ORGANIC PEROXIDES AND OXIDIZING MATERIALS

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1.0 SCOPE

This document provides guidelines for the safe storage and handling of organic peroxides and oxidizing materials in liquid and solid form, including the bulk storage of various concentrated hydrogen peroxide solutions.

The storage arrangements for organic peroxides in this document take into consideration the hazards of these materials and the approved packaging for transportation provided by manufacturers.

The safeguards apply specifically to facilities storing and handling these materials in manufacturing processes.

1.1 Hazards

The hazards associated with organic peroxides and oxidizers are fire and explosion.

Organic peroxides are reactive and thermally unstable materials with an intrinsic fire hazard. Some peroxide formulations may also present an explosive decomposition or deflagration hazard. Most organic peroxides burn vigorously and, once ignited, are difficult to control or extinguish.

Oxidizers are materials that do not burn but will support combustion when in contact with other materials. The decomposition process of these materials releases oxygen and can create enough heat to ignite nearby combustibles. Oxidizers generally produce intense, long-duration fires. Some oxidizers, under conditions such as contamination, thermal or shock exposure, can develop an explosion reaction.

1.2 Changes

July 2020. This document has been completely revised. The following significant changes were made:

A. Changed the name of Data Sheet 7-80 to *Organic Peroxides and Oxidizing Materials* (from *Organic Peroxides*).

B. Incorporated the following data sheets: 7-81, *Organic Peroxides Hazard Classification*; 7-82N, *Storage of Liquid and Solid Oxidizing Materials*; and 7-84, *Hydrogen Peroxide*. Those data sheets will be made obsolete.

C. Updated guidance for the storage and handling of organic peroxides and hydrogen peroxide storage tanks.

D. Added new guidance on oxidizing materials.

E. Created new hazard types for organic peroxide formulations to replace the hazard classifications in Data Sheet 7-81. Updated the list of materials.

F. Revised separation distances for the storage of explosive organic peroxides and hydrogen peroxide storage tanks. Added new guidance to determine necessary separation distances for the storage of explosive oxidizing materials.

G. Added new guidance on retail storage of pool chemicals.

H. Updated loss history and illustrative losses.

1.3 Superseded Information

FM Data Sheets 7-80 *Organic Peroxides*, 7-81 *Organic Peroxides Hazard Classification*, 7-82N *Storage of Liquid/Solids Oxidizers Materials* and 7-84 *Hydrogen Peroxide* will be replaced by this Data Sheet.

2.0 LOSS PREVENTION RECOMMENDATIONS

2.1 Introduction

This data sheet is divided in general recommendations that apply to both organic peroxides and oxidizing materials, including hydrogen peroxide bulk storage. Specific recommendations for these materials are provided in their own separate sections.

Use FM Approved equipment, materials, and services whenever they are applicable. For a list of products and services that are FM Approved, see the *Approval Guide*, an online resource of FM Approvals.

2.2 Construction and Location

The storage of some organic peroxides and oxidizing materials require isolation, either by distance or construction, to prevent exposure from fire or explosion to important buildings or processes. The extent of the necessary isolation depends on the properties and hazard classification of each one of those materials.

2.2.1 Locate and construct cutoff, attached, and detached organic peroxide and oxidizer storage areas in accordance with Figure 1, plus Section 2.9.2 for organic peroxides and Section 2.10.2 for oxidizing materials.

The separation distance of detached storage areas in which more than one class of material is stored will be driven by the amount of the highest-hazard material.

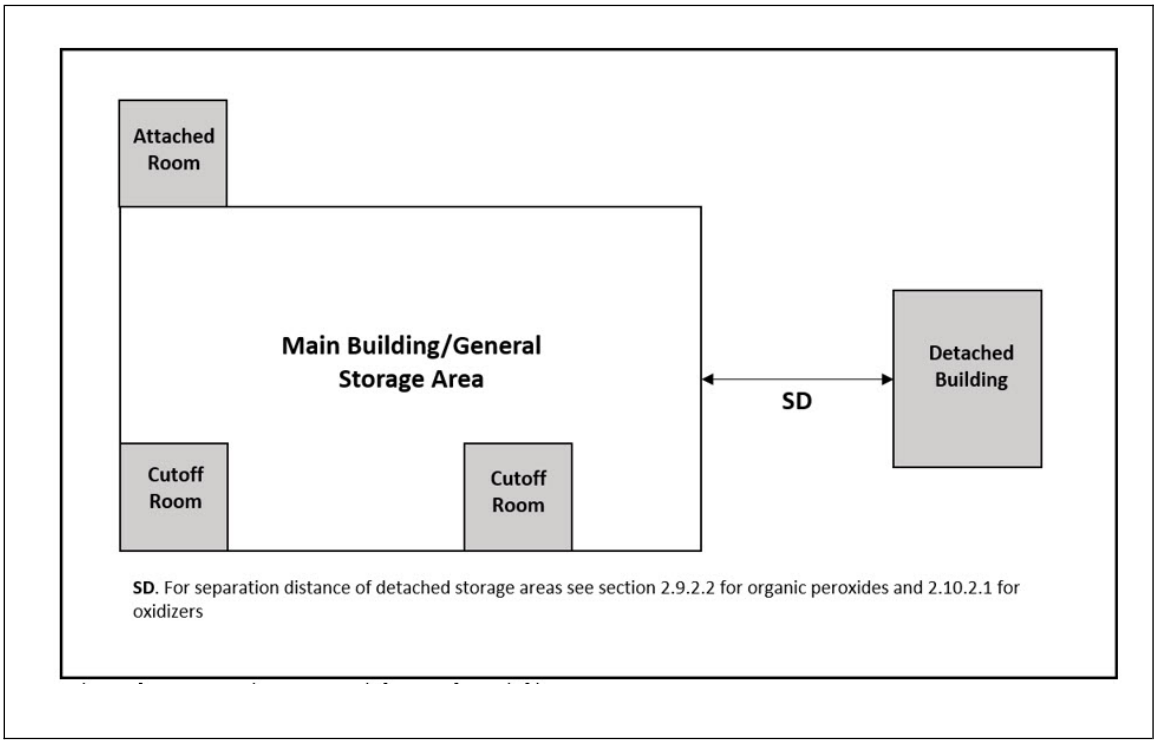


Fig. 1. Organic peroxide and oxidizer storage areas

2.2.2 Construct storage areas with noncombustible or FM Approved Class 1 materials. Ensure all materials and fittings used during construction that may come in contact with the stored materials under normal operation or in the event of spillage are compatible or protected.

2.2.3 Construct detached storage buildings or similar storage units to be one story in height.

2.2.4 Provide storage areas with natural ventilation.

2.3 Protection

2.3.1 Design the sprinkler system in areas with more than one class or hazard group for the highest-hazard material.

2.3.2 For storage areas with materials that present an explosion or deflagration hazard, arrange sprinkler piping in accordance with Data Sheet 7-14, *Fire Protection for Chemical Plants*, Section 2.3.9, protection of piping, valves, and fittings against damage from explosion hazards.

2.4 Occupancy

2.4.1 Provide stock rotation procedures (first-in, first-out) for storage areas to prevent material decomposition due to long storage periods.

2.4.2 For storage, use only pallets that are clean and free of any oil or combustible substances or materials.

2.4.3 Store and handle organic peroxides and oxidizing materials in cool, dry, well-ventilated areas.

2.4.4 Keep areas clean and free of combustible materials. Immediately remove leaking or broken containers and clean any spills. Follow the specific manufacturer's recommendations for cleanup and disposal procedures.

2.4.5 Use only clean tools and equipment for handling and dispensing operations. Ensure tools and equipment are made with only compatible materials. Thoroughly clean all equipment after use in accordance with the manufacturer's instructions.

2.4.6 Maintain containers securely closed in storage areas to prevent any contamination. Keep all packaging clean and free of all contamination.

2.4.7 Dispose of unused or contaminated materials in accordance with the manufacturer's recommendations. Do not return unused materials to the original container.

2.4.8 Provide storage arrangements according to chemical compatibility and physical form. Store solids above liquids.

2.4.9 Store materials away from heat sources, including radiant heat.

2.4.10 Dispose of empty containers in accordance with the manufacturer's recommendations and avoid accumulation in process or storage areas.

2.5 Equipment and Processes

2.5.1 Storage Tanks

This section provides general recommendations for storage tanks. For specific recommendations for organic peroxide storage tanks see Section 2.9.2.4, and for hydrogen peroxide storage tanks see Section 2.11.

2.5.1.1 Where piping is directly interconnected with equipment or pipelines containing different materials, arrange piping systems with appropriate devices to prevent backflow of one material to another.

2.5.1.2 Arrange all piping and equipment to drain and to prevent backflow. Design equipment to avoid trapping material at dead ends or between closed valves. Provide suitable pressure-relief devices if trapping of liquid cannot be avoided.

2.5.1.3 Provide a remote supply shutoff. This arrangement is particularly important in case of liquid leakage or process upset inside the buildings.

2.5.1.4 Route discharge from relief devices and equipment vents to a safe outdoor location. Ensure a release does not expose buildings, equipment, or other tanks that may be affected by the released products.

2.5.1.5 Provide level indicators and a high-level alarm.

2.5.1.6 Where normal ambient temperature ranges would subject the material to unsafe temperatures, do one or both of the following:

A. Fully insulate the tank using a noncombustible insulation compatible with the material in storage.

B. Provide a heating and/or cooling system using a heat transfer medium compatible with the material in storage.

In either case, provide instrumentation to monitor the temperature of the material in storage.

2.5.1.7 Provide separate dikes or drainage to hold 100% of the content of the tank to prevent storage area spills from approaching buildings and other storage. Do not store any other liquid or combustible materials in the diked area. Avoid drains that may contain other wastes or pass under buildings.

2.6 Operation and Maintenance

2.6.1 Unloading Operations

2.6.1.1 Clearly identify the pipe connections to prevent introducing any other material into the system or vice versa. Lock all fill lines and assign the key to the person responsible for the storage tank.

2.6.1.2 Have tank cars and trucks unloaded and removed promptly. Keep full tank cars on sidings at least 100 ft (30 m) from important buildings or equipment until they are unloaded.

2.6.1.3 Provide water hoses near the unloading stations to wash down any spills.

2.6.2 Provide an inspection, testing, and maintenance program for the alarms and temperature indicators in accordance with Data Sheet 7-45, *Safety Controls, Alarms, and Interlocks*.

2.7 Training

2.7.1 Train operators on the functions and required actions associated with the storage and handling of organic peroxides and oxidizers. At a minimum, include the following in the training:

- Hazards and hazard classifications
- Handling and storage procedures
- Cleanup and disposal procedures
- Normal and emergency procedures

2.8 Human Factor

2.8.1 Implement management of change procedures to review and evaluate any changes to equipment, processes, or storage conditions. Refer to Data Sheet 7-43, *Process Safety*, for additional information.

2.9 Organic Peroxides

Recommendations for organic peroxides in this data sheet are based on five different hazard types: explosion hazard (EH), deflagration hazard (DH), severe fire hazard (SFH), fire hazard (FH), and low hazard (LH). See hazard type definitions in Appendix A.

2.9.1 Occupancy

2.9.1.1 General

2.9.1.1.1 Perform onsite dilution operations only when specific instructions from manufacturers have been provided, including detailed procedures, compatible diluents or solvents, and hazardous conditions that could produce accelerated decomposition of the organic peroxide.

2.9.1.1.2 Keep organic peroxides in their original shipping containers provided by manufacturers and approved for transportation.

2.9.1.1.3 Protect organic peroxide storage areas from direct sunlight and all other sources of heat.

2.9.1.1.4 Store organic peroxides within the temperature range specified by their manufacturers.

2.9.1.1.5 Limit the quantity of organic peroxides in process areas, cutoff/attached areas, and detached areas per Table 1.

Table 1. Maximum Quantities of Organic Peroxide in Areas by Hazard Type

Hazard Type	*Process Area*	*Cutoff/Attached*	*Detached*
EH	Immediate needs	NP	See 2.9.2.2.1.
DH	Immediate needs	2000 lb (910 kg)	150,000 lb (68,000 kg)
SFH	Immediate needs	20,000 lb (9100 kg)[a]	250,000 lb (110,000 kg)
FH	Shift supply	UN	UN
LH	Shift supply	UN	UN

[a] DLC is not needed for SFH amounts of less than 10,000 lb (4550 kg).
UN = unlimited
NP = not permitted

2.9.1.1.6 Provide a minimum separation distance between pallets of 4 in. (0.1 m) and a minimum aisle width of 8 ft (2.4 m). Between pallets and walls, provide a separation of at least 2 ft (0.6 m).

2.9.1.2 Process Area

2.9.1.2.1 Remove unused quantities of organic peroxides from process areas. Unopened containers may be returned to the main storage area. Use suitable storage cabinets for storing small quantities in process or manufacturing areas.

2.9.1.2.2 Place organic peroxides that require temperature control in suitable refrigerated cabinets or freezers, with temperature monitoring controls and alarms set at the emergency temperature of the materials.

2.9.1.3 IBC Storage

2.9.1.3.1 Limit storage arrangements of organic peroxides in IBC containers to one (1) unit high.

2.9.1.3.2 Provide metal and plastic IBCs with an emergency pressure-relief or venting device, designed in accordance with manufacturer's recommendations.

2.9.1.3.3 Provide containment to hold 100% of the content of a single metal IBC. Provide containment to hold 100% of all composite IBCs or provide emergency drainage to a safe location.

2.9.2 Construction and Location

2.9.2.1 General

2.9.2.1.1 Provide cooling for organic peroxides that require temperature controls in storage areas and tanks in accordance with Section 2.9.4.2.

2.9.2.2 Detached Storage

2.9.2.2.1 Locate detached storage areas containing EH materials in accordance with Figure 2.

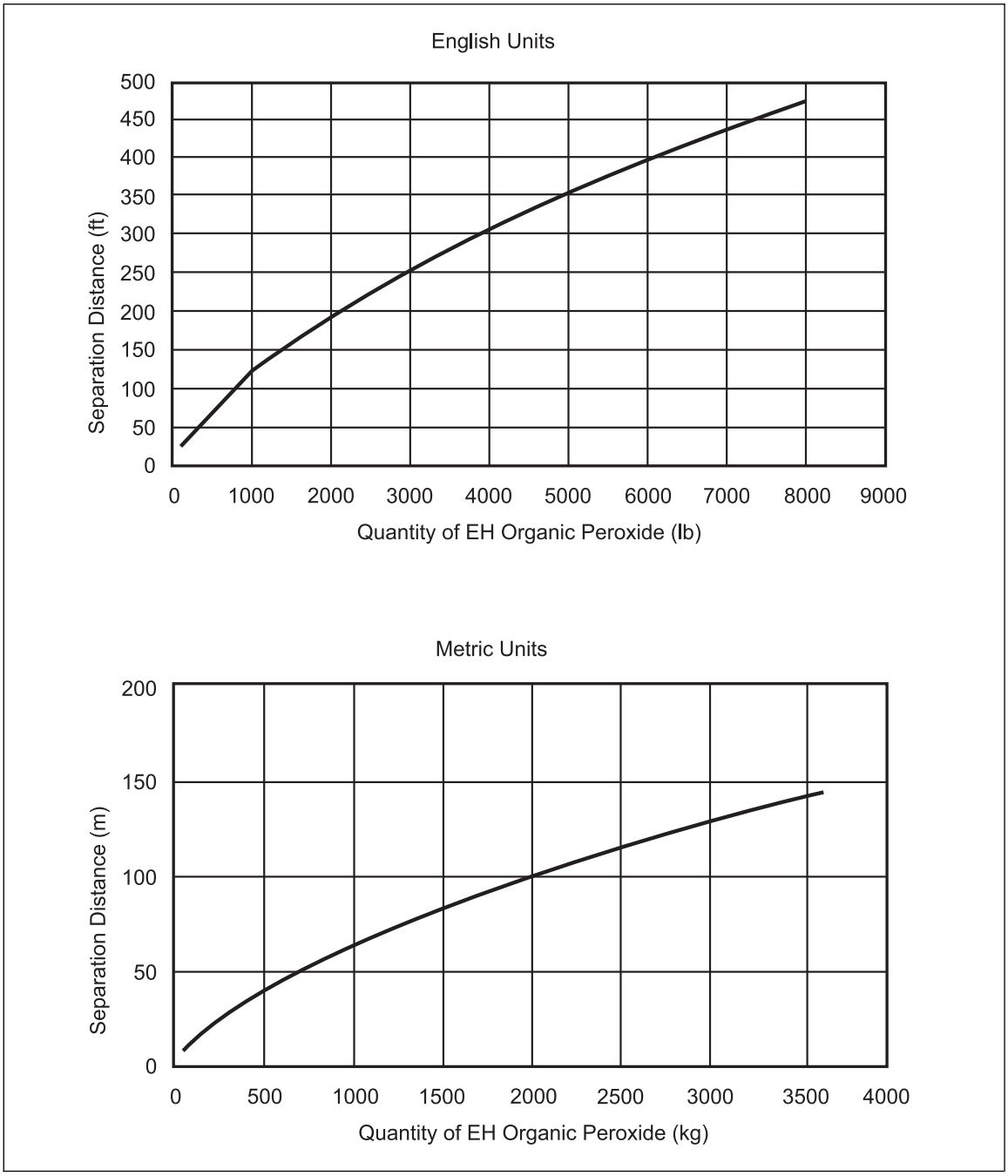


Fig. 2. Minimum separation distance for EH materials in detached storage

2.9.2.2.2 Locate detached storage areas containing materials other than EH in quantities shown in Table 1 with a minimum distance of 50 ft (15 m) from important buildings and critical equipment.

2.9.2.3 Cutoff/Attached Storage

2.9.2.3.1 Provide damage-limiting construction (DLC) for cutoff rooms or attached storage rooms storing DH or SFH organic peroxides. Design the DLC using Data Sheet 1-44, *Damage-Limiting Construction*. Use the methane fuel group for the design.

2.9.2.3.2 Design walls, doors, roofs, or ceilings and floors exposing the main building for a minimum two-hour fire resistance rating.

2.9.2.3.3 Locate building or room at ground floor level. Avoid below-grade locations because of difficulties in providing drainage, ventilation, and explosion venting. Exterior rooms at upper floor levels may be used if all of the following criteria are met:

A. Floors can be arranged to withstand 100 psf (0.05 bar) in addition to their normal load.

B. Drainage from the room can be safely arranged.

C. Peroxides can be transported through the main building areas safely.

2.9.2.3.4 Keep the venting area clear of buildings, structures, storage, and vital utilities.

2.9.2.3.5 Provide access from outdoors only. If direct access from the process building is necessary, install self-closing, normally closed fire doors on the peroxide-storage side of the wall, or activate doors upon sprinkler activation or other detection means. If the interior door is in a pressure-resistant wall, see Data Sheet 1-44, *Damage-Limiting Construction*.

2.9.2.3.6 Provide containment and emergency drainage in accordance with Data Sheet 7-29, *Ignitable Liquid Storage in Portable Containers*. Use the liquid's flash point or SADT (whichever is lower), container construction, and container size to define the needed protection level.

2.9.2.4 Tank Storage

2.9.2.4.1 Construct storage tanks and components that are in direct contact with the organic peroxide using only compatible materials. Follow applicable national or international standards, as well as the supplier's guidelines, for atmospheric tanks.

2.9.2.4.2 Provide storage tanks with an adequate emergency overpressure relief system. Ensure its design is based on the evaluation of the worst credible case. Refer to Data Sheet 7-49, *Emergency Venting of Vessels*, for additional guidance.

2.9.2.4.3 Locate storage tanks outdoors. If outdoor tank location is not possible, indoor tanks can be permitted if the emergency pressure-relief vent is connected to an outdoor safe discharge location where a release would not expose buildings, equipment, or other tanks that may be affected by the peroxide decomposition products.

2.9.2.4.4 Arrange indoor tanks in accordance with Data Sheet 7-32, *Ignitable Liquid Operations*.

2.9.2.4.5 Locate outdoor tanks with respect to buildings and other tanks or process structures in accordance with Data Sheet 7-88, *Outdoor Ignitable Liquid Storage Tanks*, using liquids with a flash point ≤140°F (60°C).

2.9.3 Protection

2.9.3.1 Provide automatic sprinkler protection in accordance with Table 2.

Table 2. Sprinkler Protection for Organic Peroxides

Hazard Type	*Max. Storage Height,*[1] *ft (m)*	*Sprinkler System and Water Supplies*			
		Sprinkler Temp Rating	Type of system	Density, gpm/ft^2 (mm/min)	Area of Demand
EH	5	Open	Deluge	0.6 (24)	Entire Area
DH/SFH	10	Open	Deluge	0.9 (24)	Entire Area
FH/LH Liquids	Protect per Data Sheet 7-29. Use the liquid's flash point or SADT (whichever is lower), container construction, and container size to define the needed protection level.				
FH/LH Solids	10	Protect per Data Sheet 8-9 by packaging material as follows: • Treat solids stored in paper bags, super sacks, fiber drums, fiber boxes, etc., as Cartoned Unexpanded Plastic (CUP). • Treat solids and liquids stored in plastic containers or plastic bags as Uncartoned Unexpanded Plastic (UUP).			

[1] EH, DH, and SFH organic peroxides could be stored in limited height palletized arrays. FH/LH liquid organic peroxides in either palletized or rack storage arrays, per Table 2, for the liquid-container combination. FH/LH solid organic peroxides in either palletized or rack storage arrays.

2.9.3.1.1 The EH protection criteria is acceptable for all organic peroxide types stored in detached, low-value storage buildings.

2.9.3.2 If a dry sprinkler system is used, arrange it so the sprinkler operating area is equal to the room's footprint and water is delivered to the most remote sprinkler within 60 seconds of activation in a fire.

2.9.3.3 Protect indoor storage tanks in accordance with Data Sheet 7-32, *Ignitable Liquid Operations*.

2.9.3.4 Provide the water supply durations and hose stream allowances per Table 3.

Table 3. Water Supply Duration and Hose Stream Demand

Organic Peroxide Liquid Type	*Water Supply Duration, hr*	*Hose Demand, gpm (L/min)*
EH	2	500 (1900)
DH / SFH	1	
FH / LH	1	

2.9.4 Equipment and Processes

2.9.4.1 General

2.9.4.1.1 Locate critical equipment and generators that support climate-controlled areas above the 0.2% annual exceedance (500-year) flood elevation and include 1 to 2 ft (0.3 to 0.6 m) of freeboard. If this is not possible, see Data Sheet 1-40, *Flood*, for other mitigation options.

2.9.4.1.2 Use warm air injection, steam, or rated electric units in storage areas where heating devices are required. Install them so they do not directly heat containers.

2.9.4.1.3 Provide backup generators for the electrically powered refrigeration and heating systems.

2.9.4.2 Refrigerated Storage Areas and Tanks

2.9.4.2.1 Provide refrigerated storage areas with a temperature monitoring system and at least two independent temperature alarms set at the emergency temperature of the materials (see Appendix C). Design the system to alarm to a constantly attended control room or equivalent location. Provide an independent dual power supply for the alarm system.

2.9.4.2.2 Provide refrigerated storage areas with at least two independent refrigeration systems, with one serving as a backup (e.g., liquid nitrogen).

2.9.4.2.3 For storage tanks of organic peroxides that require temperature control and cooling, do all of the following:

A. Provide constant temperature monitoring by at least three independent temperature indicators and alarms set at the emergency temperature of the organic peroxide. Arrange two temperature indicators for the liquid phase at different height levels in the tank (i.e., near the bottom and near the top) and one more for the tank head space.

B. Design the alarm system to alarm to a constantly attended control room or equivalent location.

C. Provide redundancy for the cooling system with at least two independent refrigeration systems, with one serving as a backup (e.g., liquid nitrogen).

2.9.5 Contingency Planning

2.9.5.1 Develop an emergency response plan (ERP) in accordance with Data Sheet 10-1, *Pre-Incident Planning*. Include actions for natural disasters as well as loss of power to areas or tanks where temperature control is required.

2.9.6 Ignition Source Control

2.9.6.1 Keep organic peroxides away from all sources of ignition, such as open flames, electrical devices, heating equipment, and sparking tools. Prohibit smoking in these areas.

2.9.6.2 Provide direct-strike lightning protection for all buildings that store or handle organic peroxides.

2.9.6.3 For all areas storing or handling organic peroxides, provide electrical bonding and grounding to reduce the hazard of static electricity. See Data Sheet 5-8, *Static Electricity*, for additional guidance.

2.9.7 Electrical

2.9.7.1 For storage areas with unopen containers of organic peroxides with an EH, DH, or SFH, provide Class I, Division 2 electrical rated equipment.

2.9.7.2 For areas with open containers of organic peroxides with an EH, DH, and SFH (for example in processing, mixing, or transfer operations), provide Class I, Division 1 electrical rated equipment.

2.10 Oxidizers

In order to maximize efficient communication with the industry and current codes, the oxidizers hazard classification used in this data sheet is consistent with NFPA 400, *Hazardous Materials Code*, Ed. 2019.

2.10.1 Occupancy

2.10.1.1 For oxidizer packaging operations, provide a temporary storage area to monitor the material after packaging for at least 12 hours before it is moved to the main storage area. Decomposition reactions may occur after packaging due to contamination. Small cutoff/attached areas with noncombustible building materials may be used for this purpose (see Section 2.10.2.2).

2.10.1.2 Provide a reliable fire detection system for the oxidizer storage areas that is able to detect early fire stages. Flame detectors such as infrared (IR) or ultraviolet (UV) may be used. For additional guidance, refer to Data Sheet 5-48, *Automatic Fire Detection*.

2.10.1.3 Use only plastic pallets for drum storage of hydrogen peroxide.

2.10.1.4 Store hydrogen peroxide drums with the vent up and unobstructed to allow continuous gas release.

2.10.1.5 Limit the quantity of oxidizers in cutoff/attached areas and detached areas per Table 4.

Table 4. Maximum Quantities of Oxidizers in Storage Areas by Class

Oxidizer Class	*Cutoff/Attached Area, tons (tonnes)*	*Detached Area, tons (tonnes)*
1	UN	UN
2	2,000 (1,800)	UN
3	1,200 (1,100)	UN
4	NP	See 2.10.2.1.1

UN = Unlimited
NP = Not permitted

2.10.1.6 For oxidizers storage arrangements, provide the following:

A. Minimum aisle width of 4 ft (1.2 m).

B. Minimum separation distance to walls of 2 ft (0.6 m).

2.10.1.7 Bulk storage of class 4 oxidizers is not permitted.

2.10.2 Construction and Location

2.10.2.1 Detached storage

2.10.2.1.1 Locate detached storage areas for class 4 oxidizers according to the quantity of material stored and separation distances provided in Figure 3.

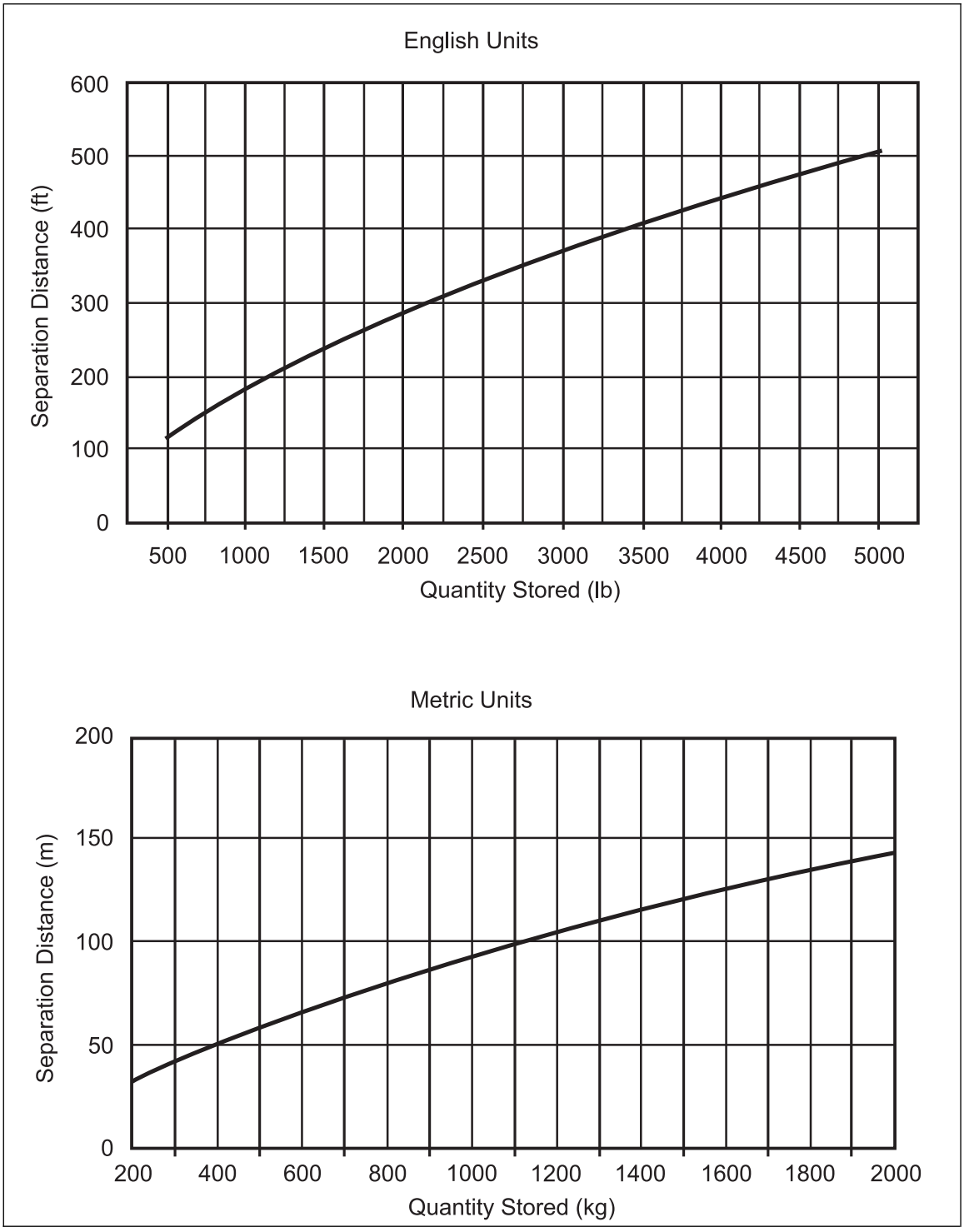


Fig. 3. Separation distances, Class 4 oxidizers

2.10.2.1.2 Locate detached storage areas containing oxidizers with classes other than 4 at a minimum separation distance of 50 ft (15 m) from buildings and critical process/equipment.

2.10.2.2 Cutoff or Attached Storage

2.10.2.2.1 Design walls, doors, roofs or ceilings, and floors exposing the main building with a minimum fire resistance rating in accordance with Table 5.

Table 5. Minimum Construction Fire Resistance Rating for Storage of Oxidizers

Class	*Storage Configuration*		*Minimum Fire Resistance Rating, hr*
	Pile/Bulk	Rack	
1	X	X	1
2	X	X	1
3	X		2
		X	1

2.10.2.2.2 Activate fire doors with direct access to main buildings upon sprinkler activation or other detection means.

2.10.2.2.3 For class 3 oxidizers, limit amounts in the storage space to no more than 250,000 lb (110,000 kg). For quantities greater than 250,000 lb (110,000 kg) up to the limit in Table 4, individual cell arrangements can be used if fire resistance separation is provided in accordance with 2.10.2.2.1.

2.10.2.3 Bulk Storage Areas

2.10.2.3.1 Locate bulk storages in noncombustible construction floors with no open drains, traps, tunnels, pits, or pockets where molten material can collect and be confined in the event of a fire.

2.10.2.3.2 Dedicate the building storage area to compatible materials only. Separation by noncombustible walls can be used if different materials are to be stored in the building, to prevent mixing and contamination. Include curbs or drains to prevent materials from flowing from one side to the other.

2.10.3 Protection

2.10.3.1 See Table 6 for ceiling sprinkler protection for oxidizers.

Table 6. Ceiling Sprinkler Protection for Oxidizers, Solid-Piled and Palletized Arrangements

Class	*Max. Storage Height, ft (m)*	*Nominal Temp. Rating*	*Density, gpm/ft^2 (mm/min)*	*Area*
1	15 (4.5)	Low/SR	Protect per Data Sheet 8-9 in accordance with packaging material as follows: • Protect solids stored in paper bags, super sacks, fiber drums, fiber boxes, etc., as Cartoned Unexpanded Plastic (CUP). • Protect solids and liquids stored in plastic containers or plastic bags as Uncartoned Unexpanded Plastic (UUP).	
2	15 (4.5)	Low/QR		
3	10 (3)	Low/QR	0.8 (33)[a]	Entire area
4	5 (1.5)	Low/QR	0.8 (33)[a]	Entire area

[a] Maximum ceiling height up to 30 ft (9.1 m).

2.10.3.1.1 Design sprinkler ceiling protection for class 3 oxidizers according to the surrounding occupancy when in-rack sprinkler protection is provided in accordance with 2.10.3.2.

2.10.3.2 For in-rack sprinkler protection, follow the guidance in Table 7.

Table 7. In-Rack Sprinkler Protection for Oxidizers

Class	*Max. Storage Height, ft (m)*	*Sprinkler Type/Temp*	*Minimum Flow, gpm (L/min)*	*Number of Sprinklers*
1	15 (4.5)	SR/Ordinary	Protect per Data Sheet 8-9 according to packaging material as follows: • Protect solids stored in paper bags, super sacks, fiber drums, fiber boxes, etc., as Cartoned Unexpanded Plastic (CUP). • Protect solids and liquids stored in plastic containers or plastic bags as Uncartoned Unexpanded Plastic (UUP).	
2	15 (4.5)	QR/Ordinary		
3	10 (3)	QR/Ordinary	40 (150)	6 (See 2.10.3.3)
4	NP			

NP = Not permitted

2.10.3.3 For the configuration of class 3 oxidizers, see Figures 4 and 5 for single and double-row racks, respectively. Install 3 sprinklers on each line, with a total of 6 sprinklers per cell. The sprinkler system does not have to be hydraulically balanced with the ceiling-level sprinkler system.

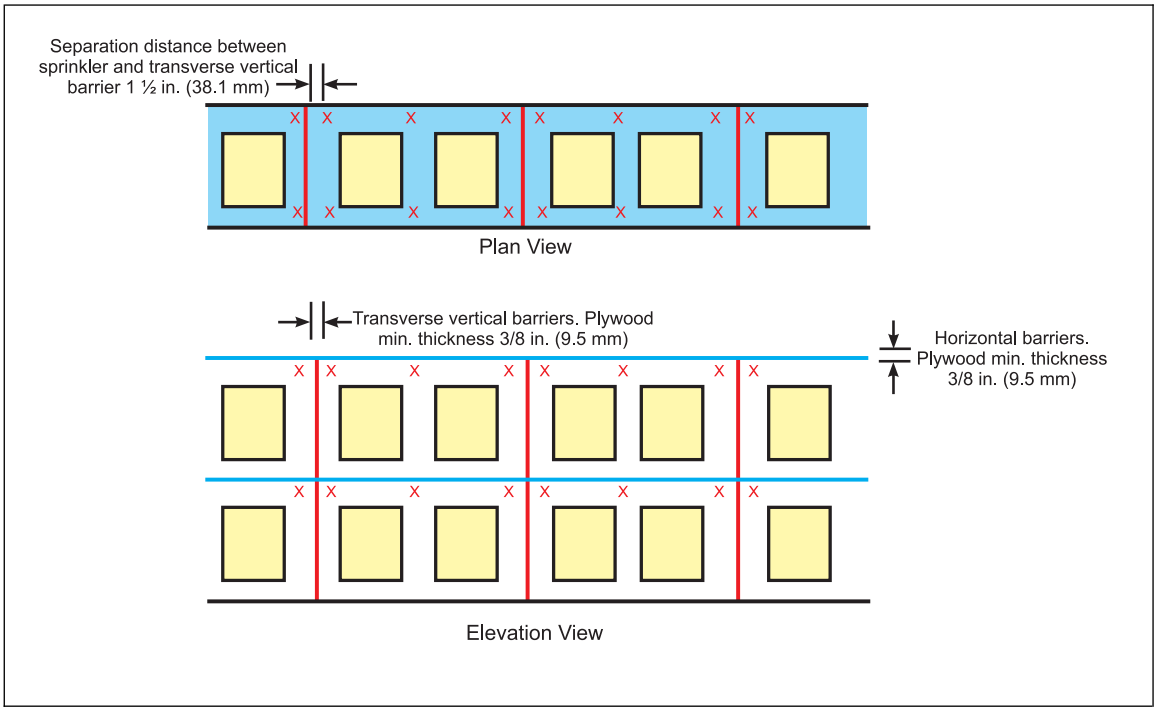


Fig. 4. In-rack sprinkler arrangement for single-row racks (Class 3)

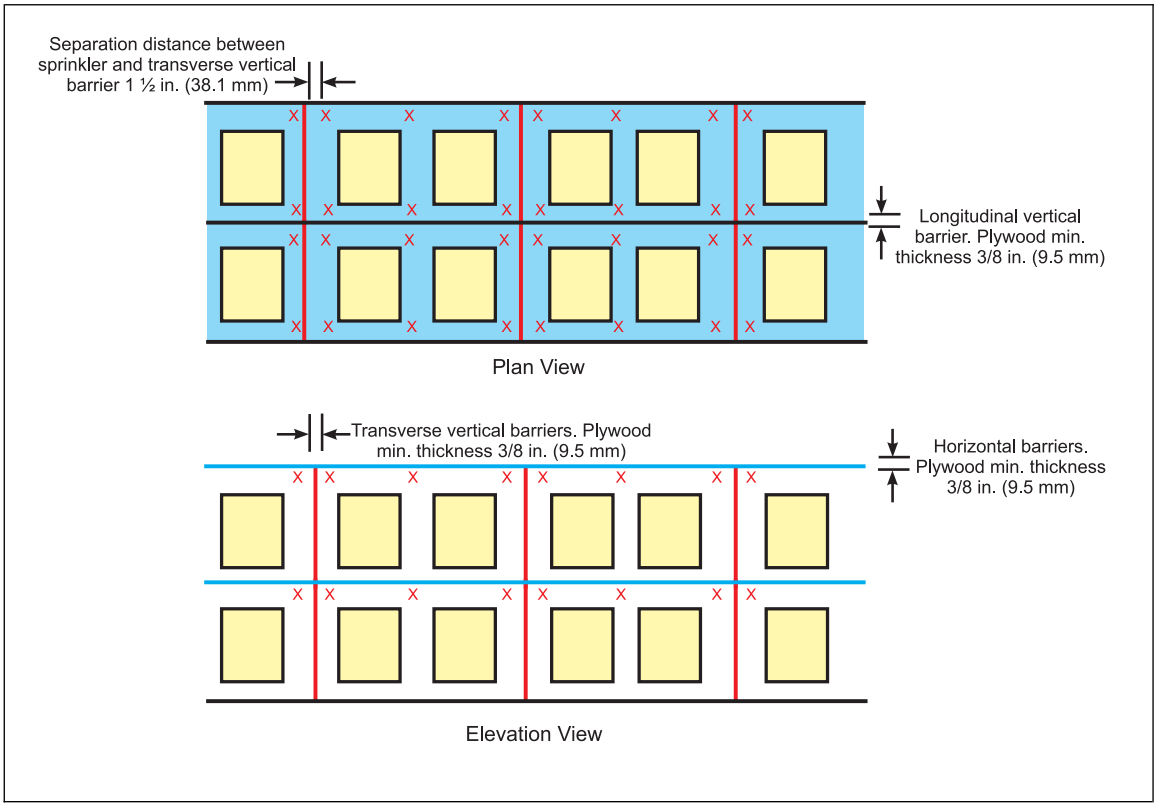


Fig. 5. In-rack sprinkler arrangement for double-row racks (Class 3)

2.10.3.4 For all locations handling oxidizers, conduct annually visual sprinkler inspections for corrosion. This recommendation does not apply to areas only handling oxidizers in closed containers.

2.10.4 Retail Storage of Pool Chemicals

This section applies to storage and sales displays of pool chemicals that consist of Class 1 through Class 3 oxidizers. Some common pool chemicals stored and displayed are trichloro-s-triazinetrione (Trichlor, Class 1 oxidizer), sodium dichloroisocyanurate (Class 1 oxidizer), and calcium hypochlorite (Cal-Hypo, Class 3 oxidizer).

2.10.4.1 Locate Class 2 and 3 oxidizer sales displays outside the building. If the sales displays cannot be located outside the building, do the following:

A. Limit Class 3 oxidizers to 3 of each container/package size on cantilever shelving. If located in rack storage displays, limit storage to the first tier and protect in accordance with 2.10.3.2.

B. Limit Class 2 oxidizers to what is needed for the shelf or rack display and protect in accordance with 2.10.3.1.

2.10.4.2 Store overstock outside the facility in a low-value building. If overstock needs to be stored inside the building, protect in accordance with this data sheet.

2.10.4.3 Maintain containers securely closed to prevent any contamination. Keep all packaging clean and free of all contamination.

2.10.4.4 Provide storage arrangements according to chemical compatibility and physical form. Store solids above liquids.

2.10.4.5 If storage arrangements are not possible to do by chemical compatibility on the display rack/shelf storage, provide segregation by physical barriers to prevent the contact of incompatible materials.

2.11 Hydrogen Peroxide Storage Tanks

The information in this section applies only to the storage of hydrogen peroxide in atmospheric vessels with concentrations greater than 27.5% up to 70% in weight.

2.11.1 Construction and Location

2.11.1.1 Locate hydrogen peroxide storage tanks out of doors for concentrations equal to or greater than 50% in weight, and in accordance with the minimum separation distances indicated in Figure 6. Locate them away from combustible materials, direct heat, and any potential contaminants.

Follow manufacturers recommendations for the location of tanks with concentrations lower than 50% in weight or indoor tanks.

2.11.1.2 Construct storage tanks and their components (including piping systems, gaskets, etc.) that are in direct contact with hydrogen peroxide only of compatible materials that have been proven safe.

2.11.1.3 Provide all hydrogen peroxide tanks with a minimum emergency venting capacity of 200 cm2 per metric ton of stored H_2O_2 (100% concentration) to prevent overpressure buildup scenarios due to decomposition.

2.11.1.4 Provide continuous vents to release the amount of oxygen normally liberated from hydrogen peroxide. Provide vents with filters to prevent contamination of the solution.

2.11.2 Protection

2.11.2.1 Install a water spray system to provide a density of 0.25 gpm/ft^2 (10 mm/min) over the external surface area of the tank when an external fire exposure is present. See Data Sheet 7-14, *Fire Protection for Chemical Plants*, for additional guidance.

2.11.3 Equipment and Processes

2.11.3.1 Provide continuous tank temperature monitoring interlocked to an alarm that activates when temperature increase is detected. Design the alarm system to sound to a constantly attended control room or equivalent location.

2.11.4 Operation and Maintenance

2.11.4.1 Ensure all equipment used in hydrogen peroxide service is cleaned and passivated in accordance with the manufacturer's procedures prior to any addition of peroxide solutions.

2.11.4.2 Do not return hydrogen peroxide to the storage tank after withdrawal.

2.11.4.3 If a dilution operation needs to be performed on site, use a diluent water free from catalytic or other impurities that may initiate a decomposition reaction. Typically, demineralized or deionized water is used. Follow specific manufacturer's recommendations and procedures.

2.11.4.4 Develop an emergency procedure for hydrogen peroxide decomposition reactions for concentrations above 27.5%. See Section 3.5.3 for additional information.

3.0 SUPPORT FOR RECOMMENDATIONS

3.1 Loss History

FM client losses involving organic peroxides, oxidizers, and hydrogen peroxide during the period 1988–2018 were mostly fires and explosions. During this period, the losses involving oxidizing materials represented 56% of the total losses, as shown in Figure 7.

The causes of the loss in some cases were similar for these materials. Incompatible reactions and operational procedures were common causes, as shown in Figure 8. For organic peroxides, most of the losses were caused by incompatible reactions and decomposition due to high temperature exposure. For oxidizers and hydrogen peroxide, contamination and operational procedure errors were the leading causes.

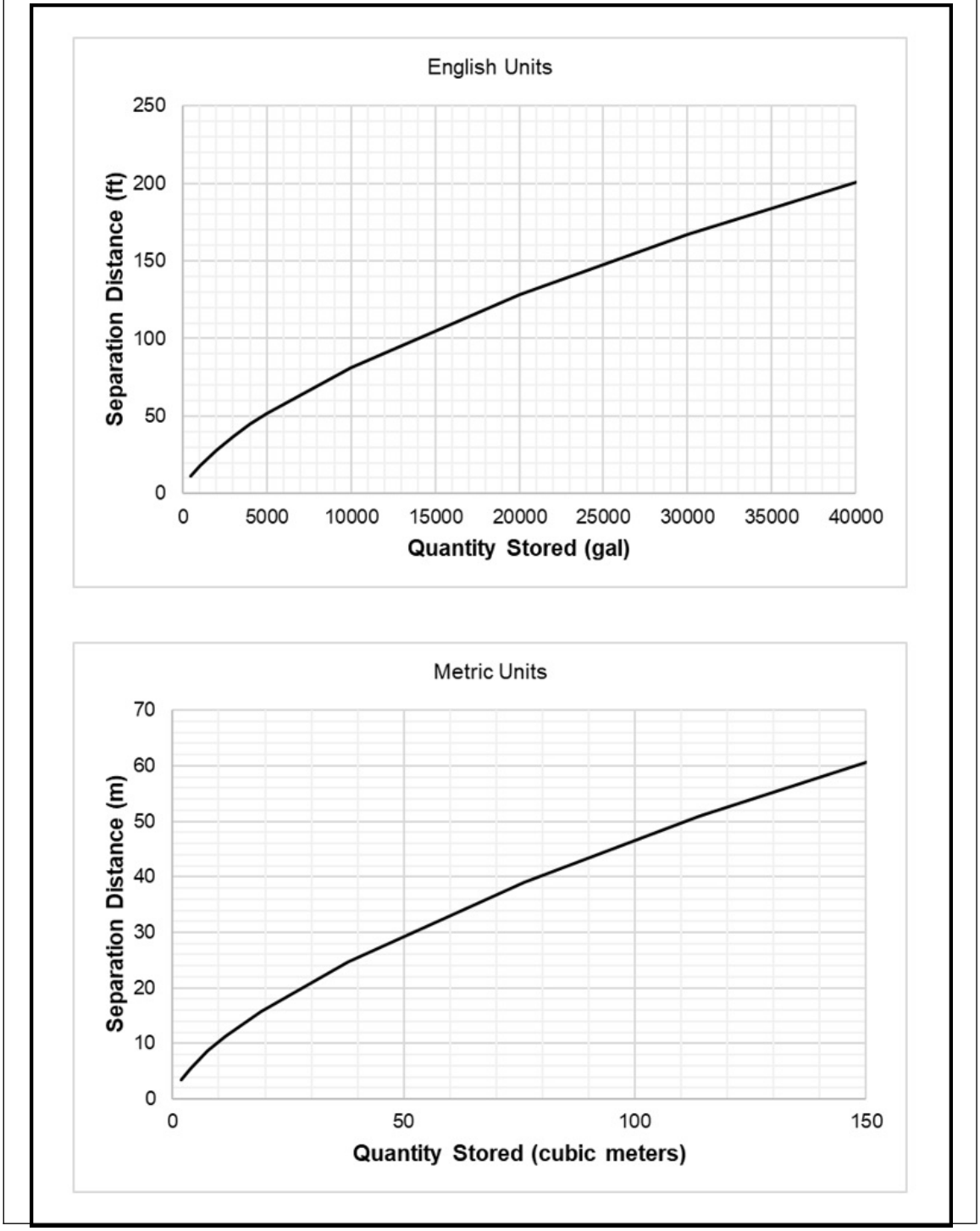


Fig. 6. Minimum separation distances for hydrogen peroxide storage tanks with concentration equal to or greater than 50% in weight

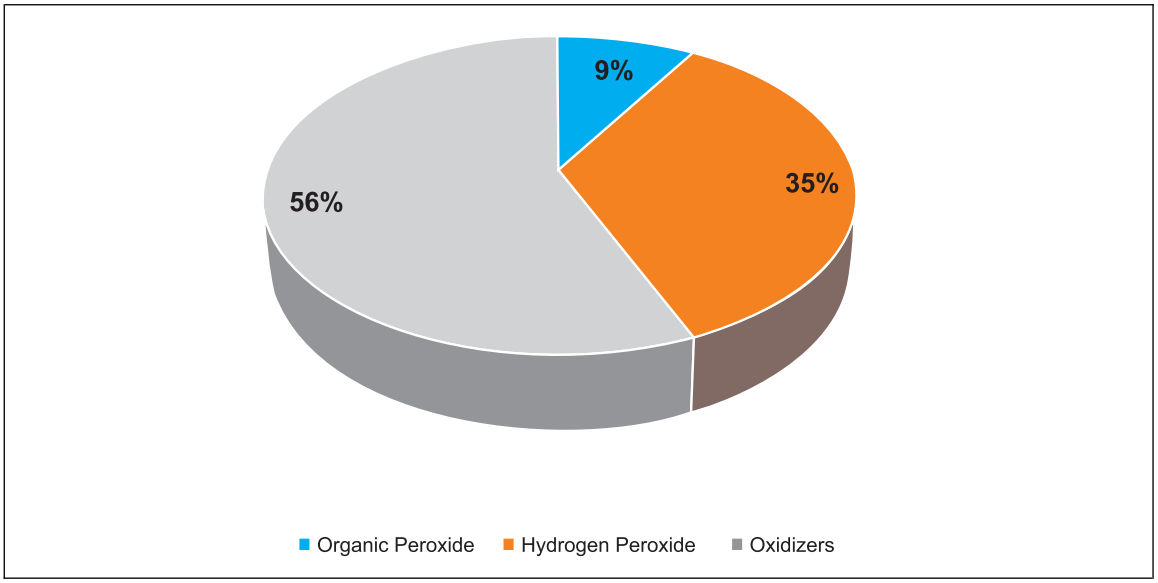


Fig. 7. Losses by type of material (1988-2018)

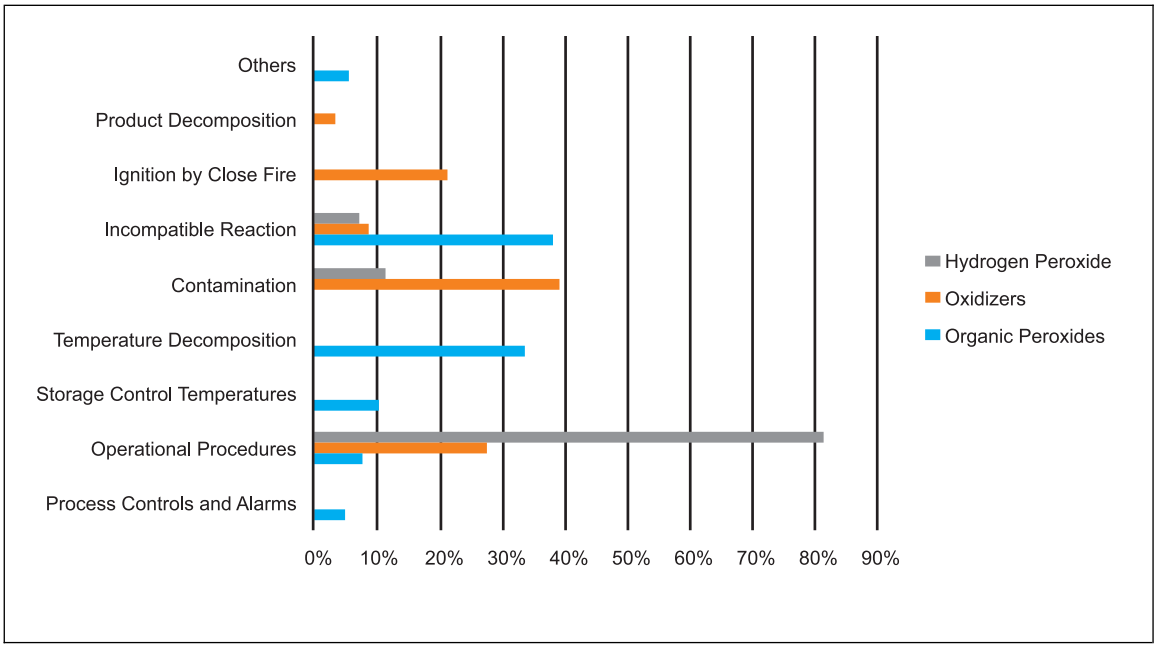


Fig. 8. Loss causes by material (1988–2018)

3.2 Illustrative Losses

3.2.1 Lack of Sprinkler Protection Results in Destruction of an Ammonium Perchlorate Manufacturing Plant

A fire started by improperly supervised cutting and welding in an unsprinklered ammonium perchlorate (AP) manufacturing facility went out of control. The fire in the fiberglass-reinforced plastic panel on steel frame building was assisted by the AP, a strong oxidizer. Manual firefighting by plant personnel could not control the fire. The fire spread to outside storage of the AP in polypropylene drums, resulting in the fire spreading throughout the plant in a very short time. The large fires caused heating of the ammonium perchlorate above its decomposition temperature and resulted in numerous explosions, including detonations of 1,000 and

1,500 tons (910 and 1360 tones) of material. These large explosions broke windows up to 20 miles (32 km) away and destroyed the plant and a neighboring facility.

3.2.2 Organic Peroxide Decomposition and Fire at a Manufacturing Plant Following Hurricane Harvey Flooding

Flooding from Hurricane Harvey disable the refrigeration systems of the organic peroxide storage areas. The plant had multiple safety systems and layers of protection in place to ensure that organic peroxide products were kept cold and would not reach their SADTs. However, all these layers of protection and safety systems failed due to a common failure mode, flooding. Hurricane Harvey had an unprecedent flood level, which extended above the 500-year flood plain elevation.

The organic peroxides were moved into temporary refrigerated trailers to prevent decomposition. After several days of rain, the water reached the trailers, causing them to lose their cooling systems. As the trailers increased in temperature, the organic peroxides decomposed and spontaneously combusted. During the event, 9 trailers ignited, involving over 350,000 lb (158,760 kg) of organic peroxides.

3.3 Organic Peroxides

3.3.1 General Information

Organic peroxides are highly reactive and thermally unstable materials with an intrinsic fire hazard. Some peroxide formulations may also present an explosive decomposition or deflagration hazard. Most organic peroxides burn vigorously and once ignited, it will be difficult to control or extinguish the fire. Other hazards presented by these materials are sensitivity to shock, heat, friction, and light, basically due to the high local temperatures they create, which could propagate a decomposition throughout the peroxide.

Organic peroxides when decompose will generate heat and flammable gasses. The rate of decomposition is considerably increased if the peroxide is contaminated with incompatible materials, used or store at high temperatures or if exposed to open flames or hot surfaces.

Organic peroxides are available as solids (usually as finely divided powders), liquids, or pastes. Various concentrations in various diluents are available to meet specific requirements of consumers and to reduce the hazards. Virtually all organic peroxides become less prone to violent reaction if diluted.

Some materials are inert to peroxides and can be used to dilute peroxides and thereby make them less sensitive to thermal and physical shock. The more active peroxides, which could not otherwise be manufactured safely, are made and handled in a diluted form. Common diluents used for desensitization are generally classified as type A and B (see Appendix A), which could include materials such as water, phthalates, isododecane, calcium carbonates, etc.

The terms accelerators, activators, actuators, catalysts, cross-linking agents, curing agents, driers, hardeners, initiators, promoters, and vulcanizing agents are often used to describe peroxides or mixtures of a peroxide compound with other compounds. These terms are sometimes misleading because they are also used for materials that do not contain peroxides.

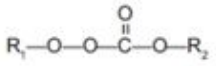
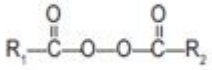
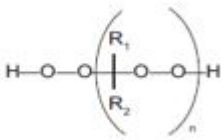
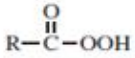
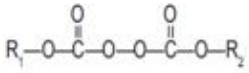
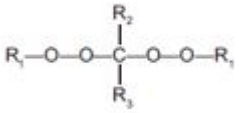
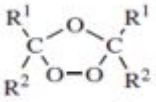
3.3.2 Chemical Information

All peroxide compounds have the double oxygen or peroxy (-O-O-) group in common in their chemical structure. The peroxy group gives these compounds their unique and useful characteristics. Organic peroxides are commonly used as a free radical source, where the -O-O- bond must be broken. When properly used, these free radicals can initiate polymerization or other desired chemical reactions. This decomposition leads to heat and by-products generation.

The -O-O- bond is also the source of the hazardous characteristics of these materials. The -O-O- bond is thermally sensitive, which make organic peroxides highly reactive and unstable materials.

The most common organic peroxide types are shown in Table 8.

Table 8. Common Types of Organic Peroxide

Organic Peroxides Common Types	*Basic Formula*
Alkylperoxy carbonates	
Diacyl Peroxides	
Dialkyl Peroxides	$R_1—O—O—R_2$
Hydroperoxides	R—O—O—H
Ketone Peroxides	
Peroxyacids	
Peroxydicarbonates	
Peroxyketals	
Ozonides	

Organic peroxides can also be formed by the autoxidation process of several organic solvents. Ethers are generally recognized as dangerous peroxide formers. However, other organic structures (e.g., acetals, allyl or benzyl compounds, ketones, vinyl monomers, secondary alcohols) are capable of spontaneous autoxidation to form highly unstable hydroperoxides.

3.3.3 Self-Accelerating Decomposition Temperature (SADT)

The self-accelerating decomposition temperature (SADT) is the lowest temperature at which a packed organic peroxide may start a self-accelerating decomposition. SADT values are different for each peroxide and influenced by external conditions such as amount of peroxide, heat transfer coefficient, and type of packaging. Contamination of the peroxides can drastically reduce the SADT values, making the material prone to decomposition at lower temperatures.

Organic peroxides exposed to temperatures at or above the SADT, can lead to an accelerated decomposition. Proper temperature control is important to prevent run-away decompositions, generation of flammable gases, auto-ignition, or explosions.

SADT values are provided by manufacturers as well as safe temperature at which the peroxides need to be store or transported. Provisions for the determination of the SADT are given in the UN Manual of Test and Criteria, Part II.

3.3.4 Uses

Organic peroxide compounds are used in a wide variety of industrial processes, generally as initiators or catalysts. A major consumer of organic peroxides is the chemical industry, which uses them in the polymerization of synthetic resins, plastics, elastomers, and synthetic finishes. Large quantities are used in the manufacture of organic intermediates and complex organic compounds.

Outside the chemical industry, the largest use of organic peroxides is for in-place polymerization of reinforced plastics (laminates, building and vehicle components, etc.) and finishes (coatings and paints).

Peroxides are also used as bactericides and fungicides, bleaching and maturing agents for flours, driers for unsaturated oils such as linseed oil, and vulcanizing agents for rubbers.

In the pharmaceutical industry, organic peroxides are used in the manufacturing of personal care products.

3.4 Oxidizers

3.4.1 General Information

Oxidizers do not burn but will support combustion and can readily yield oxygen. Generally, oxidizers can promote combustion of other materials due to the release of oxygen. However, not all the oxidizing materials needs to contain oxygen. A good example are halogens (fluorine, chlorine, bromine and iodine), which are considered good oxidizers due to their ability to transfer electrons. In an oxidation reaction the oxidizer may provide oxygen to the substance being oxidized, or it may receive electrons being transferred from the substance undergoing oxidation.

Oxidizers can be found in liquid, solid, or gas forms. Some of the common oxidizing substances usually include recognizable functional chemical groups. For example, perchlorate (ClO_4), chlorate (ClO_3), chlorite (ClO_2), hypochlorite (ClO), nitrate (NO_3), nitrite (NO_2), dichromate (Cr_2O_7), persulfate (S_2O_8), and permanganate (MnO_4).

Oxidizers themselves are not combustible, but they can be responsible for two sides of the fire triangle: the oxygen/oxidizer and the ignition source. The decomposition process releases oxygen and can create enough heat to ignite nearby combustibles, such as cardboard packaging. Decomposition can be initiated by excessive heat, relatively small amounts of water or mixing with incompatible materials, including other oxidizers. Other incompatible materials that can initiate decomposition include paints, oils, grease and other hydrocarbons, ordinary combustibles and sawdust or floor-sweeping compounds.

When very diluted oxidizers solutions get in contact with combustible materials (e.g., paper or cardboard), a decomposition reaction that would produce a fire may be difficult to initiate immediately. However, as the solution dries, the oxidizer will concentrate, causing the combustible material to spontaneously ignite and burn intensely.

For some oxidizers the concentration at which the material is used or stored will play an important role to define its hazards, hazard classification and the level of protection required.

3.4.2 Uses

Oxidizers are used in many industries and can result in a rapidly growing fire if improperly handled or stored. They can be found in the pulp and paper and textile industries for bleaching, in chemical manufacturing processes, in agriculture as fertilizers, and be used by the general public as a swimming pool sanitizer, being the most common used calcium hypochlorite and chlorinated isocyanurates. Additionally, some oxidizers can be used as component of rocket propellant or explosives.

3.5 Hydrogen Peroxide

3.5.1 General Information

Hydrogen peroxide is an odorless, colorless, inorganic liquid. It is a strong oxidizing agent and is classified as corrosive by the U. S. Department of Transportation. Although nonflammable, it will support combustion and can readily start fires when in contact with combustible materials such as wood, leather, cotton, and paper. It is completely miscible in water. The commonly used concentrations of 35% and 50% by weight are commercially available. Some facilities receive 70% material, which is diluted to 50% or 35% for storage. Higher strength solutions are sometimes used at specialized installations. The very dilute concentrations of hydrogen peroxide used in most plant processes do not present serious fire or explosion-protection problems.

A continuous decomposition of hydrogen peroxide to water and oxygen gas naturally occur under normal storage conditions. Commercial formulations are stabilized to keep a low decomposition rate. However, appropriate vents are needed to relieve the oxygen pressure generated during normal decomposition. The normal decomposition rate of hydrogen peroxide solutions at 80°F (27°C) is less than 1% per year.

Hydrogen peroxide decompositions are mainly caused by contamination, temperature and pH. Neutral pH regions provide better stability for hydrogen peroxide solutions.

Contamination with metals (i.e., iron, manganese, copper, chromium, nickel and zinc), alkalis, organic substances and other impurities such as certain dusts, can cause a rapid and dangerous decomposition with a drastic rise in temperature and pressure, releasing large amounts of water vapor and oxygen gas. The volume of gas evolved from liquid decomposition is many times the original liquid volume. For example, one volume of 50% by weight hydrogen peroxide yields about 1,000 volumes of gas (oxygen and water vapor). Higher concentrations yield even more gas.

Gross contamination, for example, with permanganate or hypochlorite solutions, can cause immediate rapid decomposition. A warning that serious decomposition is occurring is indicated by liquid temperatures 30°F (17°C) or more above the recent maximum ambient temperature or a liquid temperature rising at a rate of about 4°F (2°C) or more per hour; under these conditions prompt action is essential.

Hydrogen peroxide in a storage tank may heat to the boiling point if the heat evolved from decomposition is greater than the heat loss from the tank to the atmosphere. It is recommended to keep the storage temperatures below 86°F (30°C) and never exceed 95°F (35°C) to prevent a decomposition due to high temperature. The rate of decomposition increases 2.2 times for each 10°C rise in temperature.

The recommended floating manhole and rupture disks for bulk storage tanks are sized to relieve severely contaminated hydrogen peroxide solution. Other safeguards are designed to reduce the possibility of gross contamination.

To deactivate the wetted surfaces and prevent a decomposition reaction, all storage tanks surfaces, pipes, valves, and accessories require a pretreatment process before any hydrogen peroxide is dispense into the vessel. This may involve thorough cleaning, pickling, passivating, and surface testing. The pretreatment process applies differently for metal and plastic equipment.

3.5.2 Uses

Hydrogen peroxide is used as a bleaching agent for textiles (natural and synthetic fibers), wood pulp, oils, fats, and waxes. In the case of textiles and wood pulp, the final solution usually contains 0.5% to 6% hydrogen peroxide.

In the food industry, hydrogen peroxide is used to sterilize packaging with special hydrogen peroxide grades. For cosmetics and personal care products, hydrogen peroxide is used as an antimicrobial and oxidizing agent. Some of the applications in this industry are in hair coloring and tooth whitening products. Hydrogen peroxide topical solutions (3% by weight) are widely used in medicine as an antiseptic for wound treatment and soft contact lens disinfection.

Other uses are organic synthesis and polymerizations, ore leaching, starch conversion, electroplating, vat dye “fixing,” glue and gelatin production, and fungicides. Very high concentrations are used in rocket fuels and in some chemical processes.

3.5.3 Storage Tank Decomposition Reactions

Temperatures in tanks need to be constantly monitored in order to detect early decompositions. The number of tank temperature sensors are commonly installed according to the size of the vessel, as shown in Table 9.

Table 9. Temperature Sensors for Hydrogen Peroxide Storage Tanks

Tank Volume, gal (m^3)	*No. of Temp. Sensors*
Less than 26,000 (100)	1
26,000 (100) <V <130,000 (500)	2
130,000 (500) <V <260,000 (1,000)	3
More than 260,000 (1,000)	4

The first indication of a decomposition is when the temperature in the tank contents starts to rise above ambient. Decomposition is normally slow in the early stages when spray cooling outside of the tank and dilution could be effective. For decompositions that occur at faster temperature increase rates, prompt action is required. Dilution and then dumping the contents to a safe location could be needed.

4.0 REFERENCES

4.1 FM

Data Sheet 1-40, *Flood*
Data Sheet 1-44, *Damage-Limiting Construction*
Data Sheet 5-48, *Automatic Fire Detection*
Data Sheet 5-8, mditStatic Electricity
Data Sheet 7-14, *Fire Protection for Chemical Plants*
Data Sheet 7-29, *Ignitable Liquid Storage in Portable Containers*
Data Sheet 7-32, *Ignitable Liquid Operations*
Data Sheet 7-43, *Process Safety*
Data Sheet 7-45, *Safety Controls, Alarms and Interlocks*
Data Sheet 7-49, *Emergency Venting of Vessels*
Data Sheet 7-88, *Outdoor Ignitable Liquid Storage Tanks*
Data Sheet 8-1, *Commodity Classification*
Data Sheet 8-9, *Storage Class 1,2,3,4 and Plastic Commodities*
Data Sheet 10-1, *Pre-Incident Planning*

4.2 NFPA Standards

National Fire Protection Association (NFPA). NFPA 400, *Hazardous Materials Code*, 2019 Edition.

APPENDIX A GLOSSARY OF TERMS

Atmospheric tank: A storage tank that has been designed to operate at pressures from atmospheric through a gauge pressure of 1.0 psig (6.9 kPa) measured at the top of the tank.

Attached: Refers to a building or room used for storage or mixing that is physically separated from other areas containing incompatible materials or operations.

Damage-limiting construction (DLC): A type of construction that consists of both pressure-resistant and pressure-relieving ceiling and/or walls that allows the internal pressure buildup from a deflagration explosion to release safely to a designated external area. See FM Data Sheet 1-44, *Damage-Limiting Construction*, for further details.

Deionized water: Water that has had all charged particles removed from it.

Diluent Type A: Organic liquids, compatible with the organic peroxide, which have a boiling point of not less than 300°F (150°C).

Diluent Type B: Organic liquids, compatible with the organic peroxide, which have a boiling point of less than 300°F (150°C) but not less than 140°F (60°C) and a flash point of not less than 41°F (5°C).

Emergency temperature: Is the temperature at which immediate action needs to be taken to prevent the material to reach its SADT, where a self-accelerating decomposition may be initiated. This temperature is derived from the SADT.

Fire wall: A fire-resistance-rated wall designed to restrict the spread of fire in which continuity is maintained, openings are protected, and penetrations sealed.

Fire-rated wall: A wall that meets the required fire rating per Data Sheet 1-21, *Fire Resistance of Building Assemblies*.

Flame detection: Detection that is sensitive to infrared, visible, or ultraviolet radiation produced by a fire, or to specific ranges of radiation that are modulated at characteristic flame flicker frequencies. Flame detectors are essentially line-of-sight devices and are usually designed to respond to a fire within the detector's cone of vision in approximately one second or less. Typical flame detectors include infrared, ultraviolet, photoelectric, and flame-flicker. See Data Sheet 5-48, *Automatic Fire Detection*, for more information regarding these types of detectors and the type of fire hazard they are appropriate for.

Hazard Groups: Organic Peroxides in this data sheet are grouped based on five different hazard types, using the testing and classification provided in the UN Manual of Test and Criteria, Part II (types A to G), and the burning rate of the materials.

- **Explosion Hazard (EH).** Organic peroxides that present an explosion hazard, showing violent decomposition (run-away) effects or a rapid propagation of the decomposition.
- **Deflagration Hazard (DH).** Organic peroxides that present a deflagration hazard. The effect will depend upon the degree of confinement and the amount of material stored.
- **Severe Fire Hazard (SFH).** Organic peroxides that present a severe fire hazard, with characteristics of rapid burning and high heat generation. Materials classified in this category have a burning rate greater than 132 lb/min (60 kg/min) and do not present an explosion or deflagration hazard.
- **Fire Hazard (FH).** Organic peroxides that present a moderate fire hazard that could be compared to some ignitable liquids. Materials classified in this category have burning rates lower than 132 lb/min (60 kg/min) but greater than 22 lb/min (10 kg/min).
- **Low Hazard (LH).** Organic peroxides that present a low fire hazard with burning rates lower than 22 lb/min (10 kg/min).

Intermediate Bulk Container (IBC): Any container that has a volumetric capacity of not more than 793 gallons (3,000 L) and not less than 119 gallons (450 L) as defined and regulated by the U.S. Department of Transportation in CFR Title 49, Part 178, subpart N, and the United Nations Recommendations on the Transport of Dangerous Goods, chapter 6.5.

Passivation: The process by which a material is made inactive or less reactive to chemical attack. In hydrogen peroxide service this often includes washing or flushing with a dilute hydrogen peroxide solution. The actual process should be strictly in accordance with the manufacturer's guidelines.

Self-Acceleration Decomposition Temperature (SADT): Is the lowest temperature at which a packed organic peroxide may start a self-accelerating decomposition. SADT values are different for each peroxide and influenced by external conditions such as amount of peroxide, heat transfer coefficient and type of packaging.

Storage tank: Any vessel having a liquid capacity that exceeds 60 gal (230 L), is intended for fixed installation, and is not used for processing.

United Nations Recommendations on the Transport of Dangerous Goods: Model Regulations directed at providing safe packaging criteria but only related to the transport of all types of dangerous solids, liquids, and gases. Hazard class 5 addresses organic peroxides and oxidizers.

APPENDIX B DOCUMENT REVISION HISTORY

The purpose of this appendix is to capture the changes that were made to this document each time it was published. Please note that section numbers refer specifically to those in the version published on the date shown (i.e., the section numbers are not always the same from version to version).

July 2020. This document has been completely revised. The following significant changes were made:

A. Changed the name of Data Sheet 7-80 to *Organic Peroxides and Oxidizing Materials* (from *Organic Peroxides*).

B. Incorporated the following data sheets: 7-81, *Organic Peroxides Hazard Classification*; 7-82N, *Storage of Liquid and Solid Oxidizing Materials*; and 7-84, *Hydrogen Peroxide*. Those data sheets will be made obsolete.

C. Updated guidance for the storage and handling of organic peroxides and hydrogen peroxide storage tanks.

D. Added new guidance on oxidizing materials.

E. Created new hazard types for organic peroxide formulations to replace the hazard classifications in Data Sheet 7-81. Updated the list of materials.

F. Revised separation distances for the storage of explosive organic peroxides and hydrogen peroxide storage tanks. Added new guidance to determine necessary separation distances for the storage of explosive oxidizing materials.

G. Added new guidance on retail storage of pool chemicals.

H. Updated loss history and illustrative losses.

January 2012. Terminology related to ignitable liquids has been revised to provide increased clarity and consistency with regard to FM Global's loss prevention recommendations for ignitable liquid hazards.

September 2010. Minor editorial change in Section 4.2, NFPA Standards, was made.

September 2000. This revision of the document has been reorganized to provide a consistent format. A number of recommendations were re-worded to clarify intent.

March 1972. Minor updates and modifications.

June 1969. Minor updates and modifications.

September 1962. Original document.

APPENDIX C ORGANIC PEROXIDE HAZARD TYPES

Table C.1 Organic Peroxide Hazard Types

CAS Number	*Chemical Name*	*Physical Form*	*Concentration (%)*	*Diluent (%)*	*Inert Solid (%)*	*Water (%)*	*Max. Container Size*	*Hazard Type*	*Emergency Temperature °F (°C)*	*Risks and Remarks*
37187-22-7	ACETYL ACETONE PEROXIDE	Liquid	≤ 42	A ≥ 48		≥ 8	16 gal (60 L)	SFH		Active oxygen content ≤ 4.7%
37187-22-7	ACETYL ACETONE PEROXIDE	Solid	≤ 32 as a paste				110 lb (50 kg)	FH		With diluent A, with or without water
3179-56-4	ACETYL CYCLOHEXANESULPHONYL PEROXIDE	Solid	≤ 82			≥ 12	55 lb (25 kg)	EH	32 (0)	
3179-56-4	ACETYL CYCLOHEXANESULPHONYL PEROXIDE	Liquid	≤ 32	B ≥ 68			16 gal (60 L)	FH	32 (0)	
3425-61-4	tert-AMYL HYDROPEROXIDE	Liquid	≤ 88	A ≥ 6		≥ 6	60 gal (225 L)	SFH		
690-83-5	tert-AMYL PEROXYACETATE	Liquid	≤ 62	A ≥ 38			16 gal (60 L)	SFH		
4511-39-1	tert-AMYL PEROXYBENZOATE	Liquid	≤ 100				16 gal (60 L)	DH		
686-31-7	tert-AMYL PEROXY-2-ETHYLHEXANOATE	Liquid	≤ 100				16 gal (60 L)	SFH	77 (25)	
70833-40-8	tert-AMYL PEROXY-2-ETHYLHEXYL CARBONATE	Liquid	≤ 100				16 gal (60 L)	SFH		
2372-22-7	tert-AMYL PEROXY ISOPROPYL CARBONATE	Liquid	≤ 77	A ≥ 23			16 gal (60 L)	DH		
68299-16-1	tert-AMYL PEROXINEODECANOATE	Liquid	≤ 77	B ≥ 23			16 gal (60 L)	SFH	50 (10)	
68299-16-1	tert-AMYL PEROXINEODECANOATE	Liquid	≤ 47	A ≥ 53			IBC and tank	FH	50 (10)	
29240-17-3	tert-AMYL PEROXYPIVALATE	Liquid	≤ 77	B ≥ 23			16 gal (60 L)	DH	59 (15)	
3457-61-2	tert-BUTYL CUMYL PEROXIDE	Liquid	> 42 - 100				60 gal (225 L)	SFH		
3457-61-2	tert-BUTYL CUMYL PEROXIDE	Solid	≤ 52		≥ 48		440 lb (200 kg)	SFH		
995-33-5	n-BUTYL-4,4-DI (tert-BUTYLPEROXY) VALERATE	Liquid	> 52 - 100				16 gal (60 L)	DH		
995-33-5	n-BUTYL-4,4-DI (tert-BUTYLPEROXY) VALERATE	Solid	≤ 52		≥ 48		440 lb (200 kg)	FH		
75-91-2	tert-BUTYL HYDROPEROXIDE	Liquid	> 79 - 90			≥ 10	16 gal (60 L)	DH		
75-91-2	tert-BUTYL HYDROPEROXIDE	Liquid	≤ 80	A ≥ 20			16 gal (60 L)	SFH		Diluent may be replaced by di-tert-butyl peroxide
75-91-2	tert-BUTYL HYDROPEROXIDE	Liquid	≤ 79			> 14	60 gal (225 L)	SFH		With <6% di-tert-butyl peroxide
75-91-2 + 110-05-4	tert-BUTYL HYDROPEROXIDE +DI-tert-BUTILPEROXIDE	Liquid	< 81 + >9			≥ 7	16 gal (60 L)	DH		

Table C.1. Organic Peroxide Hazard Types (continued)

CAS Number	Chemical Name	Physical Form	Concentration (%)	Diluent (%)	Inert Solid (%)	Water (%)	Max. Container Size	Hazard Type	Emergency Temperature °F (°C)	Risks and Remarks
1931-62-0	tert-BUTYL MONOPEROXYMALEATE	Solid	< 52-100				55 lb (25 kg)	EH		
1931-62-0	tert-BUTYL MONOPEROXYMALEATE	Liquid	≤ 52	A ≥ 48			16 gal (60 L)	DH		
1931-62-0	tert-BUTYL MONOPEROXYMALEATE	Solid	≤ 52		≥ 48		440 lb (200 kg)	SFH		
1931-62-0	tert-BUTYL MONOPEROXYMALEATE	Solid	≤ 52 as a paste				440 lb (200 kg)	SFH		
107-71-1	tert-BUTYL PEROXYACETATE	Liquid	> 52-77	A ≥ 23			8 gal (30 L)	EH		
107-71-1	tert-BUTYL PEROXYACETATE	Liquid	> 32-55	A ≥ 48			16 gal (60 L)	DH		
107-71-1	tert-BUTYL PEROXYACETATE	Liquid	≤ 32	B ≥ 68			IBC and tank	FH		
614-45-9	tert-BUTYL PEROXYBENZOATE	Liquid	> 77-100				16 gal (60 L)	DH		
614-45-9	tert-BUTYL PEROXYBENZOATE	Liquid	> 52-77	A ≥ 23			16 gal (60 L)	SFH		
614-45-9	tert-BUTYL PEROXYBENZOATE	Solid	≤ 52		≥ 48		110 lb (50 kg)	SFH		
	tert-BUTYL PEROXYBUTYL FUMARATE	Liquid	≤ 52	A ≥ 48			16 gal (60 L)	SFH		
23474-91-1	tert-BUTYL PEROXYCROTONATE	Liquid	≤ 77	A ≥ 23			16 gal (60 L)	SFH		
2550-33-6	tert-BUTYL PEROXYDIETHYLACETATE	Liquid	≤ 100				16 gal (60 L)	DH	77 (25)	
3006-82-4	tert-BUTYL PEROXY-2-ETHYLHEXANOATE	Liquid	> 52-100				16 gal (60 L)	DH	77 (25)	
3006-82-4	tert-BUTYL PEROXY-2-ETHYLHEXANOATE	Liquid	> 32 -52	B ≥ 48			60 gal (225 L)	SFH	95 (35)	
3006-82-4	tert-BUTYL PEROXY-2-ETHYLHEXANOATE	Solid	≤ 52		≥ 48		440 lb (200 kg)	SFH	77 (25)	
3006-82-4	tert-BUTYL PEROXY-2-ETHYLHEXANOATE	Liquid	≤ 32	B ≥ 68			IBC and tank	FH	113 (45)	
3006-82-4 + 2167-23-9	tert-BUTYL PEROXY-2-ETHYLHEXANOATE + 2,2 DI (tert-BUTYLPEROXY) BUTANE	Solid	≤ 12 + ≤ 14	A ≥14	≥ 60		110 lb (50 kg)	SFH		
3006-82-4 + 2167-23-9	tert-BUTYL PEROXY-2-ETHYLHEXANOATE + 2,2 DI (tert-BUTYLPEROXY) BUTANE	Liquid	≤ 31 + ≤ 36	B ≥ 33			16 gal (60 L)	SFH	104 (40)	
34443-12-4	tert-BUTYL PEROXY-2-ETHYLHEXYLCARBONATE	Liquid	≤ 100				16 gal (60 L)	SFH		
109-13-7	tert-BUTYL PEROXYISOBUTYRATE	Liquid	> 52 - 77	B ≥ 23			8 gal (30 L)	EH	68 (20)	
109-13-7	tert-BUTYL PEROXYISOBUTYRATE	Liquid	≤ 52	B ≥ 48			16 gal (60 L)	SFH	68 (20)	
2372-21-6	tert-BUTYLPEROXY ISOPROPYLCARBONATE	Liquid	≤ 77	A ≥ 23			16 gal (60 L)	DH		
96319-55-0	1-(2-tert-BUTYLPEROXY ISOPROPYL)-3-ISOPROPENYLBENZENE	Liquid	≤ 77	A ≥ 23			16 gal (60 L)	SFH		

Table C.1 Organic Peroxide Hazard Types (continued)

CAS Number	Chemical Name	Physical Form	Concentration (%)	Diluent (%)	Inert Solid (%)	Water (%)	Max. Container Size	Hazard Type	Emergency Temperature °F (°C)	Risks and Remarks
96319-55-0	1-(2-tert-BUTYLPEROXY ISOPROPYL)-3-ISOPROPENYLBENZENE	Solid	≤ 42		≥ 58		440 lb (200 kg)	SFH		
22313-62-8	tert-BUTYL PEROXY-2-METHYLBENZOATE	Liquid	≤ 100				16 gal (60 L)	DH		
26748-41-4	tert-BUTYL PEROXYNEODECANOATE	Liquid	> 77 - 100				16 gal (60 L)	SFH	41 (5)	
26748-41-4	tert-BUTYL PEROXYNEODECANOATE	Liquid	≤ 77	B ≥ 23			16 gal (60 L)	SFH	50 (10)	
26748-41-4	tert-BUTYL PEROXYNEODECANOATE	Liquid	≤ 52 as a stable dispersion in water				IBC and tank	LH	50 (10)	
26748-41-4	tert-BUTYL PEROXYNEODECANOATE	Solid	≤ 42 as a stable dispersion in water (frozen)				440 lb (200 kg)	LH	50 (10)	
26748-41-4	tert-BUTYL PEROXYNEODECANOATE	Liquid	≤ 32	A ≥ 68			IBC and tank	FH	50 (10)	
26748-38-9	tert-BUTYL PEROXYNEOHEPTANOATE	Liquid	≤ 77	A ≥ 23			16 gal (60 L)	SFH	50 (10)	
26748-38-9	tert-BUTYL PEROXYNEOHEPTANOATE	Liquid	≤ 42 as a stable dispersion in water				60 gal (225 L)	LH	50 (10)	
927-07-1	tert-BUTYL PEROXYPIVALATE	Liquid	> 67 - 77	A ≥ 23			16 gal (60 L)	DH	50 (10)	
927-07-1	tert-BUTYL PEROXYPIVALATE	Liquid	> 27 - 67	B ≥ 33			16 gal (60 L)	SFH	50 (10)	
927-07-1	tert-BUTYL PEROXYPIVALATE	Liquid	≤ 27	B ≥ 73			IBC and tank	FH	95 (35)	
62476-60-6	tert-BUTYLPEROXY STEARYLCARBONATE	Solid	≤ 100				110 lb (50 kg)	SFH		
13122-18-4	tert-BUTYL PEROXY-3,5,5-TRIMETHYLHEXANOATE	Liquid	> 32 - 100				16 gal (60 L)	SFH		
13122-18-4	tert-BUTYL PEROXY-3,5,5-TRIMETHYLHEXANOATE	Solid	≤ 42		≥ 58		110 lb (50 kg)	SFH		
13122-18-4	tert-BUTYL PEROXY-3,5,5-TRIMETHYLHEXANOATE	Liquid	≤ 32	B ≥ 68			IBC and tank	FH		
937-14-4	3-CHLOROPEROXYBENZOIC ACID	Solid	> 57 - 86		≥ 14		55 lb (25 kg)	EH		
937-14-4	3-CHLOROPEROXYBENZOIC ACID	Solid	≤ 57		≥ 3	≥ 40	110 lb (50 kg)	SFH		
937-14-4	3-CHLOROPEROXYBENZOIC ACID	Solid	≤ 77		≥ 6	≥ 17	110 lb (50 kg)	SFH		
80-15-9	CUMYL HYDROPEROXIDE	Liquid	> 90 - 98	A ≤ 10			60 gal (225 L)	FH		
80-15-9	CUMYL HYDROPEROXIDE	Liquid	≤ 90	A ≥ 10			IBC and tank	FH		
26748-47-0	CUMYL PEROXYNEODECANOATE	Liquid	≤ 87	A ≥ 13			16 gal (60 L)	SFH	32 (0)	
26748-47-0	CUMYL PEROXYNEODECANOATE	Liquid	≤ 77	B ≥ 23			16 gal (60 L)	SFH	32 (0)	

Table C.1 Organic Peroxide Hazard Types (continued)

CAS Number	Chemical Name	Physical Form	Concentration (%)	Diluent (%)	Inert Solid (%)	Water (%)	Max. Container Size	Hazard Type	Emergency Temperature °F (°C)	Risks and Remarks
26748-47-0	CUMYL PEROXYNEODECANOATE	Liquid	≤ 52 as a stable dispersion in water				IBC and tank	FH	32 (0)	
104852-44-0	CUMYL PEROXYNEOHEPTANOATE	Liquid	≤ 77	A ≥ 23			16 gal (60 L)	SFH	32 (0)	
23383-59-7	CUMYL PEROXYPIVALATE	Liquid	≤ 77	B ≥ 23			16 gal (60 L)	SFH	41 (5)	
12262-58-7	CYCLOHEXANONE PEROXIDE(S)	Solid	≤ 91			≥ 9	110 lb (50 kg)	DH		
12262-58-7	CYCLOHEXANONE PEROXIDE(S)	Liquid	≤ 72	A ≥ 28			16 gal (60 L)	SFH		Active oxygen content ≤ 9%
12262-58-7	CYCLOHEXANONE PEROXIDE(S)	Solid	≤ 72 as a paste				110 lb (50 kg)	SFH		Active oxygen content ≤ 9%. With diluent A, with or without water
12262-58-7	CYCLOHEXANONE PEROXIDE(S)		≤ 32		≥ 68			Exempt*		
54693-46-8	DIACETONE ALCOHOL PEROXIDES	Liquid	≤ 57	B ≥ 26		≥ 8	16 gal (60 L)	SFH	113 (45)	With ≤ 9% hydrogen peroxide; active oxygen content ≤10%
110-22-5	DIACETYL PEROXIDE	Liquid	≤ 27	B ≥ 73			16 gal (60 L)	SFH	77 (25)	Only non-metal packages permitted
10508-09-5	DI-tert-AMYL PEROXIDE	Liquid	≤ 100				60 gal (225 L)	SFH		
13653-62-8	2, 2 DI-(tert-AMYLPEROXY) BUTANE	Liquid	≤ 57	A ≥ 43			16 gal (60 L)	SFH		
15667-10-4	1, 1-DI-(tert-AMILPEROXY) CYCLOHEXANE	Liquid	≤ 82	A ≥ 18			16 gal (60 L)	DH		
94-36-0	DIBENZOYL PEROXIDE	Solid	> 51 - 100		≤ 48		55 lb (25 kg)	EH		
94-36-0	DIBENZOYL PEROXIDE	Solid	> 77 - 94			≥ 6	55 lb (25 kg)	EH		
94-36-0	DIBENZOYL PEROXIDE	Solid	≤ 77			≥ 23	110 lb (50 kg)	DH		
94-36-0	DIBENZOYL PEROXIDE	Solid	≤ 62		≥ 28	≥ 10	110 lb (50 kg)	SFH		
94-36-0	DIBENZOYL PEROXIDE	Solid	> 52 - 62 as a paste				110 lb (50 kg)	SFH		With diluent A, with or without water
94-36-0	DIBENZOYL PEROXIDE	Solid	> 35 - 52		≥ 48		110 lb (50 kg)	SFH		
94-36-0	DIBENZOYL PEROXIDE	Liquid	> 36 - 42	A ≥ 18		≤ 40	60 gal (225 L)	SFH		
94-36-0	DIBENZOYL PEROXIDE	Solid	≤ 56.5 as a paste			≥ 15	440 lb (200 kg)	SFH		
94-36-0	DIBENZOYL PEROXIDE	Solid	≤ 52 as a paste				440 lb (200 kg)	SFH		With diluent A, with or without water

Table C.1 Organic Peroxide Hazard Types (continued)

CAS Number	Chemical Name	Physical Form	Concentration (%)	Diluent (%)	Inert Solid (%)	Water (%)	Max. Container Size	Hazard Type	Emergency Temperature °F (°C)	Risks and Remarks
94-36-0	DIBENZOYL PEROXIDE	Liquid	≤ 42 as a stable dispersion in water				IBC and tank	FH		
94-36-0	DIBENZOYL PEROXIDE		≤ 35		≥ 65			Exempt*		
15520-11-3	DI-(4-tert-BUTYLCYCLOHEXYL) PEROXIDICARBONATE	Solid	≤ 100				110 lb (50 kg)	DH	95 (35)	
15520-11-3	DI-(4-tert-BUTYLCYCLOHEXYL) PEROXIDICARBONATE	Liquid	≤ 42 as a stable dispersion in water				IBC and tank	LH	95 (35)	
110-05-4	DI-tert-BUTYL PEROXIDE	Liquid	> 52 - 100				60 gal (225 L)	SFH		
110-05-4	DI-tert-BUTYL PEROXIDE	Liquid	≤ 52	B ≥ 48			IBC and tank	FH		With diluent type B, with a boiling point >230 °F (110 °C)
16580-06-6	DI-tert-BUTYL PEROXYAZELATE	Liquid	≤ 52	A ≥ 48			16 gal (60 L)	SFH		
2167-23-9	2,2-DI-(tert-BUTYLPEROXY) BUTANE	Liquid	≤ 52	A ≥ 48			16 gal (60 L)	DH		
	1,6, DI-(tert-BUTYL PEROXYCARBONYLOXY) HEXANE	Liquid	≤ 72	A ≥ 28			16 gal (60 L)	DH		
3006-86-8	1,1-DI-(tert-BUTYLPEROXY) CYCLOHEXANE	Liquid	> 80 - 100				8 gal (30 L)	EH		
3006-86-8	1,1-DI-(tert-BUTYLPEROXY) CYCLOHEXANE	Liquid	≤ 72	B ≥ 28			16 gal (60 L)	DH		Diluent type B, with a boiling point >266 °F (130 °C)
3006-86-8	1,1-DI-(tert-BUTYLPEROXY) CYCLOHEXANE	Liquid	> 52 - 80	A ≥ 20			16 gal (60 L)	DH		
3006-86-8	1,1-DI-(tert-BUTYLPEROXY) CYCLOHEXANE	Liquid	> 42 - 52	A ≥ 48			16 gal (60 L)	SFH		
3006-86-8	1,1-DI-(tert-BUTYLPEROXY) CYCLOHEXANE	Solid	≤ 42	A ≥ 13	≥ 45		110 lb (50 kg)	FH		
3006-86-8	1,1-DI-(tert-BUTYLPEROXY) CYCLOHEXANE	Liquid	≤ 42	A ≥ 58			IBC and tank	FH		
3006-86-8	1,1-DI-(tert-BUTYLPEROXY) CYCLOHEXANE	Liquid	≤ 27	A ≥ 25			60 gal (225 L)	FH		With ≥25 wt% diluent type A in addition to ethyl benzene
3006-86-8	1,1-DI-(tert-BUTYLPEROXY) CYCLOHEXANE	Liquid	≤ 13	A ≥ 13	≥ 74		IBC and tank	FH		

Table C.1 Organic Peroxide Hazard Types (continued)

CAS Number	Chemical Name	Physical Form	Concentration (%)	Diluent (%)	Inert Solid (%)	Water (%)	Max. Container Size	Hazard Type	Emergency Temperature °F (°C)	Risks and Remarks
3006-86-8 and 3006-82-4	1,1-DI-(tert-BUTYLPEROXY) CYCLOHEXANE + tert-BUTYL PEROXY-2-ETHYLHEXANOATE	Liquid	≤ 43 + ≤ 16	A ≥ 41			16 gal (60 L)	SFH		
16215-49-9	DI-n-BUTYL PEROXYDICARBONATE	Liquid	> 27 - 52	B ≥ 48			16 gal (60 L)	SFH	23 (-5)	
16215-49-9	DI-n-BUTYL PEROXYDICARBONATE	Solid	≤ 42 as a stable dispersion in water (frozen)				440 lb (200 kg)	LH	23 (-5)	
16215-49-9	DI-n-BUTYL PEROXYDICARBONATE	Liquid	≤ 27	B ≥ 73			60 gal (225 L)	FH	32 (0)	
19910-65-7	DI-sec-BUTYL PEROXYDICARBONATE	Liquid	> 52 - 100				16 gal (60 L)	DH	14 (-10)	
19910-65-7	DI-sec-BUTYL PEROXYDICARBONATE	Liquid	≤ 52	B ≥ 48			16 gal (60 L)	SFH	23 (-5)	
25155-25-3	DI-(tert-BUTYLPEROXYISOPROPYL) BENZENE (S)	Solid	> 42 - 100		≤ 57		110 lb (50 kg)	SFH		
25155-25-3	DI-(tert-BUTYLPEROXYISOPROPYL) BENZENE (S)		≤ 42		≥ 58			Exempt*		
15042-77-0	DI-(tert-BUTYLPEROXY) PHTHALATE	Liquid	> 42 - 52	A ≥ 48			16 gal (60 L)	SFH		
15042-77-0	DI-(tert-BUTYLPEROXY) PHTHALATE	Solid	≤ 52 as a paste				110 lb (50 kg)	SFH		With diluent A, with or without water
15042-77-0	DI-(tert-BUTYLPEROXY) PHTHALATE	Liquid	≤ 42	A ≥ 58			60 gal (225 L)	SFH		
2167-23-9	2,2-DI-(tert-BUTYLPEROXY) PROPANE	Liquid	≤ 52	A ≥ 48			16 gal (60 L)	SFH		
2167-23-9	2,2-DI-(tert-BUTYLPEROXY) PROPANE	Solid	≤ 42	A ≥ 13	≥ 45		110 lb (50 kg)	FH		
6731-36-8	1,1-DI-(tert-BUTYLPEROXY)-3,3,5-TRIMETHYLCYCLOHEXANE	Liquid	> 90 - 100				8 gal (30 L)	EH		
6731-36-8	1,1-DI-(tert-BUTYLPEROXY)-3,3,5-TRIMETHYLCYCLOHEXANE	Liquid	≤ 90	B ≥ 10			16 gal (60 L)	DH		Diluent type B, with a boiling point >266 °F (130 °C)
6731-36-8	1,1-DI-(tert-BUTYLPEROXY)-3,3,5-TRIMETHYLCYCLOHEXANE	Liquid	> 57 - 90	A ≥ 10			16 gal (60 L)	DH		
6731-36-8	1,1-DI-(tert-BUTYLPEROXY)-3,3,5-TRIMETHYLCYCLOHEXANE	Liquid	≤ 77	B ≥ 23			16 gal (60 L)	DH		
6731-36-8	1,1-DI-(tert-BUTYLPEROXY)-3,3,5-TRIMETHYLCYCLOHEXANE	Solid	≤ 57		≥ 43		IBC and tank	FH		
6731-36-8	1,1-DI-(tert-BUTYLPEROXY)-3,3,5-TRIMETHYLCYCLOHEXANE	Liquid	≤ 57	A ≥ 43			60 gal (225 L)	SFH		

Table C.1 Organic Peroxide Hazard Types (continued)

CAS Number	Chemical Name	Physical Form	Concentration (%)	Diluent (%)	Inert Solid (%)	Water (%)	Max. Container Size	Hazard Type	Emergency Temperature °F (°C)	Risks and Remarks
6731-36-8	1,1-DI-(tert-BUTYLPEROXY)-3,3,5-TRIMETHYLCYCLOHEXANE	Liquid	≤ 32	A ≥26; B ≥ 42			60 gal (225 L)	SFH		
26322-14-5	DICETYL PEROXYDICARBONATE	Solid	≤ 100				110 lb (50 kg)	SFH	95 (35)	
26322-14-5	DICETYL PEROXYDICARBONATE	Liquid	≤ 42 as a stable dispersion in water				IBC and tank	LH	95 (35)	
94-17-7	DI-4-CHLOROBENZOYL PEROXIDE	Solid	≤ 77			≥ 23	55 lb (25 kg)	EH		
94-17-7	DI-4-CHLOROBENZOYL PEROXIDE	Solid	≤ 52 as a paste				110 lb (50 kg)	SFH		With diluent A, with or without water
94-17-7	DI-4-CHLOROBENZOYL PEROXIDE		≤ 32		≥ 68			Exempt*		
80-43-3	DICUMYL PEROXIDE	Solid	> 52 - 100				IBC and tank	FH		Up to 2000 kg per tank classed as organic peroxide type F, based on large scale test.
80-43-3	DICUMYL PEROXIDE		≤ 52		≥ 48			Exempt*		
1561-49-5	DICYCLOHEXYL PEROXYDICARBONATE	Solid	> 91 - 100				55 lb (25 kg)	EH	59 (15)	
1561-49-5	DICYCLOHEXYL PEROXYDICARBONATE	Solid	≤ 91			≥ 9	110 lb (50 kg)	DH	59 (15)	
1561-49-5	DICYCLOHEXYL PEROXYDICARBONATE	Liquid	≤ 42 as a stable dispersion in water				IBC and tank	LH	68 (20)	
762-12-9	DIDECANOYL PEROXIDE	Solid	≤ 100				110 lb (50 kg)	DH	95 (35)	
1705-60-8	2,2-DI-(4,4-DI (tert-BUTYLPEROXY) CYCLOHEXYL) PROPANE	Solid	≤ 42		≥ 58		110 lb (50 kg)	FH		
1705-60-8	2,2-DI-(4,4-DI (tert-BUTYLPEROXY) CYCLOHEXYL) PROPANE	Liquid	≤ 22	B ≥ 78			60 gal (225 L)	FH		
133-14-2	DI-2,4-DICHLOROBENZOYL PEROXIDE	Solid	≤ 77			≥ 23	55 lb (25 kg)	EH		
133-14-2	DI-2,4-DICHLOROBENZOYL PEROXIDE	Solid	≤ 52 as a paste				440 lb (200 kg)	SFH	77 (25)	
133-14-2	DI-2,4-DICHLOROBENZOYL PEROXIDE	Solid	≤ 52 as a paste with silicon oil				110 lb (50 kg)	SFH		
	DI-(2-ETHOXYETHYL) PEROXYDICARBONATE	Liquid	≤ 52	B ≥ 48			16 gal (60 L)	SFH	32 (0)	
16111-62-9	DI-(2-ETHYLHEXYL) PEROXYDICARBONATE	Liquid	> 77 - 100				16 gal (60 L)	DH	14 (-10)	
16111-62-9	DI-(2-ETHYLHEXYL) PEROXYDICARBONATE	Liquid	≤ 77	B ≥ 23			16 gal (60 L)	SFH	23 (-5)	

Table C.1 Organic Peroxide Hazard Types (continued)

CAS Number	Chemical Name	Physical Form	Concentration (%)	Diluent (%)	Inert Solid (%)	Water (%)	Max. Container Size	Hazard Type	Emergency Temperature °F (°C)	Risks and Remarks
16111-62-9	DI-(2-ETHYLHEXYL) PEROXYDICARBONATE	Liquid	≤ 62 as a stable dispersion in water				IBC and tank	FH	23 (-5)	
16111-62-9	DI-(2-ETHYLHEXYL) PEROXYDICARBONATE	Solid	≤ 52 as a stable dispersion in water (frozen)				IBC and tank	LH	23 (-5)	
2614-76-8	2,2-DIHYDROPEROXYPROPANE	Solid	≤ 27		≥ 73		55 lb (25 kg)	EH		
2407-94-5	DI-(1-HYDROXYCYCLOHEXYL) PEROXIDE	Solid	≤ 100				110 lb (50 kg)	SFH		
3437-84-1	DI-ISOBUTYRYL PEROXIDE	Liquid	> 32 - 52	B ≥ 48			8 gal (30 L)	EH	14 (-10)	
3437-84-1	DI-ISOBUTYRYL PEROXIDE	Liquid	≤ 32	B ≥ 68			16 gal (60 L)	SFH	14 (-10)	
	DIISOPROPYLBENZENE DIHYDROPEROXIDE	Solid	≤ 82	A ≥ 5		≥ 5	110 lb (50 kg)	SFH		With ≤ 8% 1-isopropyl hydroperoxi-4-isopropyl hydroxyl benzene
105-64-6	DIISOPROPYL PEROXYDICARBONATE	Solid	> 52 - 100				55 lb (25 kg)	EH	23 (-5)	
105-64-6	DIISOPROPYL PEROXYDICARBONATE	Liquid	≤ 52	B ≥ 48			16 gal (60 L)	SFH	14 (-10)	
105-64-6	DIISOPROPYL PEROXYDICARBONATE	Liquid	≤ 32	A ≥ 68			16 gal (60 L)	SFH	23 (-5)	
105-74-8	DILAUROYL PEROXIDE	Solid	≤ 100				110 lb (50 kg)	SFH		
105-74-8	DILAUROYL PEROXIDE	Liquid	≤ 42 as a stable dispersion in water				IBC and tank	LH		
52238-68-3	DI-(3-METHOXYBUTYL) PEROXYDICARBONATE	Liquid	≤ 52	B ≥ 48			16 gal (60 L)	SFH	41 (5)	
22313-62-8	DI-(2-METHYLBENZOYL) PEROXIDE	Solid	≤ 87			≥ 13	55 lb (25 kg)	EH	95 (35)	
	DI(3-METHYLBENZOYL) PEROXIDE + BENZOYL (3-METHYLBENZOYL) PEROXIDE + DIBENZOYL PEROXIDE	Liquid	≤ 20 + ≤ 18 + ≤ 4	B ≥ 58			16 gal (60 L)	SFH	104 (40)	
895-85-2	DI-(4-METHYLBENZOYL) PEROXIDE	Solid	≤ 52 as a paste with silicon oil				110 lb (50 kg)	SFH		
2618-77-1	2,5-DIMETHYL-2,5-DI-(BENZOYLPEROXY)HEXANE	Solid	> 82 - 100				55 lb (25 kg)	EH		
2618-77-1	2,5-DIMETHYL-2,5-DI-(BENZOYLPEROXY)HEXANE	Solid	≤ 82		≥ 18		110 lb (50 kg)	SFH		
2618-77-1	2,5-DIMETHYL-2,5-DI-(BENZOYLPEROXY)HEXANE	Solid	≤ 82			≥ 18	110 lb (50 kg)	DH		
78-63-7	2,5-DIMETHYL-2,5-DI-(tert-BUTYLPEROXY) HEXANE	Liquid	> 90 - 100				16 gal (60 L)	DH		

Table C.1 Organic Peroxide Hazard Types (continued)

CAS Number	Chemical Name	Physical Form	Concentration (%)	Diluent (%)	Inert Solid (%)	Water (%)	Max. Container Size	Hazard Type	Emergency Temperature °F (°C)	Risks and Remarks
78-63-7	2,5-DIMETHYL-2,5-DI-(tert-BUTYLPEROXY) HEXANE	Liquid	> 52 - 90	A ≥ 10			16 gal (60 L)	SFH		
78-63-7	2,5-DIMETHYL-2,5-DI (tert-BUTYLPEROXY) HEXANE	Solid	≤ 77		≥ 23		440 lb (200 kg)	SFH		
78-63-7	2,5-DIMETHYL-2,5-DI (tert-BUTYLPEROXY) HEXANE	Liquid	≤ 52	A ≥ 48			IBC and tank	FH		
78-63-7	2,5-DIMETHYL-2,5-DI (tert-BUTYLPEROXY) HEXANE	Solid	≤ 47 as a paste				440 lb (200 kg)	SFH		
1068-27-5	2,5-DIMETHYL-2,5-DI-(tert-BUTYLPEROXY) HEXYNE-3	Liquid	> 86 - 100				8 gal (30 L)	EH		
1068-27-5	2,5-DIMETHYL-2,5-DI-(tert-BUTYLPEROXY) HEXYNE-3	Liquid	> 52 - 86	A ≥ 14			16 gal (60 L)	DH		
1068-27-5	2,5-DIMETHYL-2,5-DI-(tert-BUTYLPEROXY) HEXYNE-3	Solid	≤ 52		≥ 48		110 lb (50 kg)	FH		
13052-09-0	2,5-DIMETHYL-2,5-DI-(2-ETHYLHEXANOYLPEROXY) HEXANE	Liquid	≤ 100				16 gal (60 L)	DH	77 (25)	
3025-88-5	2,5-DIMETHYL -2,5-DIHYDROPEROXYHEXANE	Solid	≤ 82			≥ 18	55 lb (25 kg)	DH		
	2,5-DIMETHYL-2,5-DI-(3,5,5-TRIMETHYLHEXANOYL-PEROXY) HEXANE	Liquid	≤ 77	A ≥ 23			16 gal (60 L)	SFH		
110972-57-1	1,1-DIMETHYL-3-HYDROXYBUTYL PEROXYNEOHEPTANOATE	Liquid	≤ 52	A ≥ 48			60 gal (225 L)	SFH	50 (10)	
53220-22-7	DIMYRISTYL PEROXYDICARBONATE	Solid	≤ 100				110 lb (50 kg)	SFH	77 (25)	
53220-22-7	DIMYRISTYL PEROXYDICARBONATE	Liquid	≤ 42 as a stable dispersion in water				IBC and tank	LH	77 (25)	
117663-11-3	DI-(2-NEODECANOYLPEROXYISOPROPYL) BENZENE	Liquid	≤ 52	A ≥ 48			60 gal (225 L)	SFH	32 (0)	
762-13-0	DI-n-NONANOYL PEROXIDE	Solid	≤ 100				110 lb (50 kg)	SFH	50 (10)	
762-16-3	DI-n-OCTANOYL PEROXIDE	Solid	≤ 100				110 lb (50 kg)	DH	59 (15)	
41935-39-1	DI-(2-PHENOXYETHYL) PEROXYDICARBONATE	Solid	> 85 - 100				55 lb (25 kg)	EH		
41935-39-1	DI-(2-PHENOXYETHYL) PEROXYDICARBONATE	Solid	≤ 85			≥ 15	110 lb (50 kg)	SFH		
3248-28-0	DIPROPIONYL PEROXIDE	Liquid	≤ 27	B ≥ 73			60 gal (225 L)	FH	68 (20)	
16066-38-9	DI-n-PROPYL PEROXYDICARBONATE	Liquid	≤ 100				16 gal (60 L)	DH	5 (-15)	
16066-38-9	DI-n-PROPYL PEROXYDICARBONATE	Liquid	≤ 77	B ≥ 23			16 gal (60 L)	DH	14 (-10)	
123-23-9	DISUCCINI ACID PEROXIDE	Solid	> 72 - 100				55 lb (25 kg)	EH		Addition of water to this organic peroxide will reduce the thermal stability

Table C.1 Organic Peroxide Hazard Types (continued)

CAS Number	Chemical Name	Physical Form	Concentration (%)	Diluent (%)	Inert Solid (%)	Water (%)	Max. Container Size	Hazard Type	Emergency Temperature °F (°C)	Risks and Remarks
123-23-9	DISUCCINI ACID PEROXIDE	Solid	≤ 72			≥ 28	110 lb (50 kg)	SFH	59 (15)	
3851-87-4	DI-(3,5,5-TRIMETHYLHEXANOYL) PEROXIDE	Liquid	>52 - 82	A ≥ 18			16 gal (60 L)	SFH	50 (10)	
3851-87-4	DI-(3,5,5-TRIMETHYLHEXANOYL) PEROXIDE	Liquid	≤ 52 as a stable dispersion in water				IBC and tank	FH	59 (15)	
3851-87-4	DI-(3,5,5-TRIMETHYLHEXANOYL) PEROXIDE	Liquid	> 38 -52	A ≥ 62			IBC and tank	FH	59(15)	
3851-87-4	DI-(3,5,5-TRIMETHYLHEXANOYL) PEROXIDE	Liquid	≤ 38	A ≥ 62			IBC and tank	FH	77 (25)	
67567-23-1	ETHYL 3,3-DI-(tert-AMYLPEROXY) BUTYRATE	Liquid	≤ 67	A ≥ 33			16 gal (60 L)	SFH		
55794-20-2	ETHYL 3,3-DI-(tert-BUTYLPEROXY) BUTYRATE	Liquid	> 77 - 100				16 gal (60 L)	DH		
55794-20-2	ETHYL 3,3-DI-(tert-BUTYLPEROXY) BUTYRATE	Liquid	≤ 77	A ≥ 23			16 gal (60 L)	SFH		
55794-20-2	ETHYL 3,3-DI-(tert-BUTYLPEROXY) BUTYRATE	Solid	≤ 52		≥ 48		110 lb (50 kg)	SFH		
228415-62-1	1-(2-ETHYLHEXANOYLPEROXY) 1,3-DIMETHYLBUTYL PEROXYPIVALATE	Liquid	≤ 52	A≥45; B≥10			16 gal (60 L)	SFH	14 (-10)	
62178-88-5	tert-HEXYL PEROXYNEODECANOATE	Liquid	≤ 71	A ≥ 29			16 gal (60 L)	SFH	50 (10)	
51938-28-4	tert-HEXYL PEROXYPIVALATE	Liquid	≤ 72	B ≥ 28			16 gal (60 L)	SFH	59 (15)	
95718-78-8	3-HYDROXY-1,1-DIMETHYLBUTYL PEROXYNEODECANOATE	Liquid	≤ 77	A ≥ 23			16 gal (60 L)	SFH	41 (5)	
95718-78-8	3-HYDROXY-1,1-DIMETHYLBUTYL PEROXYNEODECANOATE	Liquid	≤ 52	A ≥ 48			60 gal (225 L)	SFH	41 (5)	
	3-HYDROXY-1,1-DIMETHYLBUTYL PEROXYNEODECANOATE	Liquid	≤ 52 as a stable dispersion in water				IBC and tank	LH	41 (5)	
	ISOPROPYL sec-BUTYL PEROXYDICARBONATE + DI-sec-BUTYL PEROXYDICARBONATE + DI-ISOPROPYL PEROXYDICARBONATE	Liquid	≤ 32 + ≤ 15-18 + ≤ 12-15	A ≥ 38			16 gal (60 L)	SFH	14 (-10)	
	ISOPROPYL sec-BUTYL PEROXYDICARBONATE + DI-sec-BUTYL PEROXYDICARBONATE + DI-ISOPROPYL PEROXYDICARBONATE	Liquid	≤ 52+ ≤ 28 + ≤ 22				8 gal (30 L)	EH	14 (-10)	
26762-93-6	ISOPROPYLCUMYL HYDROPEROXIDE	Liquid	≤ 72	A ≥ 28			IBC and tank	FH		

Table C.1 Organic Peroxide Hazard Types (continued)

CAS Number	Chemical Name	Physical Form	Concentration (%)	Diluent (%)	Inert Solid (%)	Water (%)	Max. Container Size	Hazard Type	Emergency Temperature °F (°C)	Risks and Remarks
26762-92-5	p-MENTHYL HYDROPEROXYDE	Liquid	> 72 - 100				16 gal (60 L)	SFH		
26762-92-5	p-MENTHYL HYDROPEROXYDE	Liquid	≤ 72	A ≥ 28			IBC and tank	FH		
	METHYLCYCLOHEXANONE PEROXIDE(S)	Liquid	≤ 67	B ≥ 33			16 gal (60 L)	SFH	104 (40)	
1338-23-4	METHYL ETHYL KETONE PEROXIDE (S)	Liquid	Active oxygen content >10% and ≤10.7%, with or without water	A ≥ 48			8 gal (30 L)	EH		
1338-23-4	METHYL ETHYL KETONE PEROXIDE (S)	Liquid	Active oxygen content ≤10 %, with or without water	A ≥ 55			16 gal (60 L)	SFH		
1338-23-4	METHYL ETHYL KETONE PEROXIDE (S)	Liquid	Active oxygen content ≤8.2 %, with or without water	A ≥ 60			60 gal (225 L)	SFH		
37206-20-5	METHYL ISOBUTYL KETONE PEROXIDE (S)	Liquid	≤ 62	A ≥ 19			16 gal (60 L)	SFH		With ≥ 19 wt% diluent type A in addition to methyl isobutyl ketone
	METHYL ISOPROPYL KETONE PEROXIDE (S)	Liquid	Active oxygen content ≤6.7 %	A ≥ 70			IBC and tank	FH		Active oxygen content ≤ 6.7 %
215877-64-8	3,3,5,7,7-PENTAMETHYL-1,2,4-TRIOXEPANE	Liquid	≤ 100				60 gal (225 L)	SFH		
79-21-0	PEROXYACETIC ACID, TYPE D, stabilized	Liquid	≤ 43				16 gal (60 L)	SFH		Mixtures with hydrogen peroxide, water and acid(s)
79-21-0	PEROXYACETIC ACID, TYPE E, stabilized	Liquid	≤ 43				60 gal (225 L)	FH		Mixtures with hydrogen peroxide, water and acid(s)
79-21-0	PEROXYACETIC ACID, TYPE F, stabilized	Liquid	≤ 43				IBC and tank	LH		Mixtures with hydrogen peroxide, water and acid(s)
02388-12-7	PEROXYLAURIC ACID	Solid	≤ 100				440 lb (200 kg)	SFH	104 (40)	
28324-52-9	PINANYL HYDROPEROXIDE	Liquid	> 56 - 100				16 gal (60 L)	SFH		
28324-52-9	PINANYL HYDROPEROXIDE	Liquid	≤ 56	A ≥ 44			IBC and tank	FH		
	POLYETHER POLY-tert-BUTYLPEROXYCARBONATE	Liquid	≤ 52	B ≥ 48			60 gal (225 L)	SFH		

Table C.1 Organic Peroxide Hazard Types (continued)

CAS Number	Chemical Name	Physical Form	Concentration (%)	Diluent (%)	Inert Solid (%)	Water (%)	Max. Container Size	Hazard Type	Emergency Temperature °F (°C)	Risks and Remarks
05809-08-5	1,1,3,3-TETRAMETHYLBUTYL HYDROPEROXIDE	Liquid	≤ 100				16 gal (60 L)	SFH		
22288-43-3	1,1,3,3-TETRAMETHYLBUTYL PEROXY-2-ETHYL-HEXANOATE	Liquid	≤ 100				16 gal (60 L)	SFH	68 (20)	
51240-95-0	1,1,3,3-TETRAMETHYLBUTYL PEROXYNEODECANOATE	Liquid	≤ 72	B ≥ 28			16 gal (60 L)	SFH	41 (5)	
51240-95-0	1,1,3,3-TETRAMETHYLBUTYL PEROXYNEODECANOATE	Liquid	≤ 52 as a stable dispersion in water				IBC and tank	FH	41 (5)	
22288-41-1	1,1,3,3-TETRAMETHYLBUTYL PEROXYPIVALATE	Liquid	≤ 77	A ≥ 23			16 gal (60 L)	SFH	50 (10)	
24748-23-0	3,6,9-TRIETHYL-3,6,9-TRIMETHYL-1,4,7-TRIPEROXONANE	Liquid	≤ 42	A ≥ 58			16 gal (60 L)	SFH		Active oxygen content ≤ 7.6% in diluent type A with a boiling point between 392-500°F (200-260°C)
24748-23-0	3,6,9-TRIETHYL-3,6,9-TRIMETHYL-1,4,7-TRIPEROXONANE	Solid	≤ 17	A ≥ 18	≥ 65		IBC and tank	FH		

* These formulations are exempt from category of organic peroxides

Type A diluent: Organic liquids that are compatible with the organic peroxide and have a boiling point of not less than 305°F (150°C) and can be used to desensitize all organic peroxides.
Type B diluent: Organic liquids that are compatible with the organic peroxide and have a boiling point of less than 302°F (150°C) but not less than 140°F (60°C) and a flash point of not less than 41°F (5°C). Type B can be used for desensitizing all organic peroxides, providing the boiling point is at least 108°F (60°C) higher than the SADT in a 110 lb (50 kg) package.