

# NFPA<sup>®</sup> 401

## Recommended Practice for the Prevention of Fires and Uncontrolled Chemical Reactions Associated with the Handling of Hazardous Waste

2024 Edition



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## NFPA® 401

### Recommended Practice for the

# Prevention of Fires and Uncontrolled Chemical Reactions Associated with the Handling of Hazardous Waste

## 2024 Edition

This edition of NFPA 401, *Recommended Practice for the Prevention of Fires and Uncontrolled Chemical Reactions Associated with the Handling of Hazardous Waste*, was prepared by the Technical Committee on Hazardous Waste. It was issued by the Standards Council on December 1, 2023, with an effective date of December 21, 2023.

This edition of NFPA 401 was approved as an American National Standard on December 21, 2023.

### Origin and Development of NFPA 401

The development of NFPA 401, *Recommended Practice for the Prevention of Fires and Uncontrolled Chemical Reactions Associated with the Handling of Hazardous Waste*, began with a 2011 Chemical Safety Board (CSB) recommendation that the Environmental Technology Council (ETC) petition NFPA to develop a standard for the hazardous waste industry in the wake of 21 incidents at hazardous waste facilities in the United States between 2002 and 2007. In January 2013, the CSB also recommended that NFPA develop a new standard for, or incorporate into an existing standard, best practices for the safe disposal of waste fireworks in the wake of the Donaldson Enterprises, Inc. fireworks disposal and explosion.

In January 2013, the NFPA Technical Committee on Hazardous Chemicals developed a task group to review the hazardous waste transportation, storage, and disposal (TSD) facility fire problem. Research was conducted through the NFPA Fire Protection Research Foundation to examine the fire problem at such facilities and identify gaps in hazardous waste regulations and fire codes. In August 2015, the NFPA Standards Council approved the formation of a separate task group to determine the best approach to address fire protection and life safety at hazardous waste facilities in a manner compatible with hazardous waste regulations. The task group proposed the development of a recommended practice for hazardous waste generation and management. In April 2016, the NFPA Standards Council approved the formation of a new Technical Committee on Hazardous Waste to develop the document.

In November 2016, the NFPA Standards Council appointed the first Technical Committee on Hazardous Waste to develop the recommended practice. The initial draft was developed by the technical committee over the course of six meetings and was opened for public input in 2021.

The 2024 edition is the first edition to be published.

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**Committee Scope:** This Committee shall have primary responsibility for documents on safeguarding against the fire and explosion hazards associated with the treatment, storage, disposal, generation, and transportation of hazardous waste.

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## NFPA 401

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**NOTICE:** An asterisk (\*) following the number or letter designating a paragraph indicates that explanatory material on the paragraph can be found in Annex A.

A reference in brackets [ ] following a section or paragraph indicates material that has been extracted from another NFPA document. Extracted text may be edited for consistency and style and may include the revision of internal paragraph references and other references as appropriate. Requests for interpretations or revisions of extracted text shall be sent to the technical committee responsible for the source document.

Information on referenced and extracted publications can be found in Chapter 2 and Annex J.

### Chapter 1 Administration

**1.1 Scope.** This document applies to the generation, transport, treatment, storage, and disposal of hazardous waste at generator sites, during transportation, and once it reaches a treatment, storage, and disposal facility.

**1.1.1 Applicability.** This recommended practice applies to the following wastes:

- (1) EPA hazardous wastes
- (2) Universal waste
- (3) Waste oil

**1.1.2\* Specific Applications.** This recommended practice does not apply to the following:

- (1) Radioactive and mixed waste
- (2) Toxic agents regulated as CDC select agents

**1.2 Purpose.** The purpose of this document is to provide the user with safeguards against fire and explosion hazards associated with the generation, transport, storage, and disposal of hazardous waste.

**1.3 Application.** Most of the information in this recommended practice is referenced from United States regulations and governmental agencies such as the US Code of Federal Regulations (CFR). Depending on the jurisdiction, consultation with the authority having jurisdiction (AHJ) should be done to determine if these US regulations are enforceable or provided as best practices.

**1.4 Equivalency.** Nothing in this recommended practice is intended to prevent the use of systems, methods, or devices of equivalent or superior quality, strength, fire resistance, effectiveness, durability, and safety over those prescribed by this recommended practice.

**1.4.1** Technical documentation should be submitted to the AHJ to demonstrate equivalency.

**1.4.2** The system, method, or device should be approved for the intended purpose by the AHJ.

**1.5 Units and Formulas.** The units of measure in this recommended practice are presented first in US customary units (inch-pound units), followed by International System (SI) units in parentheses.

### Chapter 2 Referenced Publications

**2.1 General.** The documents or portions thereof listed in this chapter are referenced within this recommended practice and should be considered part of the recommendations of this document.

**2.2 NFPA Publications.** National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA 10, *Standard for Portable Fire Extinguishers*, 2022 edition.

NFPA 13, *Standard for the Installation of Sprinkler Systems*, 2022 edition.

NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems*, 2023 edition.

NFPA 30, *Flammable and Combustible Liquids Code*, 2024 edition.

NFPA 70®, *National Electrical Code*®, 2023 edition.

NFPA 101®, *Life Safety Code*®, 2024 edition.

NFPA 400, *Hazardous Materials Code*, 2022 edition.

NFPA 505, *Fire Safety Standard for Powered Industrial Trucks Including Type Designations, Areas of Use, Conversions, Maintenance, and Operations*, 2024 edition.

NFPA 855, *Standard for the Installation of Stationary Energy Storage Systems*, 2023 edition.

NFPA 1124, *Code for the Manufacture, Transportation, and Storage of Fireworks and Pyrotechnic Articles*, 2022 edition.

## 2.3 Other Publications.

**2.3.1 APA Publications.** American Pyrotechnics Association, 4891 Long Beach Road, SE, Suite 3, Box #291, Southport, NC 28461.

APA 87-1, *Standard for the Construction and Approval for Transportation of Fireworks, Novelties, and Theatrical Pyrotechnics*, 2001.

**2.3.2 UN Publications.** United Nations Publications, Customer Service, P.O. Box 960, Herndon, VA 20172.

*United Nations Manual of Tests and Criteria*, 2019.

*Recommendations on the Transport of Dangerous Goods*, 2019.

**2.3.3 US Government Publications.** US Government Publishing Office, 732 North Capitol Street, NW, Washington, DC 20401.

“Emergency Response Guidebook (ERG),” Pipeline and Hazardous Materials Safety Administration, United States Department of Transportation, 2016.

Title 16, Code of Federal Regulations, Part 1500, “Hazardous Substances and Articles: Administration and Enforcement Regulations.”

Title 16, Code of Federal Regulations, Part 1507, “Fireworks Devices.”

Title 27, Code of Federal Regulations, Part 555, “Commerce in Explosives.”

Title 29, Code of Federal Regulations, Part 1910.119, “Process Safety Management of Highly Hazardous Chemicals.”

Title 29, Code of Federal Regulations, Part 1910.120, “Hazardous Waste Operations and Emergency Response (HAZWOPER).”

Title 29, Code of Federal Regulations, Part 1910, Subpart I, “Personal Protective Equipment.”

Title 29, Code of Federal Regulations, Part 1910.1200, “Hazard Communication.”

Title 29, Code of Federal Regulations, Part 1910.1201, “Retention of DOT Markings, Placards and Labels.”

Title 40, Code of Federal Regulations, Part 68, “Chemical Accident Provisions.”

Title 40, Code of Federal Regulations, Part 260.10, “Hazardous Waste Management System: General — Definitions.”

Title 40, Code of Federal Regulations, Parts 239–282, “Resource Conservation and Recovery Act (RCRA).”

Title 42, United States Code, Chapter 103, “Comprehensive Environmental Response Compensation and Liability.”

Title 49, Code of Federal Regulations, Parts 100–199, “Pipeline and Hazardous Materials Safety Administration, Department of Transportation.”

Title 49, Code of Federal Regulations, Part 107, Subpart G, “Registration of Persons Who Offer or Transport Hazardous Materials.”

Title 49, Code of Federal Regulations, Chapter I, Subchapter C, “Hazardous Materials Regulations.”

DOT Chart 16, United States Department of Transportation, Pipeline and Hazardous Materials Safety Administration, [www.phmsa.dot.gov/training/hazmat/dot-chart-16-hazardous-materials-markings-labeling-and-placarding-guide-pdf](http://www.phmsa.dot.gov/training/hazmat/dot-chart-16-hazardous-materials-markings-labeling-and-placarding-guide-pdf).

US Environmental Protection Agency, EPA Form 8700-22 and Form 8700-22A, [www.epa.gov/hwgenerators/uniform-hazardous-waste-manifest-instructions-sample-form-and-continuation-sheet](http://www.epa.gov/hwgenerators/uniform-hazardous-waste-manifest-instructions-sample-form-and-continuation-sheet).

## 2.3.4 Other Publications.

*Merriam-Webster's Collegiate Dictionary*, 11th edition, Merriam-Webster, Inc., Springfield, MA, 2020.

**2.4 References for Extracts in Recommendations Sections.** NFPA 30, *Flammable and Combustible Liquids Code*, 2024 edition.

NFPA 45, *Standard on Fire Protection for Laboratories Using Chemicals*, 2024 edition.

NFPA 59A, *Standard for the Production, Storage, and Handling of Liquefied Natural Gas (LNG)*, 2023 edition.

NFPA 72®, *National Fire Alarm and Signaling Code*®, 2022 edition.

NFPA 85, *Boiler and Combustion Systems Hazards Code*, 2023 edition.

NFPA 101®, *Life Safety Code*®, 2024 edition.

NFPA 221, *Standard for High Challenge Fire Walls, Fire Walls, and Fire Barrier Walls*, 2024 edition.

NFPA 326, *Standard for the Safeguarding of Tanks and Containers for Entry, Cleaning, or Repair*, 2020 edition.

NFPA 350, *Guide for Safe Confined Space Entry and Work*, 2022 edition.

NFPA 400, *Hazardous Materials Code*, 2022 edition.

NFPA 470, *Hazardous Materials/Weapons of Mass Destruction (WMD) Standard for Responders*, 2022 edition.

NFPA 484, *Standard for Combustible Metals*, 2022 edition.

NFPA 495, *Explosive Materials Code*, 2023 edition.

NFPA 855, *Standard for the Installation of Stationary Energy Storage Systems*, 2023 edition.

NFPA 1124, *Code for the Manufacture, Transportation, and Storage of Fireworks and Pyrotechnic Articles*, 2022 edition.

NFPA 1581, *Standard on Fire Department Infection Control Program*, 2022 edition.

NFPA 5000®, *Building Construction and Safety Code*®, 2024 edition.

## Chapter 3 Definitions

### 3.1 General.

**3.1.1** The definitions contained in this chapter apply to the terms used in this recommended practice.

**3.1.2** Where terms are not defined in this chapter or within another chapter, they should be defined using their ordinarily accepted meanings within the context in which they are used.

**3.1.3** *Merriam-Webster's Collegiate Dictionary*, 11th edition, is the source for the ordinarily accepted meaning.

### 3.2 NFPA Official Definitions.

**3.2.1\*** **Approved.** Acceptable to the authority having jurisdiction.

**3.2.2\*** **Authority Having Jurisdiction (AHJ).** An organization, office, or individual responsible for enforcing the requirements of a code or standard, or for approving equipment, materials, an installation, or a procedure.

**3.2.3 Recommended Practice.** An NFPA standard similar in content and structure to a code or standard but that contains only nonmandatory provisions using the word "should" to indicate recommendations in the body of the text.

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

### 3.3\* General Definitions.

**3.3.1 Adjacent.** Not distant, nearby, having a common endpoint or border.

**3.3.2 ANFO.** Ammonium nitrate/fuel oil.

**3.3.3 ATF.** Bureau of Alcohol, Tobacco, Firearms, and Explosives.

**3.3.4 Atmospheric Control.** The control of the vapor space above a flammable liquid or solid that minimizes or eliminates the ignition hazard.

**3.3.5\* Biological Waste.** Waste material containing or contaminated by biological materials.

**3.3.6 Bulk Liquid Storage.** Storage of hazardous waste liquids in a tank larger than an intermediate bulk container (IBC) (i.e., greater than 793 gal [3000 L]).

**3.3.7\* Bulk Solid Storage.** Solid hazardous waste stored in quantities greater than 1 yd<sup>3</sup> (0.77 m<sup>3</sup>).

**3.3.8 Bulk Solid Waste.** Solid hazardous waste shipped in quantities greater than 1 yd<sup>3</sup> (0.77 m<sup>3</sup>).

**3.3.9 Carrier.** A motor carrier that transports passengers or property for compensation.

**3.3.10 CAS Number.** A unique numerical identifier assigned by the Chemical Abstracts Service (CAS) to chemical substances and includes elements, organic and inorganic compounds, isotopes, alloys, nuclear particles, proteins, and polymers.

**3.3.11 CDC.** Centers for Disease Control and Prevention.

**3.3.12 CDC Select Agents.** Biological agents and toxins that have the potential to pose a severe threat to public health and safety, the environment or to animal or plant products.

**3.3.13 CERCLA.** Comprehensive Environmental Response Compensation and Liability Act (42 USC 103).

**3.3.14 Characteristic.** One of four US EPA-established properties — ignitability, corrosivity, reactivity, and toxicity — which, when present in a waste, indicates that the waste poses a threat to merit regulation as hazardous.

**3.3.15 Characteristic Hazardous Waste.** See 3.3.14, Characteristic.

**3.3.16\* Chemical Warfare Agents (CWA).** Any toxic chemical or its precursor that can cause sensory irritation, injury, or death when exposed to humans.

**3.3.17 Clean-Up Material.** Materials used in the response to a hazardous material release.

**3.3.18 Cleaning Agents.** Substances that are used to remove dirt, dust, stains, or odors from surfaces.

**3.3.19 Combustible Metal.** Any metal composed of distinct particles or pieces, regardless of size, shape, or chemical composition, that will burn. [484, 2022]

**3.3.20 Compatibility.** A measure of how stable a substance is when mixed with another substance. (*See also 3.3.62, Incompatibility.*)

**3.3.21 Container Storage.** Storage of containerized hazardous waste in containers up to and including 1 yd<sup>3</sup> (0.77 m<sup>3</sup>) boxes and 793 gal (3000 L) intermediate bulk containers (IBCs).

**3.3.22\* Corrosivity.** A US EPA-established characteristic for aqueous wastes with a pH of less than or equal to 2 or a pH greater than or equal to 12.5; or based on the liquid's ability to corrode steel.

**3.3.23 CWA.** See 3.3.16, Chemical Warfare Agents.

**3.3.24\* Dangerous When Wet.** As indicated in 49 CFR 173.124(c), a material that, by contact with water, is liable to become spontaneously flammable or to give off flammable or toxic gas at a rate greater than 1 L per kg (0.12 gal per lb) of the material, per hour, when tested in accordance with *United Nations Manual of Tests and Criteria*.

**3.3.25 DOT.** US Department of Transportation.

**3.3.26 DOT Emergency Response Guidebook (ERG).** A resource that provides first responders with information to deal with hazmat transportation accidents.

**3.3.27\* DOT Forbidden Materials.** A material as outlined in 49 CFR 173.21 that might not be offered for transportation or transported.

**3.3.28 Energy Storage Systems.** One or more devices, assembled together, capable of storing energy to supply electrical energy at a future time. [855, 2023]

**3.3.29 Enforceable.** Able to be imposed so that it must be complied with.

**3.3.30 EPA.** US Environmental Protection Agency.

**3.3.31 EPA Hazardous Waste.** A waste or combination of wastes as defined in 40 CFR 261.3, or those substances defined as hazardous wastes in 49 CFR 171.8.

**3.3.32 EPA ID Number.** A unique 12-character number that is assigned to facilities that generate specified amounts of hazard-

ous waste and which is used by states and the EPA to track hazardous waste activities.

**3.3.33 Explosive.** Any chemical compound, mixture, or device, the primary or common purpose of which is to function by explosion. [495, 2023]

**3.3.34\* F-List.** An EPA catalog item that identifies wastes from common manufacturing and industrial processes as hazardous.

**3.3.35 Filter Cake.** The solid mass remaining on a filter after the liquid that contained it has passed through.

**3.3.36 Fire Barrier.** A continuous membrane or a membrane with discontinuities created by protected openings with a specified fire protection rating, where such membrane is designed and constructed with a specified fire resistance rating to limit the spread of fire. [5000, 2024]

**3.3.37\* Fire Code.** The fire code enforced by the jurisdiction or agency enforcing this recommended practice. [101, 2024]

**3.3.38 Fire Wall.** A wall separating buildings or subdividing a building to prevent the spread of fire and having a fire resistance rating and structural stability. [221, 2024]

**3.3.39\* Fireworks.** Any composition or device for the purpose of producing a visible or an audible effect for entertainment purposes by combustion, deflagration, or detonation, that meets the definition of *Consumer Fireworks* or *Display Fireworks* as set forth in NFPA 1124. [1124, 2022]

**3.3.39.1\* 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 APA 87-1, *Standard for the Construction and Approval for Transportation of Fireworks, Novelties, and Theatrical Pyrotechnics*. [1124, 2022]

**3.3.39.2\* Display Fireworks.** Large fireworks devices that are explosive materials intended for use in fireworks displays and designed to produce visible or audible effects by combustion, deflagration, or detonation, as set forth in 27 CFR 555, 49 CFR 172, and APA 87-1, *Standard for the Construction and Approval for Transportation of Fireworks, Novelties, and Theatrical Pyrotechnics*. [1124, 2022]

**3.3.40 Flash Point.** The minimum temperature at which a liquid or a solid emits vapor sufficient to form an ignitable mixture with air near the surface of the liquid or the solid. [5000, 2024]

**3.3.41 FMCSA.** Federal Motor Carrier Safety Administration.

**3.3.42 Forbidden Explosive.** Material that is not permitted to be transported under normal means as defined by 49 CFR 173.54.

**3.3.43 Generator.** Industry or facility that generates hazardous waste.

**3.3.44 Generator Status.** The category of a hazardous waste generator as defined by the volume of hazardous waste generated on a monthly basis.

**3.3.45\* Globally Harmonized System of Classification and Labelling of Chemicals (GHS).** A system that defines and clas-

sifies chemical hazards and communicates related health and safety information.

**3.3.46 Hazard Evaluation.** The process of identifying hazards or potential hazards and then determining the risk or potential risk of each hazard identified. [350, 2022]

**3.3.47 Hazardous Material.** A chemical or substance that is classified as a physical hazard material or a health hazard material, whether the chemical or substance is in usable or waste condition. [400, 2022]

**3.3.48\* Hazardous Substance.** A substance to which exposure results or may result in adverse effects on the health or safety of employees.

**3.3.49\* Hazardous Waste.** Waste with properties that make it capable of having a harmful effect on human health or the environment.

**3.3.50\* Hazardous Waste Manifest.** A shipping document that tracks hazardous waste where it was generated until it reaches an off-site treatment, storage, and disposal facility (TSDF).

**3.3.51 Hazardous Waste Operations.** All operations involved with the management of hazardous wastes.

**3.3.52 HAZWOPER.** Hazardous waste operations and emergency response.

**3.3.53 Head Space.** The volume above a liquid or solid in a closed container.

**3.3.54 Header.** A pipe or duct through which liquid or gas is conveyed and supplied to or received from multiple branches. [85, 2023]

**3.3.55\* HMIS.** Hazardous materials identification system.

**3.3.56\* HMMP.** Hazardous materials management plan.

**3.3.57 Household Hazardous Waste.** Hazardous wastes generated from residential and lodging sources.

**3.3.58 IBC.** See 3.3.65, Intermediate Bulk Container.

**3.3.59\* Ignitable Waste.** Waste with a flash point of less than 60°C (140°F) that meets the criteria found in 40 CFR 261.21.

**3.3.60\* Ignitability.** The ease of ignition, as measured by the time to produce a sustained flame at a specified initial test heat flux.

**3.3.61 Incompatible.** Materials that, when in contact with each other, have the potential to react in a manner that generates heat, fumes, gases, or by-products that are hazardous to life or property.

**3.3.62 Incompatibility.** A state where two mixed substances undergo a chemical reaction when mixed. (See also 3.3.20, *Compatibility*.)

**3.3.63 Inerting.** A technique by which the atmosphere in a tank or container is rendered nonignitable or nonreactive by the addition of an inert gas. [326, 2020]

**3.3.64\* Inhibitor.** A compound that retards a chemical reaction from taking place.

**3.3.65 Intermediate Bulk Container.** Any closed vessel having a liquid capacity not exceeding 793 gal (3000 L) and intended for storing and transporting liquids, as defined in Title 49,

Code of Federal Regulations, Parts 100 through 199 or in Part 6 of the United Nations' *Recommendations on the Transport of Dangerous Goods*. [30, 2024]

**3.3.66\* K-List.** A US EPA's listing of source-specific hazardous wastes from industry and manufacturing sectors.

**3.3.67\* Lab Pack.** A container, typically a fiber or steel drum, that contains assorted, small-quantity canisters of compatible laboratory or industrial chemicals.

**3.3.68 Label.** A hazardous materials or waste identifier meeting a standard specification that is placed on packages, packaging, or overpacks.

**3.3.69 Lead Operator.** The person with overall responsibility for the operation and safety of a fireworks display.

### 3.3.70 Lithium Battery.

**3.3.70.1 Lithium-Ion Battery.** A rechargeable storage battery that is composed of nonaqueous liquid or polymerized electrolytes, which provide ionic conductivity between lithiated positive active material electrically separated from metallic lithium or lithiated negative active material.

**3.3.70.2 Lithium Metal Battery (or Lithium Metal Polymer Battery).** A nonrechargeable storage battery that is composed of nonaqueous liquid or polymerized electrolytes, which provide ionic conductivity between lithiated positive active material electrically separated from metallic lithium or lithiated negative active material.

**3.3.71 Means of Egress.** A continuous and unobstructed way of travel from any point in a building or structure to a public way consisting of three separate and distinct parts: (1) the exit access, (2) the exit, and (3) the exit discharge. [5000, 2024]

**3.3.72 Medical Waste.** Items to be disposed of that have been contaminated with human waste, blood, or body fluids, or human waste, human tissue, blood, or body fluids for which special handling precautions are necessary. [1581, 2022]

**3.3.73\* Mixed Waste.** Hazardous wastes that also contain radioactive material.

**3.3.74\* MOC.** Management of change.

**3.3.75 Monomer.** An unsaturated organic compound whose molecules contain reactive groups that polymerize with each other or with other monomer molecules to produce polymers.

**3.3.76 Organic Peroxide.** Any organic compound having a double oxygen or peroxy (-O-O-) group in its chemical structure. [400, 2022]

**3.3.77 OSHA.** US Occupational Safety and Health Administration.

**3.3.78 Oxidizer.** Any solid or liquid material that readily yields oxygen or other oxidizing gas or that readily reacts to promote or initiate combustion of combustible materials and that can, under some circumstances undergo a vigorous self-sustained decomposition due to contamination or heat exposure. [400, 2022]

**3.3.79 P-List.** A catalog of acute hazardous wastes from discarded commercial chemical products, which can be found in 40 CFR 261.33.

**3.3.80 Personal Protective Equipment (PPE).** Specialized clothing or equipment worn by a member for protection against a hazard. [1581, 2022]

**3.3.81\* Petroleum By-Products.** Waste materials derived from crude oil, generally as processed in oil refineries.

**3.3.82 pH.** A measure of acidity and alkalinity of a solution that is a number on a scale on which a value of 7 represents neutrality and lower numbers indicate increasing acidity and higher numbers increasing alkalinity and on which each unit of change represents a tenfold change in acidity or alkalinity and that is the negative logarithm of the effective hydrogen-ion concentration or hydrogen-ion activity in gram equivalents per liter of the solution.

**3.3.83 PHMSA.** Pipeline and Hazardous Materials Safety Administration.

**3.3.84 Placard.** A sign placed on trucks or other vehicles used for transport to identify material hazards.

**3.3.85 Polymerization.** A chemical reaction in which two or more molecules combine to form larger molecules that contain repeating structural units.

**3.3.86 Portable Tank.** Any vessel having a liquid capacity over 60 gal (230 L) intended for storing liquids and not intended for fixed installation. [30, 2024]

**3.3.87 PPE.** See 3.3.80, Personal Protective Equipment (PPE).

**3.3.88\* Process Safety Management.** A regulation promulgated by the US Occupational Safety and Health Administration (OSHA) that contains requirements to prevent or minimize the consequences of catastrophic releases of toxic, reactive, flammable, or explosive chemicals..

**3.3.89 Process Upset.** A result of certain problems that disturb the normal way of process functioning and can cause levels of emergency. (See also 3.3.126, *Upset Condition*.)

**3.3.90 Propellant.** An explosive that normally functions by deflagration and used for propulsion purposes. [495, 2023]

**3.3.91 Pyrophoric Material.** A chemical with an autoignition temperature in air at or below 130°F (54.4°C). [400, 2022]

**3.3.92\* Pyrotechnics.** Controlled exothermic chemical reactions that are timed to create the effects of heat, gas, sound, dispersion of aerosols, emission of visible electromagnetic radiation, or a combination of these effects to provide the maximum effect from the least volume. [1124, 2022]

**3.3.93 Radioactive Waste.** Radioactive materials at the end of their useful life or in a product that requires disposal.

**3.3.94 RCRA.** US Resource Conservation and Recovery Act (40 CFR 239–282).

**3.3.95 Reactive Chemical.** A chemical compound that has the ability to react with environmental factors under seemingly normal environmental conditions, which can release potentially dangerous amounts of energy, act as a source of ignition, or release toxic by-products.

**3.3.96\* Reactive Material.** A material that, by itself, is readily capable of detonation, explosive decomposition, or explosive reaction at normal or elevated temperatures and pressures. [45, 2024]

- 3.3.96.1 Water Reactive.** A material that explodes, violently reacts, produces flammable, toxic, or other hazardous gases; or evolves enough heat to cause self-ignition or ignition of nearby combustibles upon exposure to water. [400, 2022]
- 3.3.97 Reactive Waste.** Waste composed of any single reactive material or mixture that has been declared by the generator as a waste.
- 3.3.98 Reactivity.** The capacity for a chemical substance to undergo a chemical reaction, either by itself or with other materials.
- 3.3.99 Risk Assessment.** A process for systematically evaluating risk that considers the severity of consequences and the likelihood that the adverse event will occur. [350, 2022]
- 3.3.100 Risk Management Plan.** A plan required by the US EPA Clean Air Act for certain facilities which requires a hazard assessment describing the potential effects of a chemical accident, a spill or release prevention program, and emergency response procedures should an accident occur.
- 3.3.101 SADT.** See 3.3.106, Self-Accelerating Decomposition Temperature.
- 3.3.102 Safety Data Sheet (SDS).** The document that describes composition of a material, hazardous properties and hazard mitigation, and disposal information. [400, 2022]
- 3.3.103 Sampling.** The process of selecting materials to analyze. [470, 2022]
- 3.3.104 SDS.** See 3.3.102, Safety Data Sheet (SDS).
- 3.3.105 Select Agents.** See 3.3.12, CDC Select Agents.
- 3.3.106 Self-Accelerating Decomposition Temperature.** The lowest temperature at which a material in a typical vessel or shipping package will undergo a self-accelerating decomposition within 1 week.
- 3.3.107 Shock Sensitive.** A material that has the potential to produce a violent explosion when subjected to shock, heat, or friction.
- 3.3.108 SOC.** See 3.3.113, State of Charge (SOC).
- 3.3.109 Solid Waste.** Waste, which includes solids, liquids, and gases, as defined by 40 CFR 261.2.
- 3.3.110 Solvents.** A substance (usually liquid) capable of dissolving or dispersing another substance.
- 3.3.111 Spontaneously Combustible.** A pyrophoric material that can ignite without an ignition source within five minutes of air, or a self-heating material where the gradual reaction of the substance with oxygen generates heat.
- 3.3.112 Stabilizers.** A substance added to another substance, such as an explosive or plastic, or to a system, such as an emulsion, to prevent or retard an unwanted alteration of physical state (MW).
- 3.3.113 State of Charge (SOC).** The stored or remaining capacity of a battery at a given time expressed as a percentage of its rated capacity. [72, 2022]
- 3.3.114\* State Waste.** Waste that can be regulated has hazardous waste in a particular state that might not be required to be regulated has hazardous under federal standards.
- 3.3.115 Stranded or Stored Energy.** The unknown hazardous levels of electrical energy that can be contained in a battery, including one that has been damaged or thought to be discharged and that represents a hazard to persons in contact with the battery or cell, who are unaware of the hazardous energy.
- 3.3.116 Tank System.** Low-pressure [less than 15 psi (103 kPa)] equipment designed for storing liquefied natural gas or other hazardous liquids, consisting of one or more containers, together with various accessories, appurtenances, and insulation. [59A, 2023]
- 3.3.117 TCLP.** See 3.3.120, Toxicity Characteristic Leaching Procedure (TCLP).
- 3.3.118 Toxic Materials.** A material that produces a lethal dose or a lethal concentration within any of the following categories: (1) a chemical or substance that has a median lethal dose (LD50) of more than 50 mg/kg but not more than 500 mg/kg of body weight when administered orally to albino rats weighing between 200 g and 300 g each; (2) a chemical or substance that has a median lethal dose (LD50) of more than 200 mg/kg but not more than 1000 mg/kg of body weight when administered by continuous contact for 24 hours, or less if death occurs within 24 hours, with the bare skin of albino rabbits weighing between 2 kg and 3 kg each; (3) a chemical or substance that has a median lethal concentration (LC50) in air of more than 200 parts per million but not more than 2000 parts per million by volume of gas or vapor, or more than 2 mg/L but not more than 20 mg/L, of mist, fume, or dust when administered by continuous inhalation for 1 hour, or less if death occurs within 1 hour, to albino rats weighing between 200 g and 300 g each. [400, 2022]
- 3.3.119 Toxicity.** The degree to which a substance is harmful to humans. [326, 2020]
- 3.3.120 Toxicity Characteristic Leaching Procedure (TCLP).** An analytical method for chemical analysis used to simulate leaching through a landfill as defined in 40 CFR 261.24.
- 3.3.121 Training.** Organized activity aimed at imparting information and/or instructions to improve the recipient's performance or to help him or her attain a required level of knowledge or skill.
- 3.3.122 Treatment, Storage, and Disposal Facility (TSDF).** Waste management facilities that receive hazardous wastes for treatment, storage, or disposal.
- 3.3.123 TSCA.** US Toxic Substance Control Act.
- 3.3.124 TSDF.** See 3.3.122, Treatment, Storage, and Disposal Facility (TSDF).
- 3.3.125\* Universal Waste Regulations.** Regulations that streamline the hazardous waste management standards for common hazardous wastes generated by a variety of establishments.
- 3.3.126 Upset Condition.** A process outage caused by operational disruptions and failures on the course of its performance. (See also 3.3.89, Process Upset.)
- 3.3.127 Vapor Density.** The relative density of a gas or vapor as compared with a specific standard, generally air.
- 3.3.128 Vapor Expansion.** An increase in size, volume, or quantity, usually due to heating, where the molecular bonds

between their particles are weakened, and the particles move faster, causing the vapor to expand.

**3.3.129 Vapor Pressure.** The pressure exerted by a vapor that is in equilibrium with its solid or liquid form.

**3.3.130 Waste.** Hazardous materials that have been determined by the user to be beyond their useful life and that are awaiting disposal or processing by either public or private means. [400, 2022]

**3.3.131 Waste Minimization.** A term found in the Resource Conservation and Recovery Act (RCRA) that refers to source reduction and environmentally sound recycling of RCRA hazardous waste.

**3.3.132 Waste Oil.** Any oil that has been refined from crude oil, or any synthetic oil, that has been used and as a result of such use is contaminated by physical or chemical impurities as defined in 40 CFR 279.1 as “Used Oil.”

**3.3.133\* Waste Profile.** A description of the material characteristics, chemical composition, applicable waste codes, the waste generation process, and DOT shipping information of a waste product.

## Chapter 4 Goals, Objectives, and Assumptions

### 4.1 Administration.

**4.1.1 Scope.** This chapter covers goals, objectives, and assumptions regarding safety as it relates to hazardous waste operations.

**4.1.2 Purpose.** This chapter includes goals, objectives, and assumptions to provide a reasonable level of safety, property protection, and public welfare from the hazards created by fire, explosion, and other hazardous conditions as they relate to hazardous waste operations.

**4.2 Safety Goals and Objectives.** The goals and objectives in subsections 4.2.1 through 4.2.5 should be used to provide for life safety, property protection, and public welfare by reducing the probability of injury, death, or damage from fire, explosions, or events involving hazardous waste operations.

#### 4.2.1 Safety from Fire.

**4.2.1.1 Safety from Fire Goals.** Fire safety goals should be as follows:

- (1) To provide an environment for the occupants in a building or facility and for the public near a building or facility that is reasonably safe from fire and similar emergencies
- (2) To protect firefighters and emergency responders

#### 4.2.1.2 Safety from Fire Objectives.

**4.2.1.2.1** Hazardous waste operations should be designed and implemented to protect facility occupants and workers who are not intimate with the initial fire development for the amount of time needed to evacuate, relocate, or defend in place.

**4.2.1.2.2\*** Hazardous waste operations should be designed and implemented to provide reasonable safety for firefighters and emergency responders during their activities.

**4.2.1.2.3** Hazardous waste operations should be designed and implemented to reasonably protect persons adjacent to building or facility operations from injury or death as a result of fire.

**4.2.1.2.4** Hazardous waste operations should be designed and implemented to provide reasonable access for emergency responders.

**4.2.1.2.5** Hazardous waste operations should be conducted at facilities in a safe manner that minimizes, reduces, controls, or mitigates the risk of fire injury or death for the operators, while protecting the occupants not intimate with initial fire development for the amount of time needed to evacuate, relocate, or defend in place.

### 4.2.2 Safety During Hazardous Waste Operations.

**4.2.2.1 Safety During Hazardous Waste Operations Goal.** The hazardous waste operations goal should be to provide an environment for occupants or workers of a building or facility where hazardous waste operations are conducted that is reasonably safe during the normal operations.

#### 4.2.2.2 Safety During Hazardous Waste Operations Objectives.

**4.2.2.2.1** Hazardous waste operations should be designed and implemented to reduce the probability of death and injury of persons from falling during normal operations.

**4.2.2.2.2** Hazardous waste operations should be designed and implemented to provide for reasonably safe occupant movement during emergency and nonemergency conditions.

**4.2.2.2.3** Hazardous waste operations should be designed and implemented to provide for reasonable notification to occupants of fire and other emergency situations.

**4.2.2.2.4** Hazardous waste operations should be designed and implemented to provide for reasonable signage and lighting to identify hazards, exits, means of egress, and other building or facility safety features at locations where hazardous waste operations occur.

### 4.2.3 Safety from Hazardous Waste.

**4.2.3.1 Safety from Hazardous Waste Goal.** The hazardous waste goal should be to provide an environment for occupants or workers in a building or facility and to those adjacent to a building or facility that is reasonably safe from exposures to adverse effects from hazardous waste present therein.

#### 4.2.3.2 Safety from Hazardous Waste Objectives.

**4.2.3.2.1** The storage, use, or handling of hazardous waste in a building or facility should be accomplished in a manner that provides a reasonable level of safety for occupants and for those adjacent to a building or facility from health hazards, illness, injury, or death during normal storage, use, or handling operations and conditions.

**4.2.3.2.2** The storage, use, or handling of hazardous waste in a building or facility should be accomplished in a manner that provides a reasonable level of safety for occupants and for those adjacent to a building or facility from illness, injury, or death due to the following conditions:

- (1) An unplanned release of the hazardous waste
- (2) A fire impinging upon the hazardous waste or the involvement of the material in a fire
- (3) The application of an external force on the hazardous waste that is likely to result in an unsafe condition

#### 4.2.4 Property Protection.

**4.2.4.1 Property Protection Goal.** The property protection goal should be to limit damage created by a fire, explosion, or event associated with hazardous waste to a reasonable level to the building or facility and adjacent property.

##### 4.2.4.2 Property Protection Objectives.

**4.2.4.2.1 Prevention of Ignition.** The hazardous waste operations associated with the building or facility should be designed and implemented, and conducted in a manner to prevent unintentional explosions and fires that result in failure of or damage to adjacent compartments, emergency life safety systems, adjacent properties, adjacent outside storage, and structural elements.

**4.2.4.2.2 Fire Spread and Explosions.** In the event that a fire or explosion occurs, hazardous waste operations associated with the building or facility should be designed and implemented, and conducted in a manner to reasonably reduce the impact of unwanted fires and explosions on the adjacent compartments, emergency life safety systems, adjacent properties, adjacent outside storage, and structural elements.

**4.2.4.2.3 Structural Integrity.** The building or facility in which hazardous waste operations occur should be designed, constructed, and maintained, and operations associated with the facility should be conducted to provide a reasonable level of protection for the building or facility, its contents, and adjacent properties from collapse due to a loss of structural integrity resulting from a fire.

**4.2.4.2.4 Hazardous Waste.** The hazardous waste operations should be designed, implemented, and conducted to provide a reasonable level of property protection from damage resulting from a fire, explosion, and other unsafe conditions associated with the storage, use, and handling of hazardous waste therein.

#### 4.2.5 Public Welfare.

**4.2.5.1 Public Welfare Goal.** The public welfare goal should be to maintain service to the public by hazardous waste operations following a fire, explosion, or hazardous materials event.

**4.2.5.2 Public Welfare Objective.** Hazardous waste operations that provide a public welfare role for a community should be designed, implemented, and conducted to provide reasonable assurance of continued function following a fire, explosion, or hazardous materials event.

#### 4.3 Assumptions.

##### 4.3.1 Single Fire Source.

**4.3.1.1** Fire protection methods should assume that multiple simultaneous fire incidents will not occur.

**4.3.1.2** The single fire source assumption should not preclude the evaluation of multiple design fire scenarios.

##### 4.3.2 Single Hazardous Material Release.

**4.3.2.1** Protection methods should assume that multiple simultaneous unauthorized releases of hazardous waste from different locations will not occur.

**4.3.2.2** The single hazardous waste release assumption should not preclude the evaluation of multiple design scenarios.

**4.3.3 Incidents Impinging on Hazardous Waste.** Protection methods should assume that a fire, explosion, hazardous waste release, or external force that creates a dangerous condition has the potential to impinge on hazardous waste stored, handled, or used in the building or facility under normal conditions.

**4.4 Provision in Excess of Recommended Practice.** Nothing in this recommended practice should be construed to prohibit a better type of hazardous waste operation or an otherwise safe condition than that specified by the minimum instruction offered in this recommended practice.

## Chapter 5 Waste Characterization

### 5.1 Administration.

**5.1.1 Scope.** This chapter applies to waste characterization for the prevention of fires, explosions, and other hazardous conditions.

**5.1.2 Purpose.** This chapter provides the proper characterization of waste, which is fundamental to preventing fires, explosions, and other hazardous conditions.

### 5.2 Waste Characterization.

**5.2.1** Once declared as a waste by a generator, the materials should be safely managed while the physical, chemical, and hazardous properties of its components are characterized and understood.

**5.2.2** Waste characterization is complicated by the fact that most waste is a mixture of many materials and information should be properly applied to characterize the waste's hazards and facilitate its management and disposal while minimizing the risk of fire.

**5.2.3** Once a waste is determined to be hazardous, it should be managed in accordance with the RCRA or other jurisdictional regulations for hazardous waste.

### 5.3 Means for Characterization.

**5.3.1** Once a material is determined to be a solid waste, a determination should be made to further determine if the waste is also a hazardous waste as defined by the RCRA.

**5.3.2** Generator knowledge or analytical analysis should be used to determine a solid waste is hazardous.

**5.3.2.1** Where using generator knowledge, the generator should thoroughly understand the waste generation process as additional substances such as cleaning agents, clean-up material, stabilizers, and so forth could alter the chemical matrix of the waste.

**5.3.2.2** Waste characterization by generator knowledge should be supplemented by reviewing safety data sheets (SDSs), manufacturer-provided information, labels, and consults.

**5.3.2.3** Analytical analysis should be used as the preferred waste characterization method and provide the following:

- (1) Full evaluation of waste characterization
- (2) Additional information to the treatment, storage, and disposal facility (TSDF) to correctly treat and store the waste as well as apply appropriate DOT labels for pick up and shipping

**5.3.3** The waste characterization process should be performed to determine such parameters as chemical and physical properties, flash point, reactivity, pH, and compatibility with other chemicals, all of which can assist in making informed decisions about the safe storage, handling, and treatment of the waste.

**5.3.3.1** Chemical and physical properties of waste should be performed to determine best management practices.

**5.3.3.2** Properties such as vapor pressure and vapor density for solvents can be critical and should be determined where selecting a waste container and how much head space to leave for vapor expansion.

**5.3.3.3** Other properties, such as flashpoint and pH, should be determined where selecting a storage location.

**5.3.3.4** Container selection for storage and transport should be based on the waste's properties and any applicable regulations.

**5.3.3.5** Waste considered reactive should be placed in specially designed containers based on the waste characterization.

#### **5.4 Hazardous Waste Codes.**

**5.4.1** The EPA's RCRA regulations include several important requirements for generators of hazardous waste and should be consulted where appropriate.

**5.4.2** Caution should be used when selecting the correct waste classification codes since there are specific codes for listed and characteristic waste.

**5.4.3** Caution should be used to evaluate if a solid waste is a hazardous waste or if an ingredient is specifically listed on one of four lists (i.e., F, K, P, and U lists) found in 40 CFR 261.

**5.4.4** Facilities that generate or manage listed hazardous waste should see 8 for facility design guidance.

#### **5.4.5 Characteristic Hazardous Waste.**

**5.4.5.1** A solid waste should be considered hazardous if the waste has the potential for ignitability, corrosivity, reactivity, or toxicity in accordance with Subpart C of 40 CFR 261 or other jurisdictional regulations.

**5.4.5.2** A listed waste should also be checked for additional characteristic codes.

#### **5.4.5.3 Ignitability.**

**5.4.5.3.1** Caution should be used when working with and around ignitable waste.

**5.4.5.3.2** Hazard evaluation should be performed with ignitable waste since it can include liquids, solids, oxidizers, and compressed gases.

**5.4.5.3.3** Caution should be used around solids classified as ignitable, which can include the following:

- (1) Rags or cloths used to apply finishes or clean products
- (2) Oily clothing and cleaning rags for maintenance operations
- (3) Natural fabrics used for spill cleanup.

**5.4.5.3.4** Care should be taken with ignitable waste because it can spontaneously combust.

**5.4.5.3.5** Spontaneous combustible waste should be stored in approved containers and isolated from other combustibles and ignition sources.

#### **5.4.5.4 Corrosivity.**

**5.4.5.4.1\*** Care should be used when handling corrosive waste due to incompatibility with other wastes and risk of chemical exposure to occupants.

**5.4.5.4.2\*** Corrosive substances, such as hydrochloric acid, nitric acid, sodium hydroxide, potassium hydroxide, and sulfuric acid, should be stored in compatible containers to prevent leaks.

#### **5.4.5.5 Reactivity.**

**5.4.5.5.1** A hazardous waste should be considered reactive if it is normally unstable, water reactive, air reactive; a Division 1.1, Division 1.2, or Division 1.3 explosive as defined in 49 CFR 173.50 and 173.53; or a forbidden explosive as defined in 49 CFR 173.54 or as defined in other jurisdictional regulations.

**5.4.5.5.2** Caution should be used with reactive wastes, since, given the instability, reactive wastes can present extreme dangers.

#### **5.4.5.6 Toxicity.**

**5.4.5.6.1** Poisonous materials pose a threat to groundwater, which can have long-term effects on human health and the environment.

**5.4.5.6.2** Toxicity is different from the first three characteristic groups (i.e., ignitability, corrosivity, and reactivity), which the EPA views as containing immediate and firsthand dangers.

**5.4.5.6.3** Care should be taken to review toxic, or potentially toxic, materials since there are 60 contaminants on the toxicity characteristics list.

**5.4.5.6.4** Toxic contaminants should be identified solely through a test method called toxicity characteristic leaching procedure (TCLP).

#### **5.5 Fire Prevention.**

##### **5.5.1 Measures to Prevent Fires.**

**5.5.1.1** Measures to prevent fires should include identifying and isolating all sources of heat.

**5.5.1.2** Sources of heat should include the following:

- (1) Direct heat, such as portable heaters or equipment exhaust
- (2) Powered industrial equipment
- (3) Direct sunlight
- (4) Pouring/transferring of liquids that could generate static charges
- (5) Chemicals capable of generating heat or adding oxygen to a reaction

**5.5.1.3** Computer-generated experimental modules should be used to evaluate fire protection methods such as isolation, effectiveness of suppression systems, and access of exits.

## 5.5.2 General Fire Prevention Practices.

**5.5.2.1** Once the waste generation process is understood, fire prevention measures should focus on identifying and isolating all sources of heat throughout the generation process.

### 5.5.2.2 Polymerization Concerns.

**5.5.2.2.1** Waste that can experience polymerization should also be considered as a special care situation (*see also 3.3.85, Polymerization*).

**5.5.2.2.2** Any source of heat should be controlled so the polymerization process, which requires heat to break down double bonds, does not occur.

**5.5.2.2.3** Caution should be used when polymerization occurs, because although polymerization is useful to create plastic and other consumer products, chemical reactions in waste containers can result in significant physical damage and injury.

**5.5.2.2.4** Special care should be taken for chemical waste capable of polymerization outside of controlled environments. (*See Chapter 10.*)

### 5.5.2.3 Combustible and Reactive Metals.

**5.5.2.3.1** Extreme caution should be used to prevent water and air exposure to combustible and reactive metals such as lithium hydride and lithium aluminum.

**5.5.2.3.1.1** Where combustible and reactive metals are part of a waste stream at a disposal facility, the generator should develop a disposal plan before starting a process that includes such metals.

**5.5.2.3.1.2** A disposal plan should ensure proper disposal while minimizing environmental contamination and fire.

**5.5.2.3.1.3** When considering mixing waste streams, chemical analysis should be used to determine possible unintended reactions.

**5.5.2.3.1.4** Bench-top experiments should also be considered prior to mixing waste streams to establish compatibility.

**5.6 Other Hazard Prevention Measures.** The following safety practices should be used at disposal facilities to prevent fire and explosion:

- (1) Segregating chemical-incompatible waste by separating combustible waste from self-heating or oxidizing materials
- (2) Storing combustible waste piles away from buildings, roadways, and ignition sources
- (3) Maintaining flammable and corrosive liquid waste in approved containers
- (4) Inspecting waste containers and storage locations regularly
- (5) Properly identifying and marking waste containers
- (6) Marking the hazards associated with each waste on the exterior of each container, storage tank, transport vehicle, or building
- (7) Training personnel in proper waste handling procedures, use of personal protective equipment (PPE), and emergency procedures
- (8) Drilling employees using possible scenarios (*see Chapters 13 and 14*)

## Chapter 6 Documentation

### 6.1\* Administration.

**6.1.1 Scope.** This chapter covers documentation for managing hazardous waste from generation to disposal.

**6.1.2 Purpose.** The chapter provides documentation that should be reviewed and generated if handling hazardous waste in the United States. Other countries may require different documentation.

### 6.2 Additional References.

**6.2.1** The RCRA should be referenced for the EPA's authority to regulate hazardous waste from generation through disposal, including necessary documentation.

**6.2.2** Other jurisdictional regulations, such as PHMSA, should be checked for additional documentation requirements for hazardous waste management.

**6.2.3** Chapter 13 should be referred to for information on training documentation and record retention.

### 6.3\* Hazardous Waste Documentation.

**6.3.1** To properly document hazardous waste management, all of the following documentation should be evaluated, and if needed, generated:

- (1) EPA documentation as follows:
  - (a) EPA ID number (*see 40 CFR 262.12*)
  - (b) EPA hazardous waste manifest (*see EPA Forms 8700-22 and 8700-22A*) (*see also 6.3.2*)
  - (c) EPA risk management plan (RMP) (*see 40 CFR 68*)
- (2) Transportation documentation as follows:
  - (a) Carrier registered with the FMCSA
  - (b) DOT number
  - (c) Hazardous material/waste registration (*see Subpart G of 49 CFR 107*)
  - (d) Emergency response information, such as emergency contact number (*see Subpart G of 49 CFR 172*)
- (3) OSHA documentation as follows:
  - (a) Process safety management (*see 29 CFR 1910.119*)
  - (b) Hazardous waste operation and emergency response regulation [*see 29 CFR 1910.120(p) and 29 CFR 1910.120(q)*]
  - (c) Safety data sheets [*see 29 CFR 1910.1200(g)*]
  - (d) Personnel protective equipment (selection) (*see Subpart I of 29 CFR 1910*)
  - (e) Retention of DOT labels (*see 29 CFR 1910.1201*)
  - (f) Emergency action plan or emergency response plan, as applicable

**6.3.2** Pipeline and Hazardous Materials Safety Administration (PHMSA) requirements should be reviewed for information on hazardous material shipping papers. (*See also Annex B.*)

### 6.3.3 Permits and Licenses.

**6.3.3.1** Owners and operators of generator facilities and treatment, storage, and disposal facilities (TSDFs) should apply for a permit or license in accordance with the locally adopted fire code starting with documentation of the quantity and hazard classes of the hazardous waste to be handled, stored, and used.

**6.3.3.2** Permits or licenses should be approved by the AHJ that allows the facility to operate.

## 6.4 Hazard Communication Documents — Waste Profile.

**6.4.1** Generators should supply a waste profile for all generated waste.

**6.4.2** Generators should provide the hazardous waste technical names at every phase of the documentation, including the packaging marking, shipping papers, and hazardous waste manifest.

**6.4.3** An accurate waste profile should be developed to prevent injuries, property loss, and environment damage.

**6.4.4** An accurate waste profile should be the primary hazard communication tool for those who manage hazardous waste.

**6.4.5** The knowledge of the generator should be sufficient to supply accurate hazard information for generated hazardous waste.

**6.4.6** A hazard analysis expert should be consulted if the generator's knowledge is limited.

**6.4.7** In jurisdictions that are covered by OSHA, a waste profile should be used in lieu of an SDS for hazardous waste.

## Chapter 7 Marking, Labeling, and Placarding

### 7.1 Administration.

**7.1.1 Scope.** This chapter covers the marking, labeling, and placarding of hazardous waste.

**7.1.2 Purpose.** This chapter provides guidance for communicating hazards associated with hazardous waste handling.

### 7.2 Additional Regulations.

**7.2.1** While at a generator facility or treatment, storage, and disposal facility (TSDF), hazardous waste should be labeled according to EPA or other jurisdictional regulations.

**7.2.2** Where offered for transport, hazardous waste should be marked, labeled, and placarded as required by Pipeline and Hazardous Materials Safety Administration (PHMSA) hazardous materials regulations or other jurisdictional regulations.

**7.2.3** Companies transporting hazardous waste should be compliant with hazard communication requirements in accordance with PHMSA hazardous materials regulations or other jurisdictional regulations.

### 7.3 Hazardous Waste Marking and Labeling.

**7.3.1\*** While waste is being stored on-site prior to shipment, waste containers should be labeled with the following, as applicable per the AHJ:

- (1) Hazardous waste
- (2) Waste constituents
- (3) Waste characteristics (i.e., ignitability, corrosivity, toxicity, reactivity)
- (4) EPA waste codes or other jurisdictional waste-identifying codes
- (5) Accumulation start dates

### 7.3.2 Hazardous Waste Marking and Labeling During Transport.

**7.3.2.1** Waste containers should be compliant with the hazardous communication requirements in Subparts D and E of

49 CFR 172 for marking and labeling regulations, respectively, if waste is offered for transport in the US.

**7.3.2.2** DOT Chart 16 should be used as a reference tool for the correct hazard communication for a waste container, if waste is transported in the US.

**7.3.2.3** Once the waste has been received at the TSDF, the container should retain the marking and labeling from 7.2.2.

### 7.4\* Hazardous Waste Placarding.

**7.4.1** PHMSA placarding requirements contained in Subpart F of 49 CFR 172 should be followed, if waste is transported in the US.

**7.4.2** Subpart F of 49 CFR 172 should be referenced for applicability, general information, placard specifications, and other requirements that might apply.

**7.5\* United Nations' Globally Harmonized System of Classification and Labeling of Chemicals (GHS).** Information contained in safety data sheets (SDSs) should be used to accurately identify the hazards of hazardous waste.

## Chapter 8 Facility Design

### 8.1 Administration.

**8.1.1 Scope.** This chapter covers facility design for sites that manage hazardous waste.

**8.1.2 Purpose.** This chapter provides guidance on recommended facility design for sites that manage hazardous waste.

**8.1.3 Specific Applications.** The information in this chapter should apply to the following:

- (1) Facility design, which includes fire protection and maintenance
- (2) All types of hazardous waste storage and processing, including the following:
  - (a) Bulk solids storage
  - (b) Bulk liquid storage
  - (c) Container storage
  - (d) Hazardous waste processing

### 8.2 General Compliance.

**8.2.1 Permits and Regulations.** The storage and processing areas of facilities should be in compliance with all applicable permit and regulatory requirements for the design and operation of waste management facilities.

**8.2.2 Waste Compatibility.** Proper segregation of waste type by compatibility should be provided for and maintained in the facility design with facility operations relative to waste storage capacities.

**8.2.3 Segregation.** Consideration should be given to proper segregation, including distance and fire-rated assembly separation, including fire barriers or fire walls, between staged material of different compatibility groups.

### 8.2.4 Fire Protection.

**8.2.4.1** The storage and staging activities for all areas should not exceed the design capability of an installed fire protection system(s).

**8.2.4.2** Staff should know the waste generation process and amount to be generated to aid in fire prevention and protection.

**8.2.4.3** If a sprinkler system is provided, it should be designed and installed in accordance with NFPA 13 and tested and maintained in accordance with NFPA 25.

**8.2.4.4** Where approved by the AHJ, alternative fire suppression systems should be installed, tested, and maintained in accordance with the applicable standard and local building codes.

**8.2.4.5** Electrical systems should comply with *NFPA 70*.

### **8.2.5 Means of Egress.**

**8.2.5.1** Consideration should be given in the facility design for free and unobstructed egress of all locations where waste could be stored, processed, or treated.

**8.2.5.2** NFPA *101* and local building codes should be referenced for guidance on means of egress.

**8.2.5.3** Means of egress should be designed so that egress does not travel from lower hazard through a higher hazard to reach an exit.

### **8.2.6 Occupancy.**

#### **8.2.7**

**8.2.7.1** Consideration should be given in the design of the facility to limit worker activities in areas where hazardous waste is stored, processed, or treated.

#### **8.2.7.2**

**8.2.7.3** Any essential personnel should be properly trained for the area hazards.

### **8.3 Chemical Compatibility and Separation.**

**8.3.1 General.** Sites that manage hazardous waste should have policies, procedures, practices, controls, signs, and other methods used to ensure separation and protection of stored hazardous wastes from factors that could cause ignition or reaction.

**8.3.2 Performance-Based Option.** Chapter 10 of NFPA 400 should be referenced for performance-based options.

**8.3.2.1** A chemical hazard analysis utilizing exposure, fire, reaction, and explosion scenarios should be used to develop the fire protection levels and hazardous waste handling safety practices, including scenarios from past hazardous waste incidents.

**8.3.2.2** A complete risk assessment should be used to determine storage locations and quantities, handling procedures, waste generation and waste minimization.

### **8.4 Bulk Solid Wastes.**

**8.4.1** NFPA 400, local fire codes, or other jurisdictional regulations should be consulted for general requirements.

**8.4.2** Where a facility receives a bulk solid waste, materials should be placed as follows:

- (1) Bulk solid waste should be separated from other wastes in quantities or physical arrangement that do not negatively impact the capability of the fire protection system(s).

- (2) Bulk solid waste should be limited in total volume to limit the impact of a fire.
- (3) Bulk solid waste should be in areas where a fire from these wastes will not impact other stored/staged wastes.
- (4) Control measures should be incorporated into the facility design that minimize the manual handling of the waste, such as gravity unloading of the material directly into a below-grade pit or solid waste tank.
- (5) Control measures should be incorporated into the facility design, to control the flammable vapors generated from a bulk solid storage location or activity, such as removal of vapors with exhaust, vapor recovery, or inerting systems.

### **8.5 Bulk Liquid Storage.**

#### **8.5.1 Fixed Tanks.**

**8.5.1.1 Informational Resources.** Where enforceable, NFPA 30 and 40 CFR 260.10 should be referenced for tank systems, including piping and containment systems.

#### **8.5.1.2 Control Measures for Fixed Tank Storage.**

**8.5.1.2.1** Control measures for fixed tank storage should be incorporated into the facility design to allow segregation of different compatibility groups and to permit the ease of loading and unloading materials into and out of tanks.

**8.5.1.2.2** The design of the fixed tank storage system should include means to prevent contamination of incompatible materials in the loading and unloading headers.

**8.5.1.2.3** Between usage of loading and unloading headers, measures that establish the following should be taken to prevent contamination with incompatible materials that could result in an uncontrolled release:

- (1) Using dedicated headers
- (2) Establishing procedures to flush headers
- (3) Purging the headers in between different uses

**8.5.1.2.4** Atmospheric control measures should be incorporated into the facility design and include the following:

- (1) Control measures that appropriately handle the vapors displaced from the tanks during filling.
- (2) Inerting the tank with an oxygen-deficient atmosphere in the tank vapor space

**8.5.1.2.5** Tanks should be limited in size and segregated from other tanks such that a fire would not impact other waste storage areas.

#### **8.6\* Portable Tanks.**

##### **8.6.1 Control Measures.**

**8.6.1.1** Control measures should be incorporated into the facility design to designate storage and staging locations for portable tanks.

**8.6.1.2** Control measures should be incorporated into the facility design to do the following:

- (1) Limit the total volume of the material as allowed by the provided protection measures
- (2) Allow for the ease of sampling the containers
- (3) Inert tanks containing flammable liquids

## 8.6.2 Locations.

**8.6.2.1** Locations for portable tanks should take the following into consideration:

- (1) Containment
- (2) Ease of bonding and grounding
- (3) Segregation from other materials that could be incompatible
- (4) Ability to limit the impact of a fire on other hazardous waste storage areas

**8.6.2.2** Areas for unloading, loading, and sampling of nonfixed tanks should have consideration for bonding and grounding and vapor recovery.

## 8.7 Container Storage.

### 8.7.1\* Informational Resources.

**8.7.1.1** For storage of materials with special precautions and reactive materials, Chapter 10 should be consulted.

**8.7.1.2** Chapter 9 of NFPA 30 should be consulted for storage of liquids in containers.

**8.7.2 Control Measures.** Control measures should be incorporated into the facility design to allow segregation of different compatibility groups as follows:

- (1) Segregating with fire barriers, fire walls, spill containment, and physical separation by distance
- (2) Incorporating measures to appropriately handle exhaust of hazardous vapors and gasses from the building
- (3) Limiting the volume of the storage area so as not to exceed the capacity of the provided protection measures
- (4) Limiting the number of hazardous waste processing area activities
- (5) Limiting the number of miscellaneous waste processing activities to include, but not limited to, the following:
  - (a) Consolidating waste
  - (b) Splitting waste down into smaller containers
  - (c) Shredding
  - (d) Inspecting
  - (e) Sampling
  - (f) Transferring waste from or to containers
  - (g) Relieving pressure from containers
  - (h) Treating waste in containers
  - (i) Decanting
  - (j) General handling of waste

## 8.8 Best Practices.

### 8.8.1 Written Procedures.

**8.8.1.1** For each process activity, written instructions specific to that activity should be developed.

**8.8.1.2** Written instructions should reflect the limitations of the facility design and provided protection measures.

### 8.8.2 Fire Prevention.

#### 8.8.2.1 Measures to Prevent Fires.

**8.8.2.1.1** Measures to prevent fires should include identifying and isolating all sources of ignition.

**8.8.2.1.2** Sources of ignition to identify and isolate should include, but not be limited to, the following:

- (1) Direct heat, such as portable heaters or equipment exhaust
- (2) Powered industrial equipment
- (3) Direct sunlight
- (4) Pouring/transferring of liquids, which could generate static charges
- (5) Chemicals capable of generating heat or adding oxygen to a reaction

**8.8.2.1.3** Computer-generated experimental modules should be used to evaluate fire protection methods such as isolation, effectiveness of suppression systems, and access of exits.

#### 8.8.2.2 Fire Prevention Practices.

**8.8.2.2.1** Once the waste generation process is understood, fire prevention measures should focus on identifying and isolating all sources of ignition/heat throughout the generation process.

**8.8.2.2.2** Heat sensors, cameras, and related devices should monitor equipment, heat generation, and provide warning for facility staff.

**8.8.2.2.3** Waste that can experience polymerization should be monitored for heat that can lead to runaway reactions.

**8.8.2.2.3.1** Caution should be used when polymerization occurs because although polymerization is useful to create plastic and other consumer products, chemical reactions in waste containers can result in significant physical damage and injury.

**8.8.2.2.3.2** External sources of heat that can initiate runaway reactions also should be monitored.

**8.8.2.2.4 Combustible and Reactive Metals.** Chapter 10 should be referenced for more information on combustible and reactive materials.

### 8.8.3 Site and Floor Plan.

**8.8.3.1** Storage locations of hazardous waste at facilities should be evaluated to avoid the following:

- (1) Other processing locations that might create additional hazards
- (2) Occupied areas, such as break rooms
- (3) Poor siting that is contrary to US OSHA siting criteria in 29 CFR 1910.119

**8.8.3.2** Optimum facility design should include the following:

- (1) Proper means of separation for processing area to include fire barriers, fire walls, spill containment, and physical separation by distance
- (2) Limitation of the volume of waste in the area so as not to exceed the capacity of the provided protection measures
- (3) Maintenance of easy pathways from platforms or other restricted work areas

- (4) Incorporation of special equipment or tools needed to process waste in the processing area relative to the electrical classification of the area, including, but not limited to, the following:
  - (a) Access for forklifts (*see NFPA 505*)
  - (b) Battery charging stations
  - (c) Computers/printers
- (5) Providing a means of bonding and grounding containers of waste in processing areas
- (6) Providing a means of preventing static buildup from workers or materials used in the process area
- (7) Incorporating a means of inerting highly flammable or reactive materials when processing
- (8) Designating PPE storage areas to allow workers to have easy access
- (9) Installing liquid containment systems in the processing area to prevent the spread of hazards beyond the immediate process area
- (10) Incorporating easy access of workers to properly maintained safety showers and eyewash stations in processing areas with allowances for freeze protection for water supplies
- (11) Installation of lighting at facilities, including the following:
  - (a) Adequate lighting for process areas that meets the requirements of *NFPA 101*
  - (b) Emergency lighting at exits and egress pathways (e.g., high-bay lighting, permanently fixed battery backup lighting) that meets the requirements of *NFPA 101*
- (12) Mounting of portable fire extinguishers in processing areas that meets the requirements of *NFPA 10*

**8.8.4 Hygiene.** Workers should utilize the hygiene facilities at sites to decontaminate when appropriate.

**8.8.4.1** Written policies should be available that address worker hygiene.

**8.8.4.2** Policies should include utilization of bathrooms, showers, food storage, and necessary decontamination prior to eating or drinking.

## Chapter 9 Additional Management of Oxidizers

### 9.1 Administration.

**9.1.1 Scope.** This chapter address the management of oxidizing materials, including guidance for oxidizing material assessments and care related to incompatibility related to oxidizing materials.

**9.1.2 Purpose.** This chapter provides information on oxidizing materials referenced from the US Code of Federal Regulations, US Environmental Protection Agency, and US Department of Transportation.

### 9.2 Regulations.

**9.2.1** Facilities should refer to the proper regulatory requirements from *NFPA 400*, as well as the US Code of Federal Regulations, EPA, DOT, PHMSA, or other jurisdictional regulations.

**9.2.2** The authority having jurisdiction (AHJ) should be consulted to determine if regulations are enforceable or provided as best practices.

### 9.3 Segregation of Oxidizers and Incompatibility.

**9.3.1** *NFPA 400* should be referenced for general information on the segregation of oxidizers and incompatibility.

**9.3.2** The following additional recommendations should be adhered to for the collection and generation of oxidizer waste:

- (1) Caution should be used when storing oxidizers — although oxidizers do not burn, oxidizers can generate temperatures over 400°F (204°C), which can cause combustible packaging materials like cardboard, wood, and plastic to burn.
- (2) A temperature monitor should be used if increased heat or rise in temperature occurs.
- (3) Oxidizers should not be mixed as they are not compatible with each other.
- (4) All oxidizer collection should be in a cool, dry location.
- (5) Oxidizers should be kept dry as they will react to small amounts of water and moisture.
- (6) Oxidizers should be protected from hot environments as follows:
  - (a) Oxidizers should not be stored next to any equipment that generates heat.
  - (b) Hot work should not be conducted in the oxidizer collection areas without proper protection for the oxidizer materials.
  - (c) Caution should be used not to expose oxidizers to heat for several days since they can react if exposed to high temperatures for more than several days, which can include daily temperatures as low as 95°F (35°C)
- (7) Precautions should be used when handling and storing oxidizers.
- (8) Oxidizer waste should not accumulate with other materials so as to prevent mixing and reactions.
- (9) Oxidizers that have become contaminated with incompatible materials should be mitigated (i.e., soaked with water) prior to shipping.
- (10) If ambient temperature is over 95°F (35°C) refrigerated equipment should be used for oxidizer shipping.
- (11) Oxidizers should not be shipped in direct sunlight.
- (12) Oxidizers should not be shipped next to hot surfaces.

**9.3.3\*** Reaction between oxidizers and incompatible materials should be avoided because such reactions can generate smoke, heat, fire, and explosion.

## Chapter 10 Reactive Chemicals

### 10.1 Administration.

**10.1.1\* Scope.** This chapter addresses generalized guidance for safely managing reactive materials, including water reactives, air reactives, combustible metals, shock/friction sensitive, temperature sensitive, pyrophorics, explosives, and compressed gasses (*see Chapter 9 for oxidizers*).

**10.1.2 Purpose.** This chapter provides guidance for facilities that manage and transport reactive materials and wastes.

### 10.2\* Reactive Chemicals.

**10.2.1** Careful and thorough research should be performed to identify and manage reactive chemical hazards (*see Annex C*).

**10.2.2** When managing reactive chemicals, if a situation occurs where chemicals are undergoing an unintended reaction, both of the following should occur:

- (1) The area should be immediately evacuated
- (2) The original manufacturer or supplier for safe management practices should be contacted (*see Chapter 14*).

### 10.3 Reactive Chemical Categories.

#### 10.3.1 High-Pressure Cylinders.

**10.3.1.1** The high-pressure cylinder category should include all of the following:

- (1) Cylinders containing a known compressed gas or mixture of gases
- (2) Liquefied compressed gas under its own vapor pressure
- (3) Liquid under a pressurized carrier gas
- (4) Unknown material at unknown pressure.

**10.3.1.2\*** Caution should be taken where high-pressure cylinders are in use due to the many hazards associated with such cylinders.

**10.3.2\* Reactive or Uninhibited Monomers.** Caution should be used around reactive or uninhibited monomer products because low molecular weight monomers, which consist of a simple compound and usually contain carbon, are capable of conversion to a polymer by combination with itself or other similar molecules or compounds.

#### 10.3.3\* Temperature-Sensitive Compounds.

**10.3.3.1** Temperature-sensitive compounds should include organic peroxides and self-reactive materials.

**10.3.3.2** Care should be taken in storing compounds that are temperature sensitive because they can react in ways that can result in runaway reactions, such as the self-accelerating decomposition temperature (SADT).

**10.3.4\* Spontaneously Decomposing Materials.** Care should be taken with SADTs since materials that are in conditions associated with undisturbed storage could, with no apparent stimulus, spontaneously decompose.

#### 10.3.5\* Chemical Warfare Agents.

**10.3.5.1** Extreme precaution should be taken when handling and processing chemical-warfare-agent-related secondary wastes.

**10.3.5.2** Caution should be taken around handling chemical warfare agents such as tabun (GA), sarin (GB), soman (GD), cyclosarin (GF), VE, VG, VM, VX, and mustard agents.

**10.3.6\* Explosives, Propellants, and Shock-sensitive and Explosive Materials.** Care should be taken with storage and handling of explosives, propellants, and shock-sensitive and explosive materials since these materials could have been sold originally as commercial explosives, black powder, munitions, or reagent chemicals that were stored improperly or with incompatible materials, which can decompose, creating a hazardous condition.

#### 10.3.7\* Pyrotechnics and Fireworks.

**10.3.7.1** Care should be taken with pyrotechnics and fireworks because they are inherently designed for rapid combustion or explosion.

**10.3.7.2** Materials from pyrotechnics and fireworks that are designated as hazardous waste should have identifying features that communicate the hazard.

**10.3.7.3** Care should be taken with materials from pyrotechnics and fireworks that are designated as hazardous waste, as the material might have been physically altered so as to increase the inherent hazard of the original product.

**10.3.7.4\*** Management of leftover display site pyrotechnics and fireworks, such as misfires, should comply with 10.3.7.4.1 through 10.3.7.4.3.

**10.3.7.4.1** Treatment or disposal of waste from pyrotechnics and fireworks should not be undertaken at the display site.

**10.3.7.4.2** The display company or other provider of the regulated explosive materials used in the display, should determine whether materials from pyrotechnics and fireworks can be reused, repurposed, or declared hazardous waste.

**10.3.7.4.3** After a pyrotechnics or fireworks display, the lead operator or supervisor should make an initial determination on whether the materials from the pyrotechnics or fireworks can be repaired and function as designed at the site.

**10.3.7.4.3.1** All remaining materials from pyrotechnics or fireworks should be transported in compliance with the applicable DOT regulations to the US-based display company that provided the pyrotechnics and/or fireworks to the operator and crew that conducted the display.

**10.3.7.4.3.2** Within 60 days of the receipt of the materials, the US-based display company should determine their proper classification for use or disposal.

**10.3.7.4.3.3\*** Once properly classified, the material should comply with all the applicable regulations for that class of hazardous material, including ATF, EPA, OSHA, state, and local regulations.

**10.3.7.5** Disassembly as a means of treatment/disposal of materials from pyrotechnics or fireworks should not be performed (*see 10.3.7.6*).

**10.3.7.6** If the disassembly of materials from pyrotechnics or fireworks is performed, the following factors should be considered:

- (1) Compliance with all aspects of the applicable OSHA-enforced process safety management regulations for the manufacture of pyrotechnics and fireworks during disassembly activities
- (2) If disassembly is permitted within the scope of the EPA-issued RCRA treatment/disposal permit

**10.3.7.7** All pyrotechnics and fireworks operations, including hazardous waste handling and disposal, should comply with established safety and environmental regulatory requirements and applicable industry standards.

**10.3.7.8** Requirements under the jurisdiction of the following agencies should be followed for permitting, licensing, handling, and managing materials from pyrotechnics or fireworks:

- (1) OSHA
- (2) ATF
- (3) EPA
- (4) DOT
- (5) State and local agencies and jurisdictions

**10.3.7.9** Hazardous waste generated from pyrotechnics and fireworks should be disposed of in a safe manner that complies with the applicable regulations and standards.

**10.3.7.9.1\*** Entities disposing of explosive hazardous waste should have the appropriate permits and licenses.

**10.3.7.9.2** Disposal of explosive hazardous waste by disassembly, sea dumping, or landfilling should not be performed.

**10.3.7.9.3** Non-explosive hazardous waste generated from pyrotechnics and fireworks should be disposed of in accordance with its hazardous waste classification.

**10.3.7.9.4** Soaking pyrotechnic and fireworks materials in diesel fuel prior to incineration is discouraged and should not be attempted unless it is performed by an appropriately licensed and permitted facility.

#### **10.3.8\* Explosive Peroxide Forming Materials.**

**10.3.8.1** Care should be taken with certain organic liquids because they can form reactive and explosive peroxides in the presence of oxygen.

**10.3.8.2** Care should be taken as peroxides can increase in concentration over time, or as the parent compound evaporates, creating a hazard.

**10.3.8.3** Care should be taken with handling or transporting organic chemicals with low concentrations of organic peroxides to prevent reactions with stimulus because peroxides are sensitive to heat, friction, and shock.

**10.3.8.4** Care should be taken with some classes of peroxides since they can explode without being concentrated (*see Annex F*).

**10.3.8.5** Manufacturer recommendations should be followed for managing solvents with the potential to form peroxides.

**10.3.9\* Moisture and Moist-Air-Sensitive Materials.** Extreme care should be taken with handling and storing water, moisture, and moist-air-sensitive materials so that they do not come in contact with water or moisture since the materials can become spontaneously flammable or produce flammable or toxic gas.

#### **10.3.10\* Pyrophoric Material.**

#### **10.3.11\* Waste Containing Reactive Metals and Metal Powders.**

**10.3.11.1** Care should be taken with waste containing reactive metals, swarf, turnings, or powders because some metals can react in an explosive manner.

**10.3.11.2** Manufacturers and waste generators of reactive metals should always be consulted about material hazards.

**10.3.11.3** Care should be taken with seemingly innocuous metal powders, which can exhibit explosive properties when mixed with certain liquids.

#### **10.4\* Managing Uncharacterized Waste.**

**10.4.1** Care should be taken with uncharacterized waste because, due to the nature of such materials, many possible hazards or combination of hazards can be expected.

**10.4.2** Unidentified materials in containers can exhibit multiple hazards and should not be moved or handled if subject to any shock, friction, rough handling, or ignition sources.

**10.4.3** The waste storage container or arrangement should not be handled until more information is available.

**10.4.4** Prior to handling uncharacterized waste, containers should be visually inspected for bulging, crystallization, signs of pressure, color inconsistency, layering, potential shock sensitivity, and container type.

**10.4.5** The following hierarchy should be used when trying to identify uncharacterized waste:

- (1) Labels or discerning markings, such as container type, should be reviewed.
- (2) Local user knowledge should be obtained as much as possible.
- (3) Purchasing records, including SDS inventory, should be available and reviewed.
- (4) Hazardous waste management firms equipped to provide identification should be utilized for identifying unknown materials.

**10.4.6** If necessary, the generator should perform waste characterization prior to shipment.

**10.4.7** If waste determination cannot be made, the waste disposal vendor should be contacted for guidance.

## **Chapter 11 Lab Packs**

### **11.1 Administration.**

**11.1.1 Scope.** This chapter covers the proper procedure for lab packing waste.

**11.1.2 Purpose.** This chapter provides guidance so that sites package, label, and ship all lab pack containers in a uniform manner.

**11.2 Transport.** A lab pack used for waste materials should be transported in accordance with 49 CFR 173.12 or other jurisdictional regulations.

**11.3 General Hazards.** Care should be taken during lab pack operations because the following hazards might be present:

- (1) Incompatible materials packaged together, which is a reaction hazard
- (2) Inner container breakage inside of the outer container, which is a contamination hazard
- (3) Exceeding the recommended quantities for a particular chemical, which is an inventory control hazard
- (4) Insufficient adsorbent material or incompatible adsorbent material used in packing, which is a leakage hazard

**11.4 Prudent Practices.** The following best practices should be performed during lab pack operations:

- (1) Proper transport packaging materials should be used for all shipping materials.
- (2) Proper packing material should be used to maintain container integrity.
- (3) Double stacking should be prevented to avoid container stress.
- (4) Chemical compatibility charts should be consulted when waste and packing materials are in same container.

- (5) Proper PPE should be worn when handling waste to protect employee health.
- (6) Visitor access should be controlled to prevent unauthorized individuals from the area.
- (7) Provided inventory packing lists should be double-checked to verify proper records documentation.
- (8) Proper planning time should be allowed for managing lab pack inventories to prevent mistakes
- (9) The EPA chemical compatibility chart should be referenced for proper segregation (*see Annex G*).
- (10) Guidance should be sought from each waste management company on their internal procedures for lab packs.

## Chapter 12 Batteries and Cell Waste

### 12.1 Administration.

**12.1.1 Scope.** This chapter applies to the managing of lithium, lithium metal, and lead-acid batteries and cell waste.

**12.1.2 Purpose.** This chapter describes different battery technologies and provides potential hazards associated with managing lithium, lithium metal, and lead-acid batteries and cell waste.

### 12.2 Hazard Mitigation.

**12.2.1** The safety controls and hazard mitigation approach should consider the inherent hazards associated with batteries or cells, which can vary depending on the battery or cell chemistry.

**12.2.2\*** The hazards that should be addressed, especially for lithium batteries and cells, are fire and explosion hazards, chemical hazards, stranded or stored energy hazards, and physical hazards.

### 12.3\* Lithium Batteries.

**12.3.1\*** Discarded lithium batteries are known to present a significant fire hazard during storage, shipment, and processing and should be handled with care.

**12.3.2** Proper identification, including SOC less than 30 percent, segregation, appropriate fire protection systems, and safe packaging for shipment, should be used to avoid lithium battery or cell waste fires.

**12.3.3** Generators should develop best practices for safe packaging and shipment, including illustrated directions and training for staff responsible for this task.

**12.3.4** NFPA 855 should be referenced for segregation and provision of fire protection level requirements for facilities gathering or storing used or off-specification batteries or cells.

**12.3.5\*** Care should always be taken with lithium batteries or cells because of their hazards throughout every stage of their life cycle because of the materials utilized to manufacture the batteries or cells.

**12.4 Identifying Different Types of Lithium Batteries.** The following should be taken into consideration when identifying lithium batteries:

- (1) Lithium-ion batteries vary in size, construction, chemistry, and energy density.

- (2) Primary lithium metal, solid-state batteries cannot be recharged.
- (3) Secondary lithium-ion batteries can be repeatedly charged and discharged.
- (4) Many devices contain one or more batteries; devices range in size from hearing aids to hybrid electric vehicles to large ESS installations.
- (5) Both primary lithium metal, solid-state and secondary lithium-ion polymer batteries do not have an infinite life and are common waste material.
- (6) Lithium-ion batteries can be preinstalled in equipment, packaged with equipment, or packaged separately.
- (7) Lithium metal, solid-state batteries can be preinstalled in equipment, packaged with equipment, or packaged separately.
- (8) The construction, chemistry, and energy density of batteries can vary.
- (9) The most important hazard characteristic of batteries is SOC.
- (10) Batteries at 100 percent SOC are the most volatile.

### 12.5 Safe Packaging of Lithium Batteries for Transportation Between Facilities.

**12.5.1** The following precautions should be taken regarding the SOC of lithium batteries:

- (1) Cells and batteries with an SOC greater than 30 percent have potential for a higher heat-release fire event due to the increased level of stored energy.
- (2) Cells and batteries with a low SOC are not likely to spontaneously decompose with fire and flaming ejecta or result in a high-heat-release fire event.
- (3) Literature developed as part of FAA-sponsored investigations and full-scale burn tests show the peak heat release rate is the same but takes longer from initiation to peak with a lower SOC (but still greater than 30 percent).

**12.5.2** The following should be taken into consideration regarding the temperature of lithium batteries.

- (1) The thermal decomposition of lithium-ion batteries or cells is a function of temperature.
- (2) Elevated temperatures promote ease of ignition for lithium-ion batteries or cells at greater than 30 percent SOC and propagation of fire.
- (3) Temperatures inside shipping trucks can affect lithium battery or cell waste during transportation.

**12.6 Transportation and Packaging of Lithium Batteries.** The following steps should be taken when packing lithium or lithium-ion batteries or cells for transport (*see also Annex E*):

- (1) Single lithium or lithium-ion batteries and battery-powered devices should be packaged within fully enclosed inner packaging of nonconductive material because it is the safest approach to preventing a reaction or fire.
- (2) Care should be taken with packaging and transporting since most battery fires started at either stage are due to lack of generator knowledge on how lithium and lithium-ion batteries can react during such processes.
- (3) Each lithium or lithium-ion battery should be packed in a manner to prevent short-circuiting, including movement that could lead to a short circuit.
- (4) Exposed terminals or connectors for each lithium or lithium-ion battery should be protected with nonconduc-

tive caps, tape, or other means to prevent inadvertent contact.

- (5) A hazardous waste management vendor should be contacted for details on proper packaging and shipment.

**12.7 Damaged Batteries.** For situations involving damaged batteries, a licensed hazardous waste transporter experienced in packaging and transporting damaged lithium or lithium-ion batteries should be contacted.

## 12.8 Other Battery Types.

### 12.8.1 Lead-Acid Batteries.

**12.8.1.1\* Lead-Acid Batteries for Reclamation or Recycling.** Lead-acid batteries should be handled cautiously to prevent fires, chemical exposures, and electric shocks.

#### 12.8.1.2 Transportation and Packaging of Lead-Acid Batteries.

**12.8.1.2.1** The following should be taken into consideration when packing lead-acid batteries for transport:

- (1) Single lead-acid batteries and battery-powered devices should be packaged within fully enclosed inner packaging of nonconductive material because it is the safest approach to preventing a reaction or fire.
- (2) Care should be taken with packaging and transporting since most battery fires started at either stage are due to lack of generator knowledge on how lead-acid batteries can react during such processes.
- (3) Each lead-acid battery should be packed in a manner to prevent short-circuiting, including movement that could lead to a short circuit.
- (4) Exposed terminals or connectors for each lead-acid battery should be protected with nonconductive caps, tape, or other means to prevent inadvertent contact.

**12.8.1.2.2** A local hazardous waste management vendor should be contacted for details on proper packaging and shipment based on the types of lead-acid batteries.

**12.8.2 Damaged Batteries.** For situations involving damaged batteries, a licensed hazardous waste vendor should be contacted for handling and packaging guidance.

**12.9\* Related Regulatory and Advisory Guidance for Batteries. (Reserved)**

## Chapter 13 Training for Personnel Involved in Hazardous Waste Management

### 13.1\* Administration.

**13.1.1 Scope.** This chapter applies to US-government-mandated training and site-specific training at facilities that manage hazardous waste.

**13.1.2 Purpose.** The purpose of this chapter is to provide a reasonable degree of protection from fire and loss of life through comprehensive risk assessment evaluations, use of best practices, and implementation of a training program.

### 13.2 Training Based on Generator Status.

**13.2.1\*** Based on their generator status, generators of hazardous waste should follow prescribed mandated training for employees that manage hazardous waste.

**13.2.2** Once an organization determines its generator status, the hazardous waste training requirements determined by authorities such as EPA, OSHA, and PHMSA, or other jurisdictional regulations, should be implemented.

### 13.3 Risk Assessment.

**13.3.1** The completion of a risk assessment should form the foundation for a comprehensive training program.

**13.3.2** The risk assessment should assess the hazards associated with the facility operations to include those operations that might not fall under OSHA PSM standards.

**13.3.3** The risk assessment should identify training gaps and recommend improvements to existing training programs.

**13.3.4** The risk assessment should identify potential emergency events and evaluate the facility's capabilities to respond.

**13.3.5\*** Training programs should be continuously improved based on periodic risk assessments.

## Chapter 14 Emergency Planning

### 14.1 Administration.

**14.1.1 Scope.** This chapter covers emergency planning for transporters and facilities that manage hazardous waste.

**14.1.2 Purpose.** The purpose of this chapter is to provide information on federal, state, and other jurisdictional regulations for proper emergency planning to minimize the potential for injury, property damage, environmental damage, or death.

### 14.2 Facilities That Manage Hazardous Waste.

**14.2.1** Facilities that manage hazardous waste should maintain and operate their facilities in a manner that minimizes the possibility of fire, explosion, or any other unplanned release of hazardous waste or hazardous waste constituents to air, soil, or surface water that could threaten human health or the environment.

**14.2.2\*** To clearly explain how managers address the risks of fire, explosion, or release of hazardous materials, facilities should prepare written emergency action and response plans to minimize the hazards to human health and the environment from any such incident or release.

**14.2.3\*** An emergency action and response plan should include the following:

- (1) Descriptions of the actions facility personnel can take to minimize hazards
- (2) Descriptions of arrangements with local government emergency responders
- (3) At least one contact person designated as emergency coordinator
- (4) List of the names, addresses, and phone numbers of the emergency coordinators
- (5) List of all necessary emergency response and cleanup equipment
- (6) Descriptions of the location and each item of equipment and an outline of equipment capabilities
- (7) Evacuation plan, including procedures for facility personnel with a map of the facility
- (8) Procedures for testing and sounding alarms

- (9) Procedures for notifying and coordinating with the fire department, governmental agencies, or other emergency responders or contracts, as needed
- (10) Procedures for establishing rescue and medical duties
- (11) Procedures and schedules for conducting drills
- (12) Procedures for shutting down and isolating equipment under emergency conditions, including assignment of personnel responsible for maintaining critical plant functions or for shutdown of process operations
- (13) Appointment and training of all personnel to carry out assigned duties prior to commencing work
- (14) Plan for retraining when responsibilities or the emergency action and response plan changes
- (15) Means of egress designated as necessary for movement of personnel and emergency response
- (16) A secondary, abbreviated customized emergency response plan checklist that incorporates relevant elements of 14.2.3(1) through 14.2.3(15) to be used as a pocket guide for personnel

**14.2.4** Emergency action plans should be kept on-site and accessible to affected personnel.

**14.2.5** The emergency action plan should be reviewed at least annually.

**14.2.6** The emergency action plan and related procedures should be updated and communicated to affected personnel when conditions involving the process(es) or facilities affecting the process(es) are modified or changed in a manner that affects the plan.

**14.3 Higher Risk Chemicals.** As part of the contingency plan, generators of particular chemicals of concern, as well as receiving treatment, storage, and disposal facilities (TSDFs), should include best practices for emergency planning, fire risk control, and chemical hazards, and planning for the following chemical categories (*see NFPA 400*):

- (1) Organic peroxide formulations
- (2) Oxidized Class 3 and Class 4 solids and liquids
- (3) Pyrophoric solids, liquids, and gases
- (4) Unstable reactive Class 3 and Class 4 solids, liquids, and gases
- (5) Highly toxic solids, liquids, and gases
- (6) Class 3 water-reactive liquids
- (7) Higher hazard batteries

**14.4 Facility Siting Planning and Prevention of Upset Conditions.**

**14.4.1** Potential upset conditions should be analyzed to help prevent incidents and prepare for emergency response actions.

**14.4.2\*** Planning and preparation for consequences of any process upset condition or stored material should be done for any scenario that could result in the following:

- (1) Potential for explosion
- (2) Potential for fire
- (3) Employee inhalation exposure

**14.4.3** During planning, the hierarchy of controls should be used to mitigate the potential risk noted in 14.4.2.

**14.4.4** During an emergency response, employers should follow the hierarchy of controls to safeguard worker health and safety (i.e., engineering controls, administrative controls), with PPE as a last resort.

**14.5 Process Review, Plan Preparation, and Approval.**

**14.5.1** Part of any professional emergency action plan should include proper planning and evaluation of industrial processes.

**14.5.2** To prevent fire, explosion, and chemical hazards from causing loss of containment or chemical reactions, both of the following should be performed:

- (1) Industrial processes should be reviewed.
- (2) Written plans and procedures should be prepared by qualified personnel.

**14.5.3** Qualified personnel able to write plans and procedures should include environmental experts, health and safety experts, maintenance personnel, operations personnel, and electricians, with final approval of the plan by senior management of the facility or site.

**14.6\* Fire Risk Controls.** The extent of fire risk controls provided should be determined by means of an evaluation of the process and application of fire protection and process engineering principles.

**14.7 Operation and Maintenance Procedures.**

**14.7.1** Operating procedures should be authorized and approved by personnel designated by the process owner/operator and implemented.

**14.7.2** Emergency response actions should be included in operations and maintenance procedures.

**14.7.3** When there are changes in chemicals, equipment, processes, or procedures, the hazards of the process should be evaluated prior to start-up of the modified equipment or process.

**14.8 Incident Investigation Plan.**

**14.8.1** Investigation of a hazardous waste incident should be conducted when the following occurs:

- (1) An incident results in a fire, explosion, or unintended release.
- (2) An event does not result in a fire, explosion, or unintended release but has the potential to do so.

**14.8.2** The results of the investigation should be documented and used as a tool to revise the emergency plan.

**14.8.3** Employees involved in the incident should be involved with the investigation process.

**14.8.4** The incident should be reported to regulators as necessary.

**14.9 Transportation/Transporters.** See Chapter 6 for emergency planning information related to transporters.

## Annex A Explanatory Material

*Annex A is not a part of the recommendations of this NFPA document but is included for informational purposes only. This annex contains explanatory material, numbered to correspond with the applicable text paragraphs.*

**A.1.1.2** During the development of this document, the technical committee decided that the following wastes were within the scope of this document:

- (1) EPA hazardous waste
- (2) Universal waste
- (3) Waste oil

Although waste oil is typically a state-regulated hazardous waste, it can be mixed with other substances that make it exhibit the characteristics of an EPA hazardous waste (*see 3.3.14, Characteristic*).

The technical committee also decided that the following wastes were not within the scope of this document:

- (1) State waste — per local regulations for state hazardous waste
- (2) Household hazardous waste
- (3) Biological waste
- (4) TSCA waste
- (5) Medical waste
- (6) DOT forbidden materials
- (7) CDC select agent list (e.g., biological weapon)
- (8) Mixed waste
- (9) Radioactive waste

**A.3.2.1 Approved.** The National Fire Protection Association does not approve, inspect, or certify any installations, procedures, equipment, or materials nor does it approve or evaluate testing laboratories. In determining the acceptability of installations or procedures, equipment, or materials, the “authority having jurisdiction” may base acceptance on compliance with NFPA or other appropriate standards. In the absence of such standards, said authority may require evidence of proper installation, procedure, or use. The “authority having jurisdiction” may also refer to the listings or labeling practices of an organization that is concerned with product evaluations and is thus in a position to determine compliance with appropriate standards for the current production of listed items.

**A.3.2.2 Authority Having Jurisdiction (AHJ).** The phrase “authority having jurisdiction,” or its acronym AHJ, is used in NFPA standards in a broad manner because jurisdictions and approval agencies vary, as do their responsibilities. Where public safety is primary, the authority having jurisdiction may be a federal, state, local, or other regional department or individual such as a fire chief; fire marshal; chief of a fire prevention bureau, labor department, or health department; building official; electrical inspector; or others having statutory authority. For insurance purposes, an insurance inspection department, rating bureau, or other insurance company representative may be the authority having jurisdiction. In many circumstances, the property owner or his or her designated agent assumes the role of the authority having jurisdiction; at government installations, the commanding officer or department official may be the authority having jurisdiction.

**A.3.3 General Definitions.** The terms and their definitions apply only within the scope of the recommended practice.

**A.3.3.5 Biological Waste.** Examples include laboratory waste (e.g., Petri dishes, culture tubes, pipette tips), hospital waste (e.g., surgical wraps, syringes, needles, blood vials), absorbent material, and personal protective equipment.

**A.3.3.7 Bulk Solid Storage.** Examples include solid wastes from chemical manufacturing facilities containing flammable solvents on rags, used PPE, soil from remediation, and filter cake from wastewater treatment. This definition includes storage of solid wastes in large shipping containers (i.e., 20 yd<sup>3</sup> roll off boxes) on pads, and waste piles and pits.

**A.3.3.16 Chemical Warfare Agents (CWA).** Nerve agents, asphyxiants, blistering agents, toxic industrial chemicals, and blood agents are primary categories of these agents.

**A.3.3.22 Corrosivity.** The definition of a corrosive waste as defined by 40 CFR 261.22 is as follows:

- (1) A solid waste exhibits the characteristic of corrosivity if a representative sample of the waste has either of the following properties:
  - (a) It is aqueous and has a pH less than or equal to 2 or greater than or equal to 12.5, as determined by a pH meter using Method 9040C in “Test Methods for Evaluating Solid Waste, Physical/Chemical Methods,” EPA Publication SW-846, as incorporated by reference in 40 CFR 260.11.
  - (b) It is a liquid and corrodes steel (SAE 1020) at a rate greater than 6.35 mm (0.250 inch) per year at a test temperature of 55°C (130°F) as determined by Method 1110A in “Test Methods for Evaluating Solid Waste, Physical/Chemical Methods,” EPA Publication SW-846, and as incorporated by reference in 40 CFR 260.11.

**A.3.3.24 Dangerous When Wet.** These materials are classified as DOT Division 4.3 per 49 CFR 173.124.

**A.3.3.27 DOT Forbidden Materials.** A material list in the 49 CFR 172.101 hazardous materials table for which the entry in column (3), Forbidden, might not be offered for transportation or transported. This prohibition does not apply if the material is diluted, stabilized, or incorporated in a device and it is classed in accordance with the definitions of hazardous materials contained in part 173 of the hazardous materials regulations (*see 49 CFR 171–180*). Further explanation of materials forbidden for transport are outlined in 49 CFR 173.21.

**A.3.3.34 F-List.** The US EPA’s F-list identifies wastes from common manufacturing and industrial processes as hazardous. Because the processes generating these wastes can occur in different sectors of industry, the F-list wastes are known as wastes from nonspecific sources. They can be divided into the following seven groups depending on the type of manufacturing or industrial operation that creates them:

- (1) Spent solvent wastes
- (2) Electroplating and other metal finishing wastes
- (3) Dioxin-bearing wastes
- (4) Chlorinated aliphatic hydrocarbons production
- (5) Wood preserving wastes
- (6) Petroleum refinery wastewater treatment sludges
- (7) Multisource leachate

**A.3.3.37 Fire Code.** Where no fire code has been adopted, NFPA 1 should be used where the fire code is referenced in this recommended practice. [101, 2024]

**A.3.3.39 Fireworks.** Definitions and explanatory material for fireworks, consumer fireworks, and display fireworks can be found in NFPA 1124.

**A.3.3.39.1 Consumer Fireworks.** The 2018 version of APA 87-1 has been divided into three standards. APA 87-1A is specific to consumer fireworks classified as UN0336, Fireworks, Division 1.4G.

**A.3.3.39.2 Display Fireworks.** The 2018 version of APA 87-1 has been divided into three standards. APA 87-1B is specific to display fireworks classified as UN0335, Fireworks, Division 1.3G. Display fireworks can also be classified as UN0333, Fireworks, Division 1.1G, and UN0334, Fireworks, Division 1.2G.

**A.3.3.45 Globally Harmonized System of Classification and Labelling of Chemicals (GHS).** GHS establishes a world-wide standard for classifying and communicating hazards through labels and safety data sheets (SDS).

**A.3.3.48 Hazardous Substance.** Hazardous substance means any substance designated or listed under any of the following, exposure to which results, or could result in, adverse effects on health or safety:

- (1) Any substance defined under section 103(14) of the Comprehensive Environmental Response Compensation and Liability Act (CERCLA) (42 USC 103)
- (2) Any biologic agent and other disease-causing agent which, after release into the environment and upon exposure, ingestion, inhalation, or assimilation into any person, either directly from the environment or indirectly by ingestion through food chains, will or might reasonably be anticipated to cause death, disease, behavioral abnormalities, cancer, genetic mutation, physiological malfunctions (including malfunctions in reproduction), or physical deformations in such persons or their offspring
- (3) Any substance listed by the US Department of Transportation as hazardous materials under 49 CFR 172.101 and appendices
- (4) Hazardous waste as herein defined

**A.3.3.49 Hazardous Waste.** The Code of Federal Regulations defines hazardous waste as follows:

- (1) A waste or combination of wastes as defined in 40 CFR 261.3
- (2) Those substances defined as hazardous wastes in 49 CFR 171.8

It is important to remember that hazardous wastes are generally not pure products, or pure compounds, but they are typically mixtures of various chemical compounds. In some cases, these mixtures can retain the properties of the products from which they are derived. Frequently however, the properties of hazardous waste mixtures vary, and their behavior can be difficult to predict.

**A.3.3.50 Hazardous Waste Manifest.** This tracking system is referred to as the "cradle to grave" system of hazardous waste management.

**A.3.3.55 HMIS.** The hazardous materials identification system (HMIS) is a numerical hazard rating that incorporates the use

of labels with color developed by the American Coatings Association as a compliance aid for the OSHA Hazard Communication (HazCom) Standard.

**A.3.3.56 HMMP.** A hazardous materials management plan (HMMP) details the location and quantities of a facility's hazardous materials and wastes.

Applications for a permit to store hazardous materials should include an HMMP per the requirements in Chapter 60 of NFPA 1. Hazard analysis process safety information, such as site plan drawings included in the design hazard review, can be used to satisfy this documentation requirement provided the HMMP includes that appropriate information and is approved by AHJ.

NFPA codes and standards prescriptive- and performance-based options for fire prevention and protection should be documented in the hazards review analysis for the design and operation of treatment, storage, and disposal facilities (TSDFs). 8 shows the documentation requirements for the design and operation of fire protection and prevention system for a TSDFs.

**A.3.3.59 Ignitable Waste.** Certain liquid wastes with a flash-point of less than 60°C (140°F) could be ignitable. Ignitable waste can include solvents, petroleum by-products, and waste fuel. (See also 3.3.60, *Ignitability*.)

**A.3.3.60 Ignitability.** Ignitability is a characteristic of hazardous waste as referenced by the EPA as found in 40 CFR 261.21.

**A.3.3.64 Inhibitor.** The inhibitor might react with the initiator stimuli so that the chemical chain reaction cannot start. One class of inhibitors are antioxidants. They retard the oxidation process. Examples of inhibitors include hydroquinone, tert-butyl catechol, phenolthiazine, and butylated hydroxy toluene. Some inhibitors require dissolved oxygen to function.

**A.3.3.66 K-List.** To qualify as a K-listed hazardous waste, a waste must fit into one of the 13 categories on the list and the waste must match one of the detailed K-list waste descriptions in 40 CFR 261.32.

The 13 industries that generate K-list wastes as found on [www.epa.gov](http://www.epa.gov) are as follows:

- (1) Wood preservation
- (2) Organic chemicals manufacturing
- (3) Pesticides manufacturing
- (4) Petroleum refining
- (5) Veterinary pharmaceuticals manufacturing
- (6) Inorganic pigment manufacturing
- (7) Inorganic chemicals manufacturing
- (8) Explosives manufacturing
- (9) Iron and steel production
- (10) Primary aluminum production
- (11) Secondary lead processing
- (12) Ink formulation
- (13) Coking (i.e., processing of coal to produce coke)

**A.3.3.67 Lab Pack.** The containers are generally packed in an absorbent, such as vermiculite, labeled, and prepared for shipping.

**A.3.3.73 Mixed Waste.** Mixed waste is regulated under the RCRA and the Atomic Energy Act. The hazardous component of the mixed waste is regulated by EPA under RCRA. The radiological component of the mixed waste is regulated by the Department of Energy (DOE) or the Nuclear Regulatory

Commission (NRC). The NRC typically regulates waste from commercial and non-DOE facilities while the DOE regulates waste from DOE facilities.

**A.3.3.74 MOC.** Management of change (MOC) should be used any time the maximum aggregate quantity is exceeded. An amended HMIS must be provided within 30 days of the storage of any hazardous materials that changes or adds a hazard class or that is sufficient in quantity to cause an increase in the quantity which exceeds 5 percent for any NFPA hazard class.

**A.3.3.81 Petroleum By-Products.** These products are complex mixtures of chemicals, instead of specific chemicals.

**A.3.3.88 Process Safety Management.** These approaches consist of procedures, design guidance, and audit programs.

**A.3.3.92 Pyrotechnics.** The 2018 version of API 87-1 has been divided into three standards. APA 87-1C is specific to entertainment industry and technical pyrotechnics classified as UN0431, Articles, pyrotechnic for technical purposes, Division 1.4 G, or UN0336, Fireworks [for professional use only], Division 1.4G.

**A.3.3.96 Reactive Material.** Chapter 10 provides specific examples of reactive materials.

**A.3.3.111 Spontaneously Combustible.** See 49 CFR 173.124, Division 4.2.

**A.3.3.114 State Waste.** State regulatory requirements for generators can be more stringent than the federal program.

**A.3.3.125 Universal Waste Regulations.** Universal waste regulations are found in 40 CFR 273 and apply to batteries, pesticides, mercury-containing equipment, lamps, and aerosol cans. Four categories of regulated participants in the universal waste system are as follows:

- (1) Small-quantity handlers (accumulates less than 11,023 lb [5,000 kg] of universal waste)
- (2) Large-quantity handlers (accumulates more than 11,023 lb [5,000 kg] of universal waste)
- (3) Universal waste transporters
- (4) Universal waste destination facilities

See the following website for further information:

<https://www.epa.gov/hw/universal-waste#:~:text=EPA's%20universal%20waste%20regulations%20streamline,a%20wide%20variety%20of%20establishments.>

**A.3.3.133 Waste Profile.** In some situations, a profile is accompanied with a sample, so that receiving TSDF can confirm the characteristics and treatment method.

**A.4.2.1.2.2** As an example, this would include fire department access to site and buildings and postincident investigations and prefire planning activities.

**A.5.4.5.4.1** Concentrated acids are of particular concern because of the following:

- (1) Some acids, especially in a concentrated state, can contribute to a fire through an oxidation process, which generates heat.
- (2) Some reactions of acids can release flammable gases.

A hazard evaluation performed by the generator can analyze the waste acid/base to determine acceptable handling, storage, and disposal methods.

**A.5.4.5.4.2** Storage of corrosive substances, such as hydrochloric acid, nitric acid, and sulfuric acid, must be done carefully, because such substances have the ability dissolve containers, causing leakage of harmful materials.

**A.6.1** The EPA's mission is to protect human health and the environment by ensuring responsible management of hazardous and nonhazardous waste. Documentation is a critical part of this process. Hazardous waste generators and those that affect transportation, handling, treatment, storage, and disposal of hazardous waste are required to maintain documentation that identifies generation sites, waste hazard identification, personnel hazard identification, safety training, and compliance documents with EPA, OSHA, and DOT regulations and NFPA codes and standards.

**A.6.3** Most states issue the EPA identification number in lieu of the federal government. Generators can apply to their state agency for an EPA identification number.

A hazardous materials inventory statement is the first step in documenting hazardous waste hazard classes and quantity. Hazardous materials inventory statements are required by the AHJ pursuant to the instruction in Chapter 60 of NFPA 1. Chapter 6 of this recommended practice shows the fire protection documentation needed to obtain a fire code operation permit, including HMMP and HMIS. An HMIS must be provided for each building, including its appurtenant structures, and each exterior facility in which hazardous materials are stored. The hazardous materials inventory statement must list, by NFPA hazard class, all hazardous materials stored. The hazardous materials inventory statement must include the following information for each hazardous material listed:

- (1) NFPA hazard class
- (2) Common or trade name
- (3) Chemical name, major constituents, and concentrations if a mixture; waste category if a waste
- (4) Whether the material is pure or a mixture
- (5) Whether the material is a solid, liquid, or gas
- (6) Maximum aggregate quantity stored at any one time
- (7) Storage conditions related to the storage type, temperature, and pressure

**A.7.3.1** These are federal requirements; state-specific labeling requirements might differ and are likely to require more information.

**A.7.4** As an example, the regulations provide an exception from the placarding requirement in Subpart F of 49 CFR 172 for highway or rail shipment of nonbulk packages as defined in 49 CFR 171.8 that contain less than 1,001 lb (454 kg) of certain categories of hazardous materials. A frequent problem encountered involves this 1,001 lb (454 kg) exception, which is an aggregate gross weight. Aggregate gross weight is the total weight of all hazardous materials and its packaging loaded on a single transport vehicle.

**A.7.5** This annex material pertains to classification of hazardous materials and not hazardous waste.

The classification of hazardous waste as hazardous material for transportation based on PHMSA hazard class and packing group criteria enables the generator to determine the applicability of requirements for marking, labeling, and placarding of hazardous waste packages. A system known as the globally harmonized system of classification and labeling of chemicals (GHS) has been developed based on standards for classifica-

tion published by the United Nations (UN) Subcommittee of Experts on the GHS. The US continues its efforts to adopt the GHS in its federal regulatory scheme. For example, the DOT authorizes the use of GHS labels on hazardous material packages. Also, OSHA published its revised hazard communication standard (see 29 CFR 1910.1200) to align with the GHS in March 2012. The revised standard became effective in May 2012.

Appendix D of the United Nations' *Globally Harmonized System of Classification and Labelling of Chemicals (GHS)*, 29 CFR 1910.1200(g), and other information related to the revised hazard communication standard can be found on OSHA's Hazard Communication Safety and Health Topics page at [www.osha.gov/hazcom](http://www.osha.gov/hazcom).

It is anticipated 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, use, and handling. The evolution of this system of classification will be facilitated by the changes associated with classification, labeling, and 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.8.6** See NFPA 30 and NFPA 400 for additional information.

**A.8.7.1** See API RP 572 for additional resource information.

**A.9.3.3** Reactions between oxidizers and incompatible materials can be caused by several factors, including, but not limited to, the following:

- (1) Heat exposure through radiant heat, open flames, and sunlight
- (2) Incompatibility with other materials
- (3) Contact with water or miscellaneous liquids
- (4) Contamination by trash, liquids, or rust

**A.10.1.1** The ability of chemicals to combine with one another in a predetermined way permits the development and production of commercial and household products.

Commonly encountered chemical compounds derived from the reaction of one or more elements are stable under most environmental conditions and do not react dangerously with their immediate environment. However, every chemical compound has the potential ability to release harmful amounts of energy or to interact with environmental factors or other chemicals to release potentially dangerous reaction byproducts.

**A.10.2** For the purposes of Chapter 10, reactive chemicals do not include hazardous biological agents and other disease-causing agents because the emergency services community and hazardous waste industry tend to group such agents as extremely toxic and infectious materials, similar to select agents as defined by the US Centers for Disease Control and Prevention (CDC) and other international agencies.

It is important to remember that hazardous wastes are generally not pure products, or pure compounds, but they are typically mixtures of various chemical compounds. In some cases, these mixtures can retain the properties of the products from which they are derived. Frequently, however, the properties of hazardous waste mixtures vary and their behavior can be difficult to predict.

**A.10.3.1.2** High-pressure cylinders can have the following hazards:

- (1) *Dangerous properties.* A cylinder with unknown contents or at an unknown pressure presents a variety of hazards, including, but not limited to, compressed gas as well as flammable, corrosive, oxidizing, pyrophoric, or toxic materials.
  - (a) *Reactions.* Accidental contamination with an incompatible material, such as a cross-connection in laboratory or process settings, can result in an explosive reaction and dangerous fragmentation of the cylinder.
  - (b) *Unstable gases.* Old cylinders can contain chemical hazards, such as unstabilized hydrogen cyanide or pentaborane, or experimental/potentially unstable oxidizers, such as chlorine trifluoride and tetrafluorohydrazine, that might react dangerously with little, if any, input of energy or additional stimulus.
- (2) *Release.* A high-pressure release could result in fire, explosion, fuming gas, or a toxic gas release.
- (3) *Storage and handling considerations.* Residual gas in a cylinder must be handled with care. Contact your compressed gas supplier for guidance on managing residual gas in the cylinder.
- (4) *Safe distance concerns.* Safe distance is dependent upon the cylinder contents, size, or site conditions, or any combination thereof.

**A.10.3.2** Monomers are typically sold containing an inhibitor to prevent hazardous polymerization. The manufacturer should be contacted about the product expiration date of the monomer and the need to reinhibit the monomer periodically. Caution should be used when handling monomers as contact with any impurity, light, heat, shock, or oxygen could deplete the inhibitor or initiate polymerization. Extreme caution should be taken when polymerization has started because the process is difficult to control or stop.

All handling equipment and material should be clean to avoid contamination of the monomer, which could deplete the inhibitor or initiate polymerization.

**A.10.3.3** Most countries have very stringent standards for the safe transportation and management of temperature-sensitive compounds. They should be stabilized or inhibited in a manner to preclude dangerous evolution of heat or gas. For example, 49 CFR 173.21 outlines refrigeration (i.e., temperature control) as a means of stabilization, otherwise temperature-sensitive compounds would be forbidden from transport.

Care should be taken regarding acceptable temperatures for storage because if the maximum safe storage temperature is exceeded, the material will decompose and release heat, oxygen, and flammable gases.

Caution should be taken since decomposition rates and subsequent hazards depend on the specific chemicals decomposing.

At or above the self-accelerating decomposition temperature (SADT), the material could undergo self-accelerating decomposition releasing heat, oxygen, and flammable gas. This decomposition can cause the container to burst, ignite and burn, or explode.

Caution should be taken with storage and handling considerations for temperature-sensitive compounds because they have prescribed measures for shipping in compliance with manufacturers' recommended safe storage temperatures and identifying safe control temperatures at which self-reactive materials (e.g., organic peroxides) are stable.

If managing temperature-sensitive compounds, consideration should be given to establishing an emergency refrigeration plan if power or refrigeration is lost. For some compound storage, temperatures that are too cold can present hazards as well. The manufacturer should be consulted for the appropriate storage temperature.

**A.10.3.4** A good example of a spontaneously decomposing material is unstabilized hydrogen cyanide (or hydrocyanic acid), which is capable of undergoing an unpredictable exothermic autopolymerization. This can occur without warning and without any apparent stimulus, resulting in explosion or rupture of the cylinder.

This classification of chemicals includes peroxide formers (e.g., isopropyl ether), monomers (e.g., styrene), and contaminated mixtures (e.g., nitric acid and ethanol) because, when permitted to react, these materials tend to become more dangerous as time passes.

**A.10.3.5** Extreme caution is needed when handling and processing chemical-warfare-agent-related secondary waste because of the many hazards associated with such materials.

Chemical warfare agents can produce a harmful physiological or psychological reaction when applied to the body externally, when inhaled, or when taken internally at sufficient doses. Most chemical agents cause a disruption of normal body functions. The two main types of chemical warfare agents are blister agents and nerve agents, but there are incapacitating agents as well.

If these materials are improperly handled in concentrated form, exposure via inhalation, ingestion, contact, or injection is likely to cause death to humans and animals.

Immediate emergency medical attention should be sought if exposure is suspected. Decontamination of blister agents must be accomplished within two minutes after contamination if serious effects are to be prevented.

Caution should be used if encountering nerve agents since they are characterized by the great rapidity with which they act. First-aid measures, such as antidotes, should be carried out within a few minutes after lethal dosages of these chemical agents have been absorbed to prevent death.

The following additional considerations should be incorporated for potential chemical warfare agent exposure:

- (1) Chemical warfare agents are not typically reactive with water, air, shock, friction, or static discharge; however, if released they can cover a large area in an extremely short amount of time.
- (2) If chemical warfare agents are suspected on-site, the area should be isolated.

**A.10.3.6** Because the materials in this category can be explosive, flammable, corrosive, or toxic, extreme care should be taken and additional precautions might need to be taken. For example, many flammable solids are explosives that can be wetted with the appropriate amount of water or solvent, such

that they are no longer classified as explosive. The appropriate amount of wetting will vary depending on the chemical makeup of the flammable solid; however, if the amount of water or solvent evaporates to below the required percentage of wetting, the material could become a shock-sensitive explosive material.

Because fire or explosion are possible under adverse conditions, the following are additional concerns where storing and handling explosives, propellants, and shock-sensitive and explosive materials:

- (1) Explosives, propellants, shock-sensitive and explosive materials can emit hazardous fumes or gases (e.g., nitrogen oxides, carbon monoxide, oxygen) when heated to decomposition.
- (2) Contamination or mixing explosives, propellants, or shock-sensitive and explosive materials with incompatible solvents might lead to increased shock sensitivity.
- (3) In some cases, the formation of more sensitive decomposition products or fuming flammable/explosive vapors could result.
- (4) Fire or explosion of a shock-sensitive material does not necessarily constitute complete destruction of the material; therefore, the original hazards might still remain.

Care should be taken if the material appears to be recontaminated since it could be contaminated and extremely shock sensitive.

With increased age, explosives, propellants, and other shock-sensitive materials can become unstable.

**A.10.3.7** Hazardous waste from pyrotechnics and fireworks can be generated from a variety of sources, including, but not limited to, the following:

- (1) Seizure by law enforcement agencies
- (2) Transportation incidents
- (3) Post-display operations
- (4) Manufacturing sources
- (5) Handling, weather, or miscellaneous damage

The disposal of materials from pyrotechnics or fireworks is subject to regulation at many levels. The handling, storage, transportation, treatment, and disposal of hazardous wastes, which might include pyrotechnics and fireworks waste, requires extensive licensing and permitting, the details of which are currently beyond the scope of this recommended practice.

Each year, large quantities of fireworks are confiscated by law enforcement and fire authorities for a multitude of reasons. It is not uncommon for an entire truckload of fireworks to be taken in a single seizure. These authorities are then faced with the complex and potentially dangerous task of managing materials that might be unfamiliar, which can present storage and disposal safety risks and complex compliance requirements.

Minimizing the amount of accumulated hazardous waste from pyrotechnics and fireworks is a sound safety practice. The accumulation of large quantities of fireworks waste materials has proven to be very dangerous.

Management practices can be established to reduce, recycle, reuse, or repurpose pyrotechnics and fireworks. Of course, the best way to handle waste is to not have any. The second best way to handle waste is to reduce the amount of waste that is created. It is a sound best practice to reduce the amount of waste that is created and find ways to manage it without need-

ing to destructively dispose of it. This can include practices that legally allow materials that are classified as hazardous waste only because they are not in compliance with applicable jurisdictional requirements to be transferred to jurisdictions where they comply (e.g., transferring fireworks from a state in which they are illegal to a state in which they are legal).

It is important to distinguish between fireworks that have been confiscated for some classification shortcoming, jurisdictional prohibition, or possessor violation and fireworks and fireworks materials that no longer have commercial value in any jurisdiction or cannot function as designed.

**A.10.3.7.4** This section pertains to, but is not limited to, fireworks displays conducted in compliance with NFPA 1123 and pyrotechnics displays conducted in compliance with NFPA 1126.

**A.10.3.7.4.3.3** Materials that cannot be repurposed should be declared and managed as hazardous waste in compliance with the applicable regulations, including, but not limited to, 40 CFR 261, 40 CFR 262, 40 CFR 264, and 40 CFR 270.

**A.10.3.7.9.1** Treatment methods include, but are not limited to, thermal treatment, chemical destruction (including bioremediation), and other methods approved by the applicable permitting/licensing authorities. In certain emergency situations, expedited RCRA permitting processes and/or permit exemptions can also apply.

**A.10.3.8** There are many common compounds that can form such as ethers, ketones, furans, that can form explosive peroxides during storage.

Organic chemicals with extremely low concentrations of organic peroxides can be dangerous for handling or transportation.

Care should be taken with peroxides in storage and handling considerations so guidance should be followed with the manufacturer's recommendations in managing solvents with the potential to form peroxides.

The US National Safety Council has divided peroxide formers into three classifications or lists (i.e., A, B, and C). Compounds in List A have a 3-month shelf-life, and a peroxide hazard on storage. Compounds classified under list B have a 12-month shelf-life and a peroxide hazard on concentration. List C compounds also have a 12-month shelf-life, but their hazard is due to peroxide initiation of polymerization.

**A.10.3.9** Water reactive materials can be handled and stored safely as long as all exposure to an oxidizing atmosphere [i.e., air or oxygen] and moisture or other incompatible chemicals is avoided.

Failure to follow proper handling procedures with water reactive materials can result in fire or explosion, leading to serious injuries, death, or significant damage to property.

Water reactivity should be clearly presented in the SDSs or the waste profile.

Examples of water reactive materials include DOT materials defined as "dangerous when wet" per 49 CFR 173.124 and 49 CFR 172.101

For additional information, see Chapter 20 of NFPA 400.

**A.10.3.10** Pyrophoric materials include solids or liquids that, even in small quantities and without an external ignition source, can ignite within five minutes after contact with air.

Air reactive materials can be fuming, corrosive, pyrophoric, flammable, or otherwise reactive with air, moist air, oxygen, or water.

Air reactive materials react and decompose when exposed to air or moist air. These materials liberate toxic or corrosive gases or ignite upon contact with air.

Air reactive materials can be handled and stored safely as long as all exposure to an oxidizing atmosphere [i.e., air or oxygen] and moisture or other incompatible chemicals is avoided.

Failure to follow proper handling procedures can result in fire or explosion, leading to serious injuries, death, or significant damage to property.

Storage and handling procedures should follow manufacturers recommendations or review the SDSs for guidance.

**A.10.3.11** Metal catalysts, such as Raney nickel and, Raney cobalt, are considered pyrophoric when dry. Therefore, these types of materials are kept wet (i.e., wetted with a visible excess of liquid, usually with 40 percent water). However, sometimes the water used to wet the material evaporates and the metal catalyst becomes dry. This creates an extremely dangerous situation. Certain metal alloy swarf, turnings, and powders, such as those containing zirconium and hafnium, have unpredictable properties if not stored with proper moisture content.

In cases where all of the water or some of the wetting agent used to wet the material evaporates and the metal waste catalyst or reactive metal waste becomes dry, or partially dry, and outside of the moisture content safe range, an extremely dangerous condition can result as in the following:

- (1) Sometimes only the top layer of the metal catalyst or powdered metal allow is completely dried out, and movement of the container causes the contents to move inducing generation of heat leading to an explosive condition.
- (2) Powdered aluminum dust can form a flammable or an explosive mixture with air, especially when damp. Aluminum powder reacts violently or explosively with water, steam, or moisture, and evolves hydrogen gas in contact with water.
- (3) Metal catalysts and metal powder wastes can vary in their reactivity, thus it is always prudent to consult the material manufacturer and generator.

The reaction between some metal powders and water proceeds slowly at room temperatures.

**A.10.4** This category includes wastes that are not identified or labeled.

**A.12.2.2** The term *stranded* or *stored energy* refers to unknown hazardous levels of electrical energy that can be contained in a battery, including one that has been damaged and/or thought to be discharged and that represents a hazard to persons in contact with the battery or cell, who are unaware of the hazardous energy.

Lithium metal batteries employing liquid electrolytes have been developed for commercial use but in the past have had safety and performance problems in the field. Commonly avail-

able as “button” batteries, these batteries have been developed for larger format stationary battery energy storage.

Commercially available lithium metal batteries utilized for energy storage systems (ESS) do not employ liquid electrolytes. The current lithium metal technologies use solid polymer electrolytes, a lithium metal negative electrode, and a metal oxide cathode such as vanadium oxide combined with lithium salt and polymer to form a plastic composite.

Solid polymer electrolyte (SPE) lithium metal batteries must be heated to about 140°F to 176°F (60°C to 80°C) to be activated.

**A.12.3** The term *lithium-ion battery* or *lithium-ioncell* refers to a battery where the negative electrode (i.e., anode) and positive electrode (i.e., cathode) materials serve as a host for the lithium ion (Li+). Lithium ions move from the anode to the cathode during discharge and are intercalated into (i.e., inserted into voids in the crystallographic structure of) the cathode. The ions reverse direction during charging. Since lithium ions are intercalated into host materials during charge or discharge, there is no free lithium metal within a lithium-ion cell and thus, even if a cell does ignite due to external flame impingement or an internal fault, metal fire suppression techniques are not appropriate for controlling the lithium-ion fire.

**A.12.3.1** The primary cause of lithium-ion battery fires is batteries with a state of charge (SOC) greater than 30 percent and a mechanism of shorting, including a battery terminal short circuiting via direct terminal contact or contact due to movement within packaging.

Exposure heating of the batteries or cells can also cause the battery or cell to go into thermal runaway and ignition.

**A.12.3.5** Lithium batteries and cells can be hazardous when in use under normal conditions, when in use under emergency or abnormal conditions, and when being handled as a waste. Normal operating conditions can include hazards that exist during normal operations while the batteries or cells are being managed by the device/system they are installed within. Normal operating conditions are considered optimal for the safety of lithium batteries or cells because their conditions are monitored or managed and abnormal conditions can be identified, responded to, and mitigated. Once lithium batteries or cells are removed and designated for disposal their condition is no longer monitored or managed even though they might have stranded energy levels.

Hazard considerations for Li-ion, solid-state batteries or cells under normal operating conditions include, but are not limited to, the following:

- (1) *Fire hazards.* There can be potential for fire hazards if there are latent defects within the Li-ion batteries or cells, or design issues with the controls that prevent thermal runaway of the Li-ion batteries or cells. Systems need to be evaluated for their ability to prevent propagation due to these defects.
- (2) *Electrical hazards.* There are electrical hazards associated with routine maintenance of Li-ion batteries or cells if they are at hazardous voltage and energy levels.
- (3) *Stranded or stored energy hazards.* There can be potential for stranded or stored energy hazards during maintenance if the Li-ion batteries or cells cannot be isolated for maintenance or replacement.

Physical and chemical hazards are not expected to be present during normal lithium battery operation.

Hazard considerations for Li-ion, solid-state batteries or cells under emergency/abnormal conditions include, but are not limited to, the following:

- (1) *Fire hazards.* There can be potential for thermal runaway if the batteries are not maintained at appropriate operating parameters as a result of any of the following:
  - (a) Exposure to heat
  - (b) Crushing or other physical damage
  - (c) Short-circuiting
- (2) *Chemical hazards.* There can be potential for off-gassing of hazardous vapors under abnormal conditions depending on the size of the Li-ion batteries or cells and the level of failure.
- (3) *Electrical hazards.* Electrical hazards might be present under abnormal conditions if the system is at hazardous voltage and energy levels.
- (4) *Stranded or stored energy hazards.* There can be potential for stranded energy hazards if the Li-ion batteries or cells are exposed to abnormal conditions where they might still contain hazardous levels of energy.
- (5) *Damaged battery hazards.* Damaged Li-ion batteries or cells might contain stored energy that can be a hazard during disposal if care is not taken.
- (6) *Physical hazards.* Depending on the design of the system, potential exists for physical hazards under abnormal conditions if accessible parts are overheating or if there is exposure to moving hazardous parts, such as fans where guards might be missing.

**A.12.8.1.1** Hazard considerations for lead-acid batteries under normal operating conditions include, but are not limited to, the following:

- (1) *Fire hazards.* There can be potential for fire hazards if there are defects within the lead-acid batteries, or design issues with the controls that prevent thermal runaway of the cells. Systems need to be evaluated for their ability to prevent propagation due to these defects.
- (2) *Chemical hazards.* There can be potential exposure to acid from leaking lead-acid batteries.
- (3) *Electrical hazards.* There are electrical hazards associated with routine maintenance of lead-acid batteries if they are at hazardous voltage and energy levels.
- (4) *Stranded or stored energy hazards.* There can be potential for stranded or stored energy hazards during maintenance if the lead-acid batteries cannot be isolated for maintenance or replacement.
- (5) *Physical hazards.* Lead-acid batteries can be large in size where their weight and size have the potential to cause injury.

Hazard considerations for lead-acid batteries under emergency/abnormal conditions include, but are not limited to, the following:

- (1) *Fire hazards.* There can be potential for thermal runaway if the lead-acid batteries are not maintained at appropriate operating parameters as a result of abnormal conditions and if not evaluated for ability to prevent propagation due to latent defects. Also, there might be fire hazards due to short-circuiting conditions.
- (2) *Chemical hazards.* There can be potential exposure to leaking acid from lead-acid batteries.

- (3) *Electrical hazards.* Electrical hazards might be present under abnormal conditions if the system is at hazardous voltage and energy levels.
- (4) *Stranded or stored energy hazards.* There can be potential for stranded or stored energy hazards if the lead-acid batteries are improperly disposed into steel drums, creating a hydrogen gas reaction.
- (5) *Physical hazards.* Depending on the design of the system, potential exists for physical hazards under abnormal conditions if accessible parts are overheating or if there is exposure to moving hazardous parts, such as fans where guards might be missing.

**A.12.9** The following resources can be referenced for additional information regarding regulatory and advisory guidance for battery management:

- (1) IATA lithium battery guidance at [www.iata.org/whatwedo/cargo/dgr/Pages/lithium-batteries.aspx](http://www.iata.org/whatwedo/cargo/dgr/Pages/lithium-batteries.aspx)
- (2) NFPA Research Foundation Study, "Lithium-ion Batteries Hazard and Use Assessment," at [www.nrc.gov/docs/ML1719/ML17191A294.pdf](http://www.nrc.gov/docs/ML1719/ML17191A294.pdf)
- (3) NFPA Research Foundation Study, "Lithium-ion Batteries Use and Assessment — Phase III," at [www.nfpa.org/News-and-Research/Fire-statistics-and-reports/Research-reports/Hazardous-materials/Lithium-ion-batteries-hazard-and-use-assessment](http://www.nfpa.org/News-and-Research/Fire-statistics-and-reports/Research-reports/Hazardous-materials/Lithium-ion-batteries-hazard-and-use-assessment)
- (4) 49 CFR 173.185
- (5) Transport Canada battery transport guidance at [tc.canada.ca/en/dangerous-goods/transporting-batteries](http://tc.canada.ca/en/dangerous-goods/transporting-batteries)
- (6) US DOE Battery Abuse Testing Laboratory (BATLab) information at [energy.sandia.gov/keycapabilities/facilities/batlab/](http://energy.sandia.gov/keycapabilities/facilities/batlab/)
- (7) US EPA information on universal waste at [www.epa.gov/hw/universal-waste](http://www.epa.gov/hw/universal-waste)

**A.13.1** US or other jurisdictional regulations prescribe mandated minimum training requirements for hazardous waste management. Different business models and practices can create potential training gaps, which could cause hazardous waste to be mismanaged.

**A.13.2.1** According to the EPA, the volume of hazardous waste each generator produces determines which regulations apply to that generator, which in turn indicates the training requirements for that facility. (See [www.epa.gov/hwgenerators/categories-hazardous-waste-generators](http://www.epa.gov/hwgenerators/categories-hazardous-waste-generators).)

**A.13.3.5** The risk assessment must include planning for potential emergencies, which is a core component of 29 CFR 1910.120(q) and possibly other international documents. Both generators and TSDs must plan and prepare for emergencies by notifying local authorities. However, gaps can exist if local authorities incorrectly assume the facility will handle an emergency while the facility believes the local responders will provide necessary assistance. The risk assessment must identify potential emergency events and how the facility's capabilities can respond.

**A.14.2.2** Samples for emergency planning can be found in the following:

- (1) Annex H
- (2) Chapter 7 of NFPA 400
- (3) Annex C of NFPA 400
- (4) 40 CFR 112
- (5) 40 CFR 264.52
- (6) OSHA 3114

- (7) Subpart D of 40 CFR 265
- (8) Subpart G of 49 CFR 172

**A.14.2.3** Emergency handling information, such as the emergency response guidebook (ERG), should be available at all times for transporters.

**A.14.4.2** See Chapter 7 of NFPA 400.

**A.14.6** See Chapter 8, which includes specific recommended practices for fire risk control.

## Annex B Hazardous Waste Manifests

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

**B.1** Instructions for completing hazardous waste manifests are provided in Forms 8700-22 and 8700-22A, which can be found at [www.epa.gov/hwgenerators/uniform-hazardous-waste-manifest-instructions-sample-form-and-continuation-sheet](http://www.epa.gov/hwgenerators/uniform-hazardous-waste-manifest-instructions-sample-form-and-continuation-sheet).

**B.2** The EPA established a national system for tracking hazardous waste shipments electronically. This system, known as E-Manifest, will modernize the nation's hazardous waste tracking process.

## Annex C Hazard Communication Safety Data Sheets (SDSs)

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

**C.1** The chemical manufacturer, distributor, or importer is required by 29 CFR 1910.1200(g) to provide safety data sheets (SDSs) [formerly material safety data sheets (MSDSs)] for each hazardous chemical to downstream users to communicate information on these hazards.

Additional information related to SDSs can be found on OSHA's website at: <https://www.osha.gov/Publications/OSHA3514.html#:~:text=The%20SDS%20includes%20information%20such,storage%2C%20and%20transporting%20the%20chemical>.

## Annex D Pipeline and Hazardous Materials Safety Administration (PHMSA) Hazardous Materials Table

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

**D.1** Generators of hazardous waste who intend to transport must follow PHMSA regulations (see 49 CFR 171–180).

These regulations include the following functions for transportation, storage incidental to transport, and handling of hazardous waste regulated by PHMSA as a hazardous material:

- (1) Classification of the hazard of a material/waste
- (2) Packaging selection and maintenance of packages
- (3) Transportation and handling of hazardous materials and hazardous waste
- (4) Hazardous communication during transport (i.e., marking, labeling, placarding, and shipping documentation)
- (5) Emergency response support
- (6) Training
- (7) Accident avoidance

**D.2** Hazardous waste packages should be marked, labeled, and placarded in accordance with the hazardous materials regulations before shipping. It is recommended that the PHMSA hazard communication regulations be utilized to communicate the hazards of hazard waste from generation through disposal. Generators of hazardous waste should follow PHMSA regulations including packaging selection, marking, labeling and placarding. After completing the hazard classification of the waste, the generator can use the 49 CFR 172.101 hazardous material table (HMT) to determine the appropriate hazardous materials description that will inform the required marking, labeling, and placarding for the hazard waste.

Marking, labeling, and placarding are critical parts of hazardous communication for waste. The hazardous waste generator and those that affect hazardous waste packages, transportation, handle, treatment, storage, and disposal of hazardous waste should provide the correct hazard communications to ensure those that handle, store, use, and respond to incidents are aware of the hazards of the waste.

The generator can use additional internal hazardous communication policies and programs to communicate hazards.

Generators of hazardous waste are cautioned that the classification of hazardous waste under the requirements of the US Environmental Protection Agency (EPA) or PHMSA for shipping purposes might not correspond to the system of classification incorporated into NFPA codes and standards. In addition, some judgment is needed to apply the code in circumstances where the waste material is not in a form that is normally encountered when the hazardous material employed is in its virgin state. For example, a material that might not have been hazardous in its pure form might become hazardous when it becomes contaminated as use occurs.

#### **Annex E Improper Packaging of Batteries for Shipment**

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

**E.1** Examples of proper methods for shipping batteries can be seen in Figure E.1(a) and Figure E.1(b). [See also 49 CFR 173.185(C).]

Figure E.1(c) through Figure E.1(e) show examples of improperly shipped batteries.



FIGURE E.1(a) Example of Proper Shipping Method for Cylindrical Batteries.



**FIGURE E.1(b)** Example of Proper Shipping Method for Button Cell Batteries.



**FIGURE E.1(c)** Mixed-Type Batteries not Secured Properly (i.e., taped terminals, Example 1). (Courtesy of Clean Harbors.)



**FIGURE E.1(d)** Mixed-Type Batteries not Secured Properly (i.e., taped terminals, Example 2). (Courtesy of Clean Harbors.)



FIGURE E.1(e) Mixed-Type Batteries not Secured Properly (i.e., taped terminals, Example 3). (Courtesy of Clean Harbors.)

#### Annex F Peroxide Formers Classification

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

**F.1** Several chemical compounds form unstable organic peroxides when exposed to air.

The following technical references can aid in identifying materials that can form peroxide:

- (1) D. E. Clark, "Peroxides and peroxide-forming compounds," *Chemical Health & Safety*, September/October 2001, pp. 12–22.
- (2) R. J. Kelly, "Review of Safety Guidelines for Peroxidizable Organic Chemicals," *Chemical Health & Safety*, September/October 1996, pp. 28–36.

#### Annex G Examples of Potentially Incompatible Waste

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

**G.1** Many hazardous wastes can produce the following effects when mixed with other waste or materials:

- (1) Heat or pressure
- (2) Fire or explosion

- (3) Violent reaction
- (4) Toxic dusts, mists, fumes, or gases
- (5) Flammable fumes or gases

For more information, see Appendix V of 40 CFR 264.

#### Annex H Emergency Response Plan Check List

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

**H.1** Figure H.1 shows an example emergency response plan checklist.

HAZARDOUS WASTE TREATMENT, STORAGE, AND DISPOSAL FACILITY SAFETY CHECKLIST		
1	Location of Hazardous Waste Treatment, Storage, and Disposal Facility	Additional Descriptor
	Description of Facility	
2	Date Issued	
<b>EMERGENCY RESPONSE PLAN</b>		
3	<p>In the event of a fire, explosion, or any unplanned sudden or nonsudden release of hazardous waste or hazardous waste contamination to air, soil, or surface water that the facility generates, what is the emergency response plan?</p> <p><b>(1) Discovery</b>  <i>This section should address the initial action the person(s) discovering an incident should take to alert others to the response procedures.</i></p> <p><b>(2) Initial Response</b></p> <p>a. Procedures for internal and external notifications  <i>This section should include who will be notified in the event of an emergency. Contact information should be included in the Rescue and Emergency section of this checklist.</i></p> <p>b. Establishment of a response management system  <i>This section should instruct personnel in the implementation of a response management system for coordinating the response effort.</i></p> <p>c. Procedures for preliminary assessment of the situation  <i>This section should include an identification of incident type, hazards involved, size of the problem, and resources impacted.</i></p> <p>d. Procedures for establishment of objectives and priorities for response to the specific incident, including the following:</p> <p>i. Immediate goals/short-term response plan</p> <p>ii. Actions to be taken</p> <p>iii. Identification of resources needed for response (e.g., hazmat spill kit)</p> <p>e. Procedures for implementation of short-term response plan (i.e., hazmat response plan)</p> <p>f. Procedures for response (e.g., obtain hazmat spill kit, obtain fire extinguisher)</p>	
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FIGURE H.1 Emergency Response Plan Checklist Example.