS Section 9)
(5) Stability and reactivity (SDS Section 10)
(6) Toxicological information (SDS Section 11)
(7) Transport information (SDS Section 14)

Each section should contain relevant information that can be used in the hazard classification process. The following paragraphs provide useful information to help the user with these required SDS sections.

B.6.2.1 Identification. Product identification will typically include the chemical name, common name, and synonyms. Pure materials, sometimes referred to as “neat” to indicate that
they are in an undiluted form, are typically referred to by their chemical name. However, it is not uncommon to find that the manufacturer has identified the material under a trade name chosen by that particular manufacturer. Chemical synonyms will frequently be shown; however, it should be expected that the list of synonyms may be an abbreviated listing and that there may be other synonyms that are not listed.

For chemical mixtures the material will typically be identified by its trade name. Some confusion can be created when a material in its “neat” form is further identified in the Hazard Identification section as containing other constituents. Commercially available materials, even in the pure or neat form, contain impurities from the manufacturing process. Although there is no hard-and-fast rule, materials in concentrations of 95 percent or greater are generally considered to be in the pure form and are referred to by the CASRN for the major component. The impurities from manufacturing are generally not considered for the purposes of material identification and such materials are not considered to be “mixtures” of chemicals per se.

The product identification section provides additional information, including the identification of the manufacturer of the material and nomenclature intended to link the SDS to the label provided on the material in the container(s) as furnished by the manufacturer.

In addition to the product identifier, Section 1 of the SDS will list the chemical name, and the name, address and phone number of the responsible party. Similar to NFPA, the Hazard Communication Standard requires that hazardous chemicals be classified according to the severity of hazard presented by the chemical. However, the hazard categories defined and assigned by the Hazard Communication Standard are different than those used by NFPA. For example, the Hazard Communication Standard defines oxidizers differently than the NFPA (see Annex J of NFPA 400 for a comparison of these definitions). Within the hazard category of oxidizer, there are four subcategories or Classes of hazards recognized under the NFPA system, e.g., Class 4, Class 3, Class 2, and Class 1 materials. Hazard classes are used to describe a range of hazards within a given hazard category, and the class system is used for materials that are oxidizers other than oxidizing gases, organic peroxides, unstable reactives, and water reactives. Although not the subject of regulation by NFPA 400, flammable liquids are further subdivided into Class I, Class II, and Class III, and combustible liquids are further subdivided into Class II, IIIA, and IIIB liquids.

**B.6.2.2 Hazards Identification.** Section 2 of the SDS lists the hazard identification of the chemical, including the classification of the chemical, signal word, the pictogram(s), hazard statement(s), description of hazard(s), precautionary statements. SDS Section 2 also describes hazards that are not otherwise classified.

The hazard identification section of SDS provides an emergency overview of the material and includes information on health and physical hazards that can result from exposure to the material.

**B.6.2.3 Composition/information on ingredients.** The composition of the material or information on ingredients is listed in SDS Section 3, per the OSHA Hazard Communication Standard. The composition section typically lists the hazardous components as defined by OSHA, and not those categories used by NFPA 400. Although the OSHA hazard categories have
been incorporated into the regulatory scheme used by NFPA 400, there are differences and the converse is not true. For example, OSHA does not incorporate the traditional NFPA hazard ratings used in NFPA 704. The revised Hazard Communication Standard, allows the completed NFPA 704 diamond to be provided on the SDS. NFPA and OSHA developed a Quick Card to compare the classification and rating systems, located at [www.nfpa.org/704](http://www.nfpa.org/704).

The composition section is required to list hazardous components of a material are themselves classified and contribute to the classification of the chemical. For mixtures, the composition section must also list the chemical name and concentration of all ingredients classified as health hazards and that are present above their cut-off/concentration limits or present a health risk below the cut-off/concentration limits. The SDS may also list components that are nonhazardous. The CASRN for each component is typically listed in this section of the SDS.

**B.6.2.4 Physical and Chemical Properties.** Section 9 of the SDS lists the physical and chemical properties of the materials. A description of its physical properties, including its physical state (solid, liquid, gas) is required. It is typical to find a wide array of physical and chemical properties listed. The physical and chemical properties required in SDS Section 9 include:

1. Appearance (physical state, color, etc.)
2. Odor
3. Odor threshold
4. pH
5. Melting/freezing point (specify which)
6. Initial boiling point and boiling range
7. Flash point
8. Evaporation rate
9. Flammability (solid, gas)
10. Upper/lower flammability or explosive limits
11. Vapor pressure
12. Vapor density
13. Relative density
14. Solubility(ies) (specify solvent, e.g., water)
15. Partition coefficient: n-octanol/water
16. Auto-ignition temperature
17. Decomposition temperature
B.6.2.5 **Stability and Reactivity.** Section 10 of the SDS lists information about the stability and reactivity of materials. This section typically describes conditions which affect the intrinsic stability of a material. An intrinsic property is a property that is inherent in the material in and of itself, as compared to its properties under conditions that are brought about by the environment in which it is located. Environmental conditions can be described as extrinsic conditions, such as when the material is exposed to heat, fire, shock, or other effects.

This section of the SDS is used as a means to assess its nature within the context of the unstable reactive hazard category. While many materials have an intrinsic stability, they can become unstable when exposed to high temperatures or mechanical or physical shock. Therefore, the information found on an SDS might have to be supplemented by referring to other authoritative sources regarding the reactivity of the material.

B.6.2.6 **Toxicological Information.** Section 11 of the SDS lists toxicological information. This section contains information on the health effects of the material or its components. It typically supports the detail provided in the section on hazards identification in the SDS. The information provided is written for use by healthcare professionals and those that have the technical training and experience in the safety and toxicology aspects of interface with materials from a toxicological perspective.

However, this section of the SDS contains information that is used to establish the approach to control integral to NFPA 400 with respect to toxicity and corrosivity. Data including the effects of acute exposure to mammals and other life forms or information regarding the irreversible destruction of tissue at the site of contact will be found in this section of the SDS.

There may be other information regarding the toxicological effects resulting in but not limited to irritation, sensitization, carcinogenicity, reproductive effects, and genetic and target organ effects, none of which fall under the scope of NFPA 400.

B.6.2.7 **Transportation.** Section 14 of the SDS lists the system of classification used by the Department of Transportation (DOT) to classify materials for shipment purposes, which is not compatible with the system used to classify materials within the context of NFPA 400. With the alignment to the United Nations Globally Harmonized System of Classification and Labeling of Chemicals (GHS), it must be recognized that OSHA’s system of hazard communication has now become harmonized with the system used by the Department of Transportation. OSHA’s hazard communication system, embodied in the SDS, correlates with the DOT regulations for transporting hazardous chemicals, located in 49 CFR. The OSHA system contemplates that users and producers of hazardous materials will encounter these materials in their unpackaged state where the materials are reasonably foreseen to have a potential for bodily contact or use within the work environment on a regular basis. On the other hand, the DOT system of control views the materials in their final packaging as required for transportation where the materials are not subject to exposure to personnel except under upset conditions.

Because OSHA does not enforce the contents of Section 14 of the SDS, users may find additional information in the section for transportation on the SDS, which may or may not be further explained in preceding sections. It is important to recognize that the classification for the purposes of transportation will not suffice as a means to assign the material to a given hazard.
category under the requirements of NFPA 400, and the user must carefully apply the material specific definitions found in Chapter 3 along with the criteria obtained from the SDS and other resources in order to determine the appropriate classification of a given material.
Annex B  Chemical Data

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

B.1 General.

The information provided in Annex B is not a part of the requirements of this document but is included for informational purposes.

B.2 Hazard Recognition.

Chapter 5 introduces the concepts of control areas and MAQs. The purpose is to permit limited amounts of hazardous materials in occupancies having minimum controls without triggering the more restrictive Protection Level 1 through Protection Level 5 building requirements. The allowable quantities in Table 5.2.1.1 through Table 5.2.1.8, and Table 5.2.1.10.1 are based on demonstrated need and historical safe storage and use of hazardous contents. The preponderance of provisions contained in Chapter 5 and those of Chapters 11 through 21 establish additional controls for occupancies exceeding the hazardous materials limits (MAQs) prescribed for control areas.

Not all of the hazardous materials categories are placed into the high hazard category, and some of these materials (contents) have been recognized as being of low or ordinary hazards, depending on their nature in a fire. Class IIIB combustible liquids, Class 1 unstable (reactive) materials, Class 1 water-reactive materials, Class 1 oxidizing solids and liquids, and Class IV and Class V organic peroxides are hazardous materials, which, in some cases, do not have a MAQ and, therefore, are not required to comply with the requirements for Protection Level 1 through Protection Level 5. Some materials, though classified as high hazard, such as aerosols, are exempt from the requirements of NFPA 400, as they are regulated in the code. For additional exceptions, see 1.1.2. [5000:.A.34.1.1]

Figure B.2 helps to illustrate the conditions under which the protection level requirements are applicable. [5000:.A.34.1.1]

****INSERT FIGURE HERE****

FIGURE B.2 — Flow Chart Illustrating Protection Level Applicability. [5000:Figure A.34.1.1]

Safety data sheets (SDS) are used as a primary means to assess the hazards of a specific material. In the U.S., the OSHA Hazard Communication Rule (29 CFR 1900.1200) prescribes what information is to be provided by the SDS. The rule (29 CFR 1900.1200) also specifies the

Commented [BM1]: Should these be I-capped as in the Chapter 5 tables? If so, please confirm I-caps for all instances in Annex B.

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layout of the SDS, including a 16-section format with standardized headings, the numbering and order of these headings, and the information required to complete the SDS. The major headings of this standard include:

Section 1: Identification
Section 2: Hazard(s) Identification
Section 3: Composition/Information on Ingredients
Section 4: First-Aid Measures
Section 5: Fire-Fighting Measures
Section 6: Accidental Release Measures
Section 7: Handling and Storage
Section 8: Exposure Controls/Personal Protection
Section 9: Physical and Chemical Properties
Section 10: Stability and Reactivity
Section 11: Toxicological Information
Section 12: Ecological Information
Section 13: Disposal Considerations
Section 14: Transport Information
Section 15: Regulatory Information
Section 16: Other Information, including date of preparation or last revision

The American Chemical Society publishes chemical abstracts as pointers to the chemical literature. Since 1907, their Chemical Abstracts Service (CAS) has indexed and summarized chemistry-related articles from more than 40,000 scientific journals, in addition to patents, conference proceedings, and other documents pertinent to chemistry, life sciences, and many other fields. In total, abstracts for more than 25 million documents are accessible online through CAS.

Substance identification is a special strength of CAS. It is widely known as the CAS Registry, the largest substance identification system in existence. When CAS processes a chemical substance newly encountered in the literature, its molecular structure diagram, systematic chemical name, molecular formula, and other identifying information are added to the Registry, and it is assigned a unique CAS Registry Number. The Registry now contains records for more than 30 million organic and inorganic substances and more than 58 million sequences.

Individual chemicals are identified through the use of a CAS registry number, commonly referred to as the CAS number or CASRN. The number, which has no chemical significance, is...
used to link the material through its molecular structure into an index system where the Chemical Abstracts name is provided.

The CAS number is unique for each given material; however, with few exceptions, mixtures of chemicals are not assigned a CAS number per se, since each individual component of the mixture has its own unique CAS number. For the purposes of hazard classification and the application of NFPA 400, there are three primary identifiers for each chemical that must be known:

1. CAS number (unless it is a chemical mixture)
2. Concentration (typically expressed in weight percent for solids or liquids and volume percent for gases)
3. Physical state (solid, liquid, or gas)

For example, consider the material hydrochloric acid, also called hydrogen chloride. It can exist in the anhydrous form (as a gas) or in a water solution as the aqueous liquid material of varying concentrations. The hazard properties of the material vary with the form.

The regulatory approach used by NFPA 400 is based on hazard classification of the materials to be regulated. The materials under consideration must be evaluated to classify their hazards within the context of the code. The starting point begins with the SDS, where the material can be identified by name, and other information, such as CAS registry number and physical state, is provided. Although there are 16 different main headings in the SDS, the primary need for classification of materials rests with determining the physical and health hazards of the material or mixture in question.

Within the context of NFPA 400, the user must determine whether the physical and/or health hazards of the material place it into one or more of the following hazard categories:

1. Corrosive solids and liquids
2. Flammable solids
3. Organic peroxide formulations
4. Oxidizer solids and liquids
5. Pyrophoric solids and liquids
6. Toxic and highly toxic solids and liquids
7. Unstable (reactive) solids and liquids
8. Water-reactive solids and liquids

Each of the hazard categories can be further subdivided into subcategories, each with its attendant hazard properties. For example, oxidizer solids and liquids are subdivided into Class 4, Class 3, Class 2, and Class 1 subcategories commonly referred to as the hazard class.
Although it might be expected that the above nomenclature would appear on the SDS, this is not always the case. Appendices A and B of OSHA’s Hazard Communication Rule (29 CFR 1900.1200) identify specific health and physical hazards that may-might differ from that of NFPA 400. Terms used in NFPA 400 are consistent with those used in other NFPA standards and codes. Please see Annex J of NFPA 400 for a comparison of these hazard definitions. Therefore, the user must review the physical and chemical properties, as well as the health hazard information provided, in order to make a determination as to the appropriate hazard category and class for the material being regulated.

B.3 Chemical Family — A Pointer to Hazard Classification.

B.3.1 General.

It is quite common that preparers of SDS indicate the chemical family to which a material belongs, that is, the group of chemical substances that have a similar molecular structure. For example, materials such as acetone, methyl ethyl ketone, and amyl ethyl ketone are members of the ketone family. While the properties of various hazardous materials within a chemical family may-can vary, the chemical family becomes a pointer to the more likely hazard categories of the material under consideration.

While hundreds of thousands of chemicals are in use, this annex categorizes the more commonly used industrial chemicals into chemical families or unique groupings that have similar properties. Materials and/or chemicals exhibit a wide range of properties, some of which are hazardous. This code provides guidance for known physical and health hazards of materials within its scope.

B.3.2 Chemical Families Related to Hazard Category.

Table B.3.2 provides a summary of chemical families with associated physical and health hazard properties, which are subdivided into specific categories. This table is for informational purposes only. The physical and health hazards indicated are broad representations for the various chemical families. These classifications are not intended to cover all the hazards of a material. A more detailed description of the chemical families, subfamilies, and chemical structure of specific hazards are contained in the explanatory material following the table. For specific information, the chemical-specific SDS must be consulted. Additional information can be obtained from the manufacturer.

<table>
<thead>
<tr>
<th>CHEMICAL FAMILY (1c)</th>
<th>PHYSICAL HAZARDS (2,3a,b)</th>
<th>HEALTH HAZARDS (2,3a,b)</th>
<th>EXAMPLES (CAS No.)</th>
<th>The following examples and their</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEMICAL STRUCTURE</td>
<td>Unstable Reactive Water Reactive Oxidizer Pyrophoric Flammable Solid Organic Peroxide Flammable / Combustible</td>
<td>Corrosive Toxic</td>
<td>(S, L, G) (S, L, G) (S, L, G) (S, L, G) (S, L, G)</td>
<td></td>
</tr>
</tbody>
</table>

Table B.3.2 NFPA 400 Chemical Data

Commented [BMS]: Comp. please make this the table caption
<table>
<thead>
<tr>
<th>Classifications</th>
<th>Returned Chemicals</th>
</tr>
</thead>
</table>
| Acids R-COOH    | Acetic acid (64-17-5), propionic acid (64-60-0), butyric acid (64-18-6), caproic acid (64-19-7), caprylic acid (87-83-3), capric acid (64-24-7), lauric acid (64-27-0), myristic acid (64-29-0), palmitic acid (64-76-1), stearic acid (64-12-0), oleic acid (112-80-1), linoleic acid (112-74-2), linolenic acid (112-75-3), tallow (8018-82-7), natural fatty acids (8018-83-8), animal fats (8018-84-9), vegetable oils (8018-85-0), triglycerides (8018-86-1), isomeric oils (8018-87-2), glycerides (8018-88-3), triglycerides (8018-89-4), glycerides of long chain fatty acids (8018-90-5), glycerides of short chain fatty acids (8018-91-6), glycerides of medium chain fatty acids (8018-92-7), glycerides of unsaturated fatty acids (8018-93-8), glycerides of saturated fatty acids (8018-94-9), glycerides of saturated fatty acids (8018-95-0), glycerides of unsaturated fatty acids (8018-96-1), glycerides of saturated fatty acids (8018-97-2), glycerides of unsaturated fatty acids (8018-98-3), glycerides of saturated fatty acids (8018-99-4), glycerides of unsaturated fatty acids (8018-100-5), glycerides of saturated fatty acids (8018-101-6), glycerides of unsaturated fatty acids (8018-102-7), glycerides of saturated fatty acids (8018-103-8), glycerides of unsaturated fatty acids (8018-104-9), glycerides of saturated fatty acids (8018-105-0), glycerides of unsaturated fatty acids (8018-106-1), glycerides of saturated fatty acids (8018-107-2), glycerides of unsaturated fatty acids (8018-108-3), glycerides of saturated fatty acids (8018-109-4), glycerides of unsaturated fatty acids (8018-110-5), glycerides of saturated fatty acids (8018-111-6), glycerides of unsaturated fatty acids (8018-112-7), glycerides of saturated fatty acids (8018-113-8), glycerides of unsaturated fatty acids (8018-114-9), glycerides of saturated fatty acids (8018-115-0), glycerides of unsaturated fatty acids (8018-116-1), glycerides of saturated fatty acids (8018-117-2), glycerides of unsaturated fatty acids (8018-118-3), glycerides of saturated fatty acids (8018-119-4), glycerides of unsaturated fatty acids (8018-120-5), glycerides of saturated fatty acids (8018-121-6), glycerides of unsaturated fatty acids (8018-122-7), glycerides of saturated fatty acids (8018-123-8), glycerides of unsaturated fatty acids (8018-124-9), glycerides of saturated fatty acids (8018-125-0), glycerides of unsaturated fatty acids (8018-126-1), glycerides of saturated fatty acids (8018-127-2), glycerides of unsaturated fatty acids (8018-128-3), glycerides of saturated fatty acids (8018-129-4), glycerides of unsaturated fatty acids (8018-130-5), glycerides of saturated fatty acids (8018-131-6), glycerides of unsaturated fatty acids (8018-132-7), glycerides of saturated fatty acids (8018-133-8), glycerides of unsaturated fatty acids (8018-134-9), glycerides of saturated fatty acids (8018-135-0), glycerides of unsaturated fatty acids (8018-136-1), glycerides of saturated fatty acids (8018-137-2), glycerides of unsaturated fatty acids (8018-138-3), glycerides of saturated fatty acids (8018-139-4), glycerides of unsaturated fatty acids (8018-140-5), glycerides of saturated fatty acids (8018-141-6), glycerides of unsaturated fatty acids (8018-142-7), glycerides of saturated fatty acids (8018-143-8), glycerides of unsaturated fatty acids (8018-144-9), glycerides of saturated fatty acids (8018-145-0), glycerides of unsaturated fatty acids (8018-146-1), glycerides of saturated fatty acids (8018-147-2), glycerides of unsaturated fatty acids (8018-148-3), glycerides of saturated fatty acids (8018-149-4), glycerides of unsaturated fatty acids (8018-150-5), glycerides of saturated fatty acids (8018-151-6), glycerides of unsaturated fatty acids (8018-152-7), glycerides of saturated fatty acids (8018-153-8), glycerides of unsaturated fatty acids (8018-154-9), glycerides of satu
### Alkyl halides

| R-X | 80-9 | 2-naphthol (135-19-3), 2,4-dichlorophenol (120-83-2), p-methylphenol (p-cresol) (106-44-5) |

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### Amines

#### Aliphatic, organic

| R-NH₂, R₂NH, R₃N | - | 87-10-3 | 87-16-2 | 75-04-7 | Ethyamine (75-04-7), ethylenediamine (107-15-3), pyrrolidine (123-75-1), trimethylamine (75-50-3), hexylamine (111-26-2), isopropylamine (75-31-0), triethylamine (121-44-8), morpholine (110-91-8), butylamine (109-73-9) |

#### Aromatic

| Ar-NH₂, Ar(N) | - | 80-1 | 104-21-0 | 80-46-7 | Diethylenetriamine (66479-98-1), aniline (62-53-3), pyridine (110-86-1), N,N-diethyl aniline (91-66-7), 2-methylpyridine (3-picoline) (108-99-6), p-phenylenediamine (4-aminodimiline) (106-50-3), 4-aminotoluene (p-toluidine) (106-49-0), 2,4-diaminotoluene (TDA) (95-30-7) |

### Bases

#### Alkalis

<p>| - | ✓ | 80-9 | 1310-73-2 | Sodium hydroxide (1310-73-2), potassium |</p>
<table>
<thead>
<tr>
<th>Gaseous</th>
<th>M-C₂-M-N</th>
<th>Calcium carbide (75-20-7), lithium nitride (60134-62-3), gallium nitride (25517-97-4), boron nitride (10648-11-5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbides / Nitrides</td>
<td>M-C₂-M-N</td>
<td>Calcium carbide (75-20-7), lithium nitride (60134-62-3), gallium nitride (25517-97-4), boron nitride (10648-11-5)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Carbonyl compounds</th>
<th>Acid anhydrides</th>
<th>Acetyl chloride (75-56-5), sulfonyl chloride (7791-23-5), benzoyl chloride (98-88-4), methanesulfonyl chloride (124-63-0), p-toluene sulfonyl chloride (98-59-9), trifluoroacetyl chloride (76-02-8), pivaloyl chloride (3268-49-3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acyl halides</td>
<td>R₂C(O)X, R₂ArX</td>
<td>Acetyl chloride (75-56-5), sulfonyl chloride (7791-23-5), benzoyl chloride (98-88-4), methanesulfonyl chloride (124-63-0), p-toluene sulfonyl chloride (98-59-9), trifluoroacetyl chloride (76-02-8), pivaloyl chloride (3268-49-3)</td>
</tr>
<tr>
<td>Aldehydes</td>
<td>RCH=O, Ar-CH=O</td>
<td>Formaldehyde (50-00-0), acetaldehyde (75-07-0), butyraldehyde (123-72-8), benzaldehyde (100-52-7), 2-butanal (crotonaldehyde) (1470-53-0), n-valeraldehyde (110-62-3), p-methoxybenzaldehyde (4-aminobenzaldehyde)</td>
</tr>
<tr>
<td>Category</td>
<td>Formula</td>
<td>Examples</td>
</tr>
<tr>
<td>----------</td>
<td>---------</td>
<td>----------</td>
</tr>
<tr>
<td><strong>Esters</strong></td>
<td>$R_1(C=O)OR_2$</td>
<td>Methyl formate (107-31-3), methyl acrylate (2-propenoic acid methyl ester), (96-33-3), benzenediacarboxylic acid diocetyl ester (117-84-0), ethyl ethanoate (ethyl acetate) (141-78-6), butanedioic acid dimethyl ester (dimethyl fumarate) (106-65-0), oleic acid methyl ester (112-82-9), n-butyl acetate (123-86-4)</td>
</tr>
<tr>
<td><strong>Halides</strong></td>
<td>$C(O)X_2, C(S)X_2$</td>
<td>Phosgene (75-44-5), carbonyl fluoride (353-50-4), thiophosgene (463-71-8), oxalyl chloride (79-37-8), trichloromethyl chloroformate (diphosgene) (503-38-8), methyl chloroformate (79-22-1)</td>
</tr>
<tr>
<td><strong>Ketones</strong></td>
<td>$R_1R_2C=O$</td>
<td>Methyl propyl ketone (107-87-9), methyl isovaleryl ketone (110-12-3), acetone (67-64-1), cyclohexanone (108-94-1), 1-chloro-2-propanone (chloroacetone) (78-95-5), 2-butanone (methyl ethyl ketone) (78-93-3), cyclopentanone (120-92-3), acetophenone (98-86-2), methyl isobutyl ketone (108-10-1), limonene (138-86-3), 1,1-dichloroacetone (534-07-6)</td>
</tr>
<tr>
<td><strong>Cyanides</strong></td>
<td>Gaseous</td>
<td>Hydrogen cyanide (74-90-8), cyanogen chloride (506-77-4), cyanogen (460-19-5)</td>
</tr>
<tr>
<td>Inorganic</td>
<td>M-CN</td>
<td>-</td>
</tr>
<tr>
<td>Organic (nitriles)</td>
<td>R, Ar-CN</td>
<td>-</td>
</tr>
<tr>
<td>Epoxides</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Ethers/glycols</td>
<td>R-O-R</td>
<td>-</td>
</tr>
<tr>
<td>Gases Flammable</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Halogens X-X</td>
<td>-</td>
<td>✓</td>
</tr>
<tr>
<td>Prefixes</td>
<td>Alkenes</td>
<td>Aliphatic Gases</td>
</tr>
<tr>
<td>----------</td>
<td>---------</td>
<td>----------------</td>
</tr>
<tr>
<td>Ar, H</td>
<td>R, C=C-R, CH=CH-</td>
<td>Butane (106-87-5), 1,3-butadiene (106-49-9), hydrogen sulfide (7783-06-4)</td>
</tr>
<tr>
<td>H, C=C-H</td>
<td>R, C=C-R, CH=CH-</td>
<td>1,1,2-trichloroethane (106-92-3), butylene (106-97-4), propylene (106-98-5)</td>
</tr>
<tr>
<td>Br, Al, R-CH=CH-</td>
<td>R, C=C-R, CH=CH-</td>
<td>1,1,2-trichloroethane (106-92-3), butylene (106-97-4), propylene (106-98-5)</td>
</tr>
<tr>
<td>RN, R-CH=CH-</td>
<td>R, C=C-R, CH=CH-</td>
<td>1,1,2-trichloroethane (106-92-3), butylene (106-97-4), propylene (106-98-5)</td>
</tr>
<tr>
<td>RN, R-CH=CH-</td>
<td>R, C=C-R, CH=CH-</td>
<td>1,1,2-trichloroethane (106-92-3), butylene (106-97-4), propylene (106-98-5)</td>
</tr>
<tr>
<td>RN, R-CH=CH-</td>
<td>R, C=C-R, CH=CH-</td>
<td>1,1,2-trichloroethane (106-92-3), butylene (106-97-4), propylene (106-98-5)</td>
</tr>
<tr>
<td>RN, R-CH=CH-</td>
<td>R, C=C-R, CH=CH-</td>
<td>1,1,2-trichloroethane (106-92-3), butylene (106-97-4), propylene (106-98-5)</td>
</tr>
<tr>
<td>RN, R-CH=CH-</td>
<td>R, C=C-R, CH=CH-</td>
<td>1,1,2-trichloroethane (106-92-3), butylene (106-97-4), propylene (106-98-5)</td>
</tr>
<tr>
<td>RN, R-CH=CH-</td>
<td>R, C=C-R, CH=CH-</td>
<td>1,1,2-trichloroethane (106-92-3), butylene (106-97-4), propylene (106-98-5)</td>
</tr>
<tr>
<td>RN, R-CH=CH-</td>
<td>R, C=C-R, CH=CH-</td>
<td>1,1,2-trichloroethane (106-92-3), butylene (106-97-4), propylene (106-98-5)</td>
</tr>
<tr>
<td>RN, R-CH=CH-</td>
<td>R, C=C-R, CH=CH-</td>
<td>1,1,2-trichloroethane (106-92-3), butylene (106-97-4), propylene (106-98-5)</td>
</tr>
<tr>
<td>Isocyanates</td>
<td>R- N=C=O, Ar- N=C=O</td>
<td>Toluene diisocyanate (TDI) (584-84-9), methylene bisphenyl isocyanate (MDI) (101-68-8), hexamethylene diisocyanate (HDI) (822-06-0), p-toluenesulfonyl isocyanate (4083-64-1), methyl isocyanate (624-83-9)</td>
</tr>
<tr>
<td>-------------</td>
<td>----------------------</td>
<td>---------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Metals</td>
<td>R- N=C=O, Ar- N=C=O</td>
<td>Butyllithium (109-72-8), triethylaluminum (97-93-8), triethylborane (97-94-9), n-butyllithium (62202-86-2), diethyl zinc (557-20-0)</td>
</tr>
<tr>
<td>Metal Alkyls</td>
<td>M-R</td>
<td>Aluminum chloride (7446-70-0), chromium (III) chloride (10025-73-7), copper(I) chloride (7758-89-6), silver bromide (7785-23-1), ruthenium (II) chloride (10049-08-8), titanium tetrachloride (7550-45-0), tin chloride (7772-99-8), tungsten hexahalide (7783-82-6)</td>
</tr>
<tr>
<td>Metal Hydrides (solids)</td>
<td>M-H</td>
<td>Toluene diisocyanate (TDI) (584-84-9), methylene bisphenyl isocyanate (MDI) (101-68-8), hexamethylene diisocyanate (HDI) (822-06-0), p-toluenesulfonyl isocyanate (4083-64-1), methyl isocyanate (624-83-9)</td>
</tr>
<tr>
<td>Metal Hydrides (gases)</td>
<td>M-H</td>
<td>-</td>
</tr>
<tr>
<td>------------------------</td>
<td>-----</td>
<td>---</td>
</tr>
<tr>
<td>Metals (alkali)</td>
<td>M</td>
<td>-</td>
</tr>
<tr>
<td>Metals (powdered)</td>
<td>M</td>
<td>-</td>
</tr>
<tr>
<td>Nitrated compounds</td>
<td>R. Ar-NO₂</td>
<td>-</td>
</tr>
<tr>
<td>Azo (aliphatic)</td>
<td>R.N==N-R</td>
<td>-</td>
</tr>
<tr>
<td>Azo (aromatic)</td>
<td>Ar.N==N-Ar</td>
<td>-</td>
</tr>
</tbody>
</table>

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### Table of Chemicals

<table>
<thead>
<tr>
<th>Type</th>
<th>Formula</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Azides</td>
<td>R−N3</td>
<td></td>
</tr>
<tr>
<td>Sodium azide</td>
<td>(26628-22-8)</td>
<td></td>
</tr>
<tr>
<td>Inorganic Nitrites</td>
<td>M−NO2</td>
<td></td>
</tr>
<tr>
<td>Sodium nitrite</td>
<td>(7632-00-0), potassium nitrite (7758-09-0)</td>
<td></td>
</tr>
<tr>
<td>Inorganic Nitrates</td>
<td>M−NO3</td>
<td></td>
</tr>
<tr>
<td>Sodium nitrate</td>
<td>(7631-99-4), silver nitrate (7761-88-8), zinc nitrate (7779-88-6), lithium nitrate (7790-69-4), lead nitrate (10099-74-8), potassium nitrate (7757-79-1)</td>
<td></td>
</tr>
<tr>
<td>Nitrogen-Halogen Compounds</td>
<td>R−N−X</td>
<td></td>
</tr>
<tr>
<td>Trichloroisocyanuric acid (97-90-1), sodium dichloroisocyanurate (2893-78-9), N-bromosuccinimide (120-08-5), 1-bromo-3-chloro-5,5-dimethylhydantoin (BCDMH) (126-06-7)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oxyanions</td>
<td>M−ClO3, M−ClO2, M−ClO4, M−OCl</td>
<td></td>
</tr>
<tr>
<td>Sodium chloride</td>
<td>(7758-19-2), sodium chlorate (7775-09-9), sodium perchlorate (7601-89-0), ammonium perchlorate (798-98-9), calcium hypochlorite (7778-54-3), potassium bromate (7758-01-2), lithium hypochlorite (13840-13-0)</td>
<td></td>
</tr>
<tr>
<td>Peroxides</td>
<td>R−O−O−R</td>
<td></td>
</tr>
<tr>
<td>Benzoyl peroxide</td>
<td>(94-36-0), diacetyl peroxide (&gt;70%) (110-22-5), dibenzoyl peroxide (94-36-0), methyl ethyl ketone peroxide (&gt;90%) (97-02-9), di-tert-butyl peroxide</td>
<td></td>
</tr>
</tbody>
</table>

### Chemicals Listed

- Disperse Yellow 3 (2832-60-8)
- (N-cyanoethyl-N-ethylamino)-4-nitroazobenzene (Disperse Orange 25) (31482-56-1)
- Disperse Yellow 3 (2832-60-8)
- (N-cyanoethyl-N-ethylamino)-4-nitroazobenzene (Disperse Orange 25) (31482-56-1)
### Table B.3.2

<table>
<thead>
<tr>
<th>Metal / Inorganic</th>
<th>M-O-O</th>
<th>O=P-X₃</th>
<th>P-X</th>
<th>Sodium perborate (10486-00-7), sodium percarbonate (15630-89-4), magnesium peroxide (1335-26-8), sodium peroxide (1313-60-6)</th>
</tr>
</thead>
</table>

#### Notes:

*(S, L, G) refers to whether hazards apply to “Solid,” “Liquid,” and/or “Gaseous” physical forms.

- Indicates that most or all of the chemicals within the family or sub-family have the indicated physical and health hazards.

- Indicates that some of the chemicals in the family *m-might* have this additional physical and health hazards.

- Indicates that only a select few chemicals within a specific family display the relevant physical and health hazards.

"-" = Not applicable for the specific chemical category.

Ar = phenyl ring; X = halogen (i.e., fluorine, chlorine, bromine, iodine); R = organic; M = metal.

#### Additional Source Materials:

- [http://www.epa.gov/oppt/chemrtk/](http://www.epa.gov/oppt/chemrtk/)
- [http://www.epa.gov/oppt/chemrtk/pubs/update/hpvshtml.htm](http://www.epa.gov/oppt/chemrtk/pubs/update/hpvshtml.htm)

#### Footnotes to Table B.3.2:

2(a) The physical and health hazards are BROAD representations for the various classes of chemicals. These classifications are NOT intended to cover all hazards of a material. For specific information, the chemical-specific SDS MUST be consulted. Additional information can be obtained from the manufacturer.
2(b). For additional concentration dependent hazard categories, see B.5.

4(c). Source material for the chemical families includes Bretherick’s Handbook of Reactive Chemical Hazards (Elsevier Science & Technology Books), 7th ed.; Comprehensive Guide to Hazardous Properties of Chemical Substances (Wiley Interscience); Guidelines for Chemical Reactivity Evaluation and Application to Process Design (Tables 2.4 and 2.5) (Center for Chemical Process Safety (CCPS)/AIChE).

7. The physical and health hazards are BROAD representations for the various classes of chemicals. These classifications are NOT intended to cover all hazards of a material. For specific information, the chemical-specific SDS MUST be consulted. Additional information can be obtained from the manufacturer.

3. For additional concentration dependent hazard categories, see B.5.

6(d). “Peroxide” is not a hazard characteristic but a unique chemical family with a range of properties listed as a specific physical hazard under NFPA 400.


5(e). The “flammable or combustible” hazard categories are NOT regulated under NFPA 400. However, many chemicals exhibit the hazard properties of flammability or combustibility.


6(e). “Peroxide” is not a hazard characteristic but a unique chemical family with a range of properties listed as a specific physical hazard under NFPA 400.

Additional Source Material:
http://www.epa.gov/oppt/chemrtk/
http://www.epa.gov/oppt/chemrtk/pubs/update/hpvcmltl.htm
http://www.osha.gov/SLTC/emergencypreparedness/guides/chemical.html

B.3.2.1 Table Descriptions.

Nineteen general chemical families are listed in the first column of Table B.3.2. The chemical families include organic chemicals, inorganic chemicals, gases, and metals. Some of the general chemical families are further divided into subfamilies if one or more hazard category or categories further depend on chemical structure. The second column, Chemical Structure, shows the basic chemical formula or structure representing the chemical family and/or subfamilies.
The next several columns list the seven physical hazard categories and three health hazard
categories. The specific hazard categories are defined in Chapter 3. The physical hazard
categories include the following:

1. Unstable Reactive
2. Water Reactive
3. Oxidizer
4. Pyrophoric
5. Flammable Solid
6. Organic Peroxide
7. Flammable/Combustible

The health hazards include the following:

1. Corrosive
2. Toxic
3. Highly Toxic

Hazard categories are defined by the following symbols. A triple check mark (✓✓✓) is used to
indicate that most or all of the chemicals within the family or subfamily have the indicated
physical or health hazard. A double check mark (✓✓) is used to identify that some of the
chemicals in the family might have this additional hazard. A single check mark (✓) indicates that
only a select few chemicals within a specific family display the relevant physical and health
hazard(s). The check marks are provided to inform the user as to the likely property of materials
in each of the hazard categories listed. However, it must be recognized that the ultimate
classification of a material is dependent on the application of the definitions found in Chapter 3
and the interpretation of the information provided relative to tests conducted by authoritative
entities within the framework established by the definitions.

The last column provides examples of chemicals with the indicated hazards. The examples
illustrate materials in the concentrated or undiluted state. Concentration-specific hazards for
common materials are provided in the explanatory material following the table (see Section B.5).

B.3.2.2 Multiple Hazard Materials.

A specific chemical can exhibit multiple hazard categories. In other words, there could be
materials with more than one physical hazard property that also have one or more health hazard
properties. The regulatory controls integral to NFPA 400 require that all hazards be addressed. It
is incumbent on the code user to identify each applicable hazard property in order to properly
classify the hazards of the material. It should also be recognized that each of the hazards
considered could be concentration dependent.

B.3.2.2.1 Illustration of Table B.3.2.
To illustrate the utility of Table B.3.2, consider the chemical family of mineral acids, listed in column 1 of Table B.3.2. Specific examples of mineral acids are listed in the last column of Table B.3.2. Well-known mineral acids are hydrochloric acid and sulfuric acid. The row entries with dashes (---) under the physical hazard categories indicate that, in general, mineral acids are not considered to have the physical hazards of being unstable/reactive, oxidizer, pyrophoric, flammable solids, organic peroxides, or flammable/combustible. Specific mineral acids are water reactive (✓) based on concentration and the specific mineral acid itself. The row entries show the principal hazard properties of mineral acids are Health Hazards, especially Corrosive (✓✓✓). The one check mark under Toxic (✓) indicates that a select few of the chemicals in the mineral acid family have this additional health hazard. [See B.4.1.1 for additional information on mineral acids.] The SDS for the specific mineral acid should be consulted for more detailed information relating to physical and health hazards.

B.3.3 ADDITIONAL SOURCE MATERIALS

http://www.epa.gov/oppt/chemrtk/
http://www.epa.gov/oppt/chemrtk/pubs/update/hpvchmlt.htm
http://www.osha.gov/SLTC/emergencypreparedness/guides/chemical.html

B.4 Description of Chemical Families.

B.4.1 General.

Dilution can cause the hazard characteristics of an individual chemical to diminish until the property is no longer pertinent. Each chemical must be individually reviewed by the manufacturer to provide the data to assess the physical and health hazards. For compressed gases, there are accepted standards that can be used to estimate both the flammability and toxicity without actual test data.

B.4.1.1 Acids.

B.4.1.1.1 Acids (Carboxylic) (R-COOH, Ar-COOH).

Carboxylic acids are weak acids, unlike mineral acids, such as hydrochloric acid. Most are readily soluble in water. Physical and health properties vary significantly based on molecular weight and the number of carboxylic acid groups. Smaller molecular weight aliphatic carboxylic acids (such as formic and acetic acid) are liquids and are flammable and corrosive. Larger chain, higher molecular weight carboxylic acids are often solids with minimal hazards (such as citric acid). Aromatic acids are sometimes corrosive.

B.4.1.1.2 Acids (Peroxy) (R-OOH, Ar-OOH).

All peroxo acids are classified as organic peroxides and are classified as oxidizers and corrosive. Aromatic peroxo acids (such as perbenzoic acid) are solids and are unstable reactive and toxic.
Most are pastes or liquids and require refrigeration. Some forms of this acid family are often found as their sodium, potassium, or ammonium salts.

**B.4.1.1.3 Acids (Mineral).**

These are all strong acids, are liquids, and are corrosive, even in dilute solutions. These include hydrofluoric acid (HF), hydrochloric acid (HCl), hydrobromic acid (HBr), phosphoric acid (H₃PO₄), and sulfuric acid (H₂SO₄). In some cases they are toxic and water reactive depending on acid and concentration.

**B.4.1.1.4 Acid (Gaseous).**

The common acid gases, which include hydrogen bromide (HBr), hydrogen chloride (HCl), hydrogen fluoride (HF), and hydrogen iodide (HI), are corrosive and in some cases toxic. They are highly soluble in water, forming the corresponding aqueous acid and are packaged as liquefied compressed gases. Other acid gases include boron trichloride (BCl₃), boron trifluoride (BF₃) and silicon tetrafluoride (SiF₄).

**B.4.1.1.5 Acid (Oxidizing).**

Some strong acids are also oxidizing acids, most commonly nitric acid (HNO₃). As oxidizers, they are also corrosive and toxic. These physical and health properties are exhibited even in dilute solutions.

**B.4.1.2 Alcohols.**

**B.4.1.2.1 Aliphatic Alcohols (R-OH).**

The category includes primary (1°), secondary (2°), and tertiary (3°) branched and cyclic alcohols. Most common alcohols include methanol, ethanol, isopropanol, t-butanol (2-methylpropan-2-ol), n-butanol (butan-1-ol) and cyclohexanol. Many alcohols, especially smaller chain alcohols, are highly flammable even in dilute solutions. This generally does not hold true for the small-chain glycols (or polyhydroxylated compounds), such as propylene glycol which have significantly higher boiling points. Most smaller chain aliphatic alcohols are readily soluble in water. Longer chain alcohols “fatty alcohols” (e.g., dodecanol, hexadecanol and octadecanol) are solids, are not flammable, and are not miscible with water.

**B.4.1.2.2 Aromatic Alcohols (Ar-OH).**

The most common aromatic alcohol is phenol (hydroxybenzene). Others include the dihydroxybenzenes (e.g., catechol) and hydroxytoluenes (e.g., o-cresol). Most phenols are usually solids or high-boiling point liquids and readily soluble in water. Phenol and p-cresol are highly corrosive and toxic. Functionalized phenol derivatives (e.g., 2,4-dichlorophenol), while also soluble in water, are not flammable and can be toxic. Higher molecular weight phenols such as hydroxynaphthalene (e.g., naphthol) can also be toxic but are not corrosive. The chemical and physical properties of aliphatic and aromatic alcohols vary significantly depending on the structure of the alcohol and other functional groups.

**B.4.1.3 Alkyl Halides (R-X).**
This chemical family includes halogenated alkyl analogues, such as methylene chloride, chloroform, carbon tetrachloride, bromoform, dichloroethane, perchloroethylene, methyl bromide and methyl iodide, fluoroethane, and Freon® derivatives. Often these chemicals are nonflammable gases and liquids, used as fire extinguishers, refrigerants, and solvents. The most widely known category is the chlorofluorocarbons (CFCs). Nonflammable gases include bromochlorodifluoromethane (Halon 1211) and dichlorodifluoromethane (Freon-12). Some chemicals in this family are flammable. Highly substituted alkyl halides (i.e., those chemicals with many halogen atoms present in a molecule) such as 1,2-dichloroethane and 1,1,2,2-tetrachloroethane are liquids and toxic.

**B.4.1.4 Amines.**

**B.4.1.4.1 Amines (Aliphatic) (R-NH₂, R₂NH, R₃N).**

The aliphatic amines consist of primary (1°), secondary (2°), and tertiary (3°) branched compounds. Lower molecular weight amines such as ethylamine, propylamine, butylamine, and triethylamine are highly flammable liquids, corrosive and readily soluble in water. Some are toxic. Many amines, such as methylamine, are sold in diluted aqueous solutions, and are typically flammable. *(For ammonia, see B.4.1.5.2.)*

**B.4.1.4.2 Amines (Aromatic) (Ar-NH₂, Ar(N)).**

This family includes substituted aromatic amines, such as benzene derivatives (e.g., aniline, and o-aminoaniline) and heteroaromatics (e.g., pyridine and picoline). Most of these chemicals are solids or liquids and may be readily soluble in water and are toxic. Some are flammable. Health hazards associated with these chemicals depend heavily on the ring structure, degree of substitution, and location of the nitrogen(s) within the heteroaromatic ring.

**B.4.1.5 Bases.**

**B.4.1.5.1 Alkalis.**

Bases are found either as solids or as concentrated aqueous solutions. Most bases are highly corrosive with all tissues with which they come in contact. Bases, such as sodium carbonate (Na₂CO₃), sodium hydroxide (NaOH), and potassium hydroxide (KOH), readily absorb moisture from the air. When dissolved in water, these chemicals often liberate substantial heat and form corrosive solutions in concentrated form. The corrosiveness and toxicity of these chemicals decreases with dilution.

**B.4.1.5.2 Gaseous.**

The common basic gases, ammonia (NH₃), and the lower molecular weight amines (methylamine, dimethylamine, and trimethylamine) are all are corrosive but not toxic. They are highly soluble in water and are liquefied compressed gases. The common bases are flammable gases with a narrow flammability range. They are often sold commercially as aqueous solutions, which are also flammable.

**B.4.1.6 Carbides/Nitrides.**
Carbides have varying degrees of physical hazards. Carbides, such as calcium carbide (CaC₂) and sodium carbide (Na₃C₂), react violently with water, are flammable in the presence of moisture, and could be corrosive. Other carbides, such as zirconium carbide (ZrC), tungsten carbide (WC), and silicon carbide (SiC), have little reactivity. Nitrides, such as boron nitride (BN), are usually stable.

B.4.1.7 Carbonyl Compounds.

B.4.1.7.1 Carbonyl Compounds (Acid Anhydrides) (R₁-C(O)OC(O)-R₂).

These chemicals, often referred to as simply “anhydrides,” are more reactive than their corresponding carboxylic acids. Anhydrides react with water to form the corresponding acid or base, and are often good dehydrating agents. Lower molecular weight anhydrides, such as acetic anhydride, propionic anhydride, and isobutyric anhydride, are most often corrosive, flammable, and could react violently with water. Functionalized anhydrides such as trifluoroacetic anhydride are highly corrosive and highly water reactive. Aromatic anhydrides, such as phthalic anhydride, are also corrosive but not water reactive.

B.4.1.7.2 Carbonyl Compounds (Acyl Halides) (R, Ar-C(O)X; R, Ar-SO₂-X).

These chemicals include the most common acid halides and sulfonyl halides and are considerably more reactive than the corresponding anhydrides. Acyl halides are most often corrosive, water reactive, and volatile. Higher molecular weight aromatic acid halides, such as benzoyl chloride, are toxic and corrosive and have limited water solubility and lower water reactivity. Lower molecular weight acid halides such as acetyl chloride are flammable, highly corrosive, and react violently with water.

B.4.1.7.3 Carbonyl Compounds (Aldehydes) (R-CH=O, Ar-CH=O).

Most aldehydes are volatile organic compounds. Simple, lower molecular weight alkyl aldehydes, such as acetaldehyde, propionaldehyde (methylacetaldehyde), butyraldehyde, and 2-butenaldehyde (crotonaldehyde), for example, exist as liquids, and are most often highly flammable. Formaldehyde is known to be toxic. Many aromatic aldehydes, such as benzaldehyde, have limited flammability.

B.4.1.7.4 Carbonyl Compounds (Esters) (R₁O(C=O)R₂).

In general, the category possesses few physical or health hazards. Aliphatic and aromatic esters are significantly more stable than the acid anhydrides and are not water reactive. Lower molecular weight alkyl esters, such as methyl formate, ethyl acetate, and n-butyl acetate, are flammable liquids.

B.4.1.7.5 Carbonyl Compounds (Halides) (C(O)X₂, C(S)X₂).

These compounds are very reactive chemicals and are considered highly toxic, highly water reactive, and corrosive. Phosgene is a nonflammable gas, while thiophosgene and oxalyl chloride are liquids. Trichloromethyl chloroformate (diphosgene) and methyl chloroformate are liquids and less reactive but still water reactive.
B.4.1.7.6 Carbonyl Compounds (Ketones) (R₁R₂C=O).

Similar to aldehydes, most ketones are volatile organic compounds. Many ketones are also flammable liquids. Simple, low molecular weight ketones, such as acetone, cyclohexanone, methyl ethyl ketone (MEK), and methyl isobutyl ketone (MIBK), for example, are liquids and highly flammable. Common functionalized ketones, such as chloroacetone, 1,3-dichloro-2-propanone, and chloroacetophenone (chloromethyl phenyl ketone), while not flammable, are toxic. Many aromatic ketones have limited flammability.

B.4.1.8 Cyanides.

B.4.1.8.1 Cyanides (Gaseous).

The common cyanide gases, hydrogen cyanide (HCN), cyanogen chloride (ClCN), and cyanogen (C₂N₂), are highly toxic. Hydrogen cyanide is a liquid, but is treated and packaged as a gas. Cyanogen and hydrogen cyanide are flammable, while cyanogen chloride is corrosive.

B.4.1.8.2 Cyanides (Inorganic) (M-CN).

Common inorganic cyanides include sodium cyanide (NaCN) and trimethylsilyl cyanide (TMSCN). This family is characterized as highly toxic. Cyanide salts are readily soluble in water and highly toxic.

Trimethylsilyl cyanide is water reactive. The family does not include the many organic compounds that contain the CN group (called nitriles). Nitriles do not display the toxicity of the inorganic cyanides such as sodium and potassium cyanide.

B.4.1.8.3 Nitriles (Organic).

Common, lower molecular weight nitriles, including acetonitrile and 2-propenenitrile (acrylonitrile), are highly flammable liquids and toxic. Many aromatic nitriles (benzonitriles) are solids and often toxic, depending on substituents. Benzonitriles have limited flammability.

B.4.1.9 Epoxides.

Epoxides are very reactive chemicals. Common epoxides include ethylene oxide, which is a gas, and propylene oxide and 1-chloro-2,3-epoxypropane (epichlorohydrin), which are liquids. These chemicals most often have flammable, toxic, water-reactive, and unstable reactive hazard characteristics.

B.4.1.10 Ethers/Glycols (R-O-R).

This broad category includes both simple alcohol ethers and polyhydroxylated glycol ethers. Simple, low molecular weight ethers such as diethyl ether or vinyl ether are low boiling liquids or compressed gases and highly flammable. Cyclic ethers, such as tetrahydrofuran (THF) and 1,4-dioxane, are highly flammable liquids while slightly toxic. Common higher molecular weight glycol ethers, such as 1,2-dimethoxyethane (glyme), ethylene glycol monomethyl ether (EGME, 2-methoxyethanol), dipropylene glycol monomethyl ether (DPM, 1-(2-methoxy-2-methylthioxy)-2-propanol), propylene glycol monomethyl ether (PGME, 1-methoxy-2-propanol), diethylene glycol monomethyl ether (DEGME), and dipropylene glycol monomethy
ether (DPGME), are often water soluble liquids and combustible. Lower molecular weight glycol ethers are flammable liquids. Many are high-boiling-point liquids.

B.4.1.11 Gases.

Within the context of the model codes, gases are regulated as either compressed gases or as cryogenic fluids. Compressed gases can be found either in the nonliquefied or liquefied state. Any gas can be liquefied at a sufficiently low temperature by increasing its pressure through the use of compression. Gases that cannot be liquefied at normal ambient temperatures are called “permanent” gases. A permanent gas is able to be liquefied by reducing the temperature below ambient temperatures and increasing its pressure. However, at normal ambient temperatures of 68°F (20°C) these gases remain in a nonliquefied state.

The scientific explanation for this phenomenon is generally explained in the following discussion. There is a temperature for each gas at or below which it can be liquefied by pressure, but above which it is impossible to liquefy at any pressure. This temperature is called the critical temperature of the gas. At temperatures above the critical temperature, the substance can exist only in the gaseous state regardless of the pressure applied. The pressure that will just liquefy a gas at its critical temperature is called the critical pressure. In other words, the critical pressure of a gas is equal to the vapor pressure exerted by the liquefied gas at its critical temperature. All that is necessary to liquefy a gas is to cool it to its critical temperature and subject it to a pressure equal to or greater than its critical pressure. The farther below the critical temperature it is cooled, the less the pressure required for liquefaction. At the critical conditions of temperature and pressure the gaseous and liquid forms of the substance have the same density.

Atmospheric air is a mixture of permanent gases and principally composed of argon, oxygen, and nitrogen. Under normal ambient conditions it remains in the gaseous state. The critical temperature of air is −221.1°F (−140.6°C). The critical pressure is an absolute pressure of 547 psi (3771 kPa, absolute). To liquefy compressed air, the temperature must be reduced to −221.1°F (−140.6°C) or less with a commensurate increase in pressure above absolute pressure of 547 psia (3771 kPa, absolute). By comparison, liquefied petroleum gas (LP-Gas), is a mixture of hydrocarbon gases, principally propane and butane, which is found in the liquid form under ambient conditions. These gases have a critical temperature well in excess of 68°F (20°C), and as a result, they are found as liquefied compressed gases under ambient temperatures.

Cryogenic fluids are refrigerated liquefied gases with a boiling point lower than −130°F (−90°C) at an atmospheric pressure of an absolute pressure of 14.7 psi (101.3 kPa, absolute). They are maintained in the cryogenic (super-cooled) state by artificial means.

B.4.1.11.1 Gases (Flammable).

Common nonliquefied flammable compressed gases include carbon monoxide and hydrogen. Other flammable gases are hydrocarbon gases. The alkanes include methane (CH₄), ethane (C₂H₆), and propane (C₃H₈). Ethane and propane are liquefied compressed gases at ambient temperature. The alkenes include ethylene (C₂H₄) and propylene (C₃H₆), both liquefied compressed gases, and the alkynes include acetylene (C₂H₂). Acetylene is an unstable reactive gas; it is found in cylinders, packaged as a compressed gas dissolved in a solution of acetone or
dimethyl formamide. While acetylene can be liquefied at ambient temperatures, for safety reasons it is shipped as a nonliquefied compressed gas.

### B.4.1.11.2 Gases (Halogens) (X-X).

The pure halogen gases, fluorine (F₂), chlorine (Cl₂), bromine trifluoride (BrF₃), and chlorine trifluoride (ClF₃), are extremely powerful oxidizers, and are corrosive and toxic. Fluorine and chlorine are only slightly soluble in water, while bromine trifluoride and chlorine trifluoride are extremely water reactive. Bromine trifluoride is explosive on contact with water. Fluorine is a compressed gas while chlorine, bromine trifluoride, and chlorine trifluoride are liquefied compressed gases.

Gases that are fully halogenated, such as hexafluoroethane (C₂F₆), carbon tetrafluoride (CF₄), and sulfur hexafluoride (SF₆), are inert and nonreactive.

### B.4.1.11.3 Gases (Non-Flammable).

The atmospheric gases, with the exception of oxygen, have limited chemical reactivity, and are not corrosive, flammable, or toxic. These gases include nitrogen, argon, and carbon dioxide. Their greatest hazard is asphyxiation. The rare gases, such as helium, neon, krypton, xenon, and argon, were once thought to be inert (having no chemical activity at all); however, within the last 20 years compounds have been made through the use of strong oxidizer gases, such as fluorine, to form nitrogen trifluoride.

### B.4.1.11.4 Gases (Oxidizing).

The more common oxidizing gases are oxygen, nitrous oxide, and nitrogen trifluoride. Oxygen and nitrogen trifluoride are compressed gases, while nitrous oxide is a liquefied compressed gas.

### B.4.1.11.5 Gases (Pyrophoric).

Gases with an autoignition temperature below 130°F (54°C) are classified as pyrophoric. Silane (SiH₄) is probably one of the most common pyrophoric gases found in use today. Other pyrophoric gases include methylsilane (CH₃SiH₃) and disilane (Si₂H₆). Silane and methylsilane are compressed gases, while disilane is a liquefied compressed gas. Some pyrophoric gases, such as phosphine (PH₃) and diborane (B₂H₆), are also highly toxic. Although all pyrophoric gases are flammable by nature, they are regulated as pyrophoric gases within the context of the model codes.

### B.4.1.11.6 Gases (Sulfur Gases) (R-SH).

The common sulfur gases are hydrogen sulfide (H₂S), methyl mercaptan (CH₃SH), and carbonyl sulfide (COS) and are toxic and flammable. They are all liquefied compressed gases.

### B.4.1.12 Hydrocarbons.

#### B.4.1.12.1 Hydrocarbons (Aliphatic) (R).

Commonly referred to as saturated hydrocarbons, alkanes as a whole are unreactive chemicals. The aliphatic hydrocarbons pentane, decane, and cyclohexane are flammable liquids. Lower
molecular weight hydrocarbons such as methane, ethane, propane, and butane are flammable compressed gases.

**B.4.1.12.2 Hydrocarbons (Alkenes) (R₁CH=CHR₂).**

Alkenes are a very broad category of hydrocarbons and are commonly referred to as unsaturated hydrocarbons, olefins, or vinyl compounds. Alkenes are relatively stable compounds, but are more reactive than alkanes. Smaller chain alkenes, such as ethylene, propylene, and butene, are all flammable gases and readily form explosive mixtures with air. Common derivatized alkenes, such as styrene (vinyl benzene), vinyl chloride (monochloroethylene), vinyl acetate, and 1,4-dichloro-2-butene, are toxic. Some are flammable liquids. They also readily polymerize (without inhibitors), which leads to unstable reactive characteristics.

**B.4.1.12.3 Hydrocarbons (Alkynes) (R₁C≡CR₂, R-C≡CH).**

Of all the aliphatic hydrocarbons, alkynes are the most reactive. Many alkynes are highly reactive and considered unstable reactive, especially as molecular weights increase. Many halogenated alkenes and metal derivatives can be explosive. The most common alkynes are gases, including acetylene (ethyne — see Flammable Gases) and methyl acetylene (1-propyne), can form explosive mixtures with air. The most common derivitized alkyne is propargyl alcohol (2-propyn-1-ol), which is flammable, corrosive, and toxic.

**B.4.1.12.4 Hydrocarbons (Aromatic) (Ar).**

This family is very broad and derived from such compounds as benzene and toluene and have limited alkyl (methyl, ethyl, etc.) substitution on the ring. Smaller aromatic hydrocarbons (benzene, toluene (methyl benzene), ethyl benzene, and xylene) are flammable liquids and are sometimes toxic. High-molecular-weight compounds with many aromatic rings (such as naphthalene and anthracene) are solids and are often toxic. Substituted analogues, such as dichlorobenzene, have varying degrees of toxicity based on the degree of substitution and arrangement on its ring structure. Many are also flammable solids.

**B.4.1.13 Isocyanates (R-N=C=O, Ar-N=C=O).**

This family includes compounds such as toluene diisocyanate (TDI), p-toluenesulfonyl isocyanate, and methylene bisphenyl isocyanate (MDI). The chemicals are liquids and are typically unstable reactive, water-reactive, corrosive, and toxic. Some are highly toxic. Some are violently water reactive.

**B.4.1.14 Metals.**

**B.4.1.14.1 Metal Alkyls (M-R).**

All metal alkyls are pyrophoric, corrosive, and highly reactive. The simple metal alkyls trimethylaluminum (TMAI), trimethylgallium (TMG), and trimethylindium (TMI) are pyrophoric liquids. They are also violently water reactive. Dimethylzinc and trimethylaluminum are also unstable reactive. Tetramethyltin is a flammable liquid.

**B.4.1.14.2 Metal Halides (M-X).**
Physical and health hazards of this chemical family vary significantly based on the corresponding metal. Most metal halides are typically inert (such as sodium chloride [table salt], calcium chloride, magnesium fluoride, aluminum chloride, and palladium (II) chloride), while some have a much higher reactivity (such as silver bromide and chromium (III) chloride) and are strong oxidizers. The chemical and physical properties vary significantly depending on the metal. If a metal halide contains a heavy metal, such as lead, chromium, thallium, and mercury, it is assumed to be highly toxic. Fluoride and bromide salts are more toxic than the corresponding chloride salts.

B.4.1.14.3 Metal Hydrides (Solids).
Compounds such as lithium aluminum hydride (LiAlH₄), sodium borohydride (NaBH₄), and sodium hydride (NaH) are flammable solids, water-reactive, and corrosive. Metal hydrides react violently with water.

B.4.1.14.4 Metal Hydrides (Gaseous).
The more common metal hydride gases are arsine (arsenic hydride, AsH₃), diboran (boron hydride, B₂H₆), hydrogen selenide (selenium hydride, H₂Se), and phosphine (phosphorous hydride, PH₃). In general, these chemicals are toxic, liquefied compressed gases, with many being highly toxic. They are flammable and some have autoignition temperatures low enough to make them pyrophoric, such as diboran and phosphine. The key exception is silane (SiH₄), which is not toxic. Silane is a compressed gas rather than a liquefied compressed gas.

B.4.1.14.5 Metals (Alkali).
This category includes sodium, potassium, and lithium. All are highly corrosive and can often explode if they are exposed to water. They are all flammable solids as well.

B.4.1.14.6 Metals (Powdered).
Metals, especially those in a finely divided state, are usually categorized as flammable solids, such as aluminum, magnesium, sodium, and potassium. Some, but not all, react violently and are water-reactive. Some are also toxic.

B.4.1.15 Nitrated Organic Compounds.
B.4.1.15.1 Organic Nitro Compounds (R, Ar-NO₂).
Most often, smaller alkyl nitro compounds, such as nitromethane, are flammable, unstable reactive, and often toxic. Aromatic nitro analogues are toxic or highly toxic and unstable reactive, the latter being dependent on the amount of ring substitution.

B.4.1.15.2 Azo (Aliphatic) (R-N=N-R).
Aliphatic azo derivatives are inherently unstable and readily decompose, often violently, upon the application of heat. Aliphatic azo compounds are characterized as unstable reactive, flammable solids and are often toxic.

B.4.1.15.3 Azo (Aromatic) (Ar-N=N-Ar).
Aromatic azo derivatives have superior thermal stability properties compared to aliphatic azo derivatives. Many aromatic azo derivatives are quite stable and often used as dyes. They have a wide array of chemical and physical properties depending on the substituents on the aromatic ring and the number of azo groups present in the molecule (mono-, di-, tri-, tetra-, etc.). Most exhibit low to moderate toxicity.

**B.4.1.15.4 Azides (R, Ar-N₃).**

The most common chemicals of this family are the metal azides, including sodium and lithium azide. All the compounds in this family are unstable reactive and highly toxic.

**B.4.1.15.5 Nitrites (Inorganic) (M-NO₂).**

The most common nitrites are sodium and potassium nitrite. All are strong oxidizers and toxic.

**B.4.1.15.6 Nitrates (Inorganic) (M-NO₃).**

Examples of inorganic nitrates include sodium nitrate, silver nitrate, zinc nitrate, lithium nitrate, and lead nitrate. While all inorganic nitrates are strong oxidizers, the physical and health properties vary significantly depending on the metal. Many of these compounds are corrosive and may have unstable reactive properties. Toxicity varies with the associated metal.

**B.4.1.16 Nitrogen-Halogen compounds (R-N-X).**

This chemical family includes chlorinated isocyanurates (trichloroisocyanuric acid, sodium dichloroisocyanurate), halogenated succinimides (N-bromosuccinimide), and halogenated hydantoins (e.g., 1-bromo-3-chloro-5,5-dimethylhydantoin). Some are strong oxidizers and corrosive in their pure states, with varying properties of unstable reactive, water-reactive, and toxicity hazards. Specially formulated chlorinated isocyanurate products have been shown to reduce oxidizer properties.

**B.4.1.17 Oxyanion (M-ClO₂, M-ClO₃, M-ClO₄, M-OCl).**

This chemical family includes chlorites, chlorates, perchlorates, bromates, and hypochlorites. The most common chemicals are sodium chloride (NaClO₂), sodium chlorate (NaClO₃), ammonium perchlorate (NH₄ClO₄), potassium bromate (KBrO₃), and calcium hypochlorite (Ca(OCl)₂). Most are strong oxidizers and corrosive in their pure states with varying properties of unstable reactive, water reactive, and toxicity hazards. Chlorites and chlorates are most commonly found as diluted solutions that reduce toxicity and oxidizing properties. Specially formulated calcium hypochlorite products have been shown to reduce their oxidizing properties. Sodium hypochlorite (liquid bleach) is too unstable in solid form and is found only in dilute solutions that are corrosive.

**B.4.1.18 Peroxides.**

**B.4.1.18.1 Peroxide (Organic) (R-O-O-R).**

The common organic peroxides include such chemicals as t-amyl hydroperoxide, dibenzoyl peroxide, di-t-butyl peroxide, diacetyl peroxide, methyl ethyl ketone peroxide, diisopropyl peroxydicarbonate, and cumyl hydroperoxide. Organic peroxides possess a wide range of...
properties based on the many physical forms and concentrations and have a large range of safety-related properties, including physical as well as health hazards. Organic peroxides are either used as the technically pure compound or as formulations where the peroxide might be found in a diluted form, such as solutions, pastes, or solid granules.

Organic peroxide formulations vary in reactivity hazard from self-extinguishing to the potential for a violent deflagration or detonation. Decomposition can be initiated by heat, friction, mechanical shock, or contamination, though sensitivity to these stimuli varies greatly. Dilution with water or other solvents is used as a means to reduce the level of sensitivity to outside stimuli and the potential for decomposition. Refrigeration is also used as a means to reduce the potential for decomposition. The health hazards of these materials as provided in commerce vary greatly depending on concentration and formulation itself.

B.4.1.18.2 Metal Peroxides (Inorganic) (M-O-O).

Metal peroxides, such as sodium peroxide and calcium peroxide, are all oxidizers. Some are corrosive and water reactive. Reaction with water can be explosive in some instances.

B.4.1.19 Phosphorus-Halogen Compounds (O=P-X₃, P-X).

These phosphorus analogues are corrosive and often react violently with water and include such chemicals as phosphorus oxychloride (POCl₃), phosphorus trichloride (PCl₃), and phosphorus pentachloride (PCl₅). They are water reactive, corrosive, and toxic.

B.5 Hazard Category Based on Concentration.

B.5.1 General.

Some chemicals exhibit different physical and/or health hazards based on the concentration. Some pertinent examples of concentration-dependent hazards of specific chemicals are provided in the following list. Additional information on concentration-dependent hazards should be contained in the SDS.

(1) Acetic Acid (64-19-7). Concentration: 100 percent — corrosive, flammable/combustible; 36 percent aqueous — corrosive; <5 percent aqueous — not corrosive.

(2) Ammonia (7664-41-7). Concentration: anhydrous — corrosive, flammable gas; <50 percent aqueous — not corrosive.

(3) Formaldehyde (50-00-0). Concentration: anhydrous — flammable, corrosive, highly toxic; 37 percent aqueous — combustible, highly toxic 10 percent aqueous — combustible.


(5) Nitric Acid (7697-32-2). Concentration: 7–40 percent aqueous — oxidizer, corrosive; 1–6 percent aqueous — not oxidizer, not corrosive.
(6) Phosphine (CAS numbers based on concentration). Concentration: 5 percent phosphine, 95 percent nitrogen — pyrophoric, toxic; phosphine: 2 percent phosphine, 98 percent nitrogen — toxic.

(7) Phosphoric Acid (7664-38-2). Concentration: 85—86 percent aqueous — corrosive; <80 percent aqueous — not corrosive.

(8) Potassium Hydroxide (1310-58-3). Concentration: 100 percent — corrosive, water reactive, toxic; 45 percent aqueous — corrosive, water reactive; 5 percent aqueous — corrosive.

(9) 2-Propanol (Isopropanol) (67-63-0). Concentration; >91 percent aqueous — flammable; 25—50 percent aqueous — combustible.

(10) Sodium chlorate (7775-09-9). Concentration: 100 percent — corrosive, oxidizer, unstable reactive; 40—50 percent aqueous — corrosive, oxidizer.

(11) Sodium hydroxide (1310-73-2). Concentration: 100 percent — corrosive, water reactive, toxic; 1—50 percent aqueous — corrosive.

(12) Sulfuric Acid (7664-93-9). Concentration: 92—98 percent aqueous — corrosive, water reactive, toxic; 12.7—50 percent aqueous — corrosive, water reactive, toxic; 4—12.6 percent aqueous — corrosive.


B.6 Safety Data Sheets (SDSs) — A Starting Point for Hazards Identification.

B.6.1

Safety data sheets (SDSs) have been established as a primary means of hazard identification under OSHA’s Hazard Communication program. SDSs are provided by manufacturers or importers as a means to communicate hazards within a set of standardized terms and elements or bodies of information.

B.6.2

In 2012, OSHA revised its Hazard Communication Standard to align with the United Nations Globally Harmonized System of Classification and Labelling of Chemicals (GHS). The Hazard Communication Standard requires the use of a 16-section format for SDSs, similar to that of the ANSI format. As manufacturers and distributors transition to the 16-section SDS format, they will include information in the sixteenten 16 sections referenced in B.2. In order To classify the hazards of a given material, users should refer to key sections of the SDS that contain the following information:

(1) Identification (SDS Section 1)

(2) Hazard(s) identification (SDS Section 2)

(3) Composition/information on ingredients (SDS Section 3)
Each section should contain relevant information that can be used in the hazard classification process. The following subsections provide useful information to help the user with these required SDS sections.

### B.6.2.1 Identification.

Product identification will typically include the chemical name, common name, and synonyms. Pure materials, sometimes referred to as “neat” to indicate that they are in an undiluted form, are typically referred to by their chemical name. However, it is not uncommon to find that the manufacturer has identified the material under a trade name chosen by that particular manufacturer. Chemical synonyms will frequently be shown; however, it should be expected that the list of synonyms may be an abbreviated listing and that there may be other synonyms that are not listed.

For chemical mixtures the material will typically be identified by its trade name. Some confusion can be created when a material in its “neat” form is further identified in the Hazard Identification section as containing other constituents. Commercially available materials, even in the pure or neat form, contain impurities from the manufacturing process. Although there is no hard-and-fast rule, materials in concentrations of 95 percent or greater are generally considered to be in the pure form and are referred to by the CASRN for the major component. The impurities from manufacturing are generally not considered for the purposes of material identification and such materials are not considered to be “mixtures” of chemicals per se.

The product identification section provides additional information, including the identification of the manufacturer of the material and nomenclature intended to link the SDS to the label provided on the material in the container(s) as furnished by the manufacturer.

In addition to the product identifier, Section 1 of the SDS will list the chemical name, and the name, address, and phone number of the responsible party. Similar to NFPA, the Hazard Communication Standard requires that hazardous chemicals be classified according to the severity of hazard presented by the chemical. However, the hazard categories defined and assigned by the Hazard Communication Standard are different than those used by NFPA. For example, the Hazard Communication Standard defines oxidizers differently than the NFPA (see Annex J of NFPA 400 for a comparison of these definitions). Within the hazard category of oxidizer, there are four subcategories or Classes of hazards recognized under the NFPA system, e.g., Class 4, Class 3, Class 2, and Class 1 materials. Hazard classes are used to describe a range of hazards within a given hazard category, and the class system is used for materials that are oxidizers other than oxidizing gases, organic peroxides, unstable reactives, and water reactives. Although not the subject of regulation by NFPA 400, flammable liquids are further subdivided into Class I, Class II, and Class III, and combustible liquids are further subdivided into Class II, IIIA, and IIIB liquids.
B.6.2.2 Hazards Identification.

Section 2 of the SDS lists the hazard identification of the chemical, including the classification of the chemical, signal word, the pictogram(s), hazard statement(s), description of hazard(s), and precautionary statements. SDS Section 2 also describes hazards that are not otherwise classified. The hazard identification section of SDS provides an emergency overview of the material and includes information on health and physical hazards that can result from exposure to the material.

B.6.2.3 Composition/information on ingredients.

The composition of the material or information on ingredients is listed in SDS Section 3, per the OSHA Hazard Communication Standard. The composition section typically lists the hazardous components as defined by OSHA, and not those categories used by NFPA 400. Although the OSHA hazard categories have been incorporated into the regulatory scheme used by NFPA 400, there are differences and the converse is not true. For example, OSHA does not incorporate the traditional NFPA hazard ratings used in NFPA 704. The revised Hazard Communication Standard, allows the completed NFPA 704 diamond to be provided on the SDS. NFPA and OSHA developed a Quick Card to compare the classification and rating systems, located at www.nfpa.org/704.

The composition section is required to list hazardous components of a material that are themselves classified and contribute to the classification of the chemical. For mixtures, the composition section must also list the chemical name and concentration of all ingredients classified as health hazards and that are present above their cut-off/concentration limits or present a health risk below the cut-off/concentration limits. The SDS may also list components that are nonhazardous. The CASRN for each component is typically listed in this section of the SDS.

B.6.2.4 Physical and Chemical Properties.

Section 9 of the SDS lists the physical and chemical properties of the materials. A description of its physical properties, including its physical state (solid, liquid, gas) is required. It is typical to find a wide array of physical and chemical properties listed. The physical and chemical properties required in SDS Section 9 include:

1. Appearance (physical state, color, etc.)
2. Odor
3. Odor threshold
4. pH
5. Melting/freezing point (specify which)
6. Initial boiling point and boiling range
7. Flash point

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B.6.2.5 Stability and Reactivity.

Section 10 of the SDS lists information about the stability and reactivity of materials. This section typically describes conditions which affect the intrinsic stability of a material. An intrinsic property is a property that is inherent in the material in and of itself, as compared to its properties under conditions that are brought about by the environment in which it is located. Environmental conditions can be described as extrinsic conditions, such as when the material is exposed to heat, fire, shock, or other effects.

This section of the SDS is used as a means to assess its nature within the context of the unstable reactive hazard category. While many materials have an intrinsic stability, they can become unstable when exposed to high temperatures or mechanical or physical shock. Therefore, the information found on an SDS might have to be supplemented by referring to other authoritative sources regarding the reactivity of the material.

B.6.2.6 Toxicological Information.

Section 11 of the SDS lists toxicological information. This section contains information on the health effects of the material or its components. It typically supports the detail provided in the section on hazards identification in the SDS. The information provided is written for use by health care professionals and those that have the technical training and experience in the safety and toxicology aspects of interface with materials from a toxicological perspective.

However, this section of the SDS contains information that is used to establish the approach to control integral to NFPA 400 with respect to toxicity and corrosivity. Data including the effects of acute exposure to mammals and other life forms or information regarding the irreversible destruction of tissue at the site of contact will be found in this section of the SDS.
There may be other information regarding the toxicological effects resulting in, but not limited to, irritation, sensitization, carcinogenicity, reproductive effects, and genetic and target organ effects, none of which fall under the scope of NFPA 400.

B.6.2.7 Transportation.

Section 14 of the SDS lists the system of classification used by the Department of Transportation (DOT) to classify materials for shipment purposes, which is not compatible with the system used to classify materials within the context of NFPA 400. With the alignment to the United Nations Globally Harmonized System of Classification and Labeling of Chemicals (GHS), it must be recognized that OSHA’s system of hazard communication has now become harmonized with the system used by the Department of Transportation. OSHA’s hazard communication system, embodied in the SDS, correlates with the DOT regulations for transporting hazardous chemicals, located in 49 CFR. The OSHA system contemplates that users and producers of hazardous materials will encounter these materials in their unpackaged state where the materials are reasonably foreseen to have a potential for bodily contact or use within the work environment on a regular basis. On the other hand, the DOT system of control views the materials in their final packaging as required for transportation where the materials are not subject to exposure to personnel except under upset conditions.

Because OSHA does not enforce the contents of Section 14 of the SDS, users may find additional information in the section for transportation on the SDS, which may or might not be further explained in preceding sections. It is important to recognize that the classification for the purposes of transportation will not suffice as a means to assign the material to a given hazard category under the requirements of NFPA 400, and the user must carefully apply the material specific definitions found in Chapter 3 along with the criteria obtained from the SDS and other resources in order to determine the appropriate classification of a given material.
E.1 Properties and Uses of Ammonium Nitrate.
Ammonium nitrate is a compound containing nitrogen, hydrogen, and oxygen \( (NH_4 NO_3) \). It is commercially produced by reacting nitric acid with ammonia and evaporating the resultant solution of ammonium nitrate to make a concentrated ammonium nitrate melt, which is then spray-granulated in a spraying tower or pelletized or flaked by some other means. The flaked or pelletized material is then dried. The solid, liquid, or gas forms of ammonium nitrate are oxidizers. Ammonium nitrate is an oxidizer. Ammonium nitrate is classed as an oxidizer by the U.S. Department of Transportation (DOT) and Pipeline and Hazardous Materials Safety Administration (PHMSA). Pure AN (AMNO) has a decomposition mechanism into a self-sustaining, internal exothermic reaction that will spread within a fertilizer pile creating a zone of decomposition. This reaction can continue and spread through the entire fertilizer mass, even after the actual fire is suppressed.

Most solid, liquid, and gaseous nitrates are oxidizers. AN is an oxidizer. AN is classed as an oxidizer by the U.S. Department of Transportation (DOT) and Pipeline and Hazardous Materials Safety Administration (PHMSA). Pure AN (AMNO) manifests the definition of an oxidizer that is not combustible in and of itself but accelerates the burning of combustible materials with which it comes in contact. The burning rate of technical-grade AN pill falls within the Class 2 oxidizer criteria in Annex G. The loss history of AN also indicates potential for unstable reactive hazard properties, uncontrolled decomposition, and/or detonation if subject to one or more of the following conditions:

1. **Fire**
2. **Exposure** to strong shock waves
3. **Localized heating potentially leading to development of high-temperature areas**
4. **Exposure** to strong shock waves
5. **Contamination with combustible materials, incompatible inorganic and organic substances that can result in sensitivity to explosion**
6. **Low pH or acidic conditions**

The requirements for classification of ammonium nitrate as a Division 1.4 oxidizer by the Department of Transportation are described in the United Nations publication, Recommendations on the Transport of Dangerous Goods, Model Regulations, Revised Edition, 2005. Such oxidizing materials can yield oxygen upon decomposition under fire conditions and will therefore, under proper conditions of mixing, vigorously support combustion if involved in a fire with combustible materials.

The requirements in Chapter 11 are intended to protect AN as an oxidizer with multiple physical hazards and to prevent AN from exhibiting unstable reactive physical properties. With code compliance and proper precautions against fire and explosion, AN can be stored safely.

Ammonium nitrate in higher concentrations is capable of undergoing detonation with about half the blast effect of explosives, if heated under confinement that permits high pressure buildup. Such confinement is subject to strong shock waves. The sensitivity of ammonium nitrate to detonation increases at elevated temperatures. Additional information on the explosive nature of ammonium nitrate, including the degree of confinement along with the effect of certain inert substances, such as chalk, limestone, dolomite, etc., can be found in U.S. Bureau of Mines Report of Investigations 19014. Investigations on the Explosivity of Ammonium Nitrate, August 1963.

The physical hazards of pure AN are: capable of detonation with reported TNT equivalence between 25 and 45 percent, accelerated burning of combustibles, and self-sustaining decomposition. The health hazards of AN are consequences of decomposition and fire of gases: oxygen, ammonia, nitric acid, and nitrous oxide.

Industrial use of ammonium nitrate permits to use as an ingredient in blasting agents. When a carbonaceous or organic substance such as fuel (or diesel) oil, nuts, hulls, or carbon black is added and mixed in with ammonium nitrate, the mixture could become a blasting agent. A blasting agent as defined by NEPA-495 is a material or mixture that meets the requirements of the DOT "Hazardous Material Regulations," as set forth in 49 CFR Parts 172, 173, 177, and 178, Explosive 1.5D.

Factors influencing the risk of detonation of AN are the following:

1. **Heating under confinement permitting high-pressure buildup**
2. **Strong shocks, such as those from an explosive**

**Low pH or acidic conditions**

Test data on ammonium nitrate are included in the U.S. Bureau of Mines Report of Investigations 6746, Sympathetic Detonation of Ammonium Nitrate and Ammonium Nitrate-Fuel Oil, Report of Investigations 5689, Further Studies on Sympathetic Detonation, and Report of Investigations 6773, Explosion Hazards of Ammonium Nitrate Under Fire Exposure. On the basis of these reports, a Table of Recommended Separation Distances for Ammonium Nitrate and Blasting Agents from Explosives or Blasting Agents has been developed. (See Table 9.4.2.4(b) of NFPA 495.) The entries in the table are only valid for ammonium nitrate and ammonium nitrate-based materials that are NOT DOT Hazard Class 1 oxidizers. The table is only applicable to materials in tanks that show positive results in the UN Test Series 1 and 2 and negatively tested results in the UN Test Series 1 and 2. There are no positive results listed in the UN Test Series 1 and 2 tests; could potentially be classified as having a mass explosion hazard. NFPA 495 requires Hazard Class 1 materials to be stored in accordance with the requirements of high explosives (Division 1.1) under the quantity-distance requirements of the American Table of Hazards (ATH) developed by the Institute of Makers of Explosives (IME) and published in NEPA-495. For ammonium nitrate, the sensitivity of AN to detonation increases with contamination and increased ventilation. The likelihood of an explosion in a typical warehouse fire where AN is stored increases under the following conditions:

1. **If molten AN can accumulate in large pools**
2. **If there is potential for confinement of molten AN, such as in drains, pits, sewers, or dead spaces in equipment**
3. **If there is potential for physical shock of the molten AN, such as high-velocity projectiles generated in a fire**
4. **If the AN is or becomes contaminated before or during a fire**
5. **If the temperature is in excess of 554°F (290°C) at atmospheric pressure and adiabatic conditions**

The maximum quantities of material indicated by the ATD are limited to quantities less than what may be found on sites where large amounts of ammonium nitrate or ammonium nitrate mixtures may be found. The Department of Defense Explosions Safety Board (DOESB) currently uses software called SAFER along with a table of distance methods to assess DOD potential explosives sites. The IME, in collaboration with the DODESB, APT Research, Canadian and U.S. regulatory agencies has developed a software called IMESAFR. The software incorporates risk-based methodology to address the impact of siting for explosives and explosive operations. Provisions for ammonium nitrate are included using an approach and distances based on TNT equivalence.

Ammonium nitrate based fertilizers have certain applications. Ammonium nitrate fertilizers offer in the market place is usually between 28 and 34 percent. Other nutrients such as sulfates or phosphates, added hardening agents, coating agents, and residual water make up the balance.

While blasting agents should not be confused with fertilizer products, extreme care should be taken to ensure that stored ammonium nitrate does not become sensitized by intimate mixing with carbonaceous, organic, or combustible material.

AN as an oxidizer can support combustion even in the absence of atmospheric oxygen, such as in poorly ventilated structures. Molten AN is a powerful oxidizer capable of igniting mixing with carbonaceous, organic, or combustible material.
Typical solid and liquid AN products are listed in Table E.1.

Table E.1 Typical Solid and Liquid AN Products

<table>
<thead>
<tr>
<th>Composition</th>
<th>Common description</th>
<th>AN content (%)</th>
<th>Typical Nitrogen (N) content (%)</th>
<th>Combustible Material (maximum)</th>
<th>UN No. (Division)</th>
</tr>
</thead>
<tbody>
<tr>
<td>AN (high-density prill)</td>
<td>Fertilizer grade</td>
<td>&gt; 99%</td>
<td>34%</td>
<td>0.20%</td>
<td>1942 (5.1)</td>
</tr>
<tr>
<td>AN (low-density prill)</td>
<td>Industrial grade</td>
<td>&gt; 99%</td>
<td>34%</td>
<td>0.20%</td>
<td>1942 (5.1)</td>
</tr>
<tr>
<td>AN-based NPK (note 1)</td>
<td>Compound fertilizers</td>
<td>45–70%</td>
<td>16–25%</td>
<td>0.40%</td>
<td>2071 (9)</td>
</tr>
<tr>
<td>AN-based NPK (note 2)</td>
<td>Compound fertilizers</td>
<td>45–70%</td>
<td>16–25%</td>
<td>0.40%</td>
<td>1942 (5.1)</td>
</tr>
<tr>
<td>AN liquid – hot concentrated solution</td>
<td></td>
<td>0–45%</td>
<td>&lt; 16%</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>AN liquid</td>
<td></td>
<td>&lt; 80%</td>
<td>&gt; 28%</td>
<td>N/A</td>
<td>2426 (6.1)</td>
</tr>
</tbody>
</table>

Notes:
1. Some compound (NPK or NK) fertilizers can exhibit the self-sustaining decomposition (SSD) property by the UN Trough Test 3.1. Where not capable of SSD, the oxidizing classification (i.e., Division 5.1), might take precedence.
2. N=Nitrogen, P=Phosphorus, K=Potassium, N/A=Not Applicable

% ammonium nitrate = (% total nitrogen listed in the fertilizer/ 0.35) [Eq. 1]

AN is commonly blended with other fertilizer materials, such as diammonium phosphate, sulfates, and potash. Fertilizers containing less than 60 percent AN are not covered by this code. Fertilizer materials that contain AN are commonly described, not by their chemical composition, but by their plant nutrient (N-P-K) values. For example, agricultural-grade AN will appear in the marketplace with a guaranteed nitrogen content of 34.5–5. This means there is a guaranteed analysis of 34 percent total nitrogen, with 0 percent phosphorus and 5 percent potassium. The theoretical maximum nitrogen content of pure or 100 percent AN is 35 percent by weight. The typical nitrogen content of AN fertilizers offered in the marketplace is usually between 28 and 34 percent. Other nutrients such as sulfates or phosphates, added hardening agents, coating agents, and residual water make up the balance.

For example, a fertilizer is indicated as being 30-0-0, then:

(20/0.35) = 57.1% ammonium nitrate

The total available nitrogen in an AN-based fertilizer comes from AN, the percentage of AN can be determined through the use of the following formula:

% ammonium nitrate = (% total nitrogen listed in the fertilizer/ 0.35) [Eq. 1]

However, when some, but not all of the nitrogen could come from other nitrogen compounds in the mixture, the percentage of nitrogen for each component containing nitrogen in the fertilizer mixture must first be determined.

For example, a fertilizer product described as 28-0-0-5(S) has a guaranteed analysis of 28 percent total nitrogen, 0 percent phosphorus, 0 percent potassium, and 5 percent sulfur. Whether the nitrogen is derived from ammonium nitrate or another nitrogen fertilizer source must be disclosed by the manufacturer in order to determine the hazard classification of the material. The type of information is usually found on the SDS provided by the manufacturer where the names of the material included in the mixture along with the concentration of each material is expressed. It is not unusual for a range of concentrations to be given on an SDS, and users are cautioned to assume the ammonium nitrate concentration to be at the top of the range.

However, when some, but not all of the nitrogen could come from other nitrogen compounds in the mixture, the percentage of nitrogen for each component containing nitrogen in the fertilizer mixture must first be determined. For example, a fertilizer product described as 28-0-0-5(S) has a guaranteed analysis of 28 percent total nitrogen, 0 percent phosphorus, 0 percent potassium, and 5 percent sulfur. Whether the nitrogen is derived from AN or another nitrogen fertilizer source, it must be disclosed by the manufacturer to determine the hazard classification of the material. This type of information is usually found on the SDS provided by the manufacturer where the names of the material included in the mixture along with the concentration of each material is expressed. It is not unusual for a range of concentrations to be given on an SDS, and users are cautioned to assume the AN concentration to be at the top of the range.

By use of Equation 1, it can be seen that ammonium nitrate fertilizers with a nitrogen content of less than 21 percent by weight derived from ammonium nitrate (60 percent ammonium nitrate) are not regulated by Chapter 11. By use of Equation 1, AN fertilizers with a nitrogen content of less than 21 percent by weight derived from AN (60 percent AN) are not regulated by Chapter 11 (e.g., (21/0.35) = 65% AN). (21/0.35) = 65% ammonium nitrate

With proper precautions against fire and explosion, ammonium nitrate can be stored safely at a plant, in distributors’ warehouses, or on a farm.

For interstate shipments, the U.S. DOT classification AN with not more than 0.2 percent total combustible material, including any organic substance, calculated as carbon to the exclusion of any other added substance, as an oxidizer Division 5.1, AN with more than 0.2 percent combustible substances, including any organic substance calculated as carbon to the exclusion of any other added substance, as a Division 1.1D material. AN-based fertilizers can be classified as an oxidizer Division 5.1, or in some cases as a Division 9 material (miscellaneous hazardous material). (See U.S. DOT Transportation Regulations 49 CFR 172.101.)

The requirements for classification of AN as a Division 5.1 oxidizer by the DOT are described in the United Nations publication, Recommendations on the Transport of Dangerous Goods, Model Regulations. Such oxidizing materials can yield oxygen upon decomposition under fire conditions and will, therefore, under proper conditions of mixing, vigorously support combustion if involved in a fire with combustible materials.

AN in high concentrations is capable of undergoing detonation with about half the blast effect of explosives, if heated under confinement that permits high-pressure buildup, or if subjected to strong shock, such as those from an explosion. The sensitivity of AN to detonation increases at elevated temperatures. Additional information on the explosive nature of AN, including the degree of confinement along with the effect of certain inert diluents, such as chalk, limestone, dolomite, and so forth, can be found in U.S. Bureau of Mines Report of Investigations 4994, Investigations on the Explosibility of Ammonium Nitrate.

Industrial use of AN extends to use as an ingredient in blasting agents. When a carbonaceous or organic substance such as fuel (or diesel) oil, nut hulls, or carbon black is added to mixed in with AN, the mixture could become a blasting agent. A blasting agent as defined by Section 49 CFR 172.101 as a material or mixture that meets the requirements of the DOT Hazardous Materials Regulations, as set forth in 49 CFR Parts 173.56, 173.57, and 173.58. Explosive 1.5D.

Test data on AN are included in the U.S. Bureau of Mines Report of Investigations 6748, Sympathetic Detonation of Ammonium Nitrate and Ammonium Nitrate Fuel Oil; Report of Investigations 6903, Further Studies on Sympathetic Detonation; and Report of Investigations 8712, Explosion Hazards of Ammonium Nitrate-Under Fire Exposure. On the basis of this information, a table of recommended separation distances of AN and blasting agents from explosives or blasting agents has been developed (See Table 9.4.2.210 of NFPA 495). However, the table is only valid for AN and AN-based materials that are NOT DOT Hazard Class 1 sensitive. The table is only applicable to materials that show positive results in the UN Test Series 1 sensitivity and thermal stability tests and negative results in the UN Test Series 2 gap tests. Products that show positive results when tested in the UN Test Series 1 and 2 tests would possibly be classified as having a hazards explosion hazard. NFPA 495 requires that Hazard Class 1 materials be stored in accordance with the requirements for high explosives (Division 1.1) under the quantity-distance requirements of the American Table of Distances (ATD) developed by the Institute of Makers of Explosives (IME) and published in NFPA 495.

The maximum quantity of material indicated by the ATD are limited to quantities less than what might be found on sites where large amounts of AN or AN mixtures might be found. The Department of Defense Explosives Safety Board (DODESB) currently uses software called SAFER along with tables of distance methods to assess DOD potential explosion sites. The IME, in collaboration with the DODESB, APT Research, and Canadian and U.S. regulatory agencies, has developed a software called IME/SAFR. The software incorporates risk-based methodology to address the impact of siting for explosives and explosive operations. Provisions for AN are included using an approach and distance based on TNT equivalency.

While blasting agents should not be confused with fertilizer products, extreme care should be taken to ensure that stored AN does not become sensitized by intimate mixing with carbonaceous, organic, or combustible material.

E.2 Suggested Fire-Fighting Procedure.

For more information, please refer to the National Fire Protection Association Report.
Table: "Emergency Action Plan" in all directions.

Prohibitions should be made to avoid the following conditions with ammonium nitrate:

- Heating in a confined area
- Localization heating potentially leading to development of high-temperature areas
- Exposure to shock waves
- Contamination that can result in sensitivity to explosion
- Low pH or acidic conditions

Guidance for storage can be found in the following references:


Test data on AN are included in the following:


Committee Statement:

Committee Statement: See attached revision of Annex E.

To be submitted later.

Public Comment No. 47-NFPA 400-2014 (Section No. E.2.1)

Public Comment No. 48-NFPA 400-2014 (Section No. E.2.2)

Public Comment No. 49-NFPA 400-2014 (Sections E.2.2, E.2.3)
Annex E  Properties and Uses of Ammonium Nitrate and Fire-Fighting Procedures

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

E.1 Ammonium nitrate (AN, NH₄NO₃, CAS 6484-52-2) is used, handled, and stored in solid and liquid forms in various concentrations (see Table below). It is commercially produced by reacting nitric acid with ammonia and evaporating the resultant solution of ammonium nitrate (AN) to make a concentrated ammonium nitrate melt, which is then spray granulated in a prilling tower or pelletized or flaked by some other means. Prill form ammonium nitrate is used in industrial applications including explosives for mining and in agricultural applications as fertilizer. Solid and liquid Ammonium ammonium Nitrate nitrate can be used undiluted or in mixtures. Pure AN is stable; however, under certain conditions, Ammonium ammonium nitrate nitrate can become explosive. Ammonium nitrate in the undiluted or pure form has a higher degree of overall hazard than does ammonium nitrate when mixed or blended with materials that can reduce the concentration. Contamination must be avoided so that an unstable, unintentional mixture does not result.

Most solid, liquid, and gaseous nitrates are oxidizers. Ammonium nitrate is an oxidizer. Ammonium nitrate is classed as an oxidizer by the U.S. Department of Transportation (DOT) and Pipeline and Hazardous Materials Safety Administration (PHMSA). Pure ammonium nitrate melts and meets the definition of an oxidizer that is not combustible in and of itself but accelerates the burning of combustible materials with which it comes into contact. The burning rate of technical-grade ammonium nitrate prill falls within the Class 2 oxidizer criteria in Annex G. The loss history of ammonium nitrate also indicates potential for unstable reactive hazard properties, uncontrolled decomposition, and/or detonation if subject to one or more of the following conditions:

1. Fire
2. Heating in a confined space
3. Localized heating potentially leading to development of high-temperature areas
4. Exposure to strong shock waves
5. Contamination with combustible materials, incompatible inorganic and organic substances that can result in sensitivity to explosion. (See 11.2.14.1.1 for examples)
6. Low pH or acidic conditions
Ammonium nitrate melts at approximately 338°F (170°C). Temperatures between 374°F (190°C) and 446°F (230°C) are considered sufficient to initiate self-sustained decomposition.

The requirements in Chapter 11 are intended to protect AN as an oxidizer with multiple physical hazards and to prevent AN from exhibiting unstable reactive physical hazard properties. With code compliance and proper precautions against fire and explosion, ammonium nitrate can be stored safely.

The physical hazards of pure ammonium nitrate are: capable of detonation with reported TNT equivalence between 25% and 45% percent, accelerated burning of combustibles, and self-sustaining decomposition. The health hazards of ammonium nitrate are toxic gaseous products of decomposition and fire off-gases: oxygen, ammonia, nitric acid, and nitrous oxide.

Factors influencing the risk of detonation of AN are the following:

1. Heating under confinement permitting high-pressure buildup
2. Strong shocks, such as those from an explosive

The sensitivity of ammonium nitrate to detonation increases with contamination and elevated temperatures. The likelihood of an explosion in a typical warehouse fire is determined where ammonium nitrate is stored, increases under the following conditions:

1. If molten AN can accumulate in large pools,
2. If there is potential for confinement of molten AN, such as in drains, pits, sumps, sewers, or dead spaces in equipment,
3. If there is potential for physical shock of the molten ammonium nitrate, such as high-velocity projectiles generated in a fire,
4. If the AN is or becomes contaminated before or during a fire,
5. If the temperature is in excess of 55°F (290°C) at atmospheric pressure and adiabatic conditions,

Although ammonium nitrate can be contaminated before a fire, it can also become contaminated during a fire. Potential sources of contamination from the fire can include carbon black (creosote, asphalt and soot), charcoal from combustible materials (wood, paper, pallets, organics, etc.), spilled diesel fuel, oils, plastics, polyethylene (from bags, etc.), aluminum, and copper.

Ammonium nitrate as an oxidizer can support combustion even in the absence of atmospheric oxygen, such as in poorly ventilated structures. Molten ammonium nitrate is a powerful oxidizer capable of igniting some combustible materials with which it comes in contact and of reacting explosively with organic materials and finely divided metals. Ammonium nitrate can undergo self-sustaining decomposition when exposed to elevated temperatures including exposure to fire. The rate of self-sustained decomposition can be increased by contamination. Contamination by carbon black, charcoal, finely divided metals (copper, iron, etc.), sulfur, or potash, which liberates chlorine as it decomposes, may catalyze the decomposition mechanism into a self-sustaining, internal exothermic reaction that will spread within a fertilizer pile creating a zone of decomposition. This reaction may continue and spread through the entire fertilizer mass, even after the actual fire is suppressed.

Ammonium nitrate can undergo self-sustained decomposition when stored safely and proper precautions against fire and explosion are taken. The sensitivity of ammonium nitrate to detonation increases with contamination and elevated temperatures.

Despite its potential hazards, ammonium nitrate is widely used in various industries due to its flammability characteristics. It is important for individuals handling or storing ammonium nitrate to be aware of these risks and follow proper safety procedures.
for some mixtures and contaminated ammonium nitrate; however, some mixtures of ammonium nitrate fertilizer can undergo self-sustained decomposition at lower temperatures. A self-sustained decomposition cannot be controlled by smothering.

Typical solid and liquid ammonium nitrate products are listed in Table E.1.

Table E.1—Typical solid and liquid ammonium nitrate products

<table>
<thead>
<tr>
<th>Composition</th>
<th>Common description</th>
<th>AN content</th>
<th>Typical Nitrogen (N) content</th>
<th>Combustible Material (maximum)</th>
<th>UN No. (Division)</th>
</tr>
</thead>
<tbody>
<tr>
<td>AN (high-density prill)</td>
<td>Fertilizer grade</td>
<td>&gt; 99%</td>
<td>34%</td>
<td>0.2%</td>
<td>1942 (5.1)</td>
</tr>
<tr>
<td>AN (low-density prill)</td>
<td>Industrial grade</td>
<td>&gt; 99%</td>
<td>34%</td>
<td>0.2%</td>
<td>1942 (5.1)</td>
</tr>
<tr>
<td>AN-based NPK capable of SSD</td>
<td>Compound fertilizers</td>
<td>45—70%</td>
<td>16—25%</td>
<td>0.4%</td>
<td>2071 (9)</td>
</tr>
<tr>
<td>(note 1)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AN-based NPK capable of SSD</td>
<td>Compound fertilizers</td>
<td>0—45%</td>
<td>&lt; 16%</td>
<td>unrestricted</td>
<td>2071 (9)</td>
</tr>
<tr>
<td>(note 1)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AN-based NPK not capable of SSD</td>
<td>Compound fertilizers</td>
<td>45—70%</td>
<td>16—25%</td>
<td>0.4%</td>
<td>1942 (5.1)</td>
</tr>
<tr>
<td>(note 1)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AN-based NPK not capable of SSD</td>
<td>Compound fertilizers</td>
<td>0—45%</td>
<td>&lt; 16%</td>
<td>unrestricted</td>
<td>N/A</td>
</tr>
<tr>
<td>(note 1)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AN liquid – hot concentrated solution</td>
<td></td>
<td>≥ 80%</td>
<td>≥ 28%</td>
<td>N/A</td>
<td>2426 (5.1)</td>
</tr>
<tr>
<td>AN liquid</td>
<td></td>
<td>&lt; 80%</td>
<td>&lt; 28%</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>

Notes:
[1] Some compound (NPK or NK) fertilizers can exhibit the self-sustaining decomposition (SSD) property by the UN Trough Test S.1. Where not capable of SSD, the oxidizing classification (i.e., Division 5.1), may take precedence.
[2] N=Nitrogen, P=phosphorus, K=Potassium, N/A=Not Applicable
Ammonium nitrate is commonly blended with other fertilizer materials, such as diammonium phosphate, sulfate, and potash. Fertilizers containing less than 60 percent ammonium nitrate are not covered by this Code. Fertilizer materials that contain ammonium nitrate are commonly described, not by their chemical composition, but by their plant nutrient (N-P-K) values. For example, agricultural grade ammonium nitrate will appear in the marketplace with a guaranteed nitrogen content of 34-0-0. This means there is a guaranteed analysis of 34 percent total nitrogen, with 0 percent phosphate and 0 percent potassium. The theoretical maximum nitrogen content of pure or 100 percent ammonium nitrate is 35 percent by weight. The typical nitrogen content of ammonium nitrate fertilizers offered in the marketplace is usually between 28 and 34 percent. Other nutrients such as sulfates or phosphates, added hardening agents, coating agents, and residual water make up the balance.

If the total available nitrogen in an ammonium nitrate-based fertilizer comes from ammonium nitrate, the percentage of ammonium nitrate can be determined through the use of the following formula:

\[
\text{\% ammonium nitrate} = \left( \frac{\text{\% total nitrogen listed in the fertilizer}}{0.35} \right) \tag{Eq. E.1}
\]

For example, a fertilizer is indicated as being 30-0-0, then it contains \((30/0.35) = 85.7\%\) ammonium nitrate.

However, when some, but not all, of the nitrogen could come from other nitrogen compounds in the mixture, the percentage of nitrogen for each component containing nitrogen in the fertilizer mixture must first be determined. For example, a fertilizer product described as 28-0-0-5(S) has a guaranteed analysis of 28 percent total nitrogen, 0 percent phosphate, 0 percent potassium, and 5 percent sulfur. Whether the nitrogen is derived from ammonium nitrate or another nitrogen fertilizer source, it must be disclosed by the manufacturer in order to determine the hazard classification of the material. This type of information is usually found on the SDS provided by the manufacturer where the names of the material included in the mixture along with the concentration of each material. It is not unusual for a range of concentrations to be given on an SDS, and users are cautioned to assume the ammonium nitrate concentration to be at the top of the range.

By use of Equation 1, ammonium nitrate fertilizers with a nitrogen content of less than 21 percent by weight derived from ammonium nitrate (60 percent ammonium nitrate) are not regulated by Chapter 11 (e.g., \((21/0.35) = 60\%\) ammonium nitrate).

For interstate shipments, the U.S. Department of Transportation classifies ammonium nitrate with not more than 0.2 percent total combustible material, including any organic substance, calculated as carbon to the exclusion of any other added substance, as an oxidizer Division 5.1. Ammonium nitrate with more than 0.2 percent combustible substances, including any organic substance calculated as carbon to the exclusion of any other added substance, as a Division 1.1D material. Ammonium nitrate based fertilizers may be classified as an oxidizer Division 5.1, or in some cases as a Division 9 material (Miscellaneous hazardous material). (See U.S. DOT Transportation Regulations 49 CFR 172.101.)
The requirements for classification of ammonium nitrate as a Division 5.1 oxidizer by the Department of Transportation (DOT) are described in the United Nations publication, *Recommendations on the Transport of Dangerous Goods, Model Regulations*, 14th revised edition, 2005. Such oxidizing materials can yield oxygen upon decomposition under fire conditions and will, therefore, under proper conditions of mixing, vigorously support combustion if involved in a fire with combustible materials.

Ammonium nitrate in higher concentrations is capable of undergoing detonation with about half the blast effect of explosives, if heated under confinement that permits high-pressure buildup, or if subjected to strong shocks, such as those from an explosive. The sensitivity of ammonium nitrate to detonation increases at elevated temperatures. Additional information on the explosive nature of ammonium nitrate, including the degree of confinement along with the effect of certain inert diluents, such as chalk, limestone, dolomite, etc., can be found in U.S. Bureau of Mines Report of Investigations 4994, *Investigations on the Explosibility of Ammonium Nitrate*, August 1953.

Industrial use of ammonium nitrate extends to use as an ingredient in blasting agents. When a carbonaceous or organic substance such as fuel (or diesel) oil, nut hulls, or carbon black is added and mixed in with ammonium nitrate, the mixture could become a blasting agent. A blasting agent as defined by NFPA 495, *Explosive Materials Code*, is a material or mixture that meets the requirements of the DOT “Hazardous Material Regulations,” as set forth in 49 CFR Parts 173.56, 173.57, and 173.58, Explosive 1.5D.

Test data on ammonium nitrate are included in the U.S. Bureau of Mines Report of Investigations 6746, *Sympathetic Detonation of Ammonium Nitrate and Ammonium Nitrate Fuel Oil*: Report of Investigations 6903, *Further Studies on Sympathetic Detonation*; and Report of Investigations 6773, *Explosion Hazards of Ammonium Nitrate Under Fire Exposure*. On the basis of these reports, a table of recommended separation distances of Ammonium ammonium nitrate and Blasting agents from Explosives explosives or Blasting agents has been developed (See Table 9.4.2.2(b) of NFPA 495). However, the table is only valid for ammonium nitrate and ammonium-nitrate–based materials that are NOT DOT Hazard Class 1 sensitive. The table is only applicable to materials that show positive results in the UN Test Series 1 sensitivity and thermal stability tests and negative results in the UN Test Series 2 Gap tests. Products that show positive results when tested in the UN Test Series 1 and 2 tests could potentially be classified as having a mass explosion hazard. NFPA 495 requires that Hazard Class 1 materials be stored in accordance with the requirements for high explosives (Division 1.1) under the quantity-distance requirements of the American Table of Distances (ATD) developed by the Institute of Makers of Explosives (IME) and published in NFPA 495.

The maximum quantities of material indicated by the ATD are limited to quantities less than what may be found on sites where large amounts of ammonium nitrate or ammonium nitrate mixtures may be found. The Department of Defense Explosives Safety Board (DODESB) currently uses software called SAFER along with tables of distance methods to assess DOD potential explosives sites. The IME, in collaboration with the DODESB, APT Research, and Canadian and U.S. regulatory agencies, has developed a software called IMESAFR. The software incorporates risk-based methodology to address the impact of
siting for explosives and explosive operations. Provisions for ammonium nitrate are included using an approach and distances based on TNT equivalency.

While blasting agents should not be confused with fertilizer products, extreme care should be taken to ensure that stored ammonium nitrate does not become sensitized by intimate mixing with carbonaceous, organic, or combustible material.

**E.2 Suggested Fire Fighting Procedures**

Pre-incident planning by the fire department and/or emergency management officials should be developed for every ammonium nitrate storage facility and include when to evacuate. The pre-incident planning and emergency response should account for toxic ammonium nitrate gaseous products of decomposition, fire effluents, and potential for explosions. Pre-incident plans should account for emission of toxic gases from fires involving ammonium nitrate and plume traveling depending on wind direction.

Only incipient fires in an area where ammonium nitrate is stored or in vehicles transporting ammonium nitrate should be attacked using manual fire extinguishing methods (fire extinguishers, hose streams, etc.) that require a human operator. Firefighters, emergency responders, and/or facility personnel should withdraw to a safe distance and allow structure or vehicle to burn to completion if a fire in an area where ammonium nitrate is stored or in vehicles transporting ammonium nitrate progresses beyond the incipient stage or should a fire break out in an area where ammonium nitrate is stored, or in a vehicle transporting ammonium nitrate. When evacuation is deemed necessary, fire-fighting personnel should immediately evacuate the area within 1 mile (1609 m) (or as determined by the Emergency Action Plan) in all directions.

Water is the only satisfactory extinguishing material for fires involving ammonium nitrate. It is important that the mass be kept cool and the burning be promptly extinguished. Large volumes of water should be applied as quickly as possible. This is best accomplished by automatic fire extinguishing systems and not the use of manual suppression means (fire hoses, master streams, etc.) that require firefighter actions. Normally, ventilation and the application of water, including automatic sprinklers, can quickly desensitize and stabilize the hot ammonium nitrate material. Firewater should be contained and prevented from leaving the site and entering streams, lakes, and rivers.

After extinguishment of the fire, the loose and contaminated unsalvageable ammonium nitrate should be disposed of according to federal, state, and local environmental agencies’ acceptable practices or regulations. Any residue that cannot be removed by sweeping should be washed away; contaminated water from flushing must be disposed of. Flushing and scrubbing of all areas should be very thorough to ensure the dissolving of all residue. Wet empty bags should be removed, and disposed of in accordance with federal, state, and local regulations.

Remediation of a site involving ammonium nitrate should be conducted by someone trained on the hazards of ammonium nitrate and a HAZMAT technician-level responder or qualified third-party responder. Any contaminated material should be properly disposed of by dilution. Any wood exposed to ammonium nitrate should be properly disposed. Any porous material
should be treated with special care because of the potential to re-ignite after the material has dried. Metal surfaces in contact with the residues of ammonium nitrate should be thoroughly cleaned with water to prevent corrosion.

E.3 (Ammonium Nitrate Resources)

References that discuss the production of ammonium nitrate include *Nitric Acid and Fertilizer Nitrates* and *The Fertilizer Manual*.

Guidance for storage can be found in the following references:

1. EPA OSHA ATF Chemical Advisory: Safe Storage, Handling and Management of Ammonium Nitrate (EPA 550-S-13-001, August 2013)
2. European Fertilizers Manufacturers Association Guidance for the Storage, Handling and Transportation of Solid Mineral Fertilizers (www.efma.org)

Test data on ammonium nitrate are included in the following:

2. European Fertilizers Manufacturers Association Guidance for the Storage, Handling and Transportation of Solid Mineral Fertilizers (www.efma.org)

The assignment of the organic peroxide formulation classifications shown in the tables in this annex are based on the container sizes shown. A change in the container size could affect the classification. The information in this annex was collected from the Organic Peroxides Producers (Society of the Plastics Industry-Organic Peroxide Producers Safety Division).

For an alphabetical listing of typical organic peroxide formulations, see Table F.1.

### Table F.1: Organic Peroxide Formulations

<table>
<thead>
<tr>
<th>Organic Peroxide Formulation</th>
<th>Concentration</th>
<th>Diluent</th>
<th>Water</th>
<th>Control</th>
<th>Emergency</th>
<th>Recommended Maximum Temperatures</th>
<th>Hazard Identification-NFPA 704 Ratings</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Control</strong></td>
<td><strong>Emergency</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>100</td>
<td>50</td>
<td></td>
<td></td>
<td>1</td>
<td>3</td>
<td>II</td>
<td>50 lb</td>
</tr>
<tr>
<td>250</td>
<td>125</td>
<td></td>
<td></td>
<td>1</td>
<td>3</td>
<td>II</td>
<td>25 lb</td>
</tr>
<tr>
<td>500</td>
<td>250</td>
<td></td>
<td></td>
<td>1</td>
<td>3</td>
<td>II</td>
<td>50 lb</td>
</tr>
<tr>
<td>750</td>
<td>375</td>
<td></td>
<td></td>
<td>1</td>
<td>3</td>
<td>II</td>
<td>75 lb</td>
</tr>
<tr>
<td>1,000</td>
<td>500</td>
<td></td>
<td></td>
<td>1</td>
<td>3</td>
<td>II</td>
<td>100 lb</td>
</tr>
<tr>
<td>1,500</td>
<td>750</td>
<td></td>
<td></td>
<td>1</td>
<td>3</td>
<td>II</td>
<td>150 lb</td>
</tr>
<tr>
<td>2,000</td>
<td>1,000</td>
<td></td>
<td></td>
<td>1</td>
<td>3</td>
<td>II</td>
<td>200 lb</td>
</tr>
<tr>
<td>2,500</td>
<td>1,250</td>
<td></td>
<td></td>
<td>1</td>
<td>3</td>
<td>II</td>
<td>250 lb</td>
</tr>
<tr>
<td>3,000</td>
<td>1,500</td>
<td></td>
<td></td>
<td>1</td>
<td>3</td>
<td>II</td>
<td>300 lb</td>
</tr>
<tr>
<td>3,500</td>
<td>1,750</td>
<td></td>
<td></td>
<td>1</td>
<td>3</td>
<td>II</td>
<td>350 lb</td>
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<tr>
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<td></td>
<td>1</td>
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<td>3</td>
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<td></td>
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<tr>
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<td>5,000</td>
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<td>1</td>
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*For a complete list of organic peroxide formulations, see Table F.1.*
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<th>Concentration</th>
<th>Diluent</th>
<th>Water</th>
<th>TC</th>
<th>SC</th>
<th>HD</th>
<th>FL</th>
<th>Rm</th>
<th>Storage Class</th>
<th>Max Container Size</th>
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<td>≤ 6.2 as a paste</td>
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<td></td>
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<td></td>
<td></td>
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<td>200 kg</td>
</tr>
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<td></td>
<td></td>
<td></td>
<td>200 kg</td>
</tr>
<tr>
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<td>Recommended Maximum Temperature</td>
<td>Hazard Identification NFPA 704 Ratings</td>
<td>Control</td>
<td>Emergency</td>
<td></td>
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<tr>
<td></td>
<td>Class</td>
<td>Class</td>
<td>NE</td>
<td>3</td>
<td>II</td>
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<tr>
<td></td>
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<td>Capacity</td>
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</table>

**Organic Peroxide Formulation**

<p>| Concentration | Diluent  | Water | C/F | C/F | Health | Flammability | Instability | Storage Class | Container Size | Max Capacity |
|---------------|----------|-------|-----|-----|--------|--------------|-------------|---------------|----------------|---------------|--------------|
| ACETYL ACETONE PEROXIDE | ≤ 42%    | 42    | A | 0.15 | 2 | 2 | 2 | II | 16 gal (60 L) | 110 lb (50 kg) |
| ACETYL ACETONE PEROXIDE | ≤ 32%    | 32    | as paste | 2 | NE | 2 | 3 | III | 16 gal (60 L) | 110 lb (50 kg) |
| ACETYL CYCLOHEXANESULPHONYL PEROXIDE | ≤ 82 | 82 | B | 12 | 10/14 | 0.02 | 3 | NE | 4 | 16 gal (60 L) | 55 lb (25 kg) |
| ACETYL CYCLOHEXANESULPHONYL PEROXIDE | ≤ 32 | 32 | B | 0.68 | 10/14 | 0.02 | 3 | 4 | 3 | 16 gal (60 L) | 110 lb (50 kg) |
| J. AMYL HYDROPEROXIDE | ≤ 62 | 62 | A | 0.8 | 2 | 2 | 2 | 1 | 16 gal (60 L) | 60 gal (225 L) |
| J. AMYL PEROXYACETATE | ≤ 62 | 62 | A | 0.38 | 2 | 2 | 2 | 1 | 16 gal (60 L) | 60 gal (225 L) |
| J. AMYL PEROXOXYBENZONATE | ≤ 100 | 100 | 2 | 2 | 2 | 2 | 1 | 16 gal (60 L) | 60 gal (225 L) |
| J. AMYL PEROXY-2,4-ETHYLHEXANATE | ≤ 100 | 100 | 225 gal (1000 L) | 2 | 2 | 2 | 1 | 16 gal (60 L) | 60 gal (225 L) |
| J. AMYL PEROXY-2,4-ETHYLHEXYL CARBONATE | ≤ 100 | 100 | 2 | 2 | 2 | 2 | 1 | 16 gal (60 L) | 60 gal (225 L) |
| J. AMYL PEROXY-2,4-ETHYLHEXYL CARBONATE | ≤ 100 | 100 | 2 | 2 | 2 | 2 | 1 | 16 gal (60 L) | 60 gal (225 L) |
| J. AMYL PEROXY-2,4-ETHYLHEXYL CARBONATE | ≤ 100 | 100 | 2 | 2 | 2 | 2 | 1 | 16 gal (60 L) | 60 gal (225 L) |
| J. AMYL PEROXY-2,4-ETHYLHEXYL CARBONATE | ≤ 100 | 100 | 2 | 2 | 2 | 2 | 1 | 16 gal (60 L) | 60 gal (225 L) |
| J. AMYL PEROXY-2,4-ETHYLHEXYL CARBONATE | ≤ 100 | 100 | 2 | 2 | 2 | 2 | 1 | 16 gal (60 L) | 60 gal (225 L) |
| J. AMYL PEROXY-2,4-ETHYLHEXYL CARBONATE | ≤ 100 | 100 | 2 | 2 | 2 | 2 | 1 | 16 gal (60 L) | 60 gal (225 L) |
| J. AMYL PEROXY-2,4-ETHYLHEXYL CARBONATE | ≤ 100 | 100 | 2 | 2 | 2 | 2 | 1 | 16 gal (60 L) | 60 gal (225 L) |
| J. AMYL PEROXY-2,4-ETHYLHEXYL CARBONATE | ≤ 100 | 100 | 2 | 2 | 2 | 2 | 1 | 16 gal (60 L) | 60 gal (225 L) |</p>
<table>
<thead>
<tr>
<th>Organic Peroxide Formulation</th>
<th>Concentration</th>
<th>Diluent</th>
<th>Water</th>
<th>C/F</th>
<th>C/F</th>
<th>Health</th>
<th>Flammability</th>
<th>Instability</th>
<th>Storage Class</th>
<th>Container Size</th>
<th>Max. Container Size</th>
<th>Subsidiary Risks and Remarks</th>
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<td>2</td>
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<td>III</td>
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<td>10/90</td>
<td>15/99</td>
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<td>III</td>
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<tr>
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<td>II</td>
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<td>III</td>
<td>IBC tank</td>
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<td>II</td>
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<td></td>
<td>IBC tank</td>
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<td>IBC tank</td>
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<td>30/99</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>II</td>
<td>IBC tank</td>
<td>440 lb (200 kg)</td>
<td>16 gal (60)</td>
<td></td>
</tr>
<tr>
<td>1-BUTYL PEROX2-1,2-ETHYLENANOATE</td>
<td>≤ 32</td>
<td>Inert solid</td>
<td>48</td>
<td></td>
<td>1</td>
<td>NE</td>
<td>2</td>
<td>II</td>
<td>IBC tank</td>
<td>440 lb (200 kg)</td>
<td>16 gal (60)</td>
<td></td>
</tr>
<tr>
<td>1-BUTYL PEROX2-1,2-ETHYLENANOATE</td>
<td>≤ 32</td>
<td>B ≥ 68</td>
<td>40/104</td>
<td>40/133</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>III</td>
<td>IBC tank</td>
<td>440 lb (200 kg)</td>
<td>16 gal (60)</td>
<td></td>
</tr>
<tr>
<td>1-BUTYL PEROX2-1,2-ETHYLENANOATE + 2,2-DI-(1 : BUTYLPEROXYBUTANE</td>
<td>≤ 12 ≤ 14</td>
<td></td>
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<td></td>
<td></td>
<td>IBC tank</td>
<td>440 lb (200 kg)</td>
<td>16 gal (60)</td>
<td></td>
</tr>
<tr>
<td>1-BUTYL PEROX2-1,2-ETHYLENANOATE + 2,2-DI-(1 : BUTYLPEROXYBUTANE</td>
<td>≤ 31 ≤ 36</td>
<td>B ≥ 33</td>
<td>30/99</td>
<td>30/104</td>
<td>1</td>
<td>NE</td>
<td>2</td>
<td>II</td>
<td>IBC tank</td>
<td>440 lb (200 kg)</td>
<td>16 gal (60)</td>
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<tr>
<td>1-BUTYL PEROXYETHYLXCARBONATE</td>
<td>≤ 100</td>
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<td>IBC tank</td>
<td>440 lb (200 kg)</td>
<td>16 gal (60)</td>
<td></td>
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<tr>
<td>1-BUTYL PEROXYISOBUTYRATE</td>
<td>≤ 52 – 77</td>
<td>B ≥ 23</td>
<td>15/99</td>
<td>20/98</td>
<td>1</td>
<td>2</td>
<td>4</td>
<td>II</td>
<td>IBC tank</td>
<td>440 lb (200 kg)</td>
<td>16 gal (60)</td>
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</tr>
<tr>
<td>1-BUTYL PEROXYISOBUTYRATE</td>
<td>≤ 52</td>
<td>B ≥ 48</td>
<td>15/99</td>
<td>20/98</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td>II</td>
<td>IBC tank</td>
<td>440 lb (200 kg)</td>
<td>16 gal (60)</td>
<td></td>
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<tr>
<td>1-BUTYL PEROXISOBUTYRATE</td>
<td>≤ 52</td>
<td>A ≥ 23</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>IBC tank</td>
<td>440 lb (200 kg)</td>
<td>16 gal (60)</td>
<td></td>
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<tr>
<td>1-BUTYL PEROXYISOBUTYRATE</td>
<td>≤ 52</td>
<td>Inert solid</td>
<td>48</td>
<td></td>
<td>3</td>
<td>NE</td>
<td>2</td>
<td>II</td>
<td>IBC tank</td>
<td>440 lb (200 kg)</td>
<td>16 gal (60)</td>
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<tr>
<td>1-BUTYL PEROX2-METHYLBENZOATE</td>
<td>≤ 100</td>
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<td></td>
<td>IBC tank</td>
<td>440 lb (200 kg)</td>
<td>16 gal (60)</td>
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<tr>
<td>Organic Peroxide Formulation</td>
<td>Concentration</td>
<td>Diluent</td>
<td>Water</td>
<td>C/F</td>
<td>C/F</td>
<td>Health</td>
<td>Flammability</td>
<td>Instability</td>
<td>Storage Class</td>
<td>Max. Container Size</td>
<td>Remarks</td>
<td></td>
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<tr>
<td>BUTYL PEROXYDECANOATE</td>
<td>&gt; 77 – 100</td>
<td>NE</td>
<td>NE</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>NE</td>
<td>I</td>
<td>16 gal (60 L)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BUTYL PEROXYDECANOATE</td>
<td>77</td>
<td>B ≥ 23</td>
<td>NE</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>NE</td>
<td>IV</td>
<td>440 lb (200 kg)</td>
<td>IBC tank</td>
<td></td>
</tr>
<tr>
<td>BUTYL PEROXYDECANOATE</td>
<td>&lt; 42 as a stable dispersion in water</td>
<td>0.32</td>
<td>10/50</td>
<td>NE</td>
<td>1</td>
<td>IV</td>
<td>IBC tank</td>
<td>16 gal (60 L)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BUTYL PEROXYHEPTANOATE</td>
<td>3</td>
<td>B ≥ 68</td>
<td>0.32</td>
<td>10/50</td>
<td>NE</td>
<td>2</td>
<td>IV</td>
<td>IBC tank</td>
<td>16 gal (60 L)</td>
<td></td>
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</tr>
<tr>
<td>BUTYL PEROXYHEPTANOATE</td>
<td>77</td>
<td>A ≥ 23</td>
<td>0.32</td>
<td>10/50</td>
<td>1</td>
<td>2</td>
<td>IV</td>
<td>IBC tank</td>
<td>16 gal (60 L)</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>BUTYL PEROXYHEPTANOATE</td>
<td>67 – 77</td>
<td>A ≥ 23</td>
<td>0.32</td>
<td>10/50</td>
<td>2</td>
<td>2</td>
<td>IV</td>
<td>IBC tank</td>
<td>16 gal (60 L)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BUTYL PEROXYHEPTANOATE</td>
<td>27 – 77</td>
<td>B ≥ 33</td>
<td>0.32</td>
<td>10/50</td>
<td>2</td>
<td>2</td>
<td>IV</td>
<td>IBC tank</td>
<td>16 gal (60 L)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BUTYL PEROXYHEPTANOATE</td>
<td>27</td>
<td>B ≥ 73</td>
<td>0.26</td>
<td>10/50</td>
<td>2</td>
<td>2</td>
<td>IV</td>
<td>IBC tank</td>
<td>16 gal (60 L)</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>BUTYL PEROXYHEPTANOATE</td>
<td>100</td>
<td>NE</td>
<td>NE</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>NE</td>
<td>I</td>
<td>110 lb (50 kg)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BUTYL PEROXO-3,5,5-TRIMETHYLHETANOATE</td>
<td>&gt; 32 – 100</td>
<td>Inert solid</td>
<td>0.58</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>IBC tank</td>
<td>110 lb (50 kg)</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>BUTYL PEROXO-3,5,5-TRIMETHYLHETANOATE</td>
<td>&lt; 42</td>
<td>Inert solid</td>
<td>NE</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>IBC tank</td>
<td>110 lb (50 kg)</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>3-CHLOROPEROXYBENZONIC ACID</td>
<td>&gt; 57 – 86</td>
<td>Inert solid</td>
<td>NE</td>
<td>4</td>
<td>I</td>
<td>3</td>
<td>IBC tank</td>
<td>55 lb (25 kg)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3-CHLOROPEROXYBENZONIC ACID</td>
<td>&lt; 57</td>
<td>Inert solid</td>
<td>NE</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>IBC tank</td>
<td>110 lb (50 kg)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3-Chloroperoxybenzoic acid</td>
<td>3-CHLOROPEROXYBENZONIC ACID</td>
<td>0.32</td>
<td>B ≥ 68</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>IBC tank</td>
<td>110 lb (50 kg)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CUMYL HYDROPEROXIDE</td>
<td>&gt; 90 – 98</td>
<td>A ≥ 10</td>
<td>0.32</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>IBC tank</td>
<td>60 gal (225 L)</td>
<td>13</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CUMYL HYDROPEROXIDE</td>
<td>90</td>
<td>A ≥ 10</td>
<td>0.32</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>IBC tank</td>
<td>60 gal (225 L)</td>
<td>13, 18</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CUMYL HYDROPEROXIDE</td>
<td>87</td>
<td>A ≥ 13</td>
<td>-10/14</td>
<td>0.32</td>
<td>1</td>
<td>2</td>
<td>IBC tank</td>
<td>16 gal (60 L)</td>
<td>9</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CUMYL HYDROPEROXIDE</td>
<td>77</td>
<td>B ≥ 23</td>
<td>-10/14</td>
<td>0.32</td>
<td>1</td>
<td>2</td>
<td>IBC tank</td>
<td>16 gal (60 L)</td>
<td>9</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CUMYL HYDROPEROXIDE</td>
<td>&lt; 52 as a stable dispersion in water</td>
<td>-10/14</td>
<td>0.32</td>
<td>1</td>
<td>2</td>
<td>IBC tank</td>
<td>16 gal (60 L)</td>
<td>9</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CUMYL HYDROPEROXIDE</td>
<td>77</td>
<td>A ≥ 23</td>
<td>-10/14</td>
<td>0.32</td>
<td>1</td>
<td>2</td>
<td>IBC tank</td>
<td>16 gal (60 L)</td>
<td>9</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CUMYL HYDROPEROXIDE</td>
<td>77</td>
<td>B ≥ 23</td>
<td>-0.023</td>
<td>9/41</td>
<td>NE</td>
<td>3</td>
<td>IBC tank</td>
<td>16 gal (60 L)</td>
<td>9</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CYCLOHEXANONE PEROXIDE(S)</td>
<td>61</td>
<td>0.8</td>
<td>3</td>
<td>NE</td>
<td>2</td>
<td>I</td>
<td>5 as a paste</td>
<td>16 gal (60 L)</td>
<td>5, 20</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>CYCLOHEXANONE PEROXIDE(S)</td>
<td>72</td>
<td>B ≥ 28</td>
<td>3</td>
<td>NE</td>
<td>2</td>
<td>I</td>
<td>6</td>
<td>60 gal (225 L)</td>
<td>6</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>CYCLOHEXANONE PEROXIDE(S)</td>
<td>72 as a paste</td>
<td>3</td>
<td>NE</td>
<td>2</td>
<td>I</td>
<td>110 lb (50 kg)</td>
<td>5, 20</td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>CYCLOHEXANONE PEROXIDE(S)</td>
<td>32</td>
<td>Inert solid</td>
<td>0.68</td>
<td>3</td>
<td>NE</td>
<td>V</td>
<td>16 gal (60 L)</td>
<td>Exempt</td>
<td>29</td>
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<tr>
<td>DIACETONE ALCOHOL PEROXIDE</td>
<td>&gt; 57</td>
<td>B ≥ 26</td>
<td>0.8</td>
<td>40/104</td>
<td>49/113</td>
<td>NE</td>
<td>NE</td>
<td>IBC tank</td>
<td>16 gal (60 L)</td>
<td>6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DIACETYL PEROXIDE</td>
<td>27</td>
<td>B ≥ 73</td>
<td>20/68</td>
<td>25/77</td>
<td>1</td>
<td>2</td>
<td>I</td>
<td>60 gal (225 L)</td>
<td>7, 13</td>
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<tr>
<td>Di-AMYL PEROXIDE</td>
<td>&gt; 100</td>
<td>2</td>
<td>4</td>
<td>2</td>
<td>I</td>
<td>16 gal (60 L)</td>
<td></td>
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</tr>
<tr>
<td>2,2-DIHYDROAMYL PEROXIDE</td>
<td>&gt; 57</td>
<td>A ≥ 43</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td>I</td>
<td>16 gal (60 L)</td>
<td></td>
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<tr>
<td>1,1-DIHYDROAMYL PEROXIDE</td>
<td>&gt; 82</td>
<td>A ≥ 18</td>
<td>0.48</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>I</td>
<td>55 lb (25 kg)</td>
<td></td>
<td></td>
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<tr>
<td>DIBENZOYL PEROXIDE</td>
<td>&gt; 51 – 100</td>
<td>Inert solid</td>
<td>0.48</td>
<td>2</td>
<td>4</td>
<td>4</td>
<td>I</td>
<td>55 lb (25 kg)</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>DIBENZOYL PEROXIDE</td>
<td>&gt; 77 – 94</td>
<td>2</td>
<td>4</td>
<td>4</td>
<td>I</td>
<td>110 lb (50 kg)</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>DIBENZOYL PEROXIDE</td>
<td>77</td>
<td>B ≥ 23</td>
<td>0.25</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td></td>
<td>110 lb (50 kg)</td>
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<tr>
<td>Organic Peroxide Formulation</td>
<td>Concentration</td>
<td>Diluent</td>
<td>Water</td>
<td>G/F</td>
<td>C/F</td>
<td>Health</td>
<td>Flammability</td>
<td>Instability</td>
<td>Storage Class</td>
<td>Max. Container Size</td>
<td>Subsidiary Risk and Remarks</td>
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<td>-------------------------</td>
<td></td>
</tr>
<tr>
<td>DIBENZOYL PEROXIDE</td>
<td>&gt; 52 – 62 as a paste</td>
<td>Inert solid</td>
<td>T</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>II</td>
<td>110 lb (50 kg)</td>
<td>20</td>
<td></td>
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<tr>
<td>DIBENZOYL PEROXIDE</td>
<td>&gt; 35 – 52</td>
<td>Inert solid</td>
<td>T</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>II</td>
<td>440 lb (200 kg)</td>
<td>20</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DIBENZOYL PEROXIDE</td>
<td>&gt; 36 – 42</td>
<td>A ≥ 18</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>II</td>
<td>440 lb (200 kg)</td>
<td>20</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>DIBENZOYL PEROXIDE</td>
<td>≤ 56.5 as a paste</td>
<td>T</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>II</td>
<td>440 lb (200 kg)</td>
<td>20</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DIBENZOYL PEROXIDE</td>
<td>≤ 52 as a paste ≤ 42 as a stable dispersion in water</td>
<td>T</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>II</td>
<td>IBC tank</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DIBENZOYL PEROXIDE</td>
<td>≤ 35</td>
<td>Inert solid</td>
<td>T</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>II</td>
<td>110 lb (50 kg)</td>
<td>20</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DI-(4-(BUTYLCYCLOHEXYL)PEROXIDICARBONATE)</td>
<td>≤ 100</td>
<td>30/96 30/96</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>IV</td>
<td>IBC tank</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DI-(4-(BUTYLCYCLOHEXYL)PEROXIDICARBONATE)</td>
<td>≤ 42 as a stable dispersion in water</td>
<td>30/96 30/96</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>DI-(4-(BUTYL)PEROXIDE)</td>
<td>≤ 52</td>
<td>B ≥ 48</td>
<td>1</td>
<td>4</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>DI-(4-(BUTYL)PEROXIDE)</td>
<td>≤ 52</td>
<td>A ≥ 48</td>
<td>NE</td>
<td>2</td>
<td>2</td>
<td>II</td>
<td>IBC tank</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>2,2-DI-(BUTYL)PEROXIDE/3,3,5-TRIMETHYLCYCLOHEXANE</td>
<td>≤ 52</td>
<td>B ≥ 48</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>II</td>
<td>IBC tank</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>1,6-DI-(BUTYLPEROXYCARBONYLOXY)CYCLOHEXANE</td>
<td>≤ 72</td>
<td>A ≥ 28</td>
<td>NE</td>
<td>NE</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>1,1-DI-(BUTYLPEROXY)CYCLOHEXANE</td>
<td>≤ 80 – 100</td>
<td></td>
<td>1</td>
<td>2</td>
<td>4</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>1,1-DI-(BUTYLPEROXY)CYCLOHEXANE</td>
<td>≤ 72</td>
<td>B ≥ 28</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>II</td>
<td>LT**</td>
<td>16 gal (60 L)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1,1-DI-(BUTYLPEROXY)CYCLOHEXANE</td>
<td>≤ 52 – 80</td>
<td>A ≥ 20</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>II</td>
<td>LT**</td>
<td>16 gal (60 L)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1,1-DI-(BUTYLPEROXY)CYCLOHEXANE</td>
<td>≤ 52</td>
<td>A ≥ 48</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>II</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1,1-DI-(BUTYLPEROXY)CYCLOHEXANE</td>
<td>≤ 42</td>
<td>A ≥ 12</td>
<td>1</td>
<td>NE</td>
<td>2</td>
<td>III</td>
<td>LB</td>
<td>110 lb (50 kg)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1,1-DI-(BUTYLPEROXY)CYCLOHEXANE</td>
<td>≤ 42</td>
<td>A ≥ 58</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>III</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>1,1-DI-(BUTYLPEROXY)CYCLOHEXANE</td>
<td>≤ 27</td>
<td>A ≥ 25</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>III</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>1,1-DI-(BUTYLPEROXY)CYCLOHEXANE</td>
<td>≤ 13</td>
<td>A ≥ 13</td>
<td>L</td>
<td></td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>1,1-DI-(BUTYLPEROXY)CYCLOHEXANE</td>
<td>≤ 43 + ≤ 16</td>
<td>A ≥ 41</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>II</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>1,1-DI-(BUTYLPEROXY)CYCLOHEXANE</td>
<td>≤ 27</td>
<td>B ≥ 48</td>
<td>-15/5 -5/23</td>
<td>1</td>
<td>NE</td>
<td>2</td>
<td>IV</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1,1-DI-(BUTYLPEROXY)CYCLOHEXANE</td>
<td>≤ 27</td>
<td>B ≥ 73</td>
<td>-10/14 0/32</td>
<td>1</td>
<td>NE</td>
<td>2</td>
<td>III</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>1,1-DI-(BUTYLPEROXY)CYCLOHEXANE</td>
<td>≤ 52 – 100</td>
<td>B ≥ 48</td>
<td>-20/4 -10/14</td>
<td>1</td>
<td>4</td>
<td>3</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>1,1-DI-(BUTYLPEROXY)CYCLOHEXANE</td>
<td>≤ 52</td>
<td>B ≥ 48</td>
<td>-15/5 -5/23</td>
<td>1</td>
<td>4</td>
<td>3</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>1,1-DI-(BUTYLPEROXY)CYCLOHEXANE</td>
<td>≤ 42</td>
<td>A ≥ 41</td>
<td>Inert solid</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>II</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1,1-DI-(BUTYLPEROXY)CYCLOHEXANE</td>
<td>≤ 42</td>
<td>A ≥ 41</td>
<td>Inert solid</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>II</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1,1-DI-(BUTYLPEROXY)CYCLOHEXANE</td>
<td>≤ 42</td>
<td>A ≥ 48</td>
<td>Inert solid</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>II</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1,1-DI-(BUTYLPEROXY)CYCLOHEXANE</td>
<td>≤ 42</td>
<td>A ≥ 48</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>II</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2,2-DI-(BUTYLPEROXY)CYCLOHEXANE</td>
<td>≤ 42</td>
<td>A ≥ 45</td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>1,1-DI-(BUTYLPEROXY)3,3,5-TRIMETHYLCYCLOHEXANE</td>
<td>≤ 90</td>
<td>B ≥ 10</td>
<td>1</td>
<td>2</td>
<td>4</td>
<td>I</td>
<td>LT**</td>
<td>16 gal (60 L)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1,1-DI-(BUTYLPEROXY)3,3,5-TRIMETHYLCYCLOHEXANE</td>
<td>≤ 90</td>
<td>B ≥ 10</td>
<td>1</td>
<td>2</td>
<td>4</td>
<td>I</td>
<td>LT**</td>
<td>16 gal (60 L)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Organic Peroxide Formulation</td>
<td>Concentration</td>
<td>Diluent</td>
<td>Water</td>
<td>C/F</td>
<td>NFPA 704 Rating</td>
<td>Storage Class</td>
<td>Max. Container Size</td>
<td>Subsidiary Risks and Remarks</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td>-----------------------------</td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1,1-Di-(2-buty peroxy)3,3,5-trimethyl cyclohexane</td>
<td>&gt; 57 – 96</td>
<td>A ≥ 10</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>II</td>
<td>16 gal (60 kg)</td>
<td>Exempt</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1,1-Di-(2-buty peroxy)3,3,5-trimethyl cyclohexane</td>
<td>≥ 77</td>
<td>B ≥ 23</td>
<td>1</td>
<td>NE</td>
<td>2</td>
<td>II</td>
<td>16 gal (60 kg)</td>
<td>L1*</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1,1-Di-(2-buty peroxy)3,3,5-trimethyl cyclohexane</td>
<td>≥ 67</td>
<td>Inert solid</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>II</td>
<td>22 gal (82 kg)</td>
<td>L1*</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Diethyl peroxydicarbonate</td>
<td>≤ 100</td>
<td>≥ 42 as a stable dispersion in water</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>IV</td>
<td>IBC tank</td>
<td>55 lb (25 kg)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Di-4-chlorobenzoyl peroxide</td>
<td>≤ 77</td>
<td>≥ 23</td>
<td>NE</td>
<td>NE</td>
<td>4</td>
<td>II</td>
<td>110 lb (50 kg)</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Di-4-chlorobenzoyl peroxide</td>
<td>≤ 52 as a paste</td>
<td>NE</td>
<td>NE</td>
<td>2</td>
<td>II</td>
<td>110 lb (50 kg)</td>
<td>20</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Di-4-chlorobenzoyl peroxide</td>
<td>≤ 68</td>
<td>Inert solid</td>
<td>NE</td>
<td>NE</td>
<td>2</td>
<td>II</td>
<td>110 lb (50 kg)</td>
<td>20</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DICUMYL PEROXIDE</td>
<td>25 – 100</td>
<td>Inert solid</td>
<td>NE</td>
<td>NE</td>
<td>2</td>
<td>II</td>
<td>Exempt</td>
<td>29</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DICUMYL PEROXIDE</td>
<td>≤ 52</td>
<td>≤ 48</td>
<td>NE</td>
<td>NE</td>
<td>2</td>
<td>II</td>
<td>Exempt</td>
<td>29</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DICYCLOHEXYL PEROXYDICARBONATE</td>
<td>≥ 91 – 100</td>
<td>10/50</td>
<td>15/59</td>
<td>NE</td>
<td>NE</td>
<td>4</td>
<td>II</td>
<td>110 lb (50 kg)</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DICYCLOHEXYL PEROXYDICARBONATE</td>
<td>≥ 39</td>
<td>≥ 9</td>
<td>10/50</td>
<td>15/59</td>
<td>NE</td>
<td>NE</td>
<td>2</td>
<td>II</td>
<td>110 lb (50 kg)</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DICYCLOHEXYL PEROXYDICARBONATE</td>
<td>≤ 91</td>
<td>≥ 42 as a stable dispersion in water</td>
<td>15/59</td>
<td>20/58</td>
<td>NE</td>
<td>NE</td>
<td>2</td>
<td>II</td>
<td>110 lb (50 kg)</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DIECANOLYL PEROXIDE</td>
<td>≤ 100</td>
<td>≥ 42</td>
<td>Inert solid</td>
<td>1</td>
<td>NE</td>
<td>2</td>
<td>III</td>
<td>110 lb (50 kg)</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1,1-Di-(2-buty peroxy)cyclohexyl) propane</td>
<td>≤ 42</td>
<td>≥ 58</td>
<td>1</td>
<td>NE</td>
<td>2</td>
<td>III</td>
<td>110 lb (50 kg)</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1,1-Di-(2-buty peroxy)cyclohexyl) propane</td>
<td>≤ 22</td>
<td>B ≥ 78</td>
<td>1</td>
<td>NE</td>
<td>2</td>
<td>III</td>
<td>110 lb (50 kg)</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DI-2,4-DICHLOROBENZOYL PEROXIDE</td>
<td>≤ 77</td>
<td>≥ 23</td>
<td>1</td>
<td>NE</td>
<td>4</td>
<td>II</td>
<td>440 lb (200 kg)</td>
<td>3</td>
<td></td>
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</tr>
<tr>
<td>DI-2,4-DICHLOROBENZOYL PEROXIDE</td>
<td>≤ 52 as a paste</td>
<td>20/68</td>
<td>25/77</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>II</td>
<td>110 lb (50 kg)</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DI-2,4-DICHLOROBENZOYL PEROXIDE</td>
<td>≤ 52 as a paste with silicon oil</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>II</td>
<td>110 lb (50 kg)</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Di(2-ethylhexyl) peroxydicarbonate</td>
<td>≤ 52</td>
<td>B ≥ 48</td>
<td>10/14</td>
<td>0/32</td>
<td>NE</td>
<td>NE</td>
<td>2</td>
<td>II</td>
<td>16 gal (60 L)</td>
<td>L1*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Di(2-ethylhexyl) peroxydicarbonate</td>
<td>≤ 52</td>
<td>B ≥ 48</td>
<td>10/14</td>
<td>0/32</td>
<td>NE</td>
<td>NE</td>
<td>2</td>
<td>II</td>
<td>16 gal (60 L)</td>
<td>L1*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Di(2-ethylhexyl) peroxydicarbonate</td>
<td>≤ 62 as a stable dispersion in water</td>
<td>15/59</td>
<td>0/523</td>
<td>2</td>
<td>NE</td>
<td>2</td>
<td>II</td>
<td>IBC tank</td>
<td>55 lb (25 kg)</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Di(2-ethylhexyl) peroxydicarbonate</td>
<td>≤ 62 as a stable dispersion in water (frozen)</td>
<td>15/59</td>
<td>0/523</td>
<td>2</td>
<td>NE</td>
<td>2</td>
<td>II</td>
<td>IBC tank</td>
<td>55 lb (25 kg)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2,2-DIHYDROPEROXYPROPYNE</td>
<td>≤ 27</td>
<td>Inert solid</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>IV</td>
<td>IBC type</td>
<td>55 lb (25 kg)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DI-(1-hydroxy-cyclocyclohexyl) peroxyacrylate</td>
<td>≤ 100</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>II</td>
<td>110 lb (50 kg)</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DI-4-METHYL-2-PEROXYPERACETYL</td>
<td>≤ 32 – 52</td>
<td>B ≥ 48</td>
<td>20/4</td>
<td>10/14</td>
<td>3</td>
<td>4</td>
<td>4</td>
<td>III</td>
<td>16 gal (60 L)</td>
<td>L1*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DI-4-METHYL-2-PEROXYPERACETYL</td>
<td>≤ 32</td>
<td>B ≥ 68</td>
<td>20/4</td>
<td>10/14</td>
<td>3</td>
<td>4</td>
<td>4</td>
<td>III</td>
<td>16 gal (60 L)</td>
<td>L1*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DI-4-METHYL-2-PEROXYPERACETYL</td>
<td>≤ 28</td>
<td>A ≥ 72</td>
<td>15/59</td>
<td>0/523</td>
<td>2</td>
<td>NE</td>
<td>2</td>
<td>II</td>
<td>16 gal (60 L)</td>
<td>L1*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DIALAURYL PEROXIDE</td>
<td>≤ 100</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>II</td>
<td>110 lb (50 kg)</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Organic Peroxide Formulation</td>
<td>Concentration</td>
<td>Diluent</td>
<td>Water</td>
<td>Health</td>
<td>Flammability</td>
<td>Instability</td>
<td>Storage Class</td>
<td>Max. Container Size</td>
<td>Subsidiary Risks and Remarks</td>
<td></td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>D.I.AROYL PEROXIDE</td>
<td>72 – 100</td>
<td>L)**</td>
<td>NE</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>IBC tank</td>
<td>16 gal (60 L)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D.I.-METHOXYPERY)BUTYRATE</td>
<td>72 – 100</td>
<td>L)**</td>
<td>NE</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>IBC tank</td>
<td>16 gal (60 L)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D.I.-METHOXYPERY)BUTYRATE</td>
<td>72 – 100</td>
<td>L)**</td>
<td>NE</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>IBC tank</td>
<td>16 gal (60 L)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D.I.-METHOXYPERY)BUTYRATE</td>
<td>72 – 100</td>
<td>L)**</td>
<td>NE</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>IBC tank</td>
<td>16 gal (60 L)</td>
<td></td>
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<td>L)**</td>
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<td>IBC tank</td>
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<td>1</td>
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<td>L)**</td>
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<td>1</td>
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<td>L)**</td>
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<td>Concentration</td>
<td>Diluent</td>
<td>Water</td>
<td>C/F</td>
<td>C/F</td>
<td>Health</td>
<td>Flammability</td>
<td>Stability</td>
<td>Storage Class</td>
<td>Max. Container Size</td>
<td>Subsidiary</td>
<td>Remarks</td>
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<tr>
<td>ETHYL 3,3-DIL (1 - BUTYLPEROXYBUTYRATE</td>
<td>≤ 77</td>
<td>A ≥ 23</td>
<td></td>
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<td>2</td>
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<tr>
<td>ETHYL 3,3-DI(1 - BUTYLPEROXYBUTYRATE</td>
<td>≤ 52</td>
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<tr>
<td>1-3-DIMETHYLBUTYLPEROXYCIPAVATE</td>
<td>≤ 52</td>
<td>A ≥ 45: B</td>
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<td>16 gal (60)</td>
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<td></td>
</tr>
<tr>
<td>J HEXYL PEROXYDECANOATE</td>
<td>≤ 71</td>
<td>A ≥ 20</td>
<td>032</td>
<td>10/50</td>
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<td>16 gal (60)</td>
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</tr>
<tr>
<td>J HEXYL PEROXYDIOXANE</td>
<td>≤ 72</td>
<td>B ≥ 28</td>
<td></td>
<td></td>
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<td>16 gal (60)</td>
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<tr>
<td>3-HYDROXY-1,1-DIMETHYLBUTYL PEROXYDECANOATE</td>
<td>≤ 40</td>
<td>A ≥ 23</td>
<td>5/23</td>
<td>9/41</td>
<td>NE</td>
<td>3</td>
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<td>IBC tank</td>
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<tr>
<td>3-HYDROXY-1,1-DIMETHYLBUTYL PEROXYDECANOATE</td>
<td>≤ 52</td>
<td>A ≥ 48</td>
<td>5/23</td>
<td>9/41</td>
<td>NE</td>
<td>3</td>
<td>2</td>
<td></td>
<td>IBC tank</td>
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<tr>
<td>3-HYDROXY-1,1-DIMETHYLBUTYL PEROXYDECANOATE</td>
<td>≤ 52</td>
<td>A ≥ 48</td>
<td>5/23</td>
<td>9/41</td>
<td>NE</td>
<td>3</td>
<td>2</td>
<td></td>
<td>IBC tank</td>
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</tr>
<tr>
<td>ISOPROPYL sec -BUTYL PEROXYDICARBONATE + DI sec -BUTYL PEROXYDICARBONATE</td>
<td>≤ 32 × 15 – 18</td>
<td></td>
<td></td>
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<td></td>
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<td></td>
<td>8 gal (30)</td>
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</tr>
<tr>
<td>ISOPROPYL sec -BUTYL PEROXYDICARBONATE + DI sec -BUTYL PEROXYDICARBONATE</td>
<td>≤ 12 – 15</td>
<td>A ≥ 38</td>
<td>20/4</td>
<td>10/14</td>
<td>2</td>
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<td>2</td>
<td></td>
<td>IBC tank</td>
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</tr>
<tr>
<td>ISOPROPYL sec -BUTYL PEROXYDICARBONATE + DI sec -BUTYL PEROXYDICARBONATE</td>
<td>≤ 52 × 28 ≤ 12</td>
<td>A ≥ 28</td>
<td>20/4</td>
<td>10/14</td>
<td>2</td>
<td>4</td>
<td>4</td>
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<td>IBC tank</td>
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<tr>
<td>ISOPROPYLCUMYL HYDROPEROXIDE</td>
<td>≤ 72</td>
<td>A ≥ 28</td>
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<td>IBC tank</td>
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<tr>
<td>METHYL HYDROPEROXIDE</td>
<td>&gt; 72 – 100</td>
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<tr>
<td>METHYL HYDROPEROXIDE</td>
<td>≤ 72</td>
<td>A ≥ 28</td>
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<td>IBC tank</td>
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<tr>
<td>METHYL CYCLOHEXANONE PEROXIDE(S)</td>
<td>≤ 67</td>
<td>B ≥ 33</td>
<td>35/95</td>
<td>40/104</td>
<td>NE</td>
<td>NE</td>
<td>2</td>
<td></td>
<td>IBC tank</td>
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<tr>
<td>METHYL ETHYL KETONE PEROXIDE(S)</td>
<td>See remark 8</td>
<td>A ≥ 48</td>
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<td></td>
<td>8 gal (30)</td>
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<tr>
<td>METHYL ETHYL KETONE PEROXIDE(S)</td>
<td>See remark 9</td>
<td>A ≥ 55</td>
<td></td>
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<td></td>
<td>8 gal (30)</td>
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<td>See remark 10</td>
<td>A ≥ 60</td>
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<td>8 gal (30)</td>
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<tr>
<td>METHYL ISOBUTYL KETONE PEROXIDE(S)</td>
<td>≤ 62</td>
<td>A ≥ 19</td>
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<td>IBC tank</td>
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<td>METHYL ISOBUTYL KETONE PEROXIDE(S)</td>
<td>≤ 62</td>
<td>A ≥ 20</td>
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<td>ORGANIC PEROXIDE, LIQUID, SAMPLE</td>
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<td>ORGANIC PEROXIDE, SOLID, SAMPLE</td>
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<td>IBC tank</td>
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<td>ORGANIC PEROXIDE, SOLID, SAMPLE</td>
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<td>NE</td>
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<tr>
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<td>NE</td>
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<tr>
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<td>≤ 43</td>
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<td>NE</td>
<td>3</td>
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<td></td>
<td>IBC tank</td>
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<tr>
<td>PEROXYALIC ACID</td>
<td>≤ 100</td>
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<td>35/95</td>
<td>40/104</td>
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<tr>
<td>PEROXYLauric ACID</td>
<td>≤ 100</td>
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<td>35/95</td>
<td>40/104</td>
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<td>IBC tank</td>
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<td>PINANYL HYDROPEROXIDE</td>
<td>&gt; 56 – 100</td>
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<td></td>
<td></td>
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<td></td>
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<td></td>
<td>440 lb (200 kg)</td>
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<tr>
<td>PINANYL HYDROPEROXIDE</td>
<td>&gt; 56</td>
<td>A ≥ 44</td>
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<td></td>
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<td></td>
<td>16 gal (60)</td>
<td></td>
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<tr>
<td>POLYETHER POLY, 1 - BUTYLPEROXYCARBONATE</td>
<td>≤ 52</td>
<td>B ≥ 48</td>
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<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td>80 gal (300 L)</td>
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<td>1,1,3,3-TETRAMETHYL-2,4-ETHYLHEXANOATE</td>
<td>≤ 100</td>
<td>15/59</td>
<td>20/98</td>
<td>NE</td>
<td>3</td>
<td>2</td>
<td></td>
<td>IBC tank</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>1,1,3,3-TETRAMETHYL-2,4-ETHYLHEXANOATE</td>
<td>≤ 100</td>
<td>15/59</td>
<td>20/98</td>
<td>NE</td>
<td>3</td>
<td>2</td>
<td></td>
<td>IBC tank</td>
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</tr>
<tr>
<td>1,1,3,3-TETRAMETHYL-2,4-ETHYLHEXANOATE</td>
<td>≤ 100</td>
<td>15/59</td>
<td>20/98</td>
<td>NE</td>
<td>3</td>
<td>2</td>
<td></td>
<td>IBC tank</td>
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<tr>
<td>1,1,3,3-TETRAMETHYL-2,4-ETHYLHEXANOATE</td>
<td>≤ 100</td>
<td>15/59</td>
<td>20/98</td>
<td>NE</td>
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<td>2</td>
<td></td>
<td>IBC tank</td>
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<tr>
<td>1,1,3,3-TETRAMETHYL-2,4-ETHYLHEXANOATE</td>
<td>≤ 100</td>
<td>15/59</td>
<td>20/98</td>
<td>NE</td>
<td>3</td>
<td>2</td>
<td></td>
<td>IBC tank</td>
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</tr>
<tr>
<td>3,6,9-TRIETHYL-1,3,6,9-TRIMETHYL-1,4,7 TRIPEROXONANE</td>
<td>≤ 42</td>
<td>A ≥ 58</td>
<td></td>
<td>2</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>16 gal (60)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Depending on package used for tests.**
These columns refer to temperatures in the Department of Transportation (DOT) Organic Peroxides Table. (See 49 CFR 173.225 for more information.)

The column refers to NFPA 704 hazard ratings for health, flammability, and instability. (See NFPA 704 for more information.)

Diluents Type A — are organic liquids which are compatible with the organic peroxide and which have a boiling point of not less than 150°C. Type A diluents may be used for desensitizing all organic peroxides.

Diluents Type B — are organic liquids which are compatible with the organic peroxide and which have a boiling point of less than 150°C but not less than 60°C and a flash point of not less than 5°C. Type B diluents may be used for desensitizing of all organic peroxides providing that the boiling point is at least 60°C higher than the SADT in a 50 kg package.

See Table F.7.

See NFPA 30 for additional storage requirements.

Temperature control should be considered to reduce fire hazard depending on packaging size and recommendations in manufacturers’ literature.

<table>
<thead>
<tr>
<th>File Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Table_F.1 edited.xlsx</td>
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</tr>
</tbody>
</table>

Submitter Information Verification

Submitter Full Name: [Not Specified]
Organization: [Not Specified]
Street Address:       
City:                 
State:                
Zip:                  
Submit Date: Fri Aug 22 15:07:56 EDT 2014

Committee Statement

Committee Statement: Table update based on most recent test information. The Committee supports revising the annex based on new test data. See attached XLSX file which is the revised table for Class I through Class V organic peroxides and replaces the existing table in the code.

Note: This table was updated at first draft meeting but some of the fields in the table had been hidden so were not incorporated into first draft. These new formulations have been highlighted in the attached tables. The attached table shows the table as it should look in NFPA 400.

Response Message: 
<table>
<thead>
<tr>
<th>Organic Peroxide Formulation</th>
<th>Concentration</th>
<th>Diluent</th>
<th>Water</th>
<th>C/F</th>
<th>C/F</th>
<th>Health</th>
<th>Flammability</th>
<th>Instability</th>
<th>Storage Class</th>
<th>Max. Container Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACETYL ACETONE PEROXIDE</td>
<td>≤ 42</td>
<td>A ≥ 48%</td>
<td>≤ 12</td>
<td>≤ 12</td>
<td>≤ 10/14</td>
<td>0/32</td>
<td>3</td>
<td>NE</td>
<td>3</td>
<td>III</td>
</tr>
<tr>
<td>ACETYL CYCLOHEXANESULPHONYL PEROXIDE</td>
<td>≤ 82</td>
<td>≤ 12</td>
<td>≤ 10/14</td>
<td>0/32</td>
<td>3</td>
<td>NE</td>
<td>4</td>
<td>I</td>
<td>25 kg**</td>
<td></td>
</tr>
<tr>
<td>ACETYL CYCLOHEXANESULPHONYL PEROXIDE</td>
<td>≤ 32</td>
<td>B ≥ 68</td>
<td>-10/14</td>
<td>0/32</td>
<td>3</td>
<td>4</td>
<td>3</td>
<td>III</td>
<td>60 liter</td>
<td></td>
</tr>
<tr>
<td>tert-AMYL HYDROPEROXIDE</td>
<td>≤ 88</td>
<td>A ≥ 6</td>
<td>≥ 6</td>
<td>6</td>
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<td>2</td>
<td>II</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>tert-AMYL PEROXYACETATE</td>
<td>≤ 62</td>
<td>A ≥ 38</td>
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<td>2</td>
<td>3</td>
<td>II</td>
<td>60 liter</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>tert-AMYL PEROXYBENZOATE</td>
<td>≤ 100</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>II</td>
<td>60 liter</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>tert-AMYL PEROXY-2-ETHYLHEXANOATE</td>
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<td>20/68</td>
<td>25/77</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>II</td>
<td>60 liter</td>
<td></td>
<td></td>
</tr>
<tr>
<td>tert-AMYL PEROXY-2-ETHYLHEXYL CARBONATE</td>
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<td>1</td>
<td>2</td>
<td>3</td>
<td>II</td>
<td>60 liter</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>tert-AMYL PEROXY ISOPROPYL CARBONATE</td>
<td>≤ 77</td>
<td>A ≥ 23</td>
<td>NE</td>
<td>2</td>
<td>3</td>
<td>I</td>
<td>60 liter**</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>tert-AMYL PEROXYNEDOCANATE</td>
<td>≤ 77</td>
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<td>0/32</td>
<td>10/50</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>II</td>
<td>60 liter</td>
<td></td>
</tr>
<tr>
<td>tert-AMYL PEROXYTETRALATE</td>
<td>≤ 77</td>
<td>B ≥ 23</td>
<td>0/32</td>
<td>10/50</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>II</td>
<td>60 liter</td>
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<td>NE</td>
<td>2</td>
<td>3</td>
<td>I</td>
<td>60 liter</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>tert-BUTYL CUMYL PEROXIDE</td>
<td>&gt; 42 – 100</td>
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<td>2</td>
<td>2</td>
<td>II</td>
<td>225 liter</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>tert-BUTYL CUMYL PEROXIDE</td>
<td>≤ 52</td>
<td>Inert solid ≥ 48</td>
<td>2</td>
<td>NE</td>
<td>2</td>
<td>II</td>
<td>200 kg</td>
<td></td>
<td></td>
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</tr>
<tr>
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<td>1</td>
<td>2</td>
<td>3</td>
<td>II</td>
<td>60 liter</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>tert-BUTYL 4,4-DI-(tert-BUTYLPEROXY)VALERATE</td>
<td>≤ 52</td>
<td>Inert solid ≥ 48</td>
<td>1</td>
<td>NE</td>
<td>2</td>
<td>I</td>
<td>60 liter**</td>
<td></td>
<td></td>
<td></td>
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<tr>
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<td>&gt; 59 – 90</td>
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<td>3</td>
<td>3</td>
<td>I</td>
<td>60 liter**</td>
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<td>NE</td>
<td>3</td>
<td>II</td>
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<td></td>
</tr>
<tr>
<td>tert-BUTYL HYDROPEROXIDE</td>
<td>≤ 79</td>
<td>&gt; 14</td>
<td>3</td>
<td>NE</td>
<td>2</td>
<td>II</td>
<td>225 liter</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>tert-BUTYL HYDROPEROXIDE</td>
<td>≤ 55</td>
<td>&gt; 14</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>III</td>
<td>IBC tank/tank truck</td>
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<td></td>
</tr>
<tr>
<td>tert-BUTYL HYDROPEROXIDE +DI-tert-BUTYLPEROXY</td>
<td>&lt; 82 + 79</td>
<td>≥ 7</td>
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<td>4</td>
<td>3</td>
<td>I</td>
<td>60 liter**</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>tert-BUTYL MONOPEROXYMALEATE</td>
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<td>3</td>
<td>2</td>
<td>4</td>
<td>I</td>
<td>240 kg**</td>
<td></td>
<td></td>
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</tr>
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<td>tert-BUTYL MONOPEROXYMALEATE</td>
<td>≤ 52</td>
<td>A ≥ 48</td>
<td>3</td>
<td>NE</td>
<td>3</td>
<td>II</td>
<td>60 liter</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>tert-BUTYL MONOPEROXYMALEATE</td>
<td>≤ 52</td>
<td>Inert solid ≥ 48</td>
<td>3</td>
<td>NE</td>
<td>2</td>
<td>II</td>
<td>200 kg</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>tert-BUTYL MONOPEROXYMALEATE</td>
<td>≤ 52</td>
<td>Inert solid ≥ 48</td>
<td>3</td>
<td>NE</td>
<td>2</td>
<td>II</td>
<td>200 kg</td>
<td></td>
<td></td>
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</tr>
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<td>2</td>
<td>4</td>
<td>I</td>
<td>30 liter**</td>
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<td>2</td>
<td>3</td>
<td>II</td>
<td>60 liter</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>tert-BUTYL PEROXYBENZOATE</td>
<td>&gt; 32</td>
<td>B ≥ 68</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>II</td>
<td>60 liter</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>tert-BUTYL PEROXYBENZOATE</td>
<td>&gt; 32</td>
<td>B ≥ 68</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>II</td>
<td>60 liter</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>tert-BUTYL PEROXYBENZOATE</td>
<td>&gt; 32</td>
<td>B ≥ 68</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>II</td>
<td>60 liter</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>tert-BUTYL PEROXYBENZOATE</td>
<td>&gt; 32</td>
<td>B ≥ 68</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>II</td>
<td>60 liter</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>tert-BUTYL PEROXYDIEYLACETATE</td>
<td>≤ 100</td>
<td>20/68</td>
<td>25/77</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>I</td>
<td>60 liter**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>tert-BUTYL PEROXY-2-ETHYLHEXANOATE</td>
<td>&gt; 52 – 100</td>
<td>20/68</td>
<td>25/77</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>II</td>
<td>60 liter</td>
<td></td>
<td></td>
</tr>
<tr>
<td>tert-BUTYL PEROXY-2-ETHYLHEXANOATE</td>
<td>&gt; 32 – 52</td>
<td>B ≥ 48</td>
<td>30/86</td>
<td>35/95</td>
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<td>2</td>
<td>2</td>
<td>II</td>
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</tr>
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<td>Compound</td>
<td>T</td>
<td>Inert solid</td>
<td>I</td>
<td>NE</td>
<td>II</td>
<td>kg</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td>----------------------------------------------</td>
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<tr>
<td>tert-BUTYL PEROXY-2-ETHYLHEXANOATE</td>
<td>≤ 52</td>
<td>Inert solid ≥ 48</td>
<td>20/68</td>
<td>25/77</td>
<td>1</td>
<td>NE</td>
<td>2</td>
<td>II</td>
<td>200 kg</td>
<td></td>
</tr>
<tr>
<td>tert-BUTYL PEROXY-2-ETHYLHEXANOATE + 2,2-DI-(tert-BUTYLPEROXY)BUTANE</td>
<td>≤ 12 ≤ 14</td>
<td>A ≥ 14; Inert solid ≥ 60</td>
<td>1</td>
<td>NE</td>
<td>3</td>
<td>II</td>
<td>50 kg</td>
<td></td>
<td></td>
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<tr>
<td>tert-BUTYL PEROXY-2-ETHYLHEXANOATE + 2,2-DI-(tert-BUTYLPEROXY)BUTANE</td>
<td>≤ 31 + ≤ 36</td>
<td>B ≥ 33</td>
<td>35/95</td>
<td>40/104</td>
<td>1</td>
<td>NE</td>
<td>3</td>
<td>II</td>
<td>60 liter</td>
<td></td>
</tr>
<tr>
<td>tert-BUTYL PEROXY-2-ETHYLHEXYLCARBONATE</td>
<td>≤ 100</td>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>II</td>
<td>60 liter</td>
<td></td>
</tr>
<tr>
<td>tert-BUTYL PEROXYISOBUTYRATE</td>
<td>&gt; 52 - 77</td>
<td>B ≥ 23</td>
<td>15/59</td>
<td>20/68</td>
<td>1</td>
<td>2</td>
<td>4</td>
<td>I</td>
<td>80 liter**</td>
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</tr>
<tr>
<td>tert-BUTYL PEROXYISOBUTYRATE</td>
<td>≤ 52</td>
<td>B ≥ 48</td>
<td>15/59</td>
<td>20/68</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td>II</td>
<td>60 liter</td>
<td></td>
</tr>
<tr>
<td>tert-BUTYL PEROXYISOPropylCARBONATE</td>
<td>≤ 77</td>
<td>A ≥ 23</td>
<td></td>
<td></td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>II</td>
<td>60 liter</td>
<td></td>
</tr>
<tr>
<td>1-(2-tert-BUTYLPEROXY ISOPROPYL)-3-ISOPROPENYLBENZENE</td>
<td>≤ 77</td>
<td>A ≥ 23</td>
<td></td>
<td></td>
<td>NE</td>
<td>NE</td>
<td>3</td>
<td>II</td>
<td>60 liter</td>
<td></td>
</tr>
<tr>
<td>tert-BUTYL PEROXYISOPROPYL-3-ISOPROPENYLBENZENE</td>
<td>≤ 42</td>
<td>Inert solid ≥ 58</td>
<td></td>
<td></td>
<td>NE</td>
<td>NE</td>
<td>2</td>
<td>II</td>
<td>200 kg</td>
<td></td>
</tr>
<tr>
<td>tert-BUTYL PEROXY-2-METHYLBENZOATE</td>
<td>≤ 100</td>
<td></td>
<td></td>
<td></td>
<td>3</td>
<td>4</td>
<td>3</td>
<td>I</td>
<td>60 liter**</td>
<td></td>
</tr>
<tr>
<td>tert-BUTYL PEROXYNEODECANOATE</td>
<td>&gt; 77 - 100</td>
<td>-5/23</td>
<td>5/41</td>
<td></td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>II</td>
<td>60 liter</td>
<td></td>
</tr>
<tr>
<td>tert-BUTYL PEROXYNEODECANOATE</td>
<td>≤ 77</td>
<td>B ≥ 23</td>
<td>0/32</td>
<td>10/50</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>II</td>
<td>60 liter</td>
<td></td>
</tr>
<tr>
<td>tert-BUTYL PEROXYNEODECANOATE</td>
<td>≤ 52 as a stable dispersion in water</td>
<td>0/32</td>
<td>10/50</td>
<td></td>
<td>2</td>
<td>NE</td>
<td>1</td>
<td>IV</td>
<td>IBC tank</td>
<td></td>
</tr>
<tr>
<td>tert-BUTYL PEROXYNEODECANOATE</td>
<td>≤ 42 as a stable dispersion in water (frozen)</td>
<td>0/32</td>
<td>10/50</td>
<td></td>
<td>2</td>
<td>NE</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>tert-BUTYL PEROXYNEODECANOATE</td>
<td>≤ 32</td>
<td>A ≥ 68</td>
<td>0/32</td>
<td>10/50</td>
<td>2</td>
<td>NE</td>
<td>1</td>
<td>III</td>
<td>IBC tank</td>
<td></td>
</tr>
<tr>
<td>tert-BUTYL PEROXYNEODECANOATE</td>
<td>≤ 77</td>
<td>A ≥ 23</td>
<td>0/32</td>
<td>10/50</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>II</td>
<td>60 liter</td>
<td></td>
</tr>
<tr>
<td>tert-BUTYL PEROXYNEODECANOATE</td>
<td>≤ 42 as a stable dispersion in water</td>
<td>0/32</td>
<td>10/50</td>
<td></td>
<td>1</td>
<td>NE</td>
<td>2</td>
<td>IV</td>
<td>225 liter</td>
<td></td>
</tr>
<tr>
<td>tert-BUTYL PEROXYPIVALATE</td>
<td>&gt; 67 - 77</td>
<td>A ≥ 23</td>
<td>0/32</td>
<td>10/50</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>II</td>
<td>60 liter</td>
<td></td>
</tr>
<tr>
<td>tert-BUTYL PEROXYPIVALATE</td>
<td>≥ 27 - 67</td>
<td>B ≥ 33</td>
<td>0/32</td>
<td>10/50</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>II</td>
<td>60 liter</td>
<td></td>
</tr>
<tr>
<td>tert-BUTYL PEROXYPIVALATE</td>
<td>≥ 27</td>
<td>B ≥ 33</td>
<td>30/86</td>
<td>35/95</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>III</td>
<td>IBC tank</td>
<td></td>
</tr>
<tr>
<td>tert-BUTYL PEROXYSTEARYLCARBONATE</td>
<td>≤ 100</td>
<td></td>
<td></td>
<td></td>
<td>NE</td>
<td>NE</td>
<td>3</td>
<td>II</td>
<td>50 kg</td>
<td></td>
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<tr>
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<td></td>
<td></td>
<td></td>
<td>2</td>
<td>1</td>
<td>3</td>
<td>II</td>
<td>60 liter</td>
<td></td>
</tr>
<tr>
<td>tert-BUTYL PEROXY-3,5,5-TRIMETHYLHEXANOATE</td>
<td>≤ 42</td>
<td>Inert solid ≥ 58</td>
<td></td>
<td></td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>II</td>
<td>50 kg</td>
<td></td>
</tr>
<tr>
<td>tert-BUTYL PEROXY-3,5,5-TRIMETHYLHEXANOATE</td>
<td>≤ 32</td>
<td>B ≥ 68</td>
<td></td>
<td></td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>III</td>
<td>IBC tank</td>
<td></td>
</tr>
<tr>
<td>3-CHLOROPEROXYBENZOIC ACID</td>
<td>&gt; 57 - 86</td>
<td>Inert solid ≥ 14</td>
<td></td>
<td></td>
<td>NE</td>
<td>NE</td>
<td>4</td>
<td>I</td>
<td>25 kg**</td>
<td></td>
</tr>
<tr>
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<td>≤ 57</td>
<td>Inert solid ≥ 2</td>
<td></td>
<td></td>
<td>NE</td>
<td>NE</td>
<td>3</td>
<td>II</td>
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<tr>
<td>3-CHLOROPEROXYBENZOIC ACID</td>
<td>≤ 77</td>
<td>Inert solid ≥ 6</td>
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<td>NE</td>
<td>3</td>
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<tr>
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<td>&gt; 90 - 98</td>
<td>A ≥10</td>
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<td>3</td>
<td>1</td>
<td>2</td>
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<tr>
<td>CUMYL HYDROPEROXIDE</td>
<td>≥ 90</td>
<td>A ≥ 10</td>
<td></td>
<td></td>
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<td>2</td>
<td>1</td>
<td>III</td>
<td>IBC tank</td>
<td></td>
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<tr>
<td>tert-BUTYL PEROXYNEODECANOATE</td>
<td>≤ 67</td>
<td>A ≥ 13</td>
<td>-10/14</td>
<td>0/32</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td>II</td>
<td>60 liter</td>
<td></td>
</tr>
<tr>
<td>tert-BUTYL PEROXYNEODECANOATE</td>
<td>≤ 77</td>
<td>B ≥ 23</td>
<td>-10/14</td>
<td>0/32</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td>II</td>
<td>60 liter</td>
<td></td>
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<tr>
<td>CUMYL PEROXYNEODECANOATE</td>
<td>≤ 52 as a stable dispersion in water</td>
<td>-10/14</td>
<td>0/32</td>
<td></td>
<td>1</td>
<td>NE</td>
<td>1</td>
<td>III</td>
<td>IBC tank</td>
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</tr>
<tr>
<td>CUMYL PEROXYNEODECANOATE</td>
<td>≤ 77</td>
<td>A ≥ 23</td>
<td></td>
<td></td>
<td>1</td>
<td>3</td>
<td>3</td>
<td>II</td>
<td>60 liter</td>
<td></td>
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<tr>
<td>CUMYL PEROXYPIVALATE</td>
<td>≤ 77</td>
<td>B ≥ 23</td>
<td>-5/23</td>
<td>5/41</td>
<td>NE</td>
<td>3</td>
<td>3</td>
<td>II</td>
<td>60 liter</td>
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<tr>
<td>Chemical Name</td>
<td>Lower Limit</td>
<td>Upper Limit</td>
<td>Special Actions</td>
<td>Hazard Class</td>
<td>Quantity</td>
<td>Container Type</td>
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<td>CYCLOHEXANONE PEROXIDE(S)</td>
<td>≤ 91</td>
<td>≥ 9</td>
<td>NE</td>
<td>I</td>
<td>3</td>
<td>50 kg**</td>
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<tr>
<td>CYCLOHEXANONE PEROXIDE(S)</td>
<td>≤ 72</td>
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<td>NE</td>
<td>II</td>
<td>3</td>
<td>60 liter</td>
<td></td>
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<tr>
<td>CYCLOHEXANONE PEROXIDE(S)</td>
<td>≤ 72 as a paste</td>
<td>A ≥ 27</td>
<td>NE</td>
<td>II</td>
<td>3</td>
<td>50 kg</td>
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<tr>
<td>CYCLOHEXANONE PEROXIDE(S)</td>
<td>55</td>
<td>B ≥ 26</td>
<td>NE</td>
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<td>3</td>
<td>60 liter</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1,4-DI-n-BUTYL CYCLOHEXYL PEROXYDICARBONATE</td>
<td>≤ 100</td>
<td>30/86</td>
<td>NE</td>
<td>III</td>
<td>1</td>
<td>50 kg**</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1,4-DI-n-BUTYL CYCLOHEXYL PEROXYDICARBONATE</td>
<td>≤ 42 as a paste</td>
<td>35/95</td>
<td>NE</td>
<td>IV</td>
<td>1</td>
<td>IBC tank</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1,4-DI-n-BUTYL CYCLOHEXYL PEROXYDICARBONATE</td>
<td>≤ 52 - 100</td>
<td>30/86</td>
<td>NE</td>
<td>III</td>
<td>1</td>
<td>IBC tank</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1,4-DI-n-BUTYL CYCLOHEXYL PEROXYDICARBONATE</td>
<td>≤ 52</td>
<td>35/95</td>
<td>NE</td>
<td>III</td>
<td>1</td>
<td>IBC tank</td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>1,1-DI-(n-BUTYLPEROXY) CYCLOHEXANE+ tert-BUTYL PEROXY-2-ETHYLHEXANOATE</td>
<td>≤ 43 + ≤ 16</td>
<td>A ≥ 41</td>
<td>NE</td>
<td>III</td>
<td>1</td>
<td>IBC tank</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>DI-n-BUTYL PEROXYDICARBONATE</td>
<td>&gt; 27 - 52</td>
<td>B ≥ 48</td>
<td>NE</td>
<td>III</td>
<td>1</td>
<td>IBC tank</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

**Note:** NE = Not Evaluated, I = Inert, II = Inert solid, III = IBC tank
<table>
<thead>
<tr>
<th>Chemical Name</th>
<th>Appearance</th>
<th>Limits</th>
<th>Hazard Class</th>
<th>Toxicity</th>
<th>Compatibility</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>n-Butyl Peroxydipropionate</td>
<td>≤ 42 as a stable dispersion in water (frozen)</td>
<td>-15/5</td>
<td>I</td>
<td>NE</td>
<td>2</td>
<td>II</td>
</tr>
<tr>
<td>n-Butyl Peroxydipropionate</td>
<td>≤ 27, B ≥ 73</td>
<td>-10/14, 0/12</td>
<td>1</td>
<td>NE</td>
<td>2</td>
<td>III</td>
</tr>
<tr>
<td>sec-Butyl Peroxydipropionate</td>
<td>&gt; 52 - 100</td>
<td>-20/-4, -10/14</td>
<td>1</td>
<td>4</td>
<td>3</td>
<td>I</td>
</tr>
<tr>
<td>sec-Butyl Peroxydipropionate</td>
<td>≤ 52, B ≥ 48</td>
<td>-15/5, -5/23</td>
<td>1</td>
<td>4</td>
<td>3</td>
<td>II</td>
</tr>
<tr>
<td>tert-Butyl Peroxydipropionate</td>
<td>&gt; 42 - 100, Inert solid ≤ 57</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>II</td>
<td>50 kg</td>
</tr>
<tr>
<td>tert-Butyl Peroxydipropionate</td>
<td>≤ 42, Inert solid ≥ 58</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>V</td>
<td>Exempt</td>
</tr>
<tr>
<td>tert-Butylperoxyisopropylbenzene(s)</td>
<td>&gt; 52 - 100, A ≥ 48</td>
<td>NE</td>
<td>2</td>
<td>3</td>
<td>II</td>
<td>60 liter</td>
</tr>
<tr>
<td>tert-Butylperoxyisopropylbenzene(s)</td>
<td>≤ 52 as a paste</td>
<td>NE</td>
<td>NE</td>
<td>3</td>
<td>II</td>
<td>50 kg</td>
</tr>
<tr>
<td>tert-Butylperoxyisopropylbenzene(s)</td>
<td>≤ 42, A ≥ 58</td>
<td>NE</td>
<td>1</td>
<td>2</td>
<td>II</td>
<td>225 liter</td>
</tr>
<tr>
<td>tert-Butylperoxyisopropylbenzene(s)</td>
<td>≤ 52, A ≥ 48</td>
<td>NE</td>
<td>2</td>
<td>3</td>
<td>II</td>
<td>60 liter</td>
</tr>
<tr>
<td>tert-Butylperoxypropane</td>
<td>≤ 42, A ≥ 13, Inert solid ≥ 45</td>
<td>NE</td>
<td>NE</td>
<td>3</td>
<td>III</td>
<td>IBC type</td>
</tr>
<tr>
<td>tert-Butylperoxypropane</td>
<td>≤ 52 as a paste</td>
<td>NE</td>
<td>NE</td>
<td>3</td>
<td>II</td>
<td>60 liter</td>
</tr>
<tr>
<td>tert-Butylperoxypropane</td>
<td>≤ 90 - 100</td>
<td>1</td>
<td>2</td>
<td>4</td>
<td>IV</td>
<td>50 liter**</td>
</tr>
<tr>
<td>tert-Butylperoxypropane, 3,3,5-trimethylcyclohexane</td>
<td>≤ 57, B ≥ 10</td>
<td>1</td>
<td>2</td>
<td>4</td>
<td>I</td>
<td>60 liter**</td>
</tr>
<tr>
<td>tert-Butylperoxypropane, 3,3,5-trimethylcyclohexane</td>
<td>&gt; 57 - 90, A ≥ 10</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>II</td>
<td>60 liter</td>
</tr>
<tr>
<td>tert-Butylperoxypropane, 3,3,5-trimethylcyclohexane</td>
<td>≤ 77, B ≥ 23</td>
<td>1</td>
<td>NE</td>
<td>3</td>
<td>II</td>
<td>60 liter</td>
</tr>
<tr>
<td>tert-Butylperoxypropane, 3,3,5-trimethylcyclohexane</td>
<td>≤ 57, Inert solid ≥ 43</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>III</td>
<td>IBC type</td>
</tr>
<tr>
<td>tert-Butylperoxypropane, 3,3,5-trimethylcyclohexane</td>
<td>≤ 32, A ≥ 26, B ≥ 42</td>
<td>1</td>
<td>4</td>
<td>2</td>
<td>II</td>
<td>225 liter</td>
</tr>
<tr>
<td>tert-Butyl Peroxydipropionate</td>
<td>≤ 100</td>
<td>36/86, 35/95</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>II</td>
</tr>
<tr>
<td>tert-Butyl Peroxydipropionate</td>
<td>≤ 42 as a stable dispersion in water</td>
<td>36/86, 35/95</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>IV</td>
</tr>
<tr>
<td>4-Chlorobenzoyl Peroxide</td>
<td>≤ 77</td>
<td>NE</td>
<td>NE</td>
<td>4</td>
<td>I</td>
<td>25 kg**</td>
</tr>
<tr>
<td>4-Chlorobenzoyl Peroxide</td>
<td>≤ 52 as a paste</td>
<td>NE</td>
<td>NE</td>
<td>3</td>
<td>II</td>
<td>50 kg</td>
</tr>
<tr>
<td>4-Chlorobenzoyl Peroxide</td>
<td>≤ 32, Inert solid ≥ 68</td>
<td>NE</td>
<td>NE</td>
<td>0</td>
<td>V</td>
<td>Exempt</td>
</tr>
<tr>
<td>Cumyl Peroxide</td>
<td>&gt; 52 - 100</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>III</td>
<td>IBC type</td>
</tr>
<tr>
<td>Cumyl Peroxide</td>
<td>≤ 52, Inert solid ≥ 48</td>
<td>1</td>
<td>NE</td>
<td>0</td>
<td>V</td>
<td>Exempt</td>
</tr>
<tr>
<td>Cyclohexyl Peroxydipropionate</td>
<td>&gt; 91 - 100</td>
<td>10/50, 15/59</td>
<td>NE</td>
<td>NE</td>
<td>4</td>
<td>I</td>
</tr>
<tr>
<td>Cyclohexyl Peroxydipropionate</td>
<td>≤ 91, ≥ 9</td>
<td>10/50, 15/59</td>
<td>NE</td>
<td>NE</td>
<td>3</td>
<td>II</td>
</tr>
<tr>
<td>Cyclohexyl Peroxydipropionate</td>
<td>≤ 42 as a stable dispersion in water</td>
<td>15/59, 20/68</td>
<td>NE</td>
<td>NE</td>
<td>1</td>
<td>IV</td>
</tr>
<tr>
<td>Decanoyl Peroxide</td>
<td>≤ 100</td>
<td>30/86, 35/95</td>
<td>1</td>
<td>NE</td>
<td>3</td>
<td>II</td>
</tr>
<tr>
<td>Decanoyl Peroxide</td>
<td>≤ 42, Inert solid ≥ 58</td>
<td>1</td>
<td>NE</td>
<td>3</td>
<td>III</td>
<td>50 kg</td>
</tr>
<tr>
<td>1,4-Di-(tert-Butylperoxy)cyclohexyl propionate</td>
<td>≤ 42</td>
<td>NE</td>
<td>NE</td>
<td>3</td>
<td>II</td>
<td>60 liter**</td>
</tr>
<tr>
<td>1,4-Di-(tert-Butylperoxy)cyclohexyl propionate</td>
<td>≤ 22, B ≥ 78</td>
<td>NE</td>
<td>NE</td>
<td>3</td>
<td>II</td>
<td>225 liter</td>
</tr>
<tr>
<td>1,4-Di-(tert-Butylperoxy)cyclohexyl propionate</td>
<td>≤ 77</td>
<td>NE</td>
<td>NE</td>
<td>4</td>
<td>I</td>
<td>25 kg**</td>
</tr>
<tr>
<td>1,4-Di-(tert-Chlorobenzoyl) Peroxide</td>
<td>≤ 52 as a paste</td>
<td>NE</td>
<td>NE</td>
<td>3</td>
<td>II</td>
<td>50 kg</td>
</tr>
<tr>
<td>1,4-Di-(tert-Chlorobenzoyl) Peroxide</td>
<td>≤ 32, Inert solid ≥ 68</td>
<td>NE</td>
<td>NE</td>
<td>0</td>
<td>V</td>
<td>Exempt</td>
</tr>
<tr>
<td>1,4-Di-(tert-Chlorobenzoyl) Peroxide</td>
<td>&gt; 52 - 100</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>III</td>
<td>IBC type</td>
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<tr>
<td>1,4-Di-(tert-Chlorobenzoyl) Peroxide</td>
<td>≤ 52, Inert solid ≥ 48</td>
<td>1</td>
<td>NE</td>
<td>0</td>
<td>V</td>
<td>Exempt</td>
</tr>
<tr>
<td>4-Chlorobenzoyl Peroxide</td>
<td>≤ 77</td>
<td>NE</td>
<td>NE</td>
<td>4</td>
<td>I</td>
<td>25 kg**</td>
</tr>
<tr>
<td>4-Chlorobenzoyl Peroxide</td>
<td>≤ 52 as a paste</td>
<td>NE</td>
<td>NE</td>
<td>3</td>
<td>II</td>
<td>50 kg</td>
</tr>
<tr>
<td>4-Chlorobenzoyl Peroxide</td>
<td>≤ 32, Inert solid ≥ 68</td>
<td>NE</td>
<td>NE</td>
<td>0</td>
<td>V</td>
<td>Exempt</td>
</tr>
<tr>
<td>4-Chlorobenzoyl Peroxide</td>
<td>&gt; 52 - 100</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>III</td>
<td>IBC type</td>
</tr>
<tr>
<td>4-Chlorobenzoyl Peroxide</td>
<td>≤ 52, Inert solid ≥ 48</td>
<td>1</td>
<td>NE</td>
<td>0</td>
<td>V</td>
<td>Exempt</td>
</tr>
<tr>
<td>Chemical Name</td>
<td>CAS Number</td>
<td>Solubility</td>
<td>Physical State</td>
<td>IBC Type</td>
<td>IBC Tank</td>
<td>IBC Capacity</td>
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</tr>
<tr>
<td>DI-(2-ETHOXYETHYL) Peroxydicarbonate</td>
<td>≤ 52</td>
<td>B ≥ 48</td>
<td>-10/14</td>
<td>NE</td>
<td>NE</td>
<td>60 liter</td>
</tr>
<tr>
<td>DI-(2-ETHYLHEXYL) Peroxydicarbonate</td>
<td>&gt; 77 - 100</td>
<td>-20/-4</td>
<td>-10/14</td>
<td>2</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>DI-(2-ETHYLHEXYL) Peroxydicarbonate</td>
<td>≤ 77</td>
<td>B ≥ 23</td>
<td>-15/5</td>
<td>2</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>DI-(2-ETHYLHEXYL) Peroxydicarbonate</td>
<td>≤ 62</td>
<td>as a stable dispersion in water</td>
<td>2</td>
<td>NE</td>
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</tr>
<tr>
<td>DI-(2-ETHYLHEXYL) Peroxydicarbonate</td>
<td>≤ 52</td>
<td>as a stable dispersion in water (foams)</td>
<td>2</td>
<td>NE</td>
<td>1</td>
<td></td>
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<tr>
<td>2,5-DIHYDROPEROXYPROPAINE</td>
<td>≤ 57</td>
<td>Inert solid</td>
<td>7/3</td>
<td>NE</td>
<td>NE</td>
<td>4</td>
</tr>
<tr>
<td>2,5-DIHYDROXYCYCLOHEXYL PEROXIDE</td>
<td>≤ 100</td>
<td>NE</td>
<td>NE</td>
<td>3</td>
<td>II</td>
<td>50 kg</td>
</tr>
<tr>
<td>DIISOBUTYL PEROXIDE</td>
<td>≤ 52</td>
<td>B ≥ 48</td>
<td>-20/-4</td>
<td>3</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>DIISOBUTYL PEROXIDE</td>
<td>≤ 82</td>
<td>A ≥ 5</td>
<td>≥ 5</td>
<td>NE</td>
<td>NE</td>
<td>3</td>
</tr>
<tr>
<td>DIISOPROPYL BENZENE</td>
<td>≤ 52</td>
<td>B ≥ 48</td>
<td>-20/-4</td>
<td>3</td>
<td>NE</td>
<td>3</td>
</tr>
<tr>
<td>DIISOPROPYL PEROXYDICARBONATE</td>
<td>≤ 52</td>
<td>A ≥ 72</td>
<td>-15/5</td>
<td>2</td>
<td>NE</td>
<td>3</td>
</tr>
<tr>
<td>DILAUROYL PEROXIDE</td>
<td>≤ 100</td>
<td>NE</td>
<td>NE</td>
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<td>2</td>
<td>3</td>
</tr>
<tr>
<td>DILAUROYL PEROXIDE</td>
<td>≤ 82</td>
<td>as a stable dispersion in water</td>
<td>1</td>
<td>NE</td>
<td>1</td>
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</tr>
<tr>
<td>DILAUROYL PEROXIDE</td>
<td>≤ 52</td>
<td>B ≥ 48</td>
<td>-5/23</td>
<td>3</td>
<td>NE</td>
<td>3</td>
</tr>
<tr>
<td>DILAUROYL PEROXIDE</td>
<td>≤ 87</td>
<td>≥ 13</td>
<td>30/86</td>
<td>3</td>
<td>NE</td>
<td>4</td>
</tr>
<tr>
<td>DILAUROYL PEROXIDE + BENZOYL (3-METHYLBENZOYL) PEROXIDE + DIBENZOYL PEROXIDE</td>
<td>≤ 20 + ≤ 18 + ≤ 4</td>
<td>B ≥ 58</td>
<td>35/95</td>
<td>40/104</td>
<td>NE</td>
<td>NE</td>
</tr>
<tr>
<td>DI-(4-METHYLBENZOYL) PEROXIDE</td>
<td>≤ 52</td>
<td>as a paste with silicon oil</td>
<td>NE</td>
<td>NE</td>
<td>3</td>
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</tr>
<tr>
<td>2,5-DIMETHYL-1,5-DI-BENZOYLPEROXOHEXANE</td>
<td>&gt; 82-100</td>
<td>NE</td>
<td>3</td>
<td>50 kg</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2,5-DIMETHYL-1,5-DI-BENZOYLPEROXOHEXANE</td>
<td>≤ 82</td>
<td>Inert solid</td>
<td>18</td>
<td>1</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>2,5-DIMETHYL-1,5-DI-BENZOYLPEROXOHEXANE</td>
<td>&lt; 90 - 100</td>
<td>NE</td>
<td>3</td>
<td>50 kg</td>
<td></td>
<td></td>
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<td>2,5-DIMETHYL-1,5-DI-BENZOYLPEROXOHEXANE</td>
<td>≤ 52</td>
<td>A ≥ 10</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>2,5-DIMETHYL-1,5-DI-BENZOYLPEROXOHEXANE</td>
<td>≤ 77</td>
<td>Inert solid</td>
<td>23</td>
<td>2</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>2,5-DIMETHYL-1,5-DI-BENZOYLPEROXOHEXANE</td>
<td>≤ 52</td>
<td>A ≥ 48</td>
<td>NE</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>2,5-DIMETHYL-2,5-DI-BENZOYLPEROXOHEXANE</td>
<td>≤ 52</td>
<td>Inert solid</td>
<td>48</td>
<td>1</td>
<td>NE</td>
<td>3</td>
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<tr>
<td>2,5-DIMETHYL-2,5-DI-BENZOYLPEROXOHEXANE</td>
<td>≤ 80-100</td>
<td>Inert solid</td>
<td>18</td>
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<td>2</td>
</tr>
<tr>
<td>2,5-DIMETHYL-2,5-DI-BENZOYLPEROXOHEXANE</td>
<td>&gt; 80-100</td>
<td>NE</td>
<td>3</td>
<td>50 liter</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2,5-DIMETHYL-2,5-DI-BENZOYLPEROXOHEXANE</td>
<td>≤ 52</td>
<td>A ≥ 14</td>
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<td>2</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>2,5-DIMETHYL-2,5-DI-BENZOYLPEROXOHEXANE</td>
<td>≥ 52</td>
<td>Inert solid</td>
<td>48</td>
<td>1</td>
<td>NE</td>
<td>3</td>
</tr>
<tr>
<td>2,5-DIMETHYL-2,5-DI-BENZOYLPEROXOHEXANE</td>
<td>≤ 100</td>
<td>20/68</td>
<td>25/77</td>
<td>2</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Compound</td>
<td>≤/≥</td>
<td>Vol.</td>
<td>I</td>
<td>II</td>
<td>III</td>
<td>kg/litre</td>
</tr>
<tr>
<td>-------------------------------------------------------------------------</td>
<td>-----</td>
<td>-------</td>
<td>---</td>
<td>----</td>
<td>-----</td>
<td>---------</td>
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<tr>
<td>2,5-DIMETHYL-2,5-DIHYDROPEROXYHEXANE</td>
<td>82/18</td>
<td>50</td>
<td></td>
<td></td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>2,5-DIMETHYL-2,5-DI-(3,5,5-TRIMETHYLHEXANOYL)-PEROXYHEXANE</td>
<td>77/23</td>
<td>60</td>
<td></td>
<td></td>
<td>NE</td>
<td>2</td>
</tr>
<tr>
<td>1,1-DIMETHYL-3-HYDROXYBUTYL PEROXYNEOPENTANOATE</td>
<td>52/48</td>
<td>225</td>
<td>2</td>
<td>2</td>
<td>II</td>
<td></td>
</tr>
<tr>
<td>DYMIRYSTYL PEROXYDICARBONATE</td>
<td>100/50</td>
<td>50</td>
<td></td>
<td></td>
<td>1</td>
<td>NE</td>
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<td>DYMIRYSTYL PEROXYDICARBONATE as a stable</td>
<td>62/48</td>
<td>60</td>
<td></td>
<td></td>
<td>NE</td>
<td>2</td>
</tr>
<tr>
<td>202-NEODECANOYLPEROXYISOPROPYL) ISOYVENE</td>
<td>52/48</td>
<td>50</td>
<td></td>
<td></td>
<td>NE</td>
<td>3</td>
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<td>202-6-NONANOYL PEROXIDE</td>
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<td>50</td>
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<td></td>
<td>NE</td>
<td>3</td>
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<tr>
<td>202-6-OCTANOYL PEROXIDE</td>
<td>100/50</td>
<td>50</td>
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<td></td>
<td>NE</td>
<td>3</td>
</tr>
<tr>
<td>202-2-PHENOXYETHYL PEROXYDICARBONATE</td>
<td>85/100</td>
<td>25</td>
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<td>NE</td>
<td>4</td>
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<td>202-2-PHENOXYETHYL PEROXYDICARBONATE</td>
<td>85/15</td>
<td>50</td>
<td></td>
<td></td>
<td>NE</td>
<td>3</td>
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<td>DIPROPIONYL PEROXIDE</td>
<td>27/73</td>
<td>225</td>
<td></td>
<td></td>
<td>NE</td>
<td>2</td>
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<tr>
<td>202-3-PROPYL PEROXYDICARBONATE</td>
<td>100/25</td>
<td>60</td>
<td></td>
<td></td>
<td>4</td>
<td>3</td>
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<tr>
<td>202-6-PROPYL PEROXYDICARBONATE</td>
<td>77/22</td>
<td>60</td>
<td></td>
<td></td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>DISUCCINIC ACID PEROXIDE</td>
<td>72/50</td>
<td>50</td>
<td></td>
<td></td>
<td>NE</td>
<td>3</td>
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<tr>
<td>DISUCCINIC ACID PEROXIDE as a stable</td>
<td>52/82</td>
<td>60</td>
<td></td>
<td></td>
<td>NE</td>
<td>2</td>
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<tr>
<td>202-(3,5,5-TRIMETHYLHEXANOYL) PEROXIDE</td>
<td>77/28</td>
<td>60</td>
<td></td>
<td></td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>202-(3,5,5-TRIMETHYLHEXANOYL) PEROXIDE as a stable</td>
<td>52/82</td>
<td>60</td>
<td></td>
<td></td>
<td>NE</td>
<td>2</td>
</tr>
<tr>
<td>202-(3,5,5-TRIMETHYLHEXANOYL) PEROXIDE</td>
<td>52/50</td>
<td>60</td>
<td></td>
<td></td>
<td>NE</td>
<td>2</td>
</tr>
<tr>
<td>ETHYL 3,3-DI-(tert-AMYL)PEROXYBUTYRATE</td>
<td>67/33</td>
<td>60</td>
<td></td>
<td></td>
<td>NE</td>
<td>2</td>
</tr>
<tr>
<td>ETHYL 3,3-DI-(tert-BUTYL)PEROXYBUTYRATE</td>
<td>77/100</td>
<td>60</td>
<td></td>
<td></td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>ETHYL 3,3-DI-(tert-BUTYL)PEROXYBUTYRATE</td>
<td>77/23</td>
<td>60</td>
<td></td>
<td></td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>ETHYL 3,3-DI-(tert-BUTYL)PEROXYBUTYRATE</td>
<td>52/48</td>
<td>50</td>
<td></td>
<td></td>
<td>1</td>
<td>NE</td>
</tr>
<tr>
<td>ISOPROPYL sec-Butyl PEROXYDICARBONATE+DI-sec-Butyl PEROXYDICARBONATE</td>
<td>32/45</td>
<td>60</td>
<td></td>
<td></td>
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<td>3</td>
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<tr>
<td>ISOPROPYL sec-Butyl PEROXYDICARBONATE+DI-sec-Butyl PEROXYDICARBONATE</td>
<td>52/18</td>
<td>60</td>
<td></td>
<td></td>
<td>NE</td>
<td>3</td>
</tr>
<tr>
<td>ISOPROPYL sec-Butyl PEROXYDICARBONATE+DI-sec-Butyl PEROXYDICARBONATE</td>
<td>52/18</td>
<td>60</td>
<td></td>
<td></td>
<td>NE</td>
<td>3</td>
</tr>
<tr>
<td>ISOPROPYL sec-Butyl PEROXYDICARBONATE+DI-sec-Butyl PEROXYDICARBONATE</td>
<td>52/18</td>
<td>60</td>
<td></td>
<td></td>
<td>NE</td>
<td>3</td>
</tr>
<tr>
<td>Compound</td>
<td>≤ 72</td>
<td>A ≥ 28</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>III</td>
</tr>
<tr>
<td>----------------------------------------------</td>
<td>------</td>
<td>--------</td>
<td>-----</td>
<td>-----</td>
<td>-----</td>
<td>-----</td>
</tr>
<tr>
<td>Isopropylcumyl hydroperoxide</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3-Methyl hydroperoxide</td>
<td>≤ 72</td>
<td>-100</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3-Methyl hydroperoxide</td>
<td>≤ 72</td>
<td>-100</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Methylocyclohexanone peroxide(S)</td>
<td>≤ 67</td>
<td>B ≥ 33</td>
<td>35/95</td>
<td>40/104</td>
<td>NE</td>
<td>NE</td>
</tr>
<tr>
<td>Methylethyl ketone peroxide(S)</td>
<td>See remark 8</td>
<td>A ≤ 48</td>
<td>3</td>
<td>NE</td>
<td>4</td>
<td>I</td>
</tr>
<tr>
<td>Methylethyl ketone peroxide(S)</td>
<td>See remark 9</td>
<td>A ≥ 55</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>II</td>
</tr>
<tr>
<td>Methylethyl ketone peroxide(S)</td>
<td>See remark 10</td>
<td>A ≥ 60</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>II</td>
</tr>
<tr>
<td>Methyisobutyl ketone peroxide(S)</td>
<td>≤ 62</td>
<td>A ≥ 19</td>
<td>NE</td>
<td>2</td>
<td>3</td>
<td>II</td>
</tr>
<tr>
<td>Methylethyl ketone peroxide(S)</td>
<td>See remark 31</td>
<td>A ≥ 70</td>
<td>NE</td>
<td>NE</td>
<td>1</td>
<td>III</td>
</tr>
<tr>
<td>Organic peroxide, liquid, sample</td>
<td>NE</td>
<td>NE</td>
<td>NE</td>
<td>NE</td>
<td>II</td>
<td>60 liter</td>
</tr>
<tr>
<td>Organic peroxide, liquid, sample, temperature controlled</td>
<td>NE</td>
<td>NE</td>
<td>NE</td>
<td>NE</td>
<td>II</td>
<td>60 liter</td>
</tr>
<tr>
<td>Organic peroxide, solid, sample</td>
<td>NE</td>
<td>NE</td>
<td>NE</td>
<td>NE</td>
<td>II</td>
<td>50 kg</td>
</tr>
<tr>
<td>3,3,5,7-pentamethyl-1,2,4-trioxepane</td>
<td>≤ 100</td>
<td></td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>II</td>
</tr>
<tr>
<td>Peroxyacetic acid, Type D, stabilized</td>
<td>≤ 43</td>
<td></td>
<td>NE</td>
<td>NE</td>
<td>3</td>
<td>II</td>
</tr>
<tr>
<td>Peroxyacetic acid, Type E, stabilized</td>
<td>≤ 43</td>
<td></td>
<td>NE</td>
<td>NE</td>
<td>2</td>
<td>III</td>
</tr>
<tr>
<td>Peroxyacetic acid, Type F, stabilized</td>
<td>≤ 43</td>
<td></td>
<td>NE</td>
<td>NE</td>
<td>1</td>
<td>IV</td>
</tr>
<tr>
<td>Peroxyvaleric acid</td>
<td>≤ 100</td>
<td></td>
<td>35/95</td>
<td>40/104</td>
<td>NE</td>
<td>NE</td>
</tr>
<tr>
<td>Pinanyl hydroperoxide</td>
<td>≤ 56</td>
<td>A ≥ 44</td>
<td>NE</td>
<td>NE</td>
<td>1</td>
<td>III</td>
</tr>
<tr>
<td>Pinanyl hydroperoxide</td>
<td>≤ 52</td>
<td>B ≥ 48</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1,1,3,3-tetramethylbutyl hydroperoxide</td>
<td>≤ 100</td>
<td></td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>II</td>
</tr>
<tr>
<td>1,1,3,3-tetramethylbutyl peroxy-2 ethyl hexanoate</td>
<td>≤ 100</td>
<td></td>
<td>15/59</td>
<td>20/68</td>
<td>NE</td>
<td>3</td>
</tr>
<tr>
<td>1,1,3,3-tetramethylbutyl peroxyneodecanate</td>
<td>≤ 72</td>
<td>B ≥ 28</td>
<td>-5/23</td>
<td>5/41</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>1,1,3,3-tetramethylbutyl peroxyneodecanate</td>
<td>≤ 52 as a stable dispersion in water</td>
<td>-5/23</td>
<td>5/41</td>
<td>1</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>1,1,3,3-tetramethylbutyl peroxyvalerate</td>
<td>≤ 77</td>
<td>A ≥ 23</td>
<td>0/32</td>
<td>10/50</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>3,6,9-triethyl-3,6,9-trimethyl-1,4,7 triperoxynane</td>
<td>≤ 42</td>
<td>A ≥ 58</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>II</td>
</tr>
</tbody>
</table>

* See Table of Subsidiary Risks and Remarks

** Depending on package used for the tests

Diluents Type A - are organic liquids which are compatible with the organic peroxide and which have a boiling point of not less than 150 C. Type A diluents may be used for desensitizing all organic peroxides.
Diluents Type B - are organic liquids which are compatible with the organic peroxide and which have a boiling point of less than 150 °C but not less than 60 °C and a flash point of not less than 5 °C. Type B diluents may be used for desensitizing of all organic peroxides providing that the boiling point is at least 60 °C higher than the SADT in a 50 kg package.

<table>
<thead>
<tr>
<th>Footnote</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>8)</td>
<td>Available (or Active) oxygen &gt; 10% and ≤ 10.7%, with or without water</td>
</tr>
<tr>
<td>9)</td>
<td>Available (or Active) oxygen ≤ 10% with or without water</td>
</tr>
<tr>
<td>10)</td>
<td>Available (or Active) oxygen ≤ 8.2% with or without water</td>
</tr>
<tr>
<td>31)</td>
<td>Active oxygen ≤ 6.7%</td>
</tr>
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</table>
F.2.3 Typical Class I Formulations.
### Table F.2.3 Typical Class I Formulations

<table>
<thead>
<tr>
<th>Organic Peroxide</th>
<th>Concentration</th>
<th>Diluent</th>
<th>Water Temperature °C</th>
<th>C/F</th>
<th>C/F</th>
<th>Health</th>
<th>Flammability</th>
<th>Reactivity</th>
<th>Containers</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Butyl hydroperoxide</td>
<td>98</td>
<td>Water, A</td>
<td>&gt;10/24</td>
<td>0.52</td>
<td></td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>5 gal (19 L)</td>
</tr>
<tr>
<td>1. Butyl monopropionate peroxide</td>
<td>98</td>
<td></td>
<td>2</td>
<td>3</td>
<td></td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>50 gal (190 L)</td>
</tr>
<tr>
<td>1. Butyl peroxide</td>
<td>76</td>
<td>CMS</td>
<td>&gt;10</td>
<td>0.53</td>
<td></td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>5 gal (19 L)</td>
</tr>
<tr>
<td>1. Butyl peroxypivaloyl carbonate</td>
<td>55</td>
<td>CMS</td>
<td>&gt;10</td>
<td>0.39</td>
<td></td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>10 gal (40 L)</td>
</tr>
<tr>
<td>Dibenzoyl peroxide</td>
<td>87</td>
<td></td>
<td>2</td>
<td>2</td>
<td></td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>5 gal (19 L)</td>
</tr>
<tr>
<td>2,2-di- (1,1-diphenyl)cyclohexane</td>
<td>98</td>
<td>Dibutyl</td>
<td>&gt;10</td>
<td>0.5</td>
<td></td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>10 gal (40 L)</td>
</tr>
<tr>
<td>Diazoxyl peroxide</td>
<td>50</td>
<td>Dibutyl</td>
<td>&gt;10</td>
<td>0.5</td>
<td></td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>10 gal (40 L)</td>
</tr>
<tr>
<td>2,6-di- (1,1-diphenyl)benzene</td>
<td>98</td>
<td>Solvent</td>
<td>2</td>
<td>2</td>
<td></td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>10 gal (40 L)</td>
</tr>
<tr>
<td>Dicyclohexyl peroxide peroxide</td>
<td>88</td>
<td></td>
<td>3</td>
<td>2</td>
<td></td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>5 gal (19 L)</td>
</tr>
<tr>
<td>Di a. propiol peroxide peroxide</td>
<td>88</td>
<td></td>
<td>3</td>
<td>2</td>
<td></td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>5 gal (19 L)</td>
</tr>
</tbody>
</table>

1. These columns refer to temperatures in the Department of Transportation (DOT) Organic Peroxides Table. Refer to document 49 CFR 173.225 for details.

2. The columns refer to NFPA 704 hazard ratings for health, flammability, and reactivity. See NFPA 704 for details.

Note: Diluents: CMS = Colorless mineral spirits; A = Di-CH = Tertiary butanol.

### Table F.2.3(a) Typical Class I Formulations

<table>
<thead>
<tr>
<th>Organic Peroxide Formula</th>
<th>Concentration</th>
<th>Diluent</th>
<th>Water Temperature °C</th>
<th>C/F</th>
<th>C/F</th>
<th>Health</th>
<th>Flammability</th>
<th>Reactivity</th>
<th>Storage Class</th>
<th>Max. Container Size</th>
<th>Subsidiary Risks and Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACETYL CYCLOHEXANESULPHONYL PEROXIDE</td>
<td>≤ 82</td>
<td>≥ 12</td>
<td>&gt;10/14</td>
<td>0.52</td>
<td></td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>55 lb (25 kg)</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>1. AMYL PEROXY ISOPROPYL CARBONATE</td>
<td>≤ 97</td>
<td>A ≥ 23</td>
<td>2</td>
<td>3</td>
<td></td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>16 gal (60 L)</td>
<td>13</td>
<td></td>
</tr>
<tr>
<td>1. AMYLPEROXY-3,5,5-TRIMETHYLXANATE</td>
<td>≤ 100</td>
<td></td>
<td>2</td>
<td>3</td>
<td></td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>16 gal (60 L)</td>
<td>13</td>
<td></td>
</tr>
<tr>
<td>1. BUTYL HYDROPEROXIDE</td>
<td>&gt;79–90</td>
<td>≥ 10</td>
<td>3</td>
<td>2</td>
<td></td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>16 gal (60 L)</td>
<td>13</td>
<td></td>
</tr>
<tr>
<td>1. BUTYL HYDROPEROXIDE +DI / BUTYLPEROXIDE</td>
<td>&lt; 82 + &lt;7</td>
<td></td>
<td>3</td>
<td>2</td>
<td></td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>16 gal (60 L)</td>
<td>13</td>
<td></td>
</tr>
<tr>
<td>1. BUTYL MONOPEROXYMALLEATE</td>
<td>&gt; 52–100</td>
<td></td>
<td>3</td>
<td>2</td>
<td></td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>16 gal (60 L)</td>
<td>13</td>
<td></td>
</tr>
<tr>
<td>1. BUTYL PEROXYACAETE</td>
<td>&gt; 52–77</td>
<td>A ≥ 23</td>
<td>2</td>
<td>2</td>
<td></td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>8 gal (30 L)</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>1. BUTYL PEROXYDIETHYLACETE</td>
<td>≤ 100</td>
<td>20/68</td>
<td>25/77</td>
<td>3</td>
<td></td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>16 gal (60 L)</td>
<td>13</td>
<td></td>
</tr>
<tr>
<td>1. BUTYL PEROXYSOBUTRATE</td>
<td>≥ 52–77</td>
<td>B ≥ 23</td>
<td>15/59</td>
<td>2</td>
<td></td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>8 gal (30 L)</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>1. BUTYL PEROXY-2-METHYL BENZOATE</td>
<td>≤ 100</td>
<td></td>
<td>3</td>
<td>4</td>
<td></td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>16 gal (60 L)</td>
<td>13</td>
<td></td>
</tr>
<tr>
<td>3-CHLOROPEROXYBENZOIC ACID</td>
<td>≥ 57–86</td>
<td>Inert</td>
<td>&gt;14</td>
<td>3</td>
<td></td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>55 lb (25 kg)</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>CUMYL PEROXYNEODECANOATE</td>
<td>≤ 87</td>
<td>A ≥ 13</td>
<td>&gt;10/14</td>
<td>0.5</td>
<td></td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>16 gal (60 L)</td>
<td>13</td>
<td></td>
</tr>
<tr>
<td>CYCLOHEXANONE PEROXIDE(S)</td>
<td>≤ 91</td>
<td>≥ 9</td>
<td>3</td>
<td>3</td>
<td></td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>55 lb (25 kg)</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>2,2-di-(1-AMYLPEROXY) BUTANE</td>
<td>≤ 97</td>
<td>A ≥ 43</td>
<td>2</td>
<td>3</td>
<td></td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>16 gal (60 L)</td>
<td>13</td>
<td></td>
</tr>
<tr>
<td>1,1-di- [1-AMYLPEROXYCYCLOHEXANE</td>
<td>≤ 82</td>
<td>Inert</td>
<td>&gt;14</td>
<td>3</td>
<td></td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>16 gal (60 L)</td>
<td>13</td>
<td></td>
</tr>
<tr>
<td>DIBENZOYL PEROXIDE</td>
<td>&gt;51–100</td>
<td>Inert</td>
<td>&gt;14</td>
<td>3</td>
<td></td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>16 gal (60 L)</td>
<td>13</td>
<td></td>
</tr>
<tr>
<td>DIBENZOYL PEROXIDE</td>
<td>&gt; 77–94</td>
<td>≥ 6</td>
<td>2</td>
<td>4</td>
<td></td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>55 lb (25 kg)</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Di(4- / (BUTYL CYCLOHEXYL) PEROXOCARBONATE</td>
<td>≥ 100</td>
<td>20/85</td>
<td>35/95</td>
<td>3</td>
<td></td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>16 gal (60 L)</td>
<td>13</td>
<td></td>
</tr>
<tr>
<td>1,1-DI- [1- (BUTYLPEROXYCARBONYLOXY) CYCLOHEXANE</td>
<td>≤ 72</td>
<td>A ≥ 28</td>
<td>NE</td>
<td>NE</td>
<td></td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>16 gal (60 L)</td>
<td>13</td>
<td></td>
</tr>
<tr>
<td>1,1-DI- [1- (BUTYLPEROXY) CYCLOHEXANE</td>
<td>≥ 80–100</td>
<td></td>
<td>2</td>
<td>4</td>
<td></td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>16 gal (60 L)</td>
<td>13</td>
<td></td>
</tr>
<tr>
<td>Di- sec -BUTYL PEROXYDICARBONATE</td>
<td>≥ 52–100</td>
<td>&lt;20/4</td>
<td>&lt;10/14</td>
<td>3</td>
<td></td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>16 gal (60 L)</td>
<td>13</td>
<td></td>
</tr>
<tr>
<td>1,1-di-(1- Butoxyperoxy)-3,5,5-TRIMETHYL CYCLOHEXANE</td>
<td>≥ 90</td>
<td>B ≥ 18</td>
<td>2</td>
<td>4</td>
<td></td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>16 gal (60 L)</td>
<td>13</td>
<td></td>
</tr>
</tbody>
</table>

1. These columns refer to temperatures in the Department of Transportation (DOT) Organic Peroxides Table. Refer to document 49 CFR 173.225 for details.

2. The columns refer to NFPA 704 hazard ratings for health, flammability, and reactivity. See NFPA 704 for details.

Note: Diluents: OMS = Odorless mineral spirits; A = Di-CH = Tertiary butanol.
<table>
<thead>
<tr>
<th>Organic Peroxide Formulation</th>
<th>Concentration</th>
<th>Diluent</th>
<th>Water</th>
<th>C/F</th>
<th>C/F</th>
<th>Health</th>
<th>Flammability</th>
<th>Instability</th>
<th>Storage Class</th>
<th>Max. Container Size</th>
<th>Subsidiary Risks and Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>DI-4-CHLOROBENZOYL PEROXIDE</td>
<td>≤ 77</td>
<td>≥ 23</td>
<td></td>
<td>NE</td>
<td>NE</td>
<td>4</td>
<td>1</td>
<td></td>
<td>55 lb (25 kg)**</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>DICYCLOHEXYL PEROXYDICARBONATE</td>
<td>&gt; 81–100</td>
<td>10/50</td>
<td>15/99</td>
<td>NE</td>
<td>NE</td>
<td>4</td>
<td>1</td>
<td></td>
<td>55 lb (25 kg)**</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>DI-2,4-DICHLOROBENZOYL PEROXIDE</td>
<td>≤ 77</td>
<td>≥ 23</td>
<td></td>
<td>NE</td>
<td>NE</td>
<td>4</td>
<td>1</td>
<td></td>
<td>55 lb (25 kg)**</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>DI(2-ETHOXYETHYL) PEROXYDICARBONATE</td>
<td>≤ 52</td>
<td>B ≥ 48</td>
<td>10/14</td>
<td>0/32</td>
<td>NE</td>
<td>NE</td>
<td>3</td>
<td></td>
<td>16 gal (60 L)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2,2-DIHYDROPEROXYPROPANE</td>
<td>≤ 27</td>
<td>Inert</td>
<td>solid</td>
<td>NE</td>
<td>NE</td>
<td>4</td>
<td>1</td>
<td></td>
<td>55 lb (25 kg)**</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>DISOCTYL PEROXIDE</td>
<td>&gt; 32–52</td>
<td>B ≥ 48</td>
<td>20/4</td>
<td>10/14</td>
<td>3</td>
<td>4</td>
<td>4</td>
<td></td>
<td>8 gal (30 L)</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>DISOPROPYL PEROXYDICARBONATE</td>
<td>&gt; 52–100</td>
<td>≥ 15/5</td>
<td>≥ 5/23</td>
<td>5/41</td>
<td>NE</td>
<td>NE</td>
<td>3</td>
<td></td>
<td>16 gal (60 L)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DI(2-METHOXYBUTYL) PEROXYDICARBONATE</td>
<td>≤ 52</td>
<td>B ≥ 48</td>
<td>≥ 5/23</td>
<td>5/41</td>
<td>NE</td>
<td>NE</td>
<td>3</td>
<td></td>
<td>16 gal (60 L)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DI-(2-METHYL)BENZOYL PEROXIDE</td>
<td>≤ 87</td>
<td>≥ 13</td>
<td>30/86</td>
<td>35/95</td>
<td>3</td>
<td>NE</td>
<td>4</td>
<td>1</td>
<td>55 lb (25 kg)**</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>2,5-DIMETHYL-2,5-DI-(BENZOYLPEROXYHEXANE)</td>
<td>&gt; 82–100</td>
<td>1</td>
<td>2</td>
<td>4</td>
<td>1</td>
<td>55 lb (25 kg)</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2,5-DIMETHYL-2,5-DI-(1-BUTYLPEROXYHEXANE)</td>
<td>&gt; 86–100</td>
<td>1</td>
<td>2</td>
<td>4</td>
<td>1</td>
<td>8 gal (30 L)</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DI(2-PHENOXOETHYL) PEROXYDICARBONATE</td>
<td>&gt;85–100</td>
<td>1</td>
<td>NE</td>
<td>4</td>
<td>1</td>
<td>55 lb (25 kg)</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DI- n-PROPYL PEROXYDICARBONATE</td>
<td>≤ 100</td>
<td>≥ 25/13</td>
<td>15/5</td>
<td>2</td>
<td>4</td>
<td>3</td>
<td>1</td>
<td>16 gal (60 L)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DISUCCINIC ACID PEROXIDE</td>
<td>&gt; 72–100</td>
<td>≥ 23</td>
<td>20/4</td>
<td>10/14</td>
<td>2</td>
<td>4</td>
<td>3</td>
<td></td>
<td>16 gal (60 L)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ISO Propyl, sec-BUTYL PEROXYDICARBONATE +</td>
<td>≤ 52 + ≤ 28 + ≤</td>
<td>22</td>
<td>20/4</td>
<td>10/14</td>
<td>1</td>
<td>8 gal (30 L)</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DI- n-PROPYL PEROXYDICARBONATE + DI-ISOPROPYL PEROXYDICARBONATE</td>
<td>2</td>
<td>4</td>
<td>4</td>
<td>8 gal (30 L)</td>
<td>1</td>
<td>3</td>
<td>8,13</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>METHYL ETHYL KETONE PEROXIDE(S)</td>
<td>See remark 8</td>
<td>A ≥ 48</td>
<td></td>
<td>NE</td>
<td>NE</td>
<td>4</td>
<td></td>
<td>8 gal (30 L)</td>
<td>3</td>
<td>8,13</td>
<td></td>
</tr>
</tbody>
</table>

** Depending on package used for tests.

* These columns refer to temperatures in the Department of Transportation (DOT) Organic Peroxides Table. (See 49 CFR 173.225 for more information.)

† The column refers to NFPA 704 hazard ratings for health, flammability, and instability. (See NFPA 704 for more information.)

‡ See Table F.7

§ See NFPA 30 for additional storage requirements.
Recommended Maximum Temperatures*

Organic Peroxide Formulation
ACETYL CYCLOHEXANESULPHONYL PEROXIDE
tert-AMYL PEROXY ISOPROPYL CARBONATE
tert-AMYLPEROXY-3,5,5-TRIMETHYLHEXANOATE
tert-BUTYL HYDROPEROXIDE
tert-BUTYL HYDROPEROXIDE +DI-tert-BUTYLPEROXIDE
tert-BUTYL MONOPEROXYMALEATE
tert-BUTYL PEROXYACETATE
tert-BUTYL PEROXYDIETHYLACETATE
tert-BUTYL PEROXYISOBUTYRATE
tert-BUTYL PEROXY-2-METHYLBENZOATE
3-CHLOROPEROXYBENZOIC ACID
CUMYL PEROXYNEODECANOATE
CYCLOHEXANONE PEROXIDE(S)
2,2-DI-(tert-AMYLPEROXY)BUTANE
1,1-DI-(tert-AMYLPEROXY)CYCLOHEXANE
DIBENZOYL PEROXIDE
DIBENZOYL PEROXIDE
DI-(4-tert-BUTYLCYCLOHEXYL) PEROXYDICARBONATE
1,6-DI-(tert-BUTYLPEROXYCARBONYLOXY) HEXANE
1,1-DI-(tert-BUTYLPEROXY) CYCLOHEXANE
DI-sec-BUTYL PEROXYDICARBONATE
1,1-DI-(tert-BUTYLPEROXY)-3,3,5-TRIMETHYLCYCLOHEXANE
1,1-DI-(tert-BUTYLPEROXY)-3,3,5-TRIMETHYLCYCLOHEXANE
DI-4-CHLOROBENZOYL PEROXIDE
DICYCLOHEXYL PEROXYDICARBONATE
DI-2,4-DICHLOROBENZOYL PEROXIDE
DI-(2-ETHOXYETHYL) PEROXYDICARBONATE
2,2-DIHYDROPEROXYPROPANE
DIISOBUTYRYL PEROXIDE
DIISOPROPYL PEROXYDICARBONATE
DI-(3-METHOXYBUTYL) PEROXYDICARBONATE
DI-(2-METHYLBENZOYL) PEROXIDE
2,5-DIMETHYL-2,5-DI-(BENZOYLPEROXY)HEXANE
2,5-DIMETHYL-2,5-DI-(tert-BUTYLPEROXY)HEXYNE-3
DI-(2-PHENOXYETHYL) PEROXYDICARBONATE
DI-n-PROPYL PEROXYDICARBONATE
DI-n-PROPYL PEROXYDICARBONATE
DISUCCINIC ACID PEROXIDE
ISOPROPYL sec-BUTYL PEROXYDICARBONATE + DI-sec-BUTYL
PEROXYDICARBONATE+DI-ISOPROPYL PEROXYDICARBONATE
METHYL ETHYL KETONE PEROXIDE(S)

Remark 8)

Concentration
≤ 82
≤77
≤ 100
>79 - 90
< 82 + >9
> 52 - 100
> 52 - 77
≤ 100
> 52 - 77
≤ 100
> 57 - 86
≤ 87
≤ 91
≤ 57
≤ 82
> 51 - 100
> 77 - 94
≤ 100
≤ 72
> 80 - 100
> 52 - 100
> 90 - 100
≤ 90

Diluent

Control
C/F

Emergency
C/F

≥ 12

-10/14

0/32

A ≥ 23
≥ 10

≥7
A ≥ 23
20/68
15/59

B ≥ 23
Inert solid ≥ 14
A ≥ 13

-10/14

25/77
20/68

0/32

≥9
A ≥ 43
A ≥ 18
Inert solid ≤ 48
≥6

Flammability
NE
2
2
3
4
2
2
2
2
4
NE
3
NE
3
2
4
4
2
NE
2
4
2
2
NE

3
1
1
1
2
2
3

2
2
NE
4
4
NE

Instability
4
3
4
3
3
4
4
3
4
3
4
3
3
3
3
4
4
3
3
4
3
4
4
4
4
4
3
4
4
4
3
4
4
4
4
3
3
4

2
3

4
NE

4
4

35/95

-20/-4

-10/14

10/50

15/59

NE

-10/14

0/32

NE

NE
NE
NE

NE
3
3

NE
4
4

NE

NE
NE

≥ 23
≥ 23

≥ 13

Health
3
NE
2
3
3
3
2
3
1
3
NE
1
3
1
1
2
2
1
NE
1
1
1
1
NE

30/86
A ≥ 28

B ≥ 10
≤ 77
> 91 - 100
≤ 77
≤ 52
B ≥ 48
≤ 27
Inert solid ≥ 73
> 32 - 52
B ≥ 48
> 52-100
≤ 52
B ≥ 48
≤ 87
> 82-100
> 86-100
>85-100
≤ 100
≤ 77
B ≥ 23
> 72-100
≤ 52 + ≤ 28 + ≤ 22

See remark 8)

Water

Hazard Indentification
NFPA 704 ratings†

1

-20/-4
-15/5
-5/23
30/86

-10/14
-5/23
5/41
35/95

-25/-13
-20/-4

-15/5
-10/14

-20/-4

-10/14

A ≥ 48

Available (or Active) oxygen > 10% and < 10.7%, with or without water

Storage Class Max. Container Size
I
I
I
I
I
I
I
I
I
I
I
I
I
I
I
I
I
I
I
I
I
I
I
I
I
I
I
I
I
I
I
I
I
I
I
I
I
I
I

I

25 kg
60 liter
60 liter
60 liter

60 liter
25 kg
30 liter
60 liter
30 liter
60 liter
25 kg
60 liter
50 kg
60 liter
60 liter
25 kg
25 kg
50 kg
60 liter
30 liter
60 liter
30 liter
60 liter
25 kg
25 kg
25 kg
60 liter
25 kg
30 liter
25 kg
60 liter
25 kg
25 kg
30 liter
25 kg
60 liter
60 liter
25 kg
30 liter

30 liter


F.3.3 Typical Class II Formulations.
### Table F.3.3 Typical Class II Formulations

<table>
<thead>
<tr>
<th>Organic Peroxide</th>
<th>Concentration</th>
<th>Diluent</th>
<th>Water</th>
<th>C/F</th>
<th>C/F</th>
<th>Health</th>
<th>Flammability</th>
<th>Reactivity</th>
<th>Container</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.JJi (diallylperoxy)-2-ethylhexanol</td>
<td>52</td>
<td>OMS</td>
<td>55 gal (208 L)</td>
<td>5 gal (19 L)</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>5 gal (19 L)</td>
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<tr>
<td>1.JJl (diallylperoxy)-3,3,5-trimethylcyclohexane</td>
<td>56</td>
<td>OMS</td>
<td>55 gal (208 L)</td>
<td>5 gal (19 L)</td>
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<td>5 gal (19 L)</td>
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<tr>
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<td>OMS</td>
<td>55 gal (208 L)</td>
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<td>2</td>
<td>5 gal (19 L)</td>
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</table>

**Notes:**
- **Control:** Emergency is not shown for these columns.
- The column refers to temperatures in the Department of Transportation (DOT) Organic Peroxides Table. Refer to document 49 CFR 173.225 for details.
- Diluents: BBP — Butyl benzyl phthalate; DMP — Dimethyl phthalate; DTBP — Di-tertiary-butyl peroxide; OMS — Odorless mineral spirits; TBHQ — Tertiary butylhydroquinone.

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**Recommended Maximum Temperatures:***

<table>
<thead>
<tr>
<th>Organic Peroxide Formulation</th>
<th>Concentration</th>
<th>Diluent</th>
<th>Water</th>
<th>C/F</th>
<th>C/F</th>
<th>Health</th>
<th>Flammability</th>
<th>Reactivity</th>
<th>Max. Container Size</th>
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<tbody>
<tr>
<td>ACETYL ACETONE PEROXIDE</td>
<td>≤ 42</td>
<td>A &gt; 48%</td>
<td>≥ 88</td>
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<td>1</td>
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<tr>
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<td>≤ 88</td>
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<td>≥ 6</td>
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<td>2</td>
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<td>10/90</td>
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<td>2</td>
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<tr>
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<td>16 gal (60 L)</td>
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<td>Inert solid ≥ 48</td>
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<td>NE</td>
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<td>440 lb (200 kg)</td>
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<td>2</td>
<td>2</td>
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<tr>
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<td>1</td>
<td>3</td>
<td>16 gal (60 L)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Subsidiary Risks and Remarks:**

- **NFPA 704 Ratings:**
  - 1: Flammable
  - 2: Reactivity
  - 3: Health
  - 4: Flammability
  - 5: Reactivity
  - 6: Health

- **Storage Class:**
  - A: Inert
  - B: Reactive
  - C: Health
  - D: Flammable

- **Recommended Maximum Temperatures:**
  - 1: Solid
  - 2: Liquid
  - 3: Gas

- **Container Size:**
  - 16 gal (60 L)
  - 60 gal (220 L)
  - 440 lb (200 kg)
<p>| Organic Peroxide Formulation | Concentration | Diluent | Water | C/F | C/F | Health | Flammability | Instability | Storage Class | Max. Container Size | Subsidiary Risks and Remarks |
|------------------------------|---------------|---------|-------|-----|-----|--------|--------------|-------------|--------------|----------------|----------------------|----------------------------|
| -BUTYL PEROXYBENZOATE       | &gt; 52–77       | A ≥ 23  |       | 2   | 2   | 3      |              |             |              | 16 gal (60 L) | BA                    |                            |
| -BUTYL PEROXYBENZOATE       | ≤ 52          | Inert solid ≥ 48 |       | 2   | NE  | 3      |              |             |              | 110 lb (50 kg) | BA                    |                            |
| -BUTYL PEROXYBUTYL FORMATE  | ≤ 52          | A ≥ 48  |       |     | NE  | 3      |              |             |              | 16 gal (60 L) | BA                    |                            |
| -BUTYL PEROXYCROTONATE      | ≤ 77          | A ≥ 23  |       | 2   | 2   | 3      |              |             |              | 16 gal (60 L) | BA                    |                            |
| -BUTYL PEROXY-2-ETHYLHEXANOATE | &gt; 52–100     | 20/68   | 25/77 | 1   | 2   | 3      |              |             |              | 16 gal (60 L) | BA                    |                            |
| -BUTYL PEROXY-2-ETHYLHEXANOATE | ≤ 32–52      | B ≥ 48  | 30/86 | 35/95| 1   | 2   | 3      |              |              | 60 gal (220 L) | BA                    |                            |
| -BUTYL PEROXY-2-ETHYLHEXANOATE | ≤ 52          | Inert solid ≥ 48 |       | 1   | NE  | 2      |              |             |              | 440 lb (200 kg) | BA                    |                            |
| -BUTYL PEROXY-2-ETHYLHEXANOATE + 2,2-DI-( tert-BUTYLPEROXY)BUTANE | ≤ 12 &lt; 14 | Inert solid ≥ 50 |       | 1   | NE  | 1      |              |             |              | 110 lb (50 kg) | BA                    |                            |
| -BUTYL PEROXY-2-ETHYLHEXANOATE + 2,2-DI-( tert-BUTYLPEROXY)BUTANE | ≤ 31 &lt; 36 | B ≥ 33  | 35/95 | 40/104| 1   | NE  | 1      |              |              | 16 gal (60 L) | BA                    |                            |
| -BUTYL PEROXY-4-ETHYLXYL CARBONATE | ≤ 100       |       |       | 1   | 1   | 3      |              |             |              | 16 gal (60 L) | BA                    |                            |
| -BUTYL PEROXY-4ISOBUTYRATE  | ≤ 52          | B ≥ 48  | 10/59 | 20/68| 1   | 3   | 3      |              |              | 16 gal (60 L) | BA                    |                            |
| -BUTYL PEROXYISOPOPENTYL CARBONATE | ≤ 77       | A ≥ 23  |       | 2   | 2   | 3      |              |             |              | 16 gal (60 L) | BA                    |                            |
| 1/2 ( tert-BUTYLPEROXY ISOPOPENTYL) | ≤ 77        | A ≥ 23  |       | NE  | NE  | 3      |              |             |              | 440 lb (200 kg) | BA                    |                            |
| 1/2 ( tert-BUTYLPEROXY ISOPOPENTYL) | ≤ 52        | Inert solid ≥ 50 |       | NE  | NE  | 2      |              |             |              | 110 lb (50 kg) | BA                    |                            |
| -BUTYL PEROXYNEODECANOATE   | &gt; 77–100      | −5/23   | 5/41  | 2   | 3   | 3      |              |             |              | 16 gal (60 L) | BA                    |                            |
| -BUTYL PEROXYNEODECANOATE   | ≤ 77          | B ≥ 23  | 0/32  | 10/50| 2   | 2   | 3      |              |              | 16 gal (60 L) | BA                    |                            |
| -BUTYL PEROXYNEOHEPTANOATE  | ≤ 77          | A ≥ 23  | 0/32  | 10/90| 1   | 2   | 3      |              |              | 16 gal (60 L) | BA                    |                            |
| -BUTYL PEROXYPivalate       | &gt; 67–77       | A ≥ 23  | 0/32  | 10/50| 2   | 2   | 3      |              |              | 16 gal (60 L) | BA                    |                            |
| -BUTYL PEROXYPivalate       | ≤ 27–67       | B ≥ 33  | 0/32  | 10/90| 2   | 2   | 3      |              |              | 16 gal (60 L) | BA                    |                            |
| -BUTYL PEROXY STEARYLCARBONATE | ≤ 100        |       |       | NE  | NE  | 3      |              |             |              | 110 lb (50 kg) | BA                    |                            |
| -BUTYL PEROXY-3,5,5- TRIMETHYLCARBOXATE | ≥ 32–100 |       |       | 2   | 1   | 3      |              |             |              | 16 gal (60 L) | BA                    |                            |
| -BUTYL PEROXY-3,5,5- TRIMETHYLCARBOXATE | ≤ 42        | Inert solid ≥ 50 |       | 1   | 2   | 3      |              |             |              | 110 lb (50 kg) | BA                    |                            |
| 3-CHLOROPEROXYBENZOIC ACID  | ≤ 57          | Inert solid ≥ 48 |       | NE  | NE  | 3      |              |             |              | 110 lb (50 kg) | BA                    |                            |
| 3-CHLOROPEROXYBENZOIC ACID  | ≤ 77          | Inert solid ≥ 17 |       | NE  | NE  | 3      |              |             |              | 110 lb (50 kg) | BA                    |                            |
| CUMYL PEROXYNEODECANOATE    | ≤ 77          | B ≥ 23  | −10/14| 0/32 | 1   | 3   | 3      |              |              | 16 gal (60 L) | BA                    |                            |
| CUMYL PEROXYNEOHEPTANOATE   | ≤ 77          | A ≥ 23  | −10/14| 0/32 | 1   | 3   | 3      |              |              | 16 gal (60 L) | BA                    |                            |
| CUMYL PEROXYPivalate        | ≤ 77          | B ≥ 23  | −5/23 | 5/41 | NE  | 3   | 3      |              |              | 16 gal (60 L) | BA                    |                            |
| CYCLOHEXANONE PEROXIDE(S)   | ≤ 72          | A ≥ 28  |       | 3   | NE  | 3      |              |             |              | 110 lb (50 kg) | BA                    |                            |
| CYCLOHEXANONE PEROXIDE(S)   | ≤ 72 as a paste |       |       | 2   | NE  | 3      |              |             |              | 110 lb (50 kg) | BA                    |                            |
| DIACETONE ALCOHOL PEROXIDES | ≤ 57          | B ≥ 26  | ≥ 8   | 40/104| 45/113| NE  | NE  | 3      | 16 gal (60 L) | BA                    |                            |
| DIACETYL PEROXIDE           | ≤ 27          | B ≥ 73  | 20/68 | 25/77| 1   | 2   | 3      |              |              | 60 gal (220 L) | BA                    |                            |
| Di- α AMYL PEROXIDE         | ≤ 100         |       |       | 2   | 4   | 2      |              |             |              | 60 gal (220 L) | BA                    |                            |
| DIBENZOYL PEROXIDE          | ≤ 62          | Inert solid ≥ 16 |       | 2   | NE  | 3      |              |             |              | 110 lb (50 kg) | BA                    |                            |
| DIBENZOYL PEROXIDE          | ≥ 52–62 as a paste |       |       | 2   | NE  | 3      |              |             |              | 110 lb (50 kg) | BA                    |                            |</p>
<table>
<thead>
<tr>
<th>Organic Peroxide Formulation</th>
<th>Concentration</th>
<th>Diluent</th>
<th>Water</th>
<th>C/F</th>
<th>C/F</th>
<th>Health</th>
<th>Flammability</th>
<th>Instability</th>
<th>Storage Class</th>
<th>Max. Container Size</th>
<th>Subsidiary Risks and Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>DIBENZYL PEROXIDE</td>
<td>&gt; 35–52</td>
<td>Inert</td>
<td></td>
<td>2</td>
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<td>II</td>
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<td>110 lb (50 kg)</td>
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<tr>
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<td>≤ 40</td>
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<td>2</td>
<td>II</td>
<td>60 gal (225 L)</td>
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<td>II</td>
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<td>II</td>
<td>110 lb (50 kg)</td>
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<td>2</td>
<td>II</td>
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<td>Di-2-BUTYL PEROXY PHthalate</td>
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<td>A ≥ 58</td>
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<td>NE</td>
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<td>2</td>
<td>II</td>
<td>16 gal (60 L)</td>
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<td>II</td>
<td>16 gal (60 L)</td>
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<tr>
<td>1,1-Di-1- (BUTYL PEROXY) 3,3,5,5-TRIMETHYL CYCLOHEXANE</td>
<td>≤ 77</td>
<td>B ≥ 23</td>
<td>1</td>
<td>NE</td>
<td>2</td>
<td>3</td>
<td>II</td>
<td>60 gal (225 L)</td>
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<tr>
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<td>≤ 57</td>
<td>A ≥ 43</td>
<td>1</td>
<td>NE</td>
<td>2</td>
<td>3</td>
<td>II</td>
<td>60 gal (225 L)</td>
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<td>A ≥ 26</td>
<td>B ≥ 42</td>
<td>1</td>
<td>4</td>
<td>2</td>
<td>II</td>
<td>60 gal (225 L)</td>
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<td>35/95</td>
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<td>3</td>
<td>II</td>
<td>110 lb (50 kg)</td>
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<tr>
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<td>≤ 52 as a paste</td>
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<td></td>
<td>NE</td>
<td>2</td>
<td>3</td>
<td>II</td>
<td>110 lb (50 kg)</td>
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<td></td>
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</tr>
<tr>
<td>DICYCLOHEXYL PEROXYDICARBONATE</td>
<td>≤ 91</td>
<td>≥ 8</td>
<td>10/90</td>
<td>15/99</td>
<td>NE</td>
<td>2</td>
<td>3</td>
<td>II</td>
<td>110 lb (50 kg)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DIODECANOL PEROXIDE</td>
<td>≤ 100</td>
<td>30/86</td>
<td>35/95</td>
<td>1</td>
<td>NE</td>
<td>2</td>
<td>II</td>
<td>110 lb (50 kg)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Di-2,4-DICHLOROBENZYL PEROXIDE</td>
<td>≤ 52 as a paste</td>
<td></td>
<td></td>
<td>NE</td>
<td>2</td>
<td>3</td>
<td>II</td>
<td>110 lb (50 kg)</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Di-2,4-DICHLOROBENZYL PEROXIDE</td>
<td>≤ 52 as a paste with silicon oil</td>
<td>≥ 8</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>II</td>
<td>110 lb (50 kg)</td>
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<tr>
<td>Di-1-ETHYLHEXYL PEROXYDICARBONATE</td>
<td>≥ 77–100</td>
<td>-20–4</td>
<td>-10/14</td>
<td>2</td>
<td>4</td>
<td>3</td>
<td>II</td>
<td>16 gal (60 L)</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Di-1-ETHYLHEXYL PEROXYDICARBONATE</td>
<td>≤ 77</td>
<td>B ≥ 23</td>
<td>-15/5</td>
<td>-5/23</td>
<td>2</td>
<td>4</td>
<td>3</td>
<td>II</td>
<td>16 gal (60 L)</td>
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<td></td>
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<tr>
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<td></td>
<td></td>
<td>NE</td>
<td>2</td>
<td>3</td>
<td>II</td>
<td>110 lb (50 kg)</td>
<td></td>
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<tr>
<td>DIISOBUTYRIL PEROXIDE</td>
<td>≤ 52</td>
<td>B ≥ 68</td>
<td>≤ -20/4</td>
<td>-10/14</td>
<td>3</td>
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<td>2</td>
<td>3</td>
<td>II</td>
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<tr>
<td>DIISOPROPYLBENZENE</td>
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<td>≤ 5</td>
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<td>2</td>
<td>3</td>
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<tr>
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<td>B ≥ 48</td>
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<td>-10/14</td>
<td>3</td>
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<td>II</td>
<td>16 gal (60 L)</td>
<td></td>
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<tr>
<td>DIISOPROPYL PEROXYDICARBONATE</td>
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<td>B ≥ 48</td>
<td>-20–4</td>
<td>-10/14</td>
<td>3</td>
<td>NE</td>
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<td>II</td>
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<td>II</td>
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<td></td>
<td></td>
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<td>Diluent</td>
<td>Water</td>
<td>C/F</td>
<td>C/F</td>
<td>Health</td>
<td>Flammability</td>
<td>Instability</td>
<td>Storage Class</td>
<td>Max. Container Size</td>
<td>Subsidiary Risks and Remarks</td>
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<tr>
<td>Di-(3-METHYL BENOXYL) PEROXIDE + BENZOYL (3-METHYL BENOXYL) PEROXIDE + DIBENZOXYL PEROXIDE</td>
<td>≤ 20 ≤ 18 + ≤ 4</td>
<td>B ≥ 68</td>
<td>35/95</td>
<td>40/104</td>
<td>NE NE</td>
<td>3</td>
<td>III</td>
<td>III</td>
<td>III</td>
<td>16 gal (60 L)</td>
<td>110 lb (50 kg)</td>
</tr>
<tr>
<td>Di-(4-METHYL BENOXYL) PEROXIDE</td>
<td>≤ 52 as a paste with silicone oil</td>
<td>Inert solid 29</td>
<td>1</td>
<td>NE NE</td>
<td>3</td>
<td>III</td>
<td>III</td>
<td>III</td>
<td>III</td>
<td>110 lb (50 kg)</td>
<td>110 lb (50 kg)</td>
</tr>
<tr>
<td>2,5-DIMETHYL-2,5-DI-(BENZOXYL PEROXYHEXANE</td>
<td>≤ 52</td>
<td>≥ 18</td>
<td>1</td>
<td>NE NE</td>
<td>3</td>
<td>III</td>
<td>III</td>
<td>III</td>
<td>III</td>
<td>110 lb (50 kg)</td>
<td>110 lb (50 kg)</td>
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<tr>
<td>2,5-DIMETHYL-2,5-DI-(BENZOXYL PEROXYHEXANE</td>
<td>≤ 52</td>
<td>≥ 18</td>
<td>1</td>
<td>NE NE</td>
<td>3</td>
<td>III</td>
<td>III</td>
<td>III</td>
<td>III</td>
<td>110 lb (50 kg)</td>
<td>110 lb (50 kg)</td>
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<td>&gt; 90–100</td>
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<td>III</td>
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<td>III</td>
<td>16 gal (60 L)</td>
<td>16 gal (60 L)</td>
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<td>3</td>
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<td>III</td>
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<td>440 lb (200 kg)</td>
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<tr>
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<td>Inert solid 29</td>
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<td>1</td>
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<td>III</td>
<td>III</td>
<td>III</td>
<td>III</td>
<td>16 gal (60 L)</td>
<td>16 gal (60 L)</td>
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<tr>
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<td>3</td>
<td>III</td>
<td>III</td>
<td>III</td>
<td>III</td>
<td>16 gal (60 L)</td>
<td>16 gal (60 L)</td>
</tr>
<tr>
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<td>20/68</td>
<td>25/77</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>III</td>
<td>III</td>
<td>III</td>
<td>110 lb (50 kg)</td>
<td>110 lb (50 kg)</td>
</tr>
<tr>
<td>2,5-DIMETHYL-2,5 DI-(BUTYL PEROXYHEXANE</td>
<td>≤ 52</td>
<td>≥ 18</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>III</td>
<td>III</td>
<td>III</td>
<td>III</td>
<td>110 lb (50 kg)</td>
<td>110 lb (50 kg)</td>
</tr>
<tr>
<td>2,5-DIMETHYL-2,5 DI-(BUTYL PEROXYHEXANE</td>
<td>≤ 77</td>
<td>A ≥ 23</td>
<td>1</td>
<td>NE NE</td>
<td>3</td>
<td>III</td>
<td>III</td>
<td>III</td>
<td>III</td>
<td>110 lb (50 kg)</td>
<td>110 lb (50 kg)</td>
</tr>
<tr>
<td>1,1-DIMETHYL-3 HYDROXY BUTYL PEROXYNEOHEXANOTE</td>
<td>≤ 52</td>
<td>A ≥ 48</td>
<td>0/32</td>
<td>10/50</td>
<td>NE NE</td>
<td>2</td>
<td>2</td>
<td>III</td>
<td>III</td>
<td>60 gal (220 L)</td>
<td>60 gal (220 L)</td>
</tr>
<tr>
<td>M ethyl Peroxydicarbonate</td>
<td>≤ 100</td>
<td>20/68</td>
<td>25/77</td>
<td>1</td>
<td>NE NE</td>
<td>3</td>
<td>III</td>
<td>III</td>
<td>III</td>
<td>110 lb (50 kg)</td>
<td>110 lb (50 kg)</td>
</tr>
<tr>
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<td>≤ 52</td>
<td>A ≥ 48</td>
<td>−10/14</td>
<td>0/32</td>
<td>NE NE</td>
<td>3</td>
<td>III</td>
<td>III</td>
<td>III</td>
<td>16 gal (60 L)</td>
<td>16 gal (60 L)</td>
</tr>
<tr>
<td>Di-(3-METHYL NONANOYL) PEROXYISOPROPYL)</td>
<td>≤ 100</td>
<td>0/32</td>
<td>10/50</td>
<td>NE NE</td>
<td>3</td>
<td>III</td>
<td>III</td>
<td>III</td>
<td>III</td>
<td>110 lb (50 kg)</td>
<td>110 lb (50 kg)</td>
</tr>
<tr>
<td>Di-(4-OCTANOL) PEROXYISOPROPYL)</td>
<td>≤ 100</td>
<td>10/50</td>
<td>15/99</td>
<td>1</td>
<td>NE NE</td>
<td>3</td>
<td>III</td>
<td>III</td>
<td>III</td>
<td>110 lb (50 kg)</td>
<td>110 lb (50 kg)</td>
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<tr>
<td>Di-(2-PHENOXYETHYL) PEROXYDICARBONATE</td>
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<td>≥ 15</td>
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<td>3</td>
<td>III</td>
<td>III</td>
<td>III</td>
<td>III</td>
<td>110 lb (50 kg)</td>
<td>110 lb (50 kg)</td>
</tr>
<tr>
<td>D isuccinic acid PEROXIDE</td>
<td>≤ 72</td>
<td>≥ 28</td>
<td>10/50</td>
<td>15/99</td>
<td>3</td>
<td>NE NE</td>
<td>3</td>
<td>III</td>
<td>III</td>
<td>16 gal (60 L)</td>
<td>16 gal (60 L)</td>
</tr>
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<td>Di-(3,5,5-TRIMETHYL HEXANOL) PEROXIDE</td>
<td>&gt; 38–82</td>
<td>A ≥ 18</td>
<td>0/32</td>
<td>10/50</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>III</td>
<td>III</td>
<td>18 gal (60 L)</td>
<td>18 gal (60 L)</td>
</tr>
<tr>
<td>ETHYL 3,3 DI-(4 AMYLPEROXYISOBUTYRATE</td>
<td>≤ 87</td>
<td>A ≥ 33</td>
<td>NE</td>
<td>2</td>
<td>3</td>
<td>III</td>
<td>III</td>
<td>III</td>
<td>III</td>
<td>16 gal (60 L)</td>
<td>16 gal (60 L)</td>
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<tr>
<td>ETHYL 3,3 DI-(4 AMYLPEROXYISOBUTYRATE</td>
<td>&gt; 77–100</td>
<td>Inert solid 29</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>III</td>
<td>III</td>
<td>III</td>
<td>III</td>
<td>16 gal (60 L)</td>
<td>16 gal (60 L)</td>
</tr>
<tr>
<td>ETHYL 3,3 DI-(4 AMYLPEROXYISOBUTYRATE</td>
<td>≤ 77</td>
<td>A ≥ 23</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>III</td>
<td>III</td>
<td>III</td>
<td>III</td>
<td>16 gal (60 L)</td>
<td>16 gal (60 L)</td>
</tr>
<tr>
<td>ETHYL 3,3 DI-(4 AMYLPEROXYISOBUTYRATE</td>
<td>≤ 77</td>
<td>Inert solid 29</td>
<td>48</td>
<td>1</td>
<td>NE NE</td>
<td>3</td>
<td>III</td>
<td>III</td>
<td>III</td>
<td>110 lb (50 kg)</td>
<td>110 lb (50 kg)</td>
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<tr>
<td>1,2 ETHYL HEXANOL PEROXYISOPROPYL)</td>
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<td>A ≥ 45</td>
<td>B ≥ 10</td>
<td>−20/4</td>
<td>−10/14</td>
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<td>NE NE</td>
<td>3</td>
<td>III</td>
<td>18 gal (60 L)</td>
<td>18 gal (60 L)</td>
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<tr>
<td>1,2 ETHYL HEXANOL PEROXYISOPROPYL)</td>
<td>≤ 52</td>
<td>A ≥ 45</td>
<td>B ≥ 10</td>
<td>−20/4</td>
<td>−10/14</td>
<td>2</td>
<td>NE NE</td>
<td>3</td>
<td>III</td>
<td>18 gal (60 L)</td>
<td>18 gal (60 L)</td>
</tr>
<tr>
<td>J HEXYL PEROXYNEODECANATE</td>
<td>≤ 71</td>
<td>A ≥ 29</td>
<td>0/32</td>
<td>10/50</td>
<td>1</td>
<td>NE NE</td>
<td>3</td>
<td>III</td>
<td>III</td>
<td>18 gal (60 L)</td>
<td>18 gal (60 L)</td>
</tr>
<tr>
<td>J HEXYL PEROXYNEODECANATE</td>
<td>≤ 72</td>
<td>B ≥ 28</td>
<td>10/50</td>
<td>15/99</td>
<td>NE NE</td>
<td>3</td>
<td>III</td>
<td>III</td>
<td>III</td>
<td>16 gal (60 L)</td>
<td>16 gal (60 L)</td>
</tr>
<tr>
<td>3 HYDROXY 1,1 DIMETHYLBUTYL PEROXYNEODECANATE</td>
<td>≤ 77</td>
<td>A ≥ 23</td>
<td>−5/23</td>
<td>5/41</td>
<td>NE</td>
<td>3</td>
<td>3</td>
<td>III</td>
<td>III</td>
<td>60 gal (220 L)</td>
<td>60 gal (220 L)</td>
</tr>
<tr>
<td>3 HYDROXY 1,1 DIMETHYLBUTYL PEROXYNEODECANATE</td>
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<td>A ≥ 23</td>
<td>−5/23</td>
<td>5/41</td>
<td>NE</td>
<td>3</td>
<td>3</td>
<td>III</td>
<td>III</td>
<td>60 gal (220 L)</td>
<td>60 gal (220 L)</td>
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<tr>
<td>ISOpropyl, sec-BUTYL PEROXYDICARBONATE + Dio, sec-BUTYL PEROXYDICARBONATE + DIO, iso-SOPROPYL PEROXYDICARBONATE</td>
<td>≤ 32 + ≤ 15 ≤ 18</td>
<td>A ≥ 38</td>
<td>−20/4</td>
<td>−10/14</td>
<td>2</td>
<td>NE NE</td>
<td>3</td>
<td>III</td>
<td>III</td>
<td>16 gal (60 L)</td>
<td>16 gal (60 L)</td>
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<tr>
<td>p M ETHYL HYDROPEROXIDE</td>
<td>&gt; 72–100</td>
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<td>III</td>
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<td>III</td>
<td>III</td>
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<tr>
<td>METHYL CYCLOHEXANONE PEROXIDE(s)</td>
<td>≤ 67</td>
<td>B ≥ 33</td>
<td>35/95</td>
<td>40/104</td>
<td>NE NE</td>
<td>3</td>
<td>III</td>
<td>III</td>
<td>III</td>
<td>16 gal (60 L)</td>
<td>16 gal (60 L)</td>
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<td>See remark 9</td>
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<td>3</td>
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<td>III</td>
<td>III</td>
<td>III</td>
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<td>60 gal (220 L)</td>
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<td>METHYL ETHYL KETONE PEROXIDE(s)</td>
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<td>3</td>
<td>III</td>
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<td>16 gal (60 L)</td>
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<tr>
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<td>A ≥ 19</td>
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<td>III</td>
<td>III</td>
<td>III</td>
<td>16 gal (60 L)</td>
<td>16 gal (60 L)</td>
</tr>
</tbody>
</table>

- **NFPA 704 Ratings**
- **Control Emergency**
- **Recommended Maximum Temperature**
- **Hazard Identification**
<table>
<thead>
<tr>
<th>Organic Peroxide Formulation</th>
<th>Concentration</th>
<th>Diluent</th>
<th>Water</th>
<th>C/F</th>
<th>C/F</th>
<th>Health</th>
<th>Flammability</th>
<th>Instability</th>
<th>Storage Class</th>
<th>Max. Container Size</th>
<th>Subsidiary Risks and Remarks</th>
</tr>
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<tbody>
<tr>
<td>ORGANIC PEROXIDE, LIQUID, SAMPLE</td>
<td></td>
<td>NE</td>
<td>NE</td>
<td>NE</td>
<td>NE</td>
<td>II</td>
<td></td>
<td></td>
<td></td>
<td>16 gal (60 L)</td>
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<td>ORGANIC PEROXIDE, LIQUID, SAMPLE, TEMPERATURE CONTROLLED</td>
<td></td>
<td>NE</td>
<td>NE</td>
<td>NE</td>
<td>NE</td>
<td>II</td>
<td></td>
<td></td>
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<tr>
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<td>NE</td>
<td>NE</td>
<td>NE</td>
<td>II</td>
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<td>NE</td>
<td>NE</td>
<td>NE</td>
<td>II</td>
<td></td>
<td></td>
<td></td>
<td>11 lb (50 kg)</td>
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<td>II</td>
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<td>NE</td>
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<td>3</td>
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<td></td>
<td></td>
<td>16 gal (60 L)</td>
<td>13, 14, 19</td>
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<tr>
<td>PEROXYLauric ACID</td>
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<td>35/95</td>
<td>40/104</td>
<td>NE</td>
<td>NE</td>
<td>II</td>
<td></td>
<td></td>
<td></td>
<td>440 lb (200 kg)</td>
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<tr>
<td>PINANYL HYDROPEROXIDE</td>
<td>&gt; 56–100</td>
<td>NE</td>
<td>NE</td>
<td>NE</td>
<td>3</td>
<td>II</td>
<td></td>
<td></td>
<td></td>
<td>16 gal (60 L)</td>
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<tr>
<td>POLYETHER POLY-1, BUTYLPEROXYCARBONATE</td>
<td>≤ 52</td>
<td>B ≤ 48</td>
<td>NE</td>
<td>4</td>
<td>2</td>
<td>II</td>
<td></td>
<td></td>
<td></td>
<td>60 gal (225 L)</td>
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<td>≤ 100</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td></td>
<td>II</td>
<td></td>
<td></td>
<td></td>
<td>16 gal (60 L)</td>
<td></td>
</tr>
<tr>
<td>1,1,3,3-TETRAMETHYLBUTYL PEROXY-2 ETHYL HEXANATE</td>
<td>≤ 100</td>
<td>15/59</td>
<td>20/68</td>
<td>NE</td>
<td>1</td>
<td>3</td>
<td>II</td>
<td></td>
<td></td>
<td>16 gal (60 L)</td>
<td></td>
</tr>
<tr>
<td>1,1,3,3-TETRAMETHYLBUTYL PEROXYNEODECANATE</td>
<td>≤ 72</td>
<td>B ≤ 28</td>
<td>5/23</td>
<td>5/41</td>
<td>1</td>
<td>3</td>
<td>II</td>
<td></td>
<td></td>
<td>16 gal (60 L)</td>
<td></td>
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<tr>
<td>1,1,3,3-TETRAMETHYLBUTYL PEROXYPHthalate</td>
<td>≤ 77</td>
<td>A ≥ 23</td>
<td>0/32</td>
<td>10/50</td>
<td>2</td>
<td>4</td>
<td>3</td>
<td>II</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>3,6,9-TRIETHYL-3,6,9-TRIMETHYL-1,4,7 TRIPEROXONANE</td>
<td>≤ 42</td>
<td>A ≥ 58</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>II</td>
<td></td>
<td></td>
<td></td>
<td>16 gal (60 L)</td>
<td>28</td>
</tr>
</tbody>
</table>

* These columns refer to temperatures in the Department of Transportation (DOT) Organic Peroxides Table. (See 49 CFR 173.225 for more information.)

† The column refers to NFPA 704 hazard ratings for health, flammability, and instability. (See NFPA 704 for more information.)

‡ See Table F.7.

§ See NFPA 30 for additional storage requirements.

T — Temperature control should be considered to reduce fire hazard depending on packaging size and recommendations in manufacturers' literature.

---

**Supplemental Information**

<table>
<thead>
<tr>
<th>File Name</th>
<th>Description</th>
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**Submitter Information Verification**

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<tr>
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</tr>
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<td>State</td>
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</tr>
<tr>
<td>Submittal Date</td>
<td>Fri Aug 22 15:16:56 EDT 2014</td>
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**Committee Statement**

| Committee Statement | Table update based upon most recent test information. The Committee supports revising the annex based on new test data. See attached XLSX file which is the revised table for Class II organic peroxides and replaces the existing table in the code.  
Note: This was voted on at the first draft meeting but the spreadsheets were hidden and were not changed in the document.

**Response Message:**

[Click here to view the full document](http://submittals.nfpa.org/TerraViewWeb/ContentFetcher?commentPara...)
<table>
<thead>
<tr>
<th>Organic Peroxide Formulation</th>
<th>Concentration</th>
<th>Diluent</th>
<th>Water</th>
<th>Control</th>
<th>Emergency</th>
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<tr>
<td>ACETYL ACETONE PEROXIDE</td>
<td>≥ 42</td>
<td>A ≥ 48%</td>
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<td>≥ 6</td>
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<td>AMYL PEROXY-2-ETHYLHEXANOATE</td>
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<td>25/77</td>
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<td>2 3  II 60 liter</td>
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<td>tert-BUTYL HYDROPEROXIDE</td>
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</tr>
<tr>
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<td>Inert solid ≥ 48</td>
<td></td>
<td>3</td>
<td>NE 2  II 200 kg</td>
</tr>
<tr>
<td>tert-BUTYL PEROXYACETATE</td>
<td>≤ 52 - 52</td>
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<td>2</td>
<td>2  3  II 60 liter</td>
</tr>
<tr>
<td>tert-BUTYL PEROXYBENZOATE</td>
<td>≤ 77 - 100</td>
<td></td>
<td></td>
<td>2</td>
<td>1  3  II 60 liter</td>
</tr>
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<td>tert-BUTYL PEROXYBENZOATE</td>
<td>≤ 52 - 77</td>
<td>A ≥ 23</td>
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<td>2</td>
<td>2  3  II 60 liter</td>
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<td>tert-BUTYL PEROXYBENZOATE</td>
<td>≤ 52</td>
<td>Inert solid ≥ 48</td>
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<td>2</td>
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</tr>
<tr>
<td>tert-BUTYL PEROXYCYCLOTANE</td>
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<td>A ≥ 23</td>
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<td>2</td>
<td>2  3  II 60 liter</td>
</tr>
<tr>
<td>tert-BUTYL PEROXY-2-EHYLHEXANOATE</td>
<td>&gt; 52 - 100</td>
<td>20/08</td>
<td>25/77</td>
<td>1</td>
<td>2 3  II 225 liter</td>
</tr>
<tr>
<td>tert-BUTYL PEROXY-2-EHYLHEXANOATE</td>
<td>&gt; 52 - 52</td>
<td>B ≥ 48</td>
<td>30/86</td>
<td>1</td>
<td>2 2  II 225 liter</td>
</tr>
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<td>tert-BUTYL PEROXY-2-EHYLHEXANOATE</td>
<td>&gt; 52 - 52</td>
<td>Inert solid ≥ 48</td>
<td></td>
<td>2</td>
<td>NE 2  II 225 liter</td>
</tr>
<tr>
<td>tert-BUTYL PEROXY-2-EHYLHEXANOATE + 2,2-DEC-tert-</td>
<td>≤ 12 - ≤ 14</td>
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<td>1</td>
<td>NE 3  II 60 liter</td>
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<tr>
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<td>≤ 31 + ≤ 36</td>
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<td>35/95</td>
<td>40/104</td>
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<td>A ≥ 23</td>
<td></td>
<td>1</td>
<td>1 3  II 60 liter</td>
</tr>
<tr>
<td>tert-BUTYL PEROXY-2-EHYLHEXYL CARBONATE</td>
<td>≤ 52</td>
<td>B ≥ 48</td>
<td>15/59</td>
<td>20/08</td>
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<td>tert-BUTYL PEROXY ISOPROPYL CARBONATE</td>
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<td>2 3  II 60 liter</td>
</tr>
<tr>
<td>tert-2-tet-BUTYL PEROXY ISOPROPYL-1,3-ISOPROPENYL BENZENE</td>
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<td>A ≥ 23</td>
<td></td>
<td>2</td>
<td>2 3  II 60 liter</td>
</tr>
<tr>
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<td>Inert solid ≥ 58</td>
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<td>NE</td>
<td>NE 2  II 200 kg</td>
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<tr>
<td>tert-BUTYL PEROXYNEODECANOATE</td>
<td>≤ 77 - 100</td>
<td>B ≥ 23</td>
<td>0/32</td>
<td>2</td>
<td>2 3 II 60 liter</td>
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<tr>
<td>tert-BUTYL PEROXYNEODECANOATE</td>
<td>≤ 77</td>
<td>B ≥ 23</td>
<td>0/32</td>
<td>0/50</td>
<td>2</td>
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<td>tert-BUTYL PEROXYNEOHEPTANOATE</td>
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<td>0/32</td>
<td>0/50</td>
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<td>0/50</td>
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<td>tert-BUTYL PEROXYSTEARIC CARBONATE</td>
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<td>B ≥ 33</td>
<td>0/32</td>
<td>0/50</td>
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<td>2</td>
<td>1 3  II 60 liter</td>
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<td>≤ 42</td>
<td>Inert solid ≥ 58</td>
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<td>NE 2  II 200 kg</td>
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<tr>
<td>tert-BUTYL PEROXYBENZOIC ACID</td>
<td>≤ 57</td>
<td>Inert solid ≥ 3</td>
<td>≥ 40</td>
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<td>Inert solid ≥ 6</td>
<td>≥ 11</td>
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<td>NE 3  II 50 kg</td>
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<td>B ≥ 23</td>
<td>10/14</td>
<td>0/32</td>
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<td>20/68</td>
<td>60 liter</td>
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<td>A ≥ 43</td>
<td></td>
<td>60 liter</td>
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<tr>
<td>1,1-DI-(tert-BUTYLPEROXY)-3,3,5-TRIMETHYLCYCLOHEXANE</td>
<td>≤ 57</td>
<td>A ≥ 43</td>
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<td>60 liter</td>
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<td>1,1-DI-(tert-BUTYLPEROXY)-3,3,5-TRIMETHYLCYCLOHEXANE+ tert-BUTYL PEROXY-2-ETHYLHEXANOATE</td>
<td>≤ 43 + ≤ 16</td>
<td>A ≥ 41</td>
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<td>DI-n-BUTYL PEROXYDICARBONATE</td>
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<td>30/86</td>
<td>35/95</td>
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<td>DI-(tert-BUTYLPEROXY) PHTHALATE</td>
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<td></td>
<td>50 kg</td>
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<tr>
<td>DI-(tert-BUTYLPEROXY) PHTHALATE</td>
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<td></td>
<td></td>
<td>50 kg</td>
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<tr>
<td>DI-(tert-BUTYLPEROXY) PHTHALATE</td>
<td>≤ 52</td>
<td></td>
<td></td>
<td>50 kg</td>
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<tr>
<td>DI-(tert-BUTYLPEROXY) PHTHALATE</td>
<td>≤ 52</td>
<td></td>
<td></td>
<td>50 kg</td>
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</tr>
<tr>
<td>DI-(tert-BUTYLPEROXY) PHTHALATE</td>
<td>≤ 52</td>
<td></td>
<td></td>
<td>50 kg</td>
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<tr>
<td>DI-(tert-BUTYLPEROXY) PHTHALATE</td>
<td>≤ 52</td>
<td></td>
<td></td>
<td>50 kg</td>
<td></td>
</tr>
<tr>
<td>DI-(tert-BUTYLPEROXY) PHTHALATE</td>
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<td>10/50</td>
<td>15/59</td>
<td>50 kg</td>
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<td>DICYCLOHEXYL PEROXYDICARBONATE</td>
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<td>≥ 9</td>
<td>10/50</td>
<td>15/59</td>
<td>50 kg</td>
</tr>
<tr>
<td>DIDECANOYL PEROXIDE</td>
<td>≤ 100</td>
<td>50/86</td>
<td>55/93</td>
<td>50 kg</td>
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<tr>
<td>DI-(3-METHYLBENZOYL) PEROXIDE + BENZOYL (3-METHYLBENZOYL) PEROXIDE + DIBENZOYL PEROXIDE</td>
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<td>60 liter</td>
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</tr>
<tr>
<td>DI-(4-METHYLBENZOYL) PEROXIDE</td>
<td>≤ 52</td>
<td>10/50</td>
<td>15/59</td>
<td>50 kg</td>
<td></td>
</tr>
<tr>
<td>DI-(4-METHYLBENZOYL) PEROXIDE</td>
<td>≤ 52</td>
<td>10/50</td>
<td>15/59</td>
<td>50 kg</td>
<td></td>
</tr>
<tr>
<td>DI-(4-METHYLBENZOYL) PEROXIDE</td>
<td>≤ 52</td>
<td>10/50</td>
<td>15/59</td>
<td>50 kg</td>
<td></td>
</tr>
<tr>
<td>DILAUROYL PEROXIDE</td>
<td>≤ 100</td>
<td></td>
<td></td>
<td>50 kg</td>
<td></td>
</tr>
<tr>
<td>DI-(3-METHYLBENZOYL) PEROXIDE + BENZOYL (3-METHYLBENZOYL) PEROXIDE + DIBENZOYL PEROXIDE</td>
<td>≤ 20 + 18 + 4</td>
<td></td>
<td></td>
<td>60 liter</td>
<td></td>
</tr>
<tr>
<td>DI-(4-METHYLBENZOYL) PEROXIDE</td>
<td>≤ 52</td>
<td>10/50</td>
<td>15/59</td>
<td>50 kg</td>
<td></td>
</tr>
<tr>
<td>2,5-DIMETHYL-2,5-DI-(BENZOYLPEROXY)HEXANE</td>
<td>≤ 82</td>
<td>Inert solid ≥ 18</td>
<td>1 NE</td>
<td>3 II</td>
<td>50 kg</td>
</tr>
<tr>
<td>2,5-DIMETHYL-2,5-DI-(BENZOYLPEROXY)HEXANE</td>
<td>≤ 82</td>
<td>Inert solid ≥ 18</td>
<td>1 NE</td>
<td>3 II</td>
<td>50 kg</td>
</tr>
<tr>
<td>Name</td>
<td>Minerals</td>
<td>Maxerals</td>
<td>Purity</td>
<td>Melting Point</td>
<td>Density</td>
</tr>
<tr>
<td>----------------------------------------------------------------------</td>
<td>----------</td>
<td>----------</td>
<td>--------</td>
<td>---------------</td>
<td>---------</td>
</tr>
<tr>
<td>1,1-DIMETHYL-3-HYDROXYBUTYL PEROXYNEOHEPTANOATE</td>
<td>≤ 52</td>
<td>≥ 77</td>
<td>≥ 23</td>
<td>≤ 77</td>
<td>50 kg</td>
</tr>
<tr>
<td>2-MYRISTYL PEROXYDICARBONATE</td>
<td>≤ 120</td>
<td>≥ 200</td>
<td></td>
<td>≤ 72</td>
<td>Unknown</td>
</tr>
<tr>
<td>3-METHYL-5-METHYL-3,5-DI-(TERPENTENYL) PEROXYNEOHEPTANOATE</td>
<td>≤ 60</td>
<td>≥ 60</td>
<td></td>
<td>≥ 60</td>
<td>60 liter</td>
</tr>
<tr>
<td>3-METHYL-5-METHYL-3,5-DI-(TERPENTENYL) PEROXYNEOHEPTANOATE</td>
<td>≤ 60</td>
<td>≥ 60</td>
<td></td>
<td>≥ 60</td>
<td>60 liter</td>
</tr>
<tr>
<td>3-METHYL-5-METHYL-3,5-DI-(TERPENTENYL) PEROXYNEOHEPTANOATE</td>
<td>≤ 60</td>
<td>≥ 60</td>
<td></td>
<td>≥ 60</td>
<td>60 liter</td>
</tr>
<tr>
<td>3-METHYL-5-METHYL-3,5-DI-(TERPENTENYL) PEROXYNEOHEPTANOATE</td>
<td>≤ 60</td>
<td>≥ 60</td>
<td></td>
<td>≥ 60</td>
<td>60 liter</td>
</tr>
<tr>
<td>3-METHYL-5-METHYL-3,5-DI-(TERPENTENYL) PEROXYNEOHEPTANOATE</td>
<td>≤ 60</td>
<td>≥ 60</td>
<td></td>
<td>≥ 60</td>
<td>60 liter</td>
</tr>
<tr>
<td>3-METHYL-5-METHYL-3,5-DI-(TERPENTENYL) PEROXYNEOHEPTANOATE</td>
<td>≤ 60</td>
<td>≥ 60</td>
<td></td>
<td>≥ 60</td>
<td>60 liter</td>
</tr>
<tr>
<td>3-METHYL-5-METHYL-3,5-DI-(TERPENTENYL) PEROXYNEOHEPTANOATE</td>
<td>≤ 60</td>
<td>≥ 60</td>
<td></td>
<td>≥ 60</td>
<td>60 liter</td>
</tr>
<tr>
<td>3-METHYL-5-METHYL-3,5-DI-(TERPENTENYL) PEROXYNEOHEPTANOATE</td>
<td>≤ 60</td>
<td>≥ 60</td>
<td></td>
<td>≥ 60</td>
<td>60 liter</td>
</tr>
<tr>
<td>3-METHYL-5-METHYL-3,5-DI-(TERPENTENYL) PEROXYNEOHEPTANOATE</td>
<td>≤ 60</td>
<td>≥ 60</td>
<td></td>
<td>≥ 60</td>
<td>60 liter</td>
</tr>
<tr>
<td>3-METHYL-5-METHYL-3,5-DI-(TERPENTENYL) PEROXYNEOHEPTANOATE</td>
<td>≤ 60</td>
<td>≥ 60</td>
<td></td>
<td>≥ 60</td>
<td>60 liter</td>
</tr>
<tr>
<td>3-METHYL-5-METHYL-3,5-DI-(TERPENTENYL) PEROXYNEOHEPTANOATE</td>
<td>≤ 60</td>
<td>≥ 60</td>
<td></td>
<td>≥ 60</td>
<td>60 liter</td>
</tr>
</tbody>
</table>

**Remark:**
- **A ≥ 15 - 18**
- **≤ 12 - 15**
- **≤ 32 +**
9) Available (or Active) oxygen ≤ 10% with or without water
10) Available (or Active) oxygen ≤ 8.2% with or without water
F.4.3 Typical Class III Formulations.
<table>
<thead>
<tr>
<th>Organic Peroxide</th>
<th>Concentration</th>
<th>Diluent</th>
<th>Water</th>
<th>C/F</th>
<th>C/F</th>
<th>Health</th>
<th>Flammability</th>
<th>Instability</th>
<th>Storage Class</th>
<th>Max. Container Size</th>
<th>Subsidiary Risks and Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>3-Methyl-2,5-di-2-ethylhexanoyl peroxide</td>
<td>≤ 32 as a paste</td>
<td></td>
<td></td>
<td>2</td>
<td>NE</td>
<td>III</td>
<td></td>
<td></td>
<td></td>
<td>110 lb (50 kg)</td>
<td></td>
</tr>
<tr>
<td>Acetyl acetone peroxide</td>
<td>≤ 32</td>
<td></td>
<td></td>
<td>2</td>
<td>NE</td>
<td>III</td>
<td></td>
<td></td>
<td></td>
<td>16 gal (60 L)</td>
<td></td>
</tr>
<tr>
<td>Acetyl cyclohexanesulphonyl peroxide</td>
<td>≤ 32</td>
<td></td>
<td></td>
<td>2</td>
<td>NE</td>
<td>III</td>
<td></td>
<td></td>
<td></td>
<td>440 lb (200 kg)</td>
<td></td>
</tr>
<tr>
<td>Cumyl peroxyacetate</td>
<td>≤ 32</td>
<td></td>
<td></td>
<td>2</td>
<td>NE</td>
<td>III</td>
<td></td>
<td></td>
<td></td>
<td>110 lb (50 kg)</td>
<td></td>
</tr>
<tr>
<td>Cumyl peroxybutyrate</td>
<td>≤ 32</td>
<td></td>
<td></td>
<td>2</td>
<td>NE</td>
<td>III</td>
<td></td>
<td></td>
<td></td>
<td>440 lb (200 kg)</td>
<td></td>
</tr>
<tr>
<td>Dibenzoyl peroxide</td>
<td>≤ 32</td>
<td></td>
<td></td>
<td>2</td>
<td>NE</td>
<td>III</td>
<td></td>
<td></td>
<td></td>
<td>110 lb (50 kg)</td>
<td></td>
</tr>
</tbody>
</table>

Notes:
- Concentration: ≤ 32 as a paste, ≥ 32
- Diluent: Water, C/F
- Health: III
- Flammability: III
- Instability: III
- Storage Class: Max. Container Size: Subsidiary Risks and Remarks

These columns refer to temperatures in the Department of Transportation (DOT) Organic Peroxides Table. Refer to document 49 CFR 173.225 for details.

The column refers to DOT’s Organic Peroxides Table. Refer to document 49 CFR 173.225 for details.

Also a flammable liquid; see NFPA 30 for storage requirements.

Temperature control should be considered to reduce fire hazard depending on packaging size and recommendations in manufacturers’ literature.

Note: Diluents: AO — Active oxygen; BBP — Butyl benzyl phthalate; DBP — Dibutyl phthalate; DMP — Dimethyl phthalate; DOP — Diocetyl phthalate; OMS — Odorless mineral spirits.
<table>
<thead>
<tr>
<th>Organic Peroxide Formulation</th>
<th>Concentration</th>
<th>Diluent</th>
<th>Water</th>
<th>Control</th>
<th>Emergency</th>
<th>Health</th>
<th>Flammability</th>
<th>Instability</th>
<th>Storage Class</th>
<th>Max. Container Size</th>
<th>Subsidiary Risks and Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>(2-ETHYLHEXYL)PEROXIDE</td>
<td>≤ 0.02</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>IBC tank</td>
</tr>
<tr>
<td>DICUMYL PEROXIDE</td>
<td>&gt; 52–100</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>IBC tank</td>
</tr>
<tr>
<td>(2,5-DIMETHYL-2,5-DI-[1,1-DI- (BUTYLPEROXY)CYCLOHEXYL] PROPAINE)</td>
<td>≤ 0.02</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>IBC tank</td>
</tr>
<tr>
<td>(2,5-DIMETHYL-2,5-DI-[1,1-DI- (BUTYLPEROXY)HEXANE-3] PROPAINE)</td>
<td>≤ 0.02</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>IBC tank</td>
</tr>
<tr>
<td>(2,5-DIMETHYL-2,5-DI-[1,1-DI- (BUTYLPEROXY)HEXANE] PROPAINE)</td>
<td>≤ 0.02</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>IBC tank</td>
</tr>
<tr>
<td>DIPROPIONYL PEROXIDE</td>
<td>≤ 0.02</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>IBC tank</td>
</tr>
<tr>
<td>(2,2-DI-[1,1-DI-(BUTYLPEROXY)CUMYLHYDROPEROXIDE] CYCLOHEXANE)</td>
<td>≤ 0.02</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>IBC tank</td>
</tr>
<tr>
<td>(2,2-DI-[2,2-DI-(4,4-DI-DICUMYL PEROXYNEODECANOATE)] CYCLOHEXANE)</td>
<td>≤ 0.02</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>IBC tank</td>
</tr>
<tr>
<td>(2,2-DI-[2,2-DI-(4,4-DI-DICUMYL PEROXYNEODECANOATE)] DI-n-BUTYL PEROXYDICARBONATE)</td>
<td>≤ 0.02</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>IBC tank</td>
</tr>
<tr>
<td>2,2-DI-(BUTYLPEROXY)PROPANE</td>
<td>≤ 0.02</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>IBC tank</td>
</tr>
<tr>
<td>1,1-DI-(1,1,3,3-TETRAMETHYLBUTYL PEROXYNEODECANOATE)</td>
<td>≤ 0.02</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>IBC tank</td>
</tr>
</tbody>
</table>

These columns refer to temperatures in the Department of Transportation (DOT) Organic Peroxides Table. (See NFPA 704 hazard ratings for health, flammability, and instability. (See DOT Organic Peroxides Table.)

The column refers to NFPA 704 hazard ratings for health, flammability, and instability. (See NFPA 704 for more information.)

See Table F.7.

See NFPA 30 for additional storage requirements.
Committee Statement

<table>
<thead>
<tr>
<th>Committee Statement:</th>
<th>Table update based upon most recent test information. The Committee supports revising the annex based on new test data. See attached XLSX file which is the revised table for Class III organic peroxides and replaces the existing table in the code.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Note:</td>
<td>This change was made at the first draft meeting however the changes were not included within the document since the spreadsheets were hidden.</td>
</tr>
<tr>
<td>Organic Peroxide Formulation</td>
<td>Concentration</td>
</tr>
<tr>
<td>------------------------------</td>
<td>--------------</td>
</tr>
<tr>
<td>ACETYL ACETONE PEROXIDE</td>
<td>≤ 32 as a paste</td>
</tr>
<tr>
<td>ACETYL CYCLOHEXANESULFONYL PEROXIDE</td>
<td>≤ 32</td>
</tr>
<tr>
<td>n-AMYL PEROXYNEODECANOATE</td>
<td>≤ 52</td>
</tr>
<tr>
<td>n-BUTYL-4,4-DI-(tert-BUTYLPEROXY) VALerate</td>
<td>≤ 72</td>
</tr>
<tr>
<td>n-BUTYL HYDROPEROXIDE</td>
<td>≤ 32</td>
</tr>
<tr>
<td>n-BUTYL PEROXY-2-ETHYLHEXANATE</td>
<td>≤ 32</td>
</tr>
<tr>
<td>n-BUTYL PEROXYNEODECANOATE</td>
<td>≤ 32</td>
</tr>
<tr>
<td>n-BUTYL PEROXYPIVALATE</td>
<td>≤ 27</td>
</tr>
<tr>
<td>n-BUTYL PEROXY-3,5,5-TRIMETHYLHEXANOATE</td>
<td>≤ 32</td>
</tr>
<tr>
<td>n-CUMYL HYDROPEROXIDE</td>
<td>&gt; 60 as a stable dispersion in water</td>
</tr>
<tr>
<td>n-CUMYL PEROXYNEODECANOATE</td>
<td>≤ 32</td>
</tr>
<tr>
<td>n-CUMYL PEROXY-2-ETHYLHEXANATE</td>
<td>≤ 32</td>
</tr>
<tr>
<td>n-CUMYL PEROXY-3,5,5-TRIMETHYLHEXANOATE</td>
<td>≤ 32</td>
</tr>
<tr>
<td>n-DI-n-BUTYL PEROXYDICARBONATE</td>
<td>≤ 27</td>
</tr>
<tr>
<td>1,1-DI-(tert-BUTYLPEROXY) CYCLOHEXANE</td>
<td>≤ 32</td>
</tr>
<tr>
<td>1,1-DI-(tert-BUTYLPEROXY) CYCLOHEXANE</td>
<td>≤ 32</td>
</tr>
<tr>
<td>1,1-DI-(tert-BUTYLPEROXY) CYCLOHEXANE</td>
<td>≤ 32</td>
</tr>
<tr>
<td>1,1-DI-(tert-BUTYLPEROXY)-3,3,5-TRIMETHYLCYCLOHEXANE</td>
<td>≤ 57</td>
</tr>
<tr>
<td>DICUMYL PEROXIDE</td>
<td>&gt; 52 - 100</td>
</tr>
<tr>
<td>2,2-DI-(4,4-DI-(tert-BUTYLPEROXY)CYCLOHEXYL) PROPANE</td>
<td>≤ 32</td>
</tr>
<tr>
<td>2,2-DI-(4,4-DI-(tert-BUTYLPEROXY)CYCLOHEXYL) PROPANE</td>
<td>≤ 27</td>
</tr>
</tbody>
</table>
| 31) Active oxygen < 6.7%
Second Revision No. 141-NFPA 400-2014 [Section No. F.5.3]

F.5.3 Typical Class IV Formulations.
See Table F.5.3.
Table F.5.3(a) Typical Class IV Formulations

<table>
<thead>
<tr>
<th>Organic Peroxide</th>
<th>Concentration</th>
<th>Diluent</th>
<th>Water</th>
<th>C/F</th>
<th>C/F</th>
<th>Health</th>
<th>Flammability</th>
<th>Reactivity</th>
<th>Containment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-Butyl cumyl peroxide</td>
<td>≤ 0.5 as a stable dispersion in water</td>
<td>0/32</td>
<td>10/50</td>
<td>2</td>
<td>NE</td>
<td>1</td>
<td>IV</td>
<td>IBC tank</td>
<td></td>
</tr>
<tr>
<td>1-Butyl peroxyneodecanoate</td>
<td>≤ 0.5 as a stable dispersion in water</td>
<td>0/32</td>
<td>10/50</td>
<td>2</td>
<td>NE</td>
<td>2</td>
<td>IV</td>
<td>440 lb (200 kg)</td>
<td></td>
</tr>
<tr>
<td>1-Butyl peroxyneodecanate</td>
<td>≤ 0.5 as a stable dispersion in water</td>
<td>0/32</td>
<td>10/50</td>
<td>1</td>
<td>NE</td>
<td>2</td>
<td>IV</td>
<td>65 gal (208 L)</td>
<td></td>
</tr>
<tr>
<td>Di-1-Butyl cyclohexyl peroxydicarbonate</td>
<td>≤ 0.4 as a stable dispersion in water</td>
<td>30/66</td>
<td>35/65</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>IV</td>
<td>IBC tank</td>
<td></td>
</tr>
<tr>
<td>Di-2-Ethylhexyl peroxydicarbonate</td>
<td>≤ 0.5 as a stable dispersion in water</td>
<td>15/59</td>
<td>20/68</td>
<td>NE</td>
<td>NE</td>
<td>1</td>
<td>IV</td>
<td>IBC tank</td>
<td></td>
</tr>
<tr>
<td>Diisocyanate peroxide</td>
<td>≤ 0.5 as a stable dispersion in water</td>
<td>0/32</td>
<td>10/50</td>
<td>1</td>
<td>NE</td>
<td>1</td>
<td>IV</td>
<td>IBC tank</td>
<td></td>
</tr>
<tr>
<td>Diallyl peroxide</td>
<td>≤ 0.5 as a stable dispersion in water</td>
<td>30/66</td>
<td>35/65</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>IV</td>
<td>IBC tank</td>
<td></td>
</tr>
</tbody>
</table>

Recommended Maximum Temperatures
Control Emergency

Hazard Identification NFPA 704 Ratings

Note: Diluents: DBP—Dibutyl phthalate; DMP—Dimethyl phthalate; DOP—Dioctyl phthalate; OMS—Odorless mineral spirits; AO—Active oxygen.

These columns refer to temperatures in the Department of Transportation (DOT) Organic Peroxides Table. Refer to document 49 CFR 173.225 for details.

The column refers to NFPA 704 hazard ratings for health, flammability, and instability. See NFPA 704 for more information.

T—Temperature control should be considered to reduce fire hazard depending on packaging size and recommendations in manufacturers' literature.

See Table F.7.

Second Revision No. 141-NFPA 400-2014 [Section No. F.5.3]

F.5.3 Typical Class IV Formulations.
See Table F.5.3.
Table F.5.3(a) Typical Class IV Formulations

<table>
<thead>
<tr>
<th>Organic Peroxide Formulation</th>
<th>Concentration</th>
<th>Diluent</th>
<th>Water</th>
<th>C/F</th>
<th>C/F</th>
<th>Health</th>
<th>Flammability</th>
<th>Reactivity</th>
<th>Storage Class</th>
<th>Max Container Size</th>
<th>Subsidiary Risks and Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-Butyl peroxyneodecanoate</td>
<td>≤ 0.5 as a stable dispersion in water</td>
<td>0/32</td>
<td>10/50</td>
<td>2</td>
<td>NE</td>
<td>1</td>
<td>IV</td>
<td>IBC tank</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1-Butyl peroxyneodecanoate</td>
<td>≤ 0.5 as a stable dispersion in water</td>
<td>0/32</td>
<td>10/50</td>
<td>2</td>
<td>NE</td>
<td>2</td>
<td>IV</td>
<td>440 lb (200 kg)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1-Butyl peroxyneodecanoate</td>
<td>≤ 0.5 as a stable dispersion in water</td>
<td>0/32</td>
<td>10/50</td>
<td>1</td>
<td>NE</td>
<td>2</td>
<td>IV</td>
<td>65 gal (208 L)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Di(1-Butylcyclohexyl) peroxydicarbonate</td>
<td>≤ 0.4 as a stable dispersion in water</td>
<td>30/66</td>
<td>35/65</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>IV</td>
<td>IBC tank</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Di-2-Ethylhexyl peroxydicarbonate</td>
<td>≤ 0.5 as a stable dispersion in water</td>
<td>15/59</td>
<td>20/68</td>
<td>NE</td>
<td>NE</td>
<td>1</td>
<td>IV</td>
<td>IBC tank</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diisocyanate peroxide</td>
<td>≤ 0.5 as a stable dispersion in water</td>
<td>0/32</td>
<td>10/50</td>
<td>1</td>
<td>NE</td>
<td>1</td>
<td>IV</td>
<td>IBC tank</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diallyl peroxide</td>
<td>≤ 0.5 as a stable dispersion in water</td>
<td>30/66</td>
<td>35/65</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>IV</td>
<td>IBC tank</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dimethyl peroxydicarbonate</td>
<td>≤ 0.4 as a stable dispersion in water</td>
<td>15/59</td>
<td>20/68</td>
<td>NE</td>
<td>NE</td>
<td>1</td>
<td>IV</td>
<td>IBC tank</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dioctyl peroxydicarbonate</td>
<td>≤ 0.4 as a stable dispersion in water</td>
<td>15/59</td>
<td>20/68</td>
<td>NE</td>
<td>NE</td>
<td>1</td>
<td>IV</td>
<td>IBC tank</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dioctyl peroxydicarbonate</td>
<td>≤ 0.4 as a stable dispersion in water</td>
<td>15/59</td>
<td>20/68</td>
<td>NE</td>
<td>NE</td>
<td>1</td>
<td>IV</td>
<td>IBC tank</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dioctyl peroxydicarbonate</td>
<td>≤ 0.4 as a stable dispersion in water</td>
<td>15/59</td>
<td>20/68</td>
<td>NE</td>
<td>NE</td>
<td>1</td>
<td>IV</td>
<td>IBC tank</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dioctyl peroxydicarbonate</td>
<td>≤ 0.4 as a stable dispersion in water</td>
<td>15/59</td>
<td>20/68</td>
<td>NE</td>
<td>NE</td>
<td>1</td>
<td>IV</td>
<td>IBC tank</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dioctyl peroxydicarbonate</td>
<td>≤ 0.4 as a stable dispersion in water</td>
<td>15/59</td>
<td>20/68</td>
<td>NE</td>
<td>NE</td>
<td>1</td>
<td>IV</td>
<td>IBC tank</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dioctyl peroxydicarbonate</td>
<td>≤ 0.4 as a stable dispersion in water</td>
<td>15/59</td>
<td>20/68</td>
<td>NE</td>
<td>NE</td>
<td>1</td>
<td>IV</td>
<td>IBC tank</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diisocyanate peroxide</td>
<td>≤ 0.5 as a stable dispersion in water</td>
<td>0/32</td>
<td>10/50</td>
<td>1</td>
<td>NE</td>
<td>1</td>
<td>IV</td>
<td>IBC tank</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dimethyl peroxydicarbonate</td>
<td>≤ 0.5 as a stable dispersion in water</td>
<td>30/66</td>
<td>35/65</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>IV</td>
<td>IBC tank</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

These columns refer to temperatures in the Department of Transportation (DOT) Organic Peroxides Table. (See 49 CFR 173.225 for more information.)

The column refers to NFPA 704 hazard ratings for health, flammability, and instability. (See NFPA 704 for more information.)

See Table F.7.
Supplemental Information

File Name           Description
Table_F.5.3_edited.xlsx

Submitter Information Verification
Submitter Full Name: [ Not Specified ]
Organization: [ Not Specified ]
Street Address: 
City: 
State: 
Zip: 
Submittal Date: Fri Aug 22 15:30:06 EDT 2014

Committee Statement
Committee Statement: Table update based upon most recent test information. The Committee supports revising the annex based on new test data. See attached XLSX file which is the revised table for Class IV organic peroxides and replaces the existing table in the code.

Note: This change was made at the first draft meeting however the changes were not included within the document since the spreadsheets were hidden.

Response Message: 

National Fire Protection Association Report http://submittals.nfpa.org/TerraViewWeb/ContentFetcher?commentPara...
<table>
<thead>
<tr>
<th>Organic Peroxide Formulation</th>
<th>Concentration</th>
<th>Diluent</th>
<th>Water</th>
<th>Control C/F</th>
<th>Emergency C/F</th>
<th>Health</th>
<th>Flammability</th>
<th>Instability</th>
<th>Storage Class</th>
<th>Max. Container Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>tert-BUTYL PEROXYNEODECANOATE</td>
<td>≤ 52 as a stable dispersion in water</td>
<td>0/32</td>
<td>10/50</td>
<td>2</td>
<td>NE</td>
<td>1</td>
<td>IV</td>
<td>IBC type</td>
<td></td>
<td></td>
</tr>
<tr>
<td>tert-BUTYL PEROXYNEODECANOATE</td>
<td>≤ 42 as a stable dispersion in water (frozen)</td>
<td>0/32</td>
<td>10/50</td>
<td>2</td>
<td>NE</td>
<td>2</td>
<td>IV</td>
<td>200 kg</td>
<td></td>
<td></td>
</tr>
<tr>
<td>tert-BUTYL PEROXYNEOHEPTANOATE</td>
<td>≤ 42 as a stable dispersion in water</td>
<td>0/32</td>
<td>10/50</td>
<td>1</td>
<td>NE</td>
<td>2</td>
<td>IV</td>
<td>225 liter</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dl-(4-tert-BUTYLCYCLOHEXYL) PEROXYDICARBONATE</td>
<td>≤ 42 as a stable dispersion in water</td>
<td>30/86</td>
<td>35/95</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>IV</td>
<td>IBC type</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dl-n-BUTYL PEROXYDICARBONATE</td>
<td>≤ 42 as a stable dispersion in water (frozen)</td>
<td>-15/5</td>
<td>-5/23</td>
<td>1</td>
<td>NE</td>
<td>2</td>
<td>IV</td>
<td>200 kg</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DICYCLOHEXYL PEROXYDICARBONATE</td>
<td>≤ 42 as a stable dispersion in water</td>
<td>30/86</td>
<td>35/95</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>IV</td>
<td>IBC type</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DICYCLOHEXYL PEROXYDICARBONATE</td>
<td>≤ 42 as a stable dispersion in water</td>
<td>15/59</td>
<td>20/68</td>
<td>NE</td>
<td>NE</td>
<td>1</td>
<td>IV</td>
<td>IBC type</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DICYCLOHEXYL PEROXYDICARBONATE</td>
<td>≤ 52 as a stable dispersion in water (frozen)</td>
<td>-15/5</td>
<td>-5/23</td>
<td>2</td>
<td>NE</td>
<td>1</td>
<td>IV</td>
<td>IBC type</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DILAUROYL PEROXIDE</td>
<td>≤ 42 as a stable dispersion in water</td>
<td>-15/5</td>
<td>-5/23</td>
<td>2</td>
<td>NE</td>
<td>1</td>
<td>IV</td>
<td>IBC type</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DIMYRISTYL PEROXYDICARBONATE</td>
<td>≤ 42 as a stable dispersion in water</td>
<td>20/68</td>
<td>25/77</td>
<td>1</td>
<td>NE</td>
<td>1</td>
<td>IV</td>
<td>IBC type</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3-HYDROXY-1,1-DIMETHYLBUTYL PEROXYNEODECANOATE</td>
<td>≤ 52 as a stable dispersion in water</td>
<td>-5/23</td>
<td>5/41</td>
<td>NE</td>
<td>3</td>
<td>1</td>
<td>IV</td>
<td>IBC type</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PEROXYACETIC ACID, TYPE F, stabilized</td>
<td>≤ 43</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Table F.6.3 Typical Class V Formulations

<table>
<thead>
<tr>
<th>Organic Peroxide Formulation</th>
<th>Concentration</th>
<th>Diluent</th>
<th>Water</th>
<th>C/F</th>
<th>C/F</th>
<th>Health</th>
<th>Flammability</th>
<th>Instability</th>
<th>Storage Class</th>
<th>Max. Container Size</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>CYCLOHEXANONE PEROXIDE(S)</td>
<td>≤32</td>
<td>Inert</td>
<td>solid</td>
<td>2</td>
<td>NE</td>
<td>0</td>
<td>Y</td>
<td>V</td>
<td>Exempt</td>
<td>29</td>
<td></td>
</tr>
<tr>
<td>DIBENZOYL PEROXIDE</td>
<td>≤35</td>
<td>Inert</td>
<td>solid</td>
<td>2</td>
<td>2</td>
<td>0</td>
<td>Y</td>
<td>V</td>
<td>Exempt</td>
<td>29</td>
<td></td>
</tr>
<tr>
<td>DI-4 CHLOROBENZOYL PEROXIDE</td>
<td>≤32</td>
<td>Inert</td>
<td>solid</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>V</td>
<td>V</td>
<td>Exempt</td>
<td>29</td>
<td></td>
</tr>
<tr>
<td>DICUMYL PEROXIDE</td>
<td>≤52</td>
<td>Inert</td>
<td>solid</td>
<td>1</td>
<td>NE</td>
<td>0</td>
<td>Y</td>
<td>V</td>
<td>Exempt</td>
<td>29</td>
<td></td>
</tr>
</tbody>
</table>

1. These columns refer to temperatures in the Department of Transportation (DOT) Organic Peroxides Table. Refer to 49 CFR 173.225 for details.
2. The column refers to NFPA 704 hazard ratings for health, flammability, and instability. See NFPA 704 for details.
3. AO — Active oxygen.

### Notes
- These columns refer to temperatures in the Department of Transportation (DOT) Organic Peroxides Table. Refer to 49 CFR 173.225 for details.
- The column refers to NFPA 704 hazard ratings for health, flammability, and instability. See NFPA 704 for details.
- AO — Active oxygen.
<table>
<thead>
<tr>
<th>Organic Peroxide Formulation</th>
<th>Concentration</th>
<th>Diluent</th>
<th>Water</th>
<th>C/F</th>
<th>C/F</th>
<th>Health</th>
<th>Flammability</th>
<th>Instability</th>
<th>Storage Class</th>
<th>Max. Container Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>CYCLOHEXANONE PEROXIDE(S)</td>
<td>≤ 32</td>
<td>Inert solid ≥ 68</td>
<td></td>
<td></td>
<td></td>
<td>3</td>
<td>NE</td>
<td>0</td>
<td>V</td>
<td>Exempt</td>
</tr>
<tr>
<td>DIBENZOYL PEROXIDE</td>
<td>≤ 35</td>
<td>Inert solid ≥ 65</td>
<td></td>
<td></td>
<td></td>
<td>2</td>
<td>2</td>
<td>0</td>
<td>V</td>
<td>Exempt</td>
</tr>
<tr>
<td>DL-( tert-BUTYLPEROXYISOPROPYL)BENZENE(S)</td>
<td>≤ 42</td>
<td>Inert solid ≥ 65</td>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>V</td>
<td>Exempt</td>
</tr>
<tr>
<td>DI-4-CHLOROBENZOYL PEROXIDE</td>
<td>≤ 32</td>
<td>Inert solid ≥ 68</td>
<td></td>
<td></td>
<td></td>
<td>NE</td>
<td>NE</td>
<td>0</td>
<td>V</td>
<td>Exempt</td>
</tr>
<tr>
<td>DICUMYL PEROXIDE</td>
<td>≤ 32</td>
<td>Inert solid ≥ 48</td>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td>NE</td>
<td>0</td>
<td>V</td>
<td>Exempt</td>
</tr>
</tbody>
</table>
G.1.1 Solid Oxidizers.

Oxidizers can have both physical and health hazards. The tests and criteria described in subsections G.1.2 through G.1.5 are based on burning rate only and do not address other physical hazards of oxidizers, such as thermal instability and chemical reactivity, or health hazards of gaseous products generated during combustion or decomposition. If confined, gaseous products generated from oxidizer decomposition can result in overpressure events and explosions. Cumulative research test data indicate the burning rate of solid oxidizers is principally a function of the chemical composition of the oxidizer and its concentration, and to a lesser degree, its physical form (e.g., powder, granular, or tablets). Inclusive in the influence of the oxidizer composition are the amount and type of additives (if any) as well as the moisture content of the oxidizer or hydrated salt additives. The tests and criteria apply to oxidizers or formulations containing oxidizers that are found in commerce, use, and storage and do not apply to the evaluation of ammonium nitrate, oxidizer-containing explosive mixtures, and pyrotechnic mixtures. The tests and criteria assign an oxidizer to an NFPA Class for storage and are not applicable to and should not be confused with Department of Transportation (DOT) and United Nations (UN) Packing Group (III, II, I) assignments and vice versa. The UN and DOT Division 5.1 solid oxidizer packing groups are different from, and not synonymous with, the NFPA Class (1, 2, 3, 4) assignments for storage, handling and use. The NFPA Classes for solid oxidizers are also different from the hazard categories (Categories 3, 2, 1) for oxidizing solids defined by the Global Harmonization System (GHS) adopted by the revised OSHA Hazard Communication Standard in March, 2012.

The oxidizer classification method consists of two reaction-to-fire tests: (1) a bench-scale test with 30 g mixtures of oxidizer and dried cellulose exposed to a glowing wire and (2) an intermediate-scale test with 10.9 kg of oxidizer in combustible test packaging exposed to a constant external fire source. The key physical indicators of burning rate measured in the intermediate-scale test are peak convective heat release rate and the burning time calculated from the radiant heat flux profile. The key physical indicators of burning rate measured in the bench-scale test are mass loss rate and burning time calculated from the mass data. Either of these tests can be used to classify a solid oxidizer. If both of these tests are conducted and the results differ, then the results from the intermediate-scale fire exposure test data should be used as the basis for the classification.

Referenced Documents:

- Huczek, Jason P., Medium-Scale Burn Testing: Determination of Total (Oxygen Consumption and Carbon Dioxide Generation) and Convective (Temperature Rise) Heat Release Rates of Various Chemical Oxidizers, Final Report, Southwest Research Institute, San Antonio TX, January 7, 2009, SwRI Project No. 01.13538.01.303.

Submitter Information Verification

Submitter Full Name: [ Not Specified ]
Organization: [ Not Specified ]
Street Address: 
City: 
State: 
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Submittal Date: Thu Aug 07 10:54:55 EDT 2014

Committee Statement

Committee Statement: Ammonium nitrate was excluded from NFPA 430 Storage for the Code of Solid and Liquid Oxidizers before NFPA 430 was incorporated into NFPA 400. Since its incorporation into NFPA 400, the question has been raised regarding Ammonium Nitrate classification. Tests were performed with industrial grade AN prill and cellulose powder per the test method defined in the definition of Class 1, Class 2 and Class 3 oxidizers and as detailed in Annex G. The mass loss of the 4:1 mixture was found to meet the Class 2 oxidizer criteria (see related proposals). As a result, AN is deleted from the exclusions listed in this paragraph and will be assigned to Class 2 in the appropriate Table in Annex G.

Response Message: Public Comment No. 52-NFPA 400-2014 [Section No. G.1.1]
Second Revision No. 99-NFPA 400-2014 [Section No. G.2.3]

G.2.3 Class 2 Oxidizers.
The following are Class 2 oxidizers:

(1) Ammonium nitrate prill (99 percent)**
(2) Calcium hypochlorite (48 percent or less by weight unless covered by other formulations in G.1.2)**
(3) Calcium peroxide (75 percent)**
(4) Sodium persulfate (99 percent)**
(5) Sodium dichloro-s-triazinetrione anhydrous (sodium dichloroisocyanurate anhydrous)**

Submitter Information Verification
Submitter Full Name: [Not Specified]
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Thu Aug 07 11:17:26 EDT 2014

Committee Statement
Committee Statement:
Ammonium nitrate prill (uncoated and coated industrial grade) were subject to the bench scale test for solid oxidizers. The mass loss rate results were consistent with Class 2 oxidizer criteria and therefore was added to the list under Class 2. The percentage of prill form AN was added to the annex item to clarify what was tested.

Response Message:
Public Comment No. 54-NFPA 400-2014 [Section No. G.2.3]
Solid-form AN (NH\textsubscript{4}NO\textsubscript{3}) prill is used in agricultural applications as a fertilizer and in industrial applications as a component of explosives. AN prill for agricultural use is typically 99 percent AN, has larger prill size, and has lower porosity. AN is an oxidizer. It decomposes or melts at 337°F (169°C); the gaseous products of decomposition are toxic, can support combustion, and can cause an increase in pressure where confined. Under certain conditions, including contamination, confinement, strong shock, and exposure to an external fire, AN prill can detonate. Guidance for the safe storage, use, and handling of AN prill is contained in Chapter 11, Annex E, and EPA 550-S-13-001, Chemical Advisory: Safe Storage, Handling, and Management of Ammonium Nitrate.
Second Revision No. 101-NFPA 400-2014 [Section No. G.4]

G.4 Safety Information on Oxidizers Used in Detergents.

G.4.1 Sodium Percarbonate.
Sodium percarbonate (CAS 15630-89-4) or sodium carbonate perhydrate is a solid adduct of hydrogen peroxide (Na₂CO₃·3/2H₂O₂) used in detergent formulations. The active oxygen content of granular solid sodium percarbonate ranges from 12 to 14.5 percent. Granular particles are typically coated. Sodium percarbonate (95 percent) is a Class 1 oxidizer. Sodium percarbonate and sodium percarbonate-rich mixtures (>70 wt percent) are sensitive to gross contamination, heat, and reducing agents and are potentially explosive if mixed with organics. Sodium percarbonate and its formulated products have the propensity to undergo exothermic decomposition with the rapid release of oxygen, water, and heat sufficient to ignite nearby combustible materials. The kinetics and decomposition reactions are complex. The self-accelerating decomposition temperature (SADT), the lowest ambient temperature at which self-accelerating decomposition may occur in a material in the packaging used for transportation, is reported to be 168°F (75°C) for 55 lb (25 kg) packages and 122°F (50°C) for 1 ton (1000 lb) bags. If improperly discarded or mixed with combustible trash, a fire can result.

G.5. Safety Information on Oxidizers Used in Swimming Pools.

G.5.1 Handling Swimming Pool Chemicals.
Oxidizers and sanitizers for swimming pools are some of the most widely used, manufactured, and distributed oxidizers. Anyone handling or using swimming pool chemicals should be fully aware of proper storage and handling requirements, as well as emergency and first-aid procedures in case of an accident. Chlorinated pool chemicals are incompatible with many chemicals associated with pool care, including algaecides, pool conditioners (stabilizers), clariﬁers, and other types of chlorine. It is essential to follow all storage and handling procedures in order to prevent conditions that might cause emergencies, such as a fire or explosion. This section includes specific information on pool oxidizers.

Calcium hypochlorite (cal hypo), lithium hypochlorite, and chlorinated isocyanurates (dichlor and trichlor) are not combustibles. They are oxidizers. Some oxidizers can cause the spontaneous ignition and increase the burning rate of combustible materials, including the majority of their packaging material. Some oxidizers decompose rapidly and undergo self-sustained degradation, which can result in an intense fire or explosion. The decomposition of dry chlorinated pool chemicals can also produce toxic and corrosive gases. Because of the composition and properties of calcium hypochlorite, lithium hypochlorite, and chlorinated isocyanurates, special precautions are required to prevent contact and reaction with each other and other chemicals. Reactions will occur if they are physically mixed together.

Emergency responders should be aware of oxidizers being stored in their area of response, visit the facilities, and obtain copies of the SDS associated with the chemicals being stored. Knowledge of the facility and the chemicals being stored makes any response more efﬁcient and effective.

Containers should be stored away from combustible or ﬂammable products, and product packaging should be kept clean and free of all contamination, including other pool treatment products, acids, organic materials, nitrogen-containing compounds, dust, or power extinguishers (containing mono-ammonium phosphate), oxidizers, all corrosive liquids, ﬂammable or combustible materials, and so forth.

G.5.1.1 Calcium Hypochlorite.
Calcium hypochlorite, commonly known as cal hypo, decomposes above 350°F (177°C). The decomposition will generate oxygen and heat, possibly resulting in a fire of great intensity if combustible materials are present. Direct exposure to the vapor can cause the materials to decompose, the container to erupt, and the ﬁre to reach vastly higher levels of intensity. Decomposition leaves an inert residue consisting mainly of calcium chloride. Cal hypo (over 50 percent by weight) is classiﬁed as a Class 3 oxidizer. Cal hypo (50 percent or less by weight) is classiﬁed as a Class 2 oxidizer.

G.5.1.2 Lithium Hypochlorite.
Lithium hypochlorite decomposes at 275°F (135°C), producing oxygen, lithium hydroxide, lithium chlorates, and hazardous gases. Contamination with moisture, organic matter, or other chemicals may start a chemical reaction that generates heat, hazardous gases, fire, and explosion. Lithium hypochlorite (available chlorine of 39 percent or less) is classiﬁed as a Class 1 oxidizer. Lithium hypochlorite (more than 39 percent available chlorine) is classiﬁed as a Class 2 oxidizer.

G.5.1.3 Sodium Dichloroisocyanurate.
Sodium dichloroisocyanurate is commonly known as dichlor. It decomposes in the range of 428°F to 482°F (220°C to 250°C) and can generate enough heat to ignite items such as paper and wood. Dichlor will sustain thermal decomposition above 428°F (220°C), even in the absence of oxygen. Decomposition results in a yellow or brown porous inert residue. Anyhow, dichlor is classiﬁed as a Class 4.2 oxidizer in accordance with testing criteria found in § 1.2. Dichlor dioxide is classiﬁed as NFPA as a Class 1 oxidizer.

G.5.1.4 Trichloroisocyanuric Acid.
Trichloroisocyanuric acid is commonly known as trichlor. It decomposes in the range of 428°F to 482°F (220°C to 250°C). Decomposition of trichlor requires a continuous source of heat. Once the heat source is removed, trichlor will no longer continue to decompose. Partial decomposition leaves a yellow or brown residue. Complete decomposition leaves only traces of residue. Trichlor is classiﬁed by NFPA as a Class 1 oxidizer.

G.5.1.5 Sodium Hypochlorite.
Sodium hypochlorite (7681-52-9) solutions are not classiﬁed as oxidizers by NFPA. Sodium hypochlorite is manufactured by reacting chlorine with dilute sodium hydroxide solution. Solutions are generally formulated in the range of 3.8–20 percent sodium hypochlorite by weight. The balance of the solution consists of water, sodium chloride, and sodium hydroxide. Depending upon the residual quantity of sodium hydroxide in the ﬁnished product, it is classiﬁed as an irritant material or a corrosive material as those terms are deﬁned in OSHA’s Hazard Communication Standard, 29 CFR 1910.1200. Generally speaking, solutions with less than 1 percent residual caustic are irritants, while solutions containing more than 1 percent residual caustic are classiﬁed as corrosives. Total evaporation of sodium hypochlorite solutions yields water and sodium chloride. Unlike calcium hypochlorite, sodium hypochlorite does not exist outside of solutions and does not initiate or promote combustion of combustible materials. The major decomposition pathway of hypochlorite ion evolves chlorine ion which combines with additional hypochlorite ion to form chlorates, which in turn form chlorines. The formation of oxygen from decomposing hypochlorite ion is a very slow side reaction, although the ratio may increase with exposure to transition metals.

Other oxidizing gases, for example, chlorine, are not evolved in the decomposition. When stored correctly and not exposed to other materials, these chemicals or mixtures containing these chemicals can lead to the generation of hazardous gases and ﬁre.

G.5.2 Speciﬁc Response Information for Chlorinated Isocyanurates (Dichlor, Trichlor).
It is necessary for emergency responders to be aware of the properties of chlorinated isocyanurates (dichlor, trichlor) that can create hazardous conditions. The reaction of these chemicals or mixtures containing these chemicals can lead to the generation of hazardous gases and ﬁre.

It is essential to follow all storage and handling procedures in order to prevent conditions that might cause emergencies, such as a fire or explosion. This section includes speciﬁc information on pool oxidizers.

The best approach to dealing with the reactivity of these chemicals is to assume that they will react with anything they contact. Some of the reactions, particularly those with fuels (kerosene, diesel oil, etc.) and some other organic materials, are very fast and violent. Others take some time to happen. An example of this is when spilled material is placed in a dumpster with no apparent reaction. Hours later, a ﬁre occurs because of a slow reaction with other material.

Other oxidizers, particularly cal hypo, also react with chlorinated isocyanurates. Wet mixtures of chlorinated isocyanurates and calcium hypochlorite react vigorously, releasing large volumes of chlorine (Cl₂) gas.

The following suggested actions and precautions should be taken during an emergency where chlorinated isocyanurates are present:

(1) Emergency responders need to know their capabilities and limitations. If you are not completely sure that you can deal effectively with an emergency, get help from other responders or the manufacturer of the chemical. Contact chemical manufacturers directly or through Chemtrec® at 800-424-9300.

(2) During an emergency, only allow necessary personnel in the affected area.

(3) Because hazardous gases might be present, be sure to have self-contained breathing apparatus (SCBA) available and wear when necessary. Other personal protective equipment might also be necessary to use.

(4) Do not flush these chemicals or otherwise allow them to go into waterways or sewers without clearance from the appropriate officials.

(5) If there is any sign of a reaction taking place, cordon off and do not approach the area until a complete assessment has taken place.

(6) Breached containers of chlorinated isocyanurate products that become wet can generate nitrogen trichloride (NCl₃), a potential explosion hazard in conﬁned environments. Contact the manufacturer for detailed instructions when handling wet chlorinated isocyanurate products. Do not repackagew a wet product.

(7) Do not put spilled material back into its original container or any trash receptacle.

(8) Read the SDS and product label for additional safety information.

Chlorinated isocyanurate products should be stored in sealed original containers in a cool, dry, well-ventilated area. If the product has been contaminated, decomposition can occur. Signs of decomposition are heat product discoloration, gas formation, or package degradation. See Section G.4 for additional information.
It is necessary for emergency responders to be aware of the properties of calcium hypochlorite that can create hazardous conditions. The reactions of calcium hypochlorite or mixtures containing calcium hypochlorite with other materials can lead to fire and hazardous gases. When stored correctly and not exposed to other materials, these chemicals are safe to transport, store, handle, and use. However, in emergencies, conditions can occur that will cause containers to rupture and material to spill or become contaminated. It is important that correct actions be taken quickly in response to these conditions.

In its initial stage, the decomposition of calcium hypochlorite \([\text{Ca (OCl)}_2]\) proceeds to calcium chloride and oxygen and calcium chlorate. This reaction is an exothermic reaction, which can produce sufficient heat to decompose the product and ignite surrounding materials. Thermal runaway reaction does not occur as long as material is at equilibrium, where the heat generated is equal to the heat lost to the surroundings. A secondary reaction can give off chlorine gas.

Other oxidizers, particularly chlorinated isocyanurates, also react with calcium hypochlorite. Wet mixtures of calcium hypochlorite and chlorinated isocyanurates react vigorously, releasing large volumes of chlorine \((\text{Cl}_2)\) gas.

The following suggested actions and precautions should be taken during an emergency where calcium hypochlorite is present:

1. Emergency responders need to know their capabilities and limitations. If you are not completely sure that you can deal effectively with an emergency, get help from other responders or the manufacturer of the chemical. Contact chemical manufacturers directly or through Chemtrec\(^\text{\textregistered}\) at 800-424-9300.

2. During an emergency, allow only necessary personnel in the affected area.

3. Because hazardous gases might be present, be sure to have self-contained breathing apparatus (SCBA) available and wear when necessary. Other personal protective equipment might also be necessary to use.

4. Do not flush these chemicals or otherwise allow them to go into waterways or sewers without clearance from the appropriate officials.

5. If there is any sign of a reaction taking place, cordon off and do not approach the area until a complete assessment has taken place.

6. Do not put spilled material back into its original container or any trash receptacle.

7. Read the SDS and product label for additional safety information.

Calcium hypochlorite products should be stored in sealed original containers in a cool, dry, well-ventilated area. These products must not be stored at temperatures above 125°F (52°C). Storage above this temperature for an extended period of time (5 days or more) can result in decomposition, evolution of chlorine gas, and heat sufficient to ignite combustible products.

If calcium hypochlorite has been contaminated or stored at elevated temperatures above 125°F (52°C) for an extended period of time, decomposition can occur. Signs of decomposition are heat; calcium chloride \((\text{CaCl}_2)\) release, which can be seen as moisture on the surrounding walls from the \(\text{CaCl}_2\) absorbing moisture from the air; \(\text{Cl}_2\) gas plus container discoloration; or degradation of the packaging.

Extra caution should be taken when handling calcium hypochlorite or any other oxidizer that might be decomposing.

If the material shows signs of decomposition, it should be moved to a safe, protected, and well-ventilated area away from other hazardous materials. This movement would prevent a fire spreading in the event of rapid decomposition.

Special care should be taken when overpacking material that could be slowly decomposing to be sure that the heat can be dissipated and that a runaway reaction does not occur. If the decomposing material cannot be moved, move other hazardous or combustible material out of the area.

A fire water protection source should be available during the disposal and cleanup operation in case the product starts an accelerated decomposition. Water can be used to mitigate decomposing calcium hypochlorite; once the material is thoroughly wet, the risk of a runaway reaction has been greatly reduced. Lime can be added to reduce the fuming or off gassing of wet calcium hypochlorite.
G.4 Safety Information on Oxidizers Used in Detergents.

G.4.1 Sodium Percarbonate.

Sodium percarbonate (CAS 15630-89-4) or sodium carbonate perhydrate, is a solid adduct of hydrogen peroxide \( \text{Na}_2\text{CO}_3 \cdot \frac{3}{2}\text{H}_2\text{O}_2 \) used in detergent formulations. The active oxygen content of granular solid sodium percarbonate ranges from 12 to 14.5 percent. Granular particles are typically coated. Sodium percarbonate (99 percent) is a Class 1 oxidizer. Sodium percarbonate and sodium percarbonate-rich mixtures (>70 wt percent) are sensitive to gross contamination, to heat, and to reducing agents and are potentially explosive if mixed with organics. Sodium percarbonate and its formulated products have the propensity to undergo exothermic decomposition with the rapid release of oxygen, water as steam, and heat sufficient to ignite nearby combustible materials. The kinetics and decomposition reactions are complex. The self-accelerating decomposition temperature (SADT), the lowest ambient temperature at which self-accelerating decomposition may occur in a material in the packaging used for transportation, is reported to be 168°F (76°C) for 55 lb (25 kg) packages and 122°F (50°C) for 1 ton (1000 kg) bags. If improperly discarded or mixed with combustible trash, a fire can result.

G.5 Safety Information on Oxidizers Used in Swimming Pools.

G.5.1 Handling Swimming Pool Chemicals.

Oxidizers and sanitizers for swimming pools are some of the most widely used, manufactured, and distributed oxidizers. Anyone handling or using swimming pool chemicals should be fully aware of proper storage and handling requirements, as well as emergency and first-aid procedures in case of an accident. Chlorinated pool chemicals are incompatible with many chemicals associated with pool care, including algicides, pool conditioners (stabilizers), clarifiers, and other types of chlorine. It is essential to follow all storage and handling procedures in order to prevent conditions that might cause emergencies, such as a fire or explosion. This section includes specific information on pool oxidizers.

Calcium hypochlorite (cal hypo), lithium hypochlorite, and chlorinated isocyanurates (dichlor and trichlor) are not combustibles. They are oxidizers. Some oxidizers can cause the spontaneous ignition and increase the burning rate of combustible materials, including the majority of their packaging material. Some oxidizers decompose rapidly and undergo self-sustained decomposition, which can result in an intense fire or explosion. The decomposition of dry chlorinated pool chemicals can also produce toxic and corrosive gases.

Because of the composition and properties of calcium hypochlorite, lithium hypochlorite, and chlorinated isocyanurates, special precautions are required to prevent contact and reaction with each other and other chemicals. Reactions will occur if they are physically mixed together.

Emergency responders should be aware of oxidizers being stored in their area of response, visit the facilities, and obtain copies of the MSDS associated with the chemicals being stored. Knowledge of the facility and the chemicals being stored makes any response more efficient and effective.
Containers should be stored away from combustible or flammable products, and product packaging should be kept clean and free of all contamination, including other pool treatment products, acids, organic materials, nitrogen-containing compounds, dry-powder fire extinguishers (containing mono-ammonium phosphate), oxidizers, all corrosive liquids, flammable or combustible materials, and so forth.

G.45.1 Calcium Hypochlorite.

Calcium hypochlorite, commonly known as cal hypo, decomposes above 350°F (177°C). The decomposition will generate oxygen and heat, possibly resulting in a fire of great intensity if combustible materials are present. Direct-exposure fire could cause the materials to decompose, the container to erupt, and the fire to reach vastly higher levels of intensity. Decomposition leaves an inert residue consisting mainly of calcium chloride. Cal hypo (over 50 percent by weight) is classified as a Class 3 oxidizer. Cal hypo (50 percent or less by weight) is classified as a Class 2 oxidizer.

G.45.2 Lithium Hypochlorite.

Lithium hypochlorite decomposes at 275°F (135°C), producing oxygen, lithium hydroxide, lithium chlorates, and hazardous gases. Contamination with moisture, organic matter, or other chemicals may start a chemical reaction that generates heat, hazardous gases, fire, and explosion. Lithium hypochlorite (available chlorine of 39 percent or less) is classified as a Class 1 oxidizer. Lithium hypochlorite (more than 39 percent available chlorine) is classified as a Class 2 oxidizer.

G.45.3 Sodium Dichloroisocyanurate.

Sodium dichloroisocyanurate is commonly known as dichlor. It decomposes in the range of 428°F to 482°F (220°C to 250°C) and can generate enough heat to ignite items such as paper and wood. Dichlor will sustain thermal decomposition above 428°F (220°C), even in the absence of oxygen. Decomposition results in a yellow or brown porous inert residue. Anhydrous dichlor is classified as a Class 3 oxidizer in accordance with testing criteria found in G.1.2. Dichlor dihydrate is classified by NFPA as a Class 1 oxidizer.

G.45.4 Trichloroisocyanuric Acid.

Trichloroisocyanuric acid is commonly known as trichlor. It decomposes in the range of 428°F to 482°F (220°C to 250°C). Decomposition of trichlor requires a continuous source of heat. Once the heat source is removed, trichlor will not continue to decompose. Partial decomposition leaves a yellow or brown residue. Complete decomposition leaves only traces of residue. Trichlor is classified by NFPA as a Class 1 oxidizer.

G.45.5 Sodium Hypochlorite.

Sodium hypochlorite (7681-52-9) solutions are not classified as oxidizers by NFPA. Sodium hypochlorite is manufactured by reacting chlorine with dilute sodium hydroxide solution. Solutions are generally formulated in the range of 3–20 percent sodium hypochlorite by weight. The balance of the solution consists of water, sodium chloride, and sodium hydroxide. Depending upon the residual quantity of sodium hydroxide in the finished product, it is classified as an irritant material or a corrosive material as those terms are defined in OSHA’s Hazard
Communication Standard, 29 CFR 1910.1200. Generally speaking, solutions with less than 1 percent residual caustic are irritants, while solutions containing more than 1 percent residual caustic are classified as corrosives. Total evaporation of sodium hypochlorite solutions yields water and sodium chloride. Unlike calcium hypochlorite, sodium hypochlorite does not exist outside of solution. Sodium hypochlorite solutions do not readily yield oxygen or other oxidizing gases and do not initiate or promote combustion of combustible materials. The major decomposition pathway of hypochlorite ion evolves chlorite ion, which combines with additional hypochlorite ion to form chlorates, which in turn form chlorides. The formation of oxygen from decomposing hypochlorite ion is a very slow side reaction, although the rate may increase with exposure to transition metals. Other oxidizing gases, for example, chlorine, are not evolved in the decomposition.

G.45.2 Specific Response Information for Chlorinated Isocyanurates (Dichlor, Trichlor).

It is necessary for emergency responders to be aware of the properties of chlorinated isocyanurates (dichlor, trichlor) that can create hazardous conditions. The reaction of these chemicals or mixtures containing these chemicals with other materials can lead to the generation of hazardous gases and fire.

When stored correctly and not exposed to other materials, these chemicals are safe to transport, store, handle, and use. However, in emergencies, conditions can occur that will cause containers to rupture and material to spill or become contaminated. It is important that correct actions be taken quickly in response to these conditions.

The best approach to dealing with the reactivity of these chemicals is to assume that they will react with anything they contact. Some of the reactions, particularly those with fuels (kerosene, diesel oil, etc.) and some other organic materials, are very fast and violent. Others take some time to happen. An example of this is when spilled material is placed in a dumpster with no apparent reaction. Hours later, a fire occurs because of a slow reaction with other material.

Other oxidizers, particularly cal hypo, also react with chlorinated isocyanurates. Wet mixtures of chlorinated isocyanurates and calcium hypochlorite react vigorously, releasing large volumes of chlorine (Cl₂) gas.

The following suggested actions and precautions should be taken during an emergency where chlorinated isocyanurates are present:

1. Emergency responders need to know their capabilities and limitations. If you are not completely sure that you can deal effectively with an emergency, get help from other responders or the manufacturer of the chemical. Contact chemical manufacturers directly or through Chemtrec® at 800-424-9300.
2. During an emergency, only allow necessary personnel in the affected area.
3. Because hazardous gases might be present, be sure to have self-contained breathing apparatus (SCBA) available and wear when necessary. Other personal protective equipment might also be necessary to use.
(4) Do not flush these chemicals or otherwise allow them to go into waterways or sewers without clearance from the appropriate officials.

(5) If there is any sign of a reaction taking place, cordon off and do not approach the area until a complete assessment has taken place.

(6) Breached containers of chlorinated isocyanurate products that become wet can generate nitrogen trichloride (NCl₃), a potential explosion hazard in confined environments. Contact the manufacturer for detailed instructions when handling wet chlorinated isocyanurate products. Do not repack a wet product.

(7) Do not put spilled material back into its original container or any trash receptacle.

(8) Read the MSDS and product label for additional safety information.

Chlorinated isocyanurate products should be stored in sealed original containers in a cool, dry, well-ventilated area. If the product has been contaminated, decomposition can occur. Signs of decomposition are heat product discoloration, gas formation, or package degradation. (See Section G.5 for additional information.)

G.45.3 Specific Response Information for Calcium Hypochlorite.

It is necessary for emergency responders to be aware of the properties of calcium hypochlorite that can create hazardous conditions. The reactions of calcium hypochlorite or mixtures containing calcium hypochlorite with other materials can lead to fire and hazardous gases. When stored correctly and not exposed to other materials, these chemicals are safe to transport, store, handle, and use. However, in emergencies, conditions can occur that will cause containers to rupture and material to spill or become contaminated. It is important that correct actions be taken quickly in response to these conditions.

In its initial stage, the decomposition of calcium hypochlorite [Ca (OCl)₂] proceeds to calcium chloride and oxygen and calcium chlorate. This reaction is an exothermic reaction, which can produce sufficient heat to decompose the product and ignite surrounding materials. Thermal runaway reaction does not occur as long as material is at equilibrium, where the heat generated is equal to the heat lost to the surroundings. A secondary reaction can give off chlorine gas.

Other oxidizers, particularly chlorinated isocyanurates, also react with calcium hypochlorite. Wet mixtures of calcium hypochlorite and chlorinated isocyanurates react vigorously, releasing large volumes of chlorine (Cl₂) gas.

The following suggested actions and precautions should be taken during an emergency where calcium hypochlorite is present:

(1) Emergency responders need to know their capabilities and limitations. If you are not completely sure that you can deal effectively with an emergency, get help from other responders or the manufacturer of the chemical. Contact chemical manufacturers directly or through Chemtrec® at 800-424-9300.

(2) During an emergency, allow only necessary personnel in the affected area.
Because hazardous gases might be present, be sure to have self-contained breathing apparatus (SCBA) available and wear when necessary. Other personal protective equipment might also be necessary to use.

Do not flush these chemicals or otherwise allow them to go into waterways or sewers without clearance from the appropriate officials.

If there is any sign of a reaction taking place, cordon off and do not approach the area until a complete assessment has taken place.

Do not put spilled material back into its original container or any trash receptacle.

Read the MSDS and product label for additional safety information.

Calcium hypochlorite products should be stored in sealed original containers in a cool, dry, well-ventilated area. These products must not be stored at temperatures above 125°F (52°C). Storage above this temperature for an extended period of time (5 days or more) can result in decomposition, evolution of chlorine gas, and heat sufficient to ignite combustible products.

If calcium hypochlorite has been contaminated or stored at elevated temperatures above 125°F (52°C) for an extended period of time, decomposition can occur. Signs of decomposition are heat; calcium chloride (CaCl₂) release, which can be seen as moisture on the surrounding walls from the CaCl₂ absorbing moisture from the air; Cl₂ gas plus container discoloration; or degradation of the packaging.

Extra caution should be taken when handling calcium hypochlorite or any other oxidizer that might be decomposing.

If the material shows signs of decomposition, it should be moved to a safe, protected, and well-ventilated area away from other hazardous materials. This movement would prevent a fire spreading in the event of rapid decomposition.

Special care should be taken when overpacking material that could be slowly decomposing to be sure that the heat can be dissipated and that a runaway reaction does not occur.

If the decomposing material cannot be moved, move other hazardous or combustible material out of the area.

A fire water protection source should be available during the disposal and cleanup operation in case the product starts an accelerated decomposition. Water can be used to mitigate decomposing calcium hypochlorite; once the material is thoroughly wet, the risk of a runaway reaction has been greatly reduced. Lime can be added to reduce the fuming or off gassing of wet calcium hypochlorite.

G.5c Methods and Procedures for Emergency Response Involving Solid Oxidizers.

G.5c.1 Sodium Percarbonate. Sodium percarbonate (CAS 15630-89-4) or sodium carbonate perhydrate is a solid adduct of hydrogen peroxide (Na₂CO₃·3H₂O₂) used in detergent formulations. The active oxygen content of granular solid sodium percarbonate ranges from 12 to
14.5 percent. Granular particles are typically coated. Sodium percarbonate (99 percent) is a Class 1 oxidizer. Sodium percarbonate and sodium percarbonate–rich mixtures (>70 wt percent) are sensitive to gross contamination, to heat, and to reducing agents and are potentially explosive if mixed with organics. Sodium percarbonate and its formulated products have the propensity to undergo exothermic decomposition with the rapid release of oxygen, water as steam, and heat sufficient to ignite nearby combustible materials. The kinetics and decomposition reactions are complex. The self-accelerating decomposition temperature (SADT), the lowest ambient temperature at which self-accelerating decomposition may occur in a material in the packaging used for transportation, is reported to be 168°F (76°C) for 25 kg packages and 122°F (50°C) for 1 ton bags. If improperly discarded or mixed with combustible trash, a fire can result.

G.5.26.1 Oxidizer Hazards.

Incidents that involve oxidizers must be handled in a timely manner and with an understanding of the hazards and properties of the materials involved. This section identifies the key elements that must be understood when dealing with oxidizers that are under distress either from a spill, contamination, decomposition, or fire from a source other than the oxidizers.

The hazards of stored oxidizers can manifest themselves in one or more of six distinct hazardous situations as follows:

1. They increase the burning rate of combustible materials.
2. They can cause spontaneous ignition of combustible materials.
3. They can decompose rapidly.
4. They can liberate hazardous gases.
5. They can undergo self-sustained decomposition, which can result in an explosion.
6. They can react explosively if mixed with incompatibles or in fire conditions.

G.5.36.2 Handling Incidents Involving Oxidizers.

Anyone handling or using oxidizers should be fully aware of proper storage and handling requirements as well as emergency and first-aid procedures in case of an accident. Oxidizers are incompatible with many chemicals or other materials. It is essential to follow all storage and handling procedures in order to prevent conditions that might cause emergencies, such as a fire or explosion.

Before attempting to clean any oxidizer spill, be certain that the spilled material is dry and has not been contaminated. If there are any signs that a reaction has begun (hissing, bubbling, smoking, gassing, burning, or bulging or hot containers), evacuate the area immediately and contact your local fire department for assistance. If the product is not reacting but has mixed with chemicals or other materials, contact your local fire department. If you have any concerns regarding emergency procedures, immediately contact Chemtrec® at 800-424-9300 or the manufacturer for emergency instructions.

G.5.36.2.1
General considerations when responding to an oxidizer incident are as follows:

(1) Use trained personnel who understand the specific hazards of the oxidizers involved.
(2) Consult the manufacturer for technical assistance.
(3) Understand the reaction characteristic of the hazards of the specific oxidizer involved.
(4) Use a specific protocol on how to clean up the oxidizers involved.
(5) Prevent oxidizer and incompatibles from contacting each other.
(6) Control temperature below the maximum recommended storage temperature.
(7) If there are signs of decomposition, allow for heat dissipation.
(8) Control the cleanup site, including moving overpack containers to a safe and secure location, preferably outside the storage building.
(9) Move container to a safe, secure, dry, open outside area, or to a location designated by the competent individual, to await disposal in conformance with applicable regulations and manufacturer’s or processor’s instructions.
(10) Monitor overpacks to ensure that a slow decomposition reaction cannot lead to a self-accelerated decomposition reaction or fire.
(11) Manage the size and location of the cleanup pile so that a decomposition reaction cannot spread to other areas.
(12) Have water available for early intervention if a reaction starts.
(13) Do not use any material or equipment that could contaminate the spilled material.
(14) Do not dispose of the material with incompatible chemicals or materials.
(15) Keep material dry during cleanup and, if material becomes damp, see G.5.4.
(16) Do not allow unnecessary or untrained personnel in the area during the cleanup.
(17) Wear appropriate protective gear and refer to the emergency response plan or material safety data sheet (MSDS).
(18) Store cleanup supplies in a cabinet or marked-off area where they can be accessed quickly when needed.
(19) Train employees in the cleanup procedures of the facility.

G.5.36.2.1.1

Water is the most important element in controlling an oxidizer incident or fire. The proper use of water is the most important element in controlling a fire involving oxidizers. Do not use dry-chemical extinguishing agent on oxidizer fires.

G.5.36.2.1.2
The following are guidelines for the use of water in fire control:

1. Water in sufficient quantities stops or prevents an oxidizer fire from spreading.

2. Water in sufficient quantities greatly reduces the reactivity of most oxidizers. Refer to the MSDS to determine the characteristics of the specific oxidizers that you are handling.

3. Adding water normally slows the decomposition, reduces liberation of hazardous gas, and eliminates self-sustained decomposition.

4. Some oxidizers, primarily trichlor, can react with small amounts of water over a period of time and form NCl₃, a potentially explosive compound. Even though NCl₃ is formed, water should continue to be added. Water in sufficient quantities is still the best method to control an oxidizer in a fire. Consult the manufacturer on how to handle and dispose of damp oxidizers.

5. Some oxidizers can dry out after wetting and, if contaminated, can react, causing a possible fire.

6. The water runoff from an oxidizer fire should be contained to protect the environment.

G.5.36.2.2 Spill Responses.

If you have expertise addressing chemical spills, be sure to evaluate whether the material you are handling and the containers you are using are dry and uncontaminated. Follow applicable regulations when disposing of any material. Whether or not there is a fire, call the supplier for instructions on how best to clean up and remove spilled material and for other useful information. Use the emergency telephone number on the container, the MSDS, or other information supplied by the manufacturer. Additional emergency information can be obtained through Chemtrec® and Canutec.

G.5.36.2.3 Procedure for Cleaning Uncontaminated Dry Spills.

If the spill is dry and uncontaminated and there are no signs of decomposition or fire, the following approach should be used. Alternate or additional procedures might be advisable, depending upon site-specific circumstances. Users must tailor the cleanup to their own particular circumstances. Contact the manufacturer for further instructions.

The following procedure should be used:

1. Evaluate and respond as follows:
   (a) If reacting, call the fire department.
   (b) If product is contaminated with any other chemical or material, call the fire department.
   (c) In the event of a large spill [100 lb (45.4 kg) or more], call the fire department.
   (d) In the event of a small spill [under 100 lb (45.4 kg)], proceed only if trained, or refer to manufacturer’s instructions.
(c) Contact the manufacturer.

(2) Isolate and ventilate the area as follows:
   (a) Mark off area.
   (b) Keep people away.
   (c) Do not breathe dust.
   (d) Open doors and windows.

(3) Wear protective clothing as follows:
   (a) Rubber or neoprene gloves, boots, and aprons
   (b) Protective goggles or safety glasses
   (c) NIOSH/MSHA-approved respirator or breathing apparatus

(4) Get two clean, dry, plastic containers (or suitable containers) large enough to hold the spilled material and proceed as follows:
   (a) Line clean, suitable container with two clear-plastic bags.
   (b) Place damaged container into one of the suitable containers.
   (c) Label the container(s) properly and identify contents.
   (d) Loosely place lid and leave unsealed.
   (e) Do not place spilled chemical into original container.

(5) Get clean broom and shovel and proceed as follows:
   (a) Carefully sweep up spilled chemical.
   (b) Place spilled material in clean clear-plastic bag.
   (c) Place plastic bag into second container.
   (d) Label container(s) accordingly to identify contents.

(6) Remove containers to isolated area as follows:
   (a) Move waste material to a safe and protected location in case there is a decomposition reaction.
   (b) Keep away from children and high-traffic areas.
   (c) Avoid getting process duct wet.

(7) Thoroughly wash area with water to remove residue.

(8) Wash and dry the following equipment:
(a) Broom and shovel

(b) Protective clothing

(9) Contact manufacturer for proper disposal of chemicals.

G.5.46.3 Specific Hazards of Oxidizer Fires, Reacting Oxidizers, and Large Oxidizer Incidents.

G.5.46.3.1 Emergency Response Plans and Actions.

It is the responsibility of each facility to have an emergency plan and train their employees in the requirements of the plan.

It is the primary responsibility of each facility employee to follow the pre-established guidelines set forth in an emergency plan.

G.5.46.3.2 Specific Emergencies.

G.5.46.3.2.1 Fire and Fume Hazards.

Oxidizers are not combustible per se. However, if oxidizers are heated and/or contaminated to their decomposition range by an outside source, they can decompose, resulting in the generation of heat. The intensity of the decomposition can be sufficient to ignite paper and wood and a fire can result. Upon thermal decomposition, some oxidizers can give off dense clouds of gases that can be toxic, noxious, and very difficult to see through. Check the MSDS or contact the manufacturer for the possible types of hazardous decomposition products during a thermal decomposition.

In case of fire or decomposition, immediately implement your emergency plan to minimize loss of life or property. An emergency plan commonly includes the following steps:

(1) In the event of an emergency, contact your local fire department, ambulatory service, or police department immediately.

(2) State your full name, company name, address, and telephone number.

(3) State nature of emergency (i.e., fire, gas leak).

(4) State type of assistance required (i.e., ambulance, fire).

(5) If possible, stay on the line until the emergency operator understands the information.

Emergency numbers should be pre-set on all store phones to assist calling. Numbers should be in bold or colored print.

The following are issues regarding the use of personal protective equipment that should be considered:

(1) Be prepared to use the appropriate personal protective equipment, which can include SCBA, in an emergency.
(2) For small, controllable fires, use appropriate safety equipment. Only trained personnel should attempt to extinguish fires. Do not fight any fire alone.

(3) If swimming pool chemicals are involved in a fire or reaction, use large quantities of water. Do not use dry-chemical extinguishers because they can contain ammonium compounds, which could react and release toxic or explosive gases. Provisions should be made for the containment of runoff water (i.e., diking with sandbags, dirt, or other suitable material). If there is a fire or if the pool chemical product is contaminated with another chemical, the area should be evacuated and the fire department called immediately, even if the building has a sprinkler system.

(4) Direct unnecessary personnel away from the area.

Do not allow oxidizers or fire water to enter sewers, waterways, or trash containers, and keep unneutralized and chlorinated chemicals out of sewers, watersheds, or water systems.

G.5.4-6.3.2.2 Reacting Oxidizers.

Oxidizers are stable when stored in a cool, dry, well-ventilated area and not contaminated by other materials, such as acids, bases, or easily oxidizable materials. Oxidizers can become dangerous if mishandled, improperly stored, or contaminated. They could become unstable or undergo a decomposition reaction, which could produce intense heat, hazardous gases, fire, or explosion.

Oxidizers are also incompatible with many of the other chemicals used in commerce, such as organic solvents, algaecides, other oxidizers, and pH adjusting materials. Some of the materials that are incompatible with oxidizers are listed as follows:

1. Acids
2. Alcohols (methyl, ethyl, propyl, and higher alcohols)
3. Aliphatic and aromatic unsaturated compounds
4. Amines
5. Ammonia and ammonium salts
6. Bases
7. Carbonated beverages
8. Ethers
9. Floor sweeping compounds
10. Glycerin
11. Paint, oils, and greases
12. Peroxides (hydrogen, sodium, calcium, etc.)
(13) Petroleum products (gasoline, kerosene, etc.)

(14) Phenols

(15) Other oxidizers

(16) Quaternary ammonium compounds (“quats”), such as algaecides

(17) Reducing agents (sulfides, sulfites, bisulfites, thiosulfates)

(18) Solvents (toluene, xylene, etc.)

It should be noted that this list is not comprehensive. For more information on the incompatibilities between pool chemicals and other materials, the appropriate pool chemical supplier or manufacturer should be contacted.

Some oxidizers, such as trichloroisocyanuric acid (TCCA; trichlor) can give off toxic gases and form NCl₃ if small amounts of water are added. Special precautions should be used when handling these oxidizers. If containers of one of these oxidizers become wet, they could contain NCl₃, which is a potential explosive. Before handling wet oxidizers, the manufacturer should be contacted for instructions.

A response to a reacting oxidizer incident is as follows:

(1) Contact appropriate emergency personnel. Responder should assess the nature and magnitude of the emergency.

(2) If there are any signs that a reaction has begun (hissing, bubbling, smoking, gassing, burning, or bulging or hot containers), evacuate the area immediately and contact the local fire department for assistance. If the product is not reacting but has mixed with other chemicals or other materials, contact your local fire department.

(3) Additional information can be obtained by using the emergency telephone number on the container or other information supplied by the manufacturer or by calling Chemtrec®.

(4) Water in sufficient quantities greatly reduces the reactivity of most oxidizers and can stop or prevent a fire. Water slows the decomposition reaction, reduces liberation of hazardous gas, and eliminates self-sustained decomposition.

(5) When overpacking product, continuously monitor to be sure that the product is not decomposing, because if the heat of decomposition cannot be dissipated, then the increased temperature can result in a self-sustained decomposition and possible fire.

(6) On-site neutralization might be the only acceptable solution for reacting and contaminated material.

(7) Have a sufficient water source available to stop an oxidizer reaction in case a decomposition reaction starts.

(8) Contamination and high temperatures are the major reasons an oxidizer reaction starts. During a cleanup, packaging materials should be handled so that the product is not
contaminated and the temperatures of all packages are maintained below the recommended storage temperature for the specific oxidizers involved.

(9) Contaminated oxidizers should never be mixed with packaging material. Only original noncontaminated packaging material can be in overpack.

(10) Do not place spilled chemicals into the trash. Contact with incompatible materials could cause a reaction.

(11) Keep spilled material dry. If allowed to stand in damp or wet areas, tear-producing vapors can result. Dampening the product with water during the cleanup process can cause a decomposition reaction.

(12) Keep unneutralized and chlorinated chemicals out of sewers, watersheds, or water systems.

G.5.4.3.2.3 Personal Protective Equipment.

When handling chemicals or cleaning up a spill, the manufacturer’s MSDS for personal protective equipment recommendations should be consulted. Recommended personal protective equipment includes the following:

(1) Chemical-resistant gloves
(2) Chemical-resistant boots
(3) Chemical-resistant coveralls/aprons
(4) Face shields
(5) NIOSH-approved respiratory protection for the conditions

A NIOSH-approved, positive-pressure, self-contained breathing apparatus (SCBA) plus any other necessary personal protective equipment should be worn if toxic fumes are present. Chlorine and other toxic gases can be released during a fire or decomposing reaction.
Second Revision No. 150-NFPA 400-2014 [Section No. G.5]

G.7 Methods and Procedures for Emergency Response Involving Solid Oxidizers.

G.7.1 Sodium Percarbonate.
Sodium percarbonate (CAS 15630-89-4) or sodium carbonate perhydrate is a solid adduct of hydrogen peroxide (Na₂O₅O₂H₂O₃) used in detergent formulations. The active oxygen content of granular solid sodium percarbonate ranges from 17 to 19.5 percent. Granular percarbonate is typically coated. Sodium percarbonate (99 percent) is a Class 1 oxidizer. Sodium percarbonate and sodium percarbonate rich mixtures (>70 percent) are sensitive to gross contamination. In heat and/or reducing agents and are potentially explosive if mixed with organic. Sodium percarbonate and its formulated products have the propensity to undergo exothermic decomposition with the rapid release of oxygen, water as steam, and heat sufficient to ignite nearby combustible materials. The self-accelerating decomposition temperature (SADT), the lowest ambient temperature at which self-accelerating decomposition may occur in a material in the packaging used for transportation, is reported to be 189°F (82°C) for 75 kg packages and 172°F (78°C) for 2.5 kg packages. If improperly dispersed or mixed with combustible material, a fire can result.

G.7.1.1 Oxidizer Hazards.
Incidents that involve oxidizers must be handled in a timely manner and with an understanding of the hazards and properties of the materials involved. This section identifies the key elements that must be understood when dealing with oxidizers that are under distress either from a spill, contamination, decomposition, or fire from a source other than the oxidizers.

The hazards of stored oxidizers can manifest themselves in one or more of six distinct hazardous situations as follows:

1. They increase the burning rate of combustible materials.
2. They can cause spontaneous ignition of combustible materials.
3. They can decompose rapidly.
4. They can liberate hazardous gases.
5. They can undergo self-sustained decomposition, which can result in an explosion.
6. They can react explosively if mixed with incompatibles or in fire conditions.

G.7.2 Handling Incidents Involving Oxidizers.
Anyone handling or using oxidizers should be fully aware of proper storage and handling requirements as well as emergency and first-aid procedures in case of an accident. Oxidizers are incompatible with many chemicals or other materials. It is essential to follow all storage and handling procedures exactly to prevent conditions that might cause emergencies, such as a fire or explosion.

Before attempting to clean any oxidizer spill, be certain that the spilled material is dry and has not been contaminated. If there are any signs that a reaction has begun (hissing, bubbling, smoking, gassing, burning, or bulging or hot containers), evacuate the area immediately and contact your local fire department for assistance. If the product is not reacting but has mixed with chemicals or other materials, contact your local fire department. If you have any concerns regarding emergency procedures, immediately contact Chemtrec® at 800-424-9300 or the manufacturer for emergency instructions.

G.7.2.1 General considerations when responding to an oxidizer incident are as follows:

1. Use trained personnel who understand the specific hazards of the oxidizers involved.
2. Consult the manufacturer for technical assistance.
3. Understand the reaction characteristic of the hazards of the specific oxidizer involved.
4. Use a specific protocol on how to clean up the oxidizers involved.
5. Prevent oxidizer and incompatibles from contacting each other.
6. Control temperature below the maximum recommended storage temperature.
7. If there are signs of decomposition, allow for heat dissipation.
8. Control the cleanup site, including moving overpack containers to a safe and secure location, preferably outside the storage building.
9. Move container to a safe, secure, dry, open outside area, or to a location designated by the competent individual, to await disposal in conformance with applicable regulations and manufacturer’s or processor’s instructions.
10. Monitor overpacks to ensure that a slow decomposition reaction cannot lead to a self-accelerated decomposition reaction or fire.
11. Manage the size and location of the cleanup pile so that a decomposition reaction cannot spread to other areas.
12. Have water available for early intervention if a reaction begins.
13. Do not use any material or equipment that could contaminate the spilled material.
14. Do not dispose of the material with incompatible chemicals or materials.
15. Keep material dry during cleanup and, if material becomes damp, see G.7.2.2.1.
16. Do not allow unnecessary or untrained personnel in the area during the cleanup.
17. Wear appropriate protective gear and refer to Emergency Response Plan or safety data sheet (SDS).
18. Store cleanup supplies in a cabinet or marked, marked-off area where they can be accessed quickly when needed.
19. Train employees in the cleanup procedures of the facility.

G.7.2.1.1 Water is the most important element in controlling an oxidizer incident or fire. The proper use of water is the most important element in controlling a fire involving oxidizers. Do not use dry chemical extinguishing agent on oxidizer fires.

G.7.2.1.2 The following are guidelines for the use of water in fire control:

1. Water in sufficient quantities stops or prevents an oxidizer fire from spreading.
2. Water in sufficient quantities greatly reduces the reactivity of most oxidizers. Refer to the SDS to determine the characteristics of the specific oxidizers that you are handling.
3. Adding water normally slows the decomposition, reduces liberation of hazardous gas, and eliminates self-sustained decomposition.
4. Some oxidizers, primarily trichlor, can react with small amounts of water over a period of time and form NCl₃, a potentially explosive compound. Even though NCl₃ is formed, water should continue to be added. Water in sufficient quantities is still the best method to control an oxidizer in a fire. Consult the manufacturer on how to handle and dispose of damp oxidizers.
5. Some oxidizers can dry out after wetting and, if contaminated, can react, causing a possible fire.

G.7.2.2 Spill Responses.
If you have expertise addressing chemical spills, be sure to evaluate whether the material you are handling and the containers you are using are dry and uncontaminated. Follow applicable regulations when disposing of any material. Whether or not there is a fire, call the supplier for instructions on how best to clean up and remove spilled material and for other useful information. (Use the emergency telephone number on the container, the SDS, or other information supplied by the manufacturer. Additional emergency information can be obtained through Chemtrec® and Canutec.)
G.7.2.3 Procedure for Cleaning Uncontaminated Dry Spills.

If the spill is dry and uncontaminated and there are no signs of decomposition or fire, the following approach should be used. Alternate or additional procedures might be advisable, depending upon site-specific circumstances. Users must tailor the cleanup to their own particular circumstances. Contact the manufacturer for further instructions.

The following procedure should be used:

1. Evaluate and respond as follows:
   (a) If reacting, call the fire department.
   (b) If product is contaminated with any other chemical or material, call the fire department.
   (c) In the event of a large spill [100 lb (45.4 kg) or more], call the fire department.
   (d) In the event of a small spill [under 100 lb (45.4 kg)], proceed only if trained, or refer to manufacturer’s instructions.
   (e) Contact the manufacturer.
2. Isolate and ventilate the area as follows:
   (a) Mark off area.
   (b) Keep people away.
   (c) Do not breathe dust.
   (d) Open doors and windows.
3. Wear protective clothing as follows:
   (a) Rubber or neoprene gloves, boots, and aprons
   (b) Protective goggles or safety glasses
   (c) NIOSH/MSHA-approved respirator or breathing apparatus
4. Get two clean, dry, plastic containers (or suitable containers) large enough to hold the spilled material and proceed as follows:
   (a) Line clean, suitable container with two clear-plastic bags.
   (b) Place damaged container into one of the suitable containers.
   (c) Label the container(s) properly and identify contents.
   (d) Loosely place lid and leave unsealed.
   (e) Do not place spilled chemical into original container.
5. Get clean broom and shovel and proceed as follows:
   (a) Carefully sweep up spilled chemical.
   (b) Place spilled material in clean clear-plastic bag.
   (c) Place plastic bag into second container.
   (d) Label container(s) accordingly to identify contents.
6. Remove containers to isolated area as follows:
   (a) Move waste material to a safe and protected location in case there is a decomposition reaction.
   (b) Keep away from children and high traffic areas.
   (c) Avoid getting process duct wet.
7. Thoroughly wash area with water to remove residue.
8. Wash and dry the following equipment:
   (a) Broom and shovel
   (b) Protective clothing
9. Contact manufacturer for proper disposal of chemicals.

G.7.3 Specific Hazards of Oxidizer Fires, Reacting Oxidizers, and Large Oxidizer Incidents.

Oxidizers are not combustible per se. However, if oxidizers are heated and/or contaminated to their decomposition range by an outside source, they can decompose, resulting in the generation of heat. The intensity of the decomposition can be sufficient to ignite paper and wood and a fire can result. Upon thermal decomposition, some oxidizers can give off dense clouds of gases that can be toxic, noxious, and very difficult to see through. Check the SDS or contact the manufacturer for the possible types of hazardous decomposition products during a thermal decomposition.

In case of fire or decomposition, immediately implement your emergency plan to minimize loss of life or property. An emergency plan commonly includes the following steps:

1. In the event of an emergency, contact your local fire department, ambulatory service, or police department immediately.
2. State your full name, company name, address, and telephone number.
3. State nature of emergency (i.e., fire, gas leak).
4. State type of assistance required (i.e., ambulance, fire).
5. If possible, stay on the line until the emergency operator understands the information.

Emergency numbers should be pre-set on all store phones to assist calling. Numbers should be in bold or colored print.

The following are issues regarding the use of personal protective equipment that should be considered:

1. Be prepared to use the appropriate personal protective equipment, which can include SCBA, in an emergency.
2. For small, controllable fires, use appropriate safety equipment. Only trained personnel should attempt to extinguish fires. Do not fight any fire alone.
3. If swimming pool chemicals are involved in a fire or reaction, use large quantities of water. Do not use dry chemical extinguishers because they can contain ammonium compounds, which could react and release toxic or explosive gases. Provisions should be made for the containment of runoff water (i.e., digging with sandbags, dirt, or other suitable material). If there is a fire or if the pool chemical product is contaminated with another chemical, the area should be evacuated and the fire department called immediately, even if the building has a sprinkler system.
4. Direct unnecessary personnel away from the area.

Do not allow oxidizers or fire water to enter sewers, waterways, or trash containers, and keep unneutralized and chlorinated chemicals out of sewers, watersheds, or water systems.
### G.7.3.2 Reacting Oxidizers

Oxidizers are stable when stored in a cool, dry, well-ventilated area and not contaminated by other materials, such as acids, bases, or easily oxidizable materials. Oxidizers can become dangerous if mishandled, improperly stored, or contaminated. They could become unstable or undergo a decomposition reaction, which could produce intense heat, hazardous gases, fire, or explosion.

Oxidizers are also incompatible with many of the other chemicals used in commerce, such as organic solvents, algaecides, other oxidizers, and pH adjusting materials. Some of the materials that are incompatible with oxidizers are listed as follows:

1. Acids
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3. Aliphatic and aromatic unsaturated compounds
4. Amines
5. Ammonia and ammonium salts
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7. Carbonated beverages
8. Ethers
9. Floor sweeping compounds
10. Glycerin
11. Paint, oils, and greases
12. Peroxides (hydrogen, sodium, calcium, etc.)
13. Petroleum products (gasoline, kerosene, etc.)
14. Phenols
15. Other oxidizers
16. Quaternary ammonium compounds ("quats"), such as algaecides
17. Reducing agents (sulfides, sulfites, bisulfites, thiosulfates)
18. Solvents (toluene, xylene, etc.)

It should be noted that this list is not comprehensive. For more information on the incompatibilities between pool chemicals and other materials, the appropriate pool chemical supplier or manufacturer should be contacted.

Some oxidizers, such as trichloroisocyanuric acid (TCCA; trichlor) can give off toxic gases and form NCl\textsubscript{3} if small amounts of water are added. Special precautions should be used when handling these oxidizers. If containers of one of these oxidizers become wet, they could contain NCl\textsubscript{3}, which is a potential explosive. Before handling wet oxidizers, the manufacturer should be contacted for instructions.

A response to a reacting oxidizer incident is as follows:

1. Contact appropriate emergency personnel. Responder should assess the nature and magnitude of the emergency.
2. If there are any signs that a reaction has begun (hissing, bubbling, smoking, gassing, burning, or bulging or hot containers), evacuate the area immediately and contact the local fire department for assistance. If the product is not reacting but has mixed with other chemicals or other materials, contact your local fire department.
3. Additional information can be obtained by using the emergency telephone number on the container or other information supplied by the manufacturer or by calling Chemtrec®. Protective equipment includes the following:
   - Chemical-resistant gloves
   - Chemical-resistant boots
   - Chemical-resistant coveralls/aprons
   - Face shields
   - A NIOSH-approved, positive-pressure, self-contained breathing apparatus (SCBA) plus any other necessary personal protective equipment should be worn if toxic fumes are present.

### G.7.3.3 Personal Protective Equipment

When handling chemicals or cleaning up a spill, the manufacturer’s SDS for personal protective equipment recommendations should be consulted. Recommended personal protective equipment includes the following:

1. Chemical-resistant gloves
2. Chemical-resistant boots
3. Chemical-resistant coveralls/aprons
4. Face shields
5. NIOSH-approved respiratory protection for the conditions

A NIOSH-approved, positive-pressure, self-contained breathing apparatus (SCBA) plus any other necessary personal protective equipment should be worn if toxic fumes are present. Chlorine and other toxic gases can be released during a fire or decomposing reaction.