

COMMODITY CLASSIFICATION

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1.0 SCOPE

This data sheet provides guidance on classifying stored commodities. Examples of Class 1, 2, 3, unexpanded plastic, and expanded plastic storage commodities are also provided in this data sheet.

Recommendations for protection of these commodities can be found in Data Sheet 8-9, *Storage of Class 1, 2, 3, 4 and Plastic Commodities*.

1.1 Hazards

Refer to the applicable occupancy-specific data sheet (see Appendix A for definition) for loss prevention recommendations related to the following subjects, which are not covered in this data sheet:

- Storage of special hazards such as ignitable liquids (DS 7-29), aerosol products (DS 7-31), compressed gasses (DS 7-50)
- Storage of commodities such as rubber tires (DS 8-3), baled fiber (DS 8-7), hanging garments (DS 8-18), roll paper (DS 8-21), baled waste paper (DS 8-22), rolled non-woven fabrics (DS 8-23), pallets (DS 8-24), and carpets (DS 8-30)
- Storage arrangements, such as carousel storage (DS 8-33) or automatic storage and retrieval systems (DS 8-34), that contain high-value equipment

1.2 Changes

January 2023. Interim revision. The following changes were made:

- A. Changed the upper limit of 10% expanded plastic allowed on outer portion of product to 20% in Section 2.2.5.1C.
- B. Updated Figure 2.2.7 references and percentage of expanded plastic.
- C. Added guidance on how to treat partial packaging in Section 2.2.8.1.2.
- D. Added guidance on how to treat wooden crates for external packaging in Section 2.2.8.4.
- E. Added guidance for encapsulated product in Section 2.2.8.5.
- F. Added guidance for flexible intermediate bulk containers (i.e., bulk bags or supersacks) in Section 2.2.8.6.
- G. Clarified treatment of cardboard pallets for commodity classification in Section 2.2.9.
- H. Clarified and expanded lithium-ion battery storage guidance in Section 2.4.2.
- I. Updated empty intermediate bulk container guidance in Section 2.4.3 including Table 2.4.3.1.
- J. Updated following items in Table 2.3:
 1. Changed formatting to remove category column and added sub-heading rows.
 2. Added item 21 for melamine sheets.
 3. Clarified item 45 intent of 'no air spaces'.
 4. Removed reference to Data Sheet 7-29 in item 48, as information is now in 8-1.
 5. Clarified item 64 intent to be 100% full of produce.
 6. Added item 80 for charcoal.
 7. Added item 106 for phase change material guidance to reference Data Sheet 7-29.
 8. Added item 116 for aluminum foil laminate paper with plastic components.
 9. Updated item 165, polyester/epoxy coating powder, to Class 3 from CUP.
 10. Added item 166 for combustible dust stored in cartons or plastic bags for bulk storage.
 11. Added item 169 for metal powders in sealed metal containers/cans to reference Data Sheet 7-76.
 12. Added item 204 for green wood products.
- K. Revised figure and table numbers to align with current formatting standards.

2.0 LOSS PREVENTION RECOMMENDATIONS

2.1 General

A commodity includes stored materials, internal packaging, external packaging (e.g., cardboard containers), and material handling products (e.g., pallets). (See Figure 2.1.) When evaluating commodities to determine their classification, all these components need to be included. Section 2.2 provides guidance on evaluating these individual components of the commodity. Table 2.3 of Section 2.3 includes a list of example materials and their classifications.

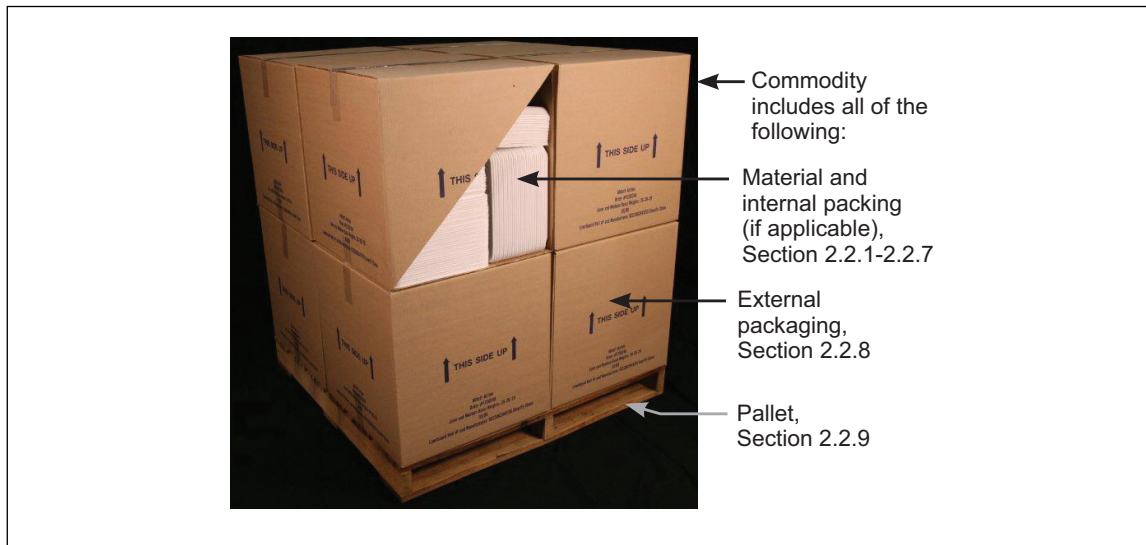


Fig. 2.1. Commodity components

FM Global's standard commodities are ranked from the lowest hazard (noncombustible) to the highest hazard (uncartoned expanded plastic), as follows:

- Noncombustible
- Class 1
- Class 2
- Class 3
- Class 4/Cartoned unexpanded plastic (CUP)
- Cartoned expanded plastic (CEP)
- Uncartoned unexpanded plastic (UUP)
- Uncartoned expanded plastic (UEP)

2.2 Commodity Classification

Follow these three steps to determine the commodity classification:

First Step: Evaluate the material and internal packaging. To do so, use Sections 2.2.1 through 2.2.6.

When there is a combination of materials (i.e. noncombustible, ordinary combustibles, unexpanded, and expanded plastic), use Figure 2.2.7 (Section 2.2.7). Include only the material and internal packaging when determining the percent of plastic. The density of expanded plastic may be assumed to be 2 lb/ft³ (32 kg/m³).

Second Step: Evaluate the effect of external packaging. Use Section 2.2.8.

Third Step: Evaluate the effect of pallets. Use Section 2.2.9.

Additionally, Section 2.3, Table 2.3 may be used as a tool to aid in the commodity classification. The "materials" listed in Table 2.3 may describe one, or a combination, of the commodity's components. For example, "materials" may describe the following:

- Stored materials
- Stored materials and internal packaging
- The material, the internal packaging, and external packaging

Depending on the information provided in Table 2.3, consider the three steps above to determine the overall commodity classification.

2.2.1 Noncombustible

2.2.1.1 Classify materials that do not burn as noncombustible. Noncombustible commodities do not require, by themselves, sprinkler protection.

Note: Sprinkler protection is required for facilities that have combustibles in the construction, the occupancy, or material-handling processes. If the current occupancy and construction is noncombustible, sprinkler protection should be considered to accommodate future changes to storage, occupancy, or construction.

2.2.2 Class 1

2.2.2.1 Classify stored materials that meet the following as Class 1 commodities:

- A. Noncombustible materials on wood or FM Approved pallets
- B. Noncombustible materials packaged in single-layer corrugated cardboard cartons with or without single thickness dividers, or in ordinary paper wrappings on wood or FM Approved pallets

Class 1 commodities may contain a negligible amount of plastic trim such as knobs or handles.

2.2.3 Class 2

2.2.3.1 Classify stored materials that meet the following as Class 2 commodities:

Noncombustible or Class 1 commodities stored in multiple-thickness corrugated cardboard cartons, slatted wooden containers, solid wooden boxes, or equivalent combustible packaging material on wood or FM Approved pallets.

2.2.4 Class 3

2.2.4.1 Classify stored materials that meet the following criteria as Class 3 commodities:

- A. Cellulosic materials, such as wood, paper, or natural textiles, on wood or FM Approved pallets. Products may or may not be stored in corrugated cardboard cartons.
- B. Classes 1, 2, and 3 materials containing no more than 5% plastic (unexpanded, expanded, or a combination of the two) by either weight or volume.

2.2.5 Class 4/Unexpanded Plastic (UP)

2.2.5.1 Treat stored materials that meet the following criteria as unexpanded plastic:

- A. Total weight or volume of unexpanded plastic is more than 5% for a single pallet load.
- B. Total volume of expanded plastic (foam plastic) is from 5% to 40% for a single pallet load.
- C. Total volume of expanded plastic is greater than 5% and up to 20% when exposed or located on the outer portion of the material (i.e., protects or envelops the material). See Figure 2.2.5.1

2.2.5.2 If the material is considered unexpanded plastic and is stored in corrugated cardboard cartons, treat the commodity as cartoned unexpanded plastic (CUP)/Class 4. Otherwise, treat it as uncartoned unexpanded plastic (UUP). Some exceptions apply and are listed in Table 2.3 (Section 2.3).

2.2.6 Expanded Plastic (EP)

2.2.6.1 Treat stored materials that meet the following criteria as expanded plastic:

- A. Total volume of expanded plastic (foam plastic) is greater than 40%.
- B. Total volume of expanded plastic is greater than 20% and is exposed or located on the outer portion of the material (i.e., protects or envelops the material). See Figure 2.2.5.1.

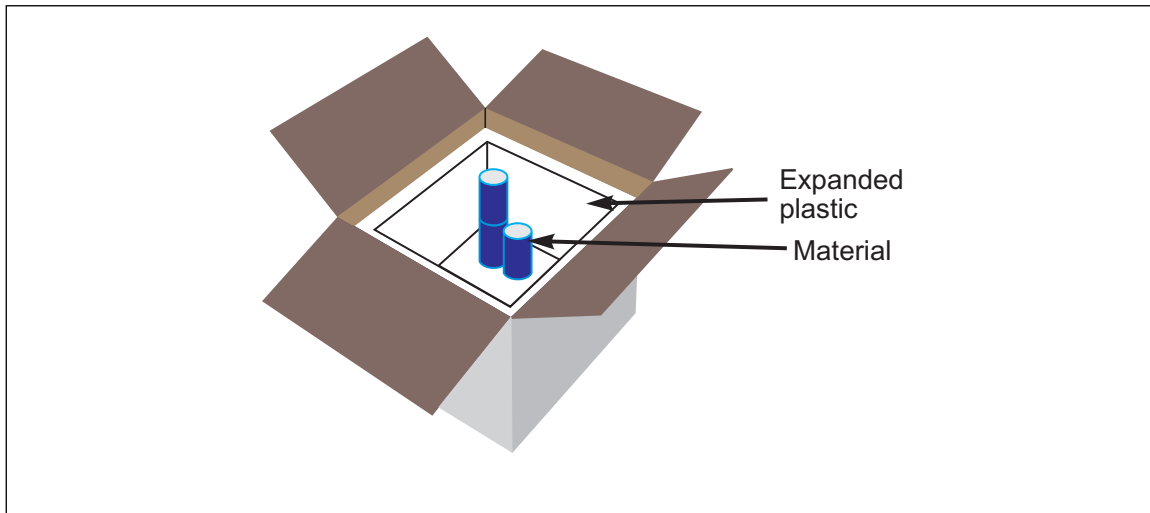


Fig. 2.2.5.1. Volume of EP that envelops the material

C. Empty plastic containers that hold more than 32 oz (1 L) and are not nested.

2.2.6.2 If the material is considered EP and is stored in corrugated cardboard cartons, treat the commodity as cartoned expanded plastic (CEP). Otherwise, treat it as uncartoned expanded plastic (UEP). Some exceptions apply and are listed in Table 2.3 of Section 2.3.

2.2.7 Classifying Commodities Containing Plastics

Apply Figure 2.2.7 to materials and the internal packaging that contain expanded plastic and/or unexpanded plastic materials.

If the material/internal packaging is stored in a corrugated cardboard box, take this into account. For example, if it is determined the material/internal packaging is unexpanded plastic but stored in cartons, the commodity classification should be cartoned unexpanded plastic (CUP).

If the material is stored in plastic containers, classify the material/internal packaging based on Figure 2.2.7 and refer to Section 2.2.8 and/or Table 2.3 for guidance on how to classify the entire commodity (i.e., including the plastic container).

2.2.8 External Packaging

The external packaging of a material will determine the early stages of fire growth. If the external packaging is a higher or lower hazard than the material inside the package, adjust the commodity classification accordingly. The commodity classification may be raised or lowered based on the external packaging. The following containers and adjustments are typically used for external packaging.

2.2.8.1 Corrugated cardboard cartons: Corrugated cardboard cartons absorb sprinkler water, which can help by wetting the commodity and reducing fire spread. **On the other hand, cartons burn easily, allowing fire to spread up a storage array quickly and operate sprinklers faster. A lack of cardboard packaging allows a fire to grow low in a storage array, leading to a larger fire when the first sprinkler operates.** A commodity that consists of plastic materials stored in a corrugated cardboard carton is treated as a cartoned plastic commodity (CUP or CEP). Noncombustible solids in corrugated cardboard cartons are protected as Class 1 commodities.

2.2.8.1.1 Partial packaging: Partial packaging using corrugated cardboard cartons can be considered as fully cartoned for commodity classification purposes when either of the following criteria are met:

- A. Only one of the carton's sides has been removed.
- B. More than one side has been removed, but cardboard covers at least the bottom, top, and 75% of the total area of the four vertical sides.

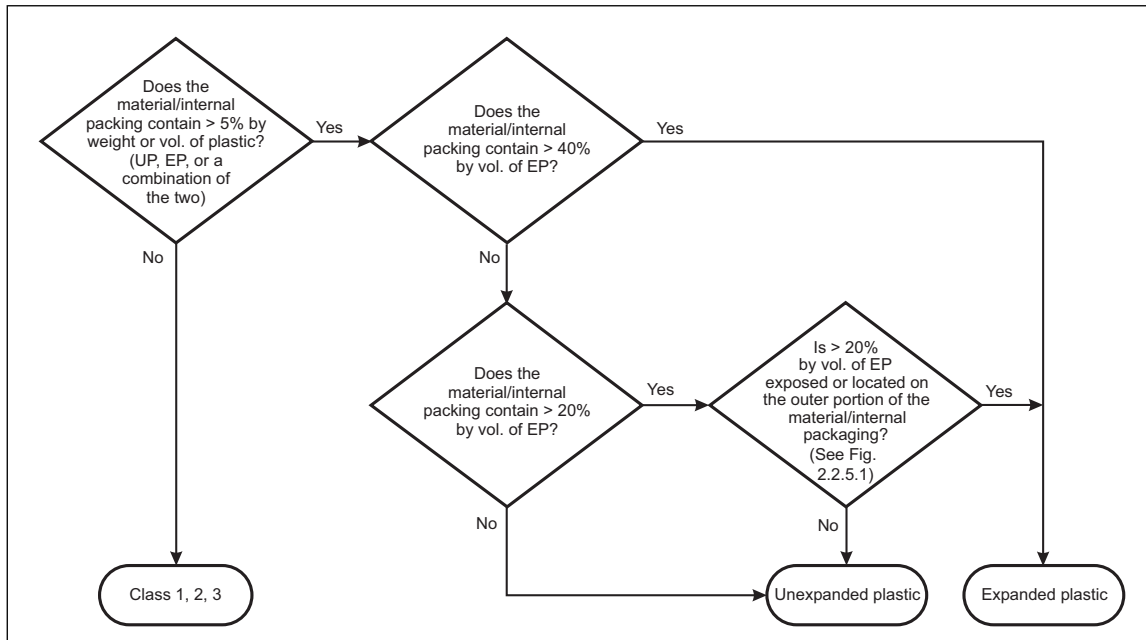


Fig. 2.2.7. Classify cartoned commodities containing plastic

If the top is completely removed and sprinkler water can be collected, see open-top container protection guidance in Data Sheet 8-9, *Storage of Class 1, 2, 3, 4 and Plastic Commodities*.

2.2.8.2 Solid metal containers: Solid metal containers will decrease the hazard. A commodity that consists of plastic materials stored in a five-sided, open top, solid metal container is treated as a Class 3 commodity. A commodity that consists of plastic materials stored in a solid metal container with a solid metal top is treated as a Class 1 commodity.

2.2.8.3 Solid and gridded unexpanded plastic storage containers (see Figures 2.2.8.3-1 and 2.2.8.3-2): In general, plastic storage containers drive the fire protection. Treat the commodity in accordance with Table 2.2.8.3.

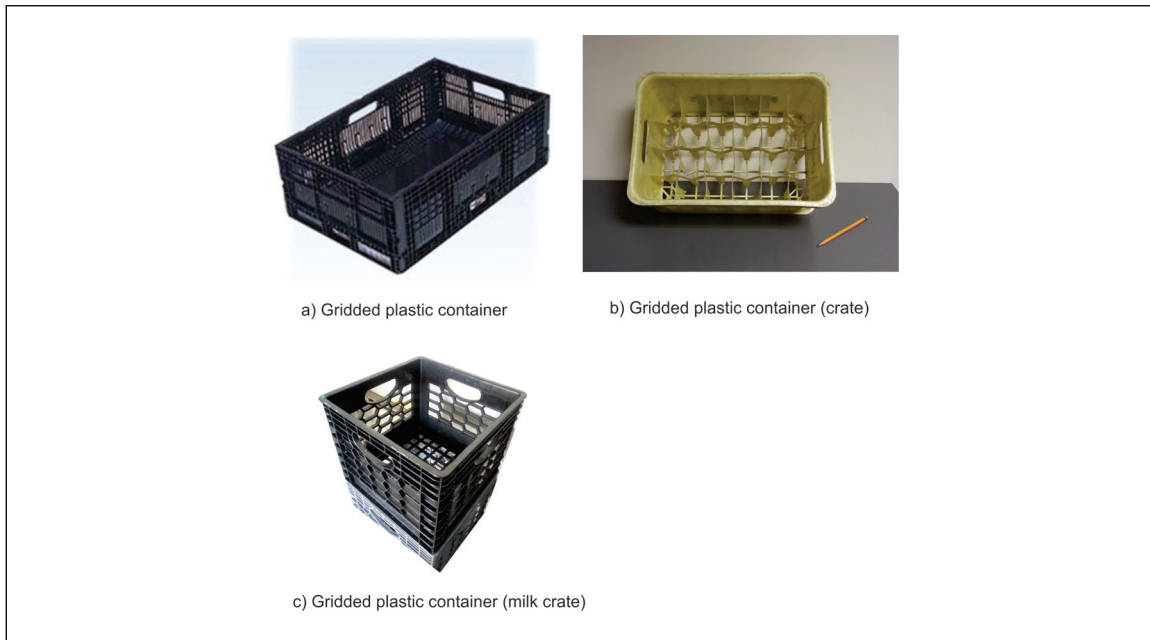


Fig. 2.2.8.3-1. Examples of gridded plastic containers (i.e., plastic containers that are significantly open on the sides and/or bottoms)



Fig. 2.2.8.3-2. Examples of solid plastic containers (i.e., plastic containers that do not have openings on the sides and/or bottoms)

Table 2.2.8.3. Products Stored in Plastic Containers

| General Contents | Container Sides and/or Bottoms | Wall Thickness in. (mm) | Volume of the Plastic Container gal (L) | Description of Contents | Commodity Classification |
|------------------------|--------------------------------|-----------------------------------|---|--|--------------------------|
| Solid | Solids or gridded | Any | > 1 (4) | Noncombustible | UUP |
| | | | ≤ 1 (4) | Noncombustible | CUP |
| | | | Any | Combustible UUP or a lesser hazard | UUP |
| | | | Any | UEP commodities | UEP |
| Liquid or Semi-Liquids | Gridded | Any | Any | Bottles or jars of any material (glass, plastic, metal, laminated paper/carton) containing nonignitable liquids/semi-liquids | Class 1 |
| | | | | Solid | Any |
| | ≤ 5 (19) | Nonignitable liquids/semi-liquids | Class 1 | | |
| | ≥ 1/4 (6) | > 5 (19) | Nonignitable liquids/semi-liquids | UUP | |
| | < 1/4 (6) | > 5 (19) | Nonignitable liquids/semi-liquids | Class 2 | |

2.2.8.4 Wood Crate: Solid wooden crates at least 0.25 in. (6.3 mm) thick, will decrease the hazard. A commodity that consists of plastic materials stored in a five-sided, closed-top, solid wooden crate is treated as a Class 3 commodity except when the commodity is li-ion batteries.

2.2.8.5 Encapsulated Commodity: Encapsulation does not significantly impact the commodity classification of a product. However, the encapsulation will impact the pre-wetting capabilities of the commodity; and therefore, needs to be accounted for in the sprinkler system design. The protection design guidelines provided in Data Sheet 8-9, *Storage of Class 1, 2, 3, 4 and Plastic Commodities*, already account for the presence of encapsulation.

2.2.8.6 Flexible Intermediate Bulk Containers (Supersacks): Flexible intermediate bulk containers are usually combustible bags that store free-flowing material. Once the bag burns through, the free-flowing material inside will flow or spill out of the bag, reducing the fire intensity. Combustible flexible intermediate bulk containers storing inert free-flowing material are protected as Class 1 commodities. Combustible flexible intermediate bulk containers storing free-flowing unexpanded plastic material are protected as CUP commodities.

2.2.9 Pallets Supporting Commodities

2.2.9.1 Wood or FM Approved pallets: There is no increase in commodity classification. Except when noncombustible materials are stored, treat as Class 1.

2.2.9.1.1 Treat cardboard pallets as wood pallets for commodity classification purposes.

2.2.9.1.2 Do not use cardboard pallets for ignitable liquid handling.

2.2.9.1.3 Only use FM Approved pallets with ignitable liquid storage where allowed by Data Sheet 7-29.

2.2.9.2 Unexpanded plastic pallets (not FM Approved): There is no increase in commodity classification if the material itself is considered a plastic (CUP, CEP, UUP, or UEP) and is supported by unexpanded plastic pallets.

Increase the classification of the commodity by one level when non-FM Approved plastic pallets are used to support stored commodities. Increase the classification of the commodity as follows:

Class 1 → Class 2

Class 2 → Class 3

Class 3 → Cartoned unexpanded plastic (CUP)

2.2.9.3 Expanded plastic pallet (not FM Approved): There is no increase in commodity classification if the material itself is considered an expanded plastic. If it is not an expanded plastic, take into consideration the volume of the pallet to determine the commodity classification. For example, if the pallet consists of 15% by volume of the overall pallet load, the commodity is considered expanded plastic.

2.2.9.4 The following assumptions may be used if the weight or volume of the material is not provided:

- A. Density of expanded plastic: 2 lb/ft³ (32 kg/m³)
- B. Weight of a plastic pallet (high-density polyethylene): 55 lb (25 kg)
- C. Weight of a hard-wood pallet: 38 lb (17 kg)
- D. Pallet dimensions: 40 in. x 48 in. x 6 in. (1 m x 1.2 m x 152 mm)
- E. Volume of solid-piled commodity: 60 ft³ (1.7 m³) on a pallet

2.3 Examples of Commodities

Table 2.3 includes a list of example materials.

Classifications listed in Table 2.3 are only examples and are based on what is described as the “material.” The materials do not necessarily take into account packaging, storage configuration, use of pallet, etc. Furthermore, products vary depending on the manufacturer.

Use the recommendations provided in this data sheet in conjunction with Table 2.3 to classify a commodity. If packaging is not included in the description of the “material,” take this into account before applying the classification recommendation. For example:

- A. Metal parts are listed as noncombustible; however, if stored in single-layer corrugated cartons, the commodity is classified as Class 1 (see Section 2.2.2).
- B. If a material is listed as unexpanded plastic (UP) or expanded plastic (EP) but is stored in cartons, classify the commodity as cartoned unexpanded plastic (CUP) or cartoned expanded plastic (CEP), respectively.
- C. If a material is listed as unexpanded plastic or expanded plastic and is not stored in cartons, classify the commodity as uncartoned unexpanded plastic (UUP) or uncartoned expanded plastic (UEP), respectively.
- D. If a material is listed as CUP or CEP, it is assumed that cartons are used in the packaging of the commodity. Some exceptions apply and are listed in Table 2.3. For example: “Finished lightweight paper products (i.e., tissue paper), uncartoned, wrapped or not wrapped in plastic sheeting” are classified as CUP, although they are not cartoned. Cartoned finished lightweight paper products are considered a Class 3 commodity.
- E. If a material is listed as UUP or UEP, it is assumed that cartons are not used for external packaging. Some exceptions apply and are listed in Table 2.3. For example: “Mineral spirit-impregnated charcoal, cartoned or uncartoned” is classified as UUP whether the charcoal is cartoned or not.

Table 2.3. Examples of Material Classification

| Item | Material | Class |
|--|--|--------------------|
| Batteries | | |
| 1 | Dry cell (Excluding lithium metal and lithium-ion batteries). Uncartoned. | Class 1 |
| 2 | Wet cell (non-ignitable electrolyte) (e.g. automobile, boats). Uncartoned. | Class 1 |
| 3 | Dry cell (Excluding lithium metal and lithium-ion batteries). Cartoned. | Class 2 |
| 4 | Wet cell (non-ignitable electrolyte) (e.g. automobile, boats). Cartoned. | Class 2 |
| 5 | Batteries with plastic casing, empty | UP |
| 6 | Wet-cell (non-ignitable electrolyte) large vehicles (e.g. truck) | UP |
| 7 | Li-ion cells, modules, and products with li-ion batteries. | See Section 2.4.2. |
| Beer and Wine | | |
| 8 | Volume of alcohol is 20% or less. Considered non-ignitable liquid. Stored in a plastic container that is 5 gal (19 l) or less | Class 1 |
| 9 | Volume of alcohol is 20% or less alcohol. Considered non-ignitable liquid. Stored in wood barrels. | Class 1 |
| 10 | Volume of alcohol is 20% or less Considered non-ignitable liquid. Stored in a plastic container greater than 5 gal (19 L) and have a wall thickness less than ¼ in (6 mm). Generally, 55 gal (208 L) drums meet this criterion. | Class 2 |
| 11 | Molded polyurethane/stainless steel beer kegs, empty | EP |
| Construction Materials/Appliances | | |
| 12 | Electrical heating coils | Non-combustible |
| 13 | Metal appliances that do not include combustible parts (stoves, washer, dryers) | Non-combustible |
| 14 | Metal pots and pans | Non-combustible |
| 15 | Mirrors | Non-combustible |
| 16 | Paint, water-based (latex). Stored in metal cans. | Class 1 |
| 17 | Polyurethane (not exposed) filled metal door panels | Class 1 |
| 18 | Fiberglass insulation: paper-backed rolls, bagged or unbagged | Class 2 |
| 19 | Appliances with plastic interiors (e.g. refrigerators) | Class 3 |
| 20 | Fiberglass matting (e.g. roofing material) | Class 3 |
| 21 | Melamine sheets (cellulosic and resin materials) | Class 3 |
| 22 | Roof insulation boards (phenolic foam) | Class 3 |
| 23 | Roofing shingles, fiberglass | Class 3 |
| 24 | Roofing shingles, asphalt. | Class 3 |
| 25 | Roofing, felt | Class 3 |
| 26 | Metal panels or doors insulated with polyurethane. Polyurethane is exposed or the thickness of the metal is less than 24 gauge. | CUP |
| 27 | Polyisocyanurate board, Class 1 roofing material. Cartoned or uncartoned. | UUP |
| 28 | Water-barrier for building construction, manufactured with nonwoven HDPE fiber | UP |
| 29 | Polyethylene foam pipe insulation | EP |
| 30 | Sealants and electrical insulation (paraffin wax based) | EP |
| Electronics | | |
| 31 | Cartoned computer software packages. Includes owner's manual and compact disc in an envelope. No plastic in packaging. | Class 2 |
| 32 | Circuit board, copper clad | Class 3 |
| 33 | Circuit boards, FRP backed | Class 3 |
| 34 | Glass light bulbs, cartoned. | Class 3 |
| 35 | E-cigarettes (excludes large quantities of e-cig fluid) | CUP |
| 36 | Personal computer printers | UP |
| 37 | Plastic computer terminal housing | UP |

Table 2.3. Examples of Material Classification (continued)

| Item | Material | Class |
|-----------------------------------|--|-------------------|
| Empty Containers | | |
| 38 | Glass bottles or jars, empty | Non-combustible |
| 39 | Metal cans, empty. Packaged on corrugated cardboard trays, in cartons, or slipsheets. No plastic (except plastic sheet wrap or banding). | Class 1 |
| 40 | Polyethylene Terephthalate (PET) bottles, empty, uncartoned or cartoned | CUP |
| 41 | Cardboard drink boxes (plastic-coated, wax-coated, and/or aluminum-lined), empty, cartoned or uncartoned | CUP |
| 42 | Collapsed wood containers, treat as UUP unless protection requirements are provided in DS 8-24 for wood pallets | UUP |
| 43 | Plastic containers, empty, including cups, bottles, or jars (not PET), up to 32 oz (1 L) | UP |
| 44 | Plastic containers, gridded or solid, collapsed. | UUP |
| 45 | Plastic containers, gridded or solid, nested with sides sliding together in a tight-fitting arrangement producing limited air spaces. | UUP |
| 46 | Plastic containers, empty, not collapsed, gridded or solid, greater than 32 oz (1 L). | EP |
| 47 | Plastic bottles (including PET), empty, stored in plastic containers, gridded or solid, any volume | UEP |
| 48 | Empty composite intermediate bulk containers (IBC) with plastic, wood, or steel pallets | See Section 2.4.3 |
| Food Products - Frozen | | |
| 49 | Solid foods (e.g., prepared frozen meals on thin plastic trays and cartoned) | Class 2 |
| 50 | Meat on plastic trays, cartoned or uncartoned | Class 2 |
| Food Products - Not Frozen | | |
| 51 | Fresh fruit and vegetables | Non-combustible |
| 52 | Meat, bulk, uncartoned | Class 1 |
| 53 | Dry pet food in plastic-laminated paper bags | Class 2 |
| 54 | Meat, fresh, cartoned, no plastic | Class 2 |
| 55 | Butter stored in plastic containers, cartoned or uncartoned | Class 3 |
| 56 | Margarine stored in plastic containers, cartoned or uncartoned | Class 3 |
| 57 | Cereal or combustible food products stored in cartons | Class 3 |
| 58 | Cheese, wheels, wax-coated, cartoned or uncartoned | Class 3 |
| 59 | Cookies, cartoned or uncartoned | Class 3 |
| 60 | Chocolate, cartoned or uncartoned | Class 3 |
| 61 | Dry pet food in cartons | Class 3 |
| 62 | Meat, fresh, on plastic trays, cartoned or uncartoned | Class 3 |
| 63 | Candy, stored in plastic trays and packaged in cardboard boxes | Class 3 |
| 64 | Produce, fresh, bulk, stored in any volume gridded plastic containers, if the container is 100% full | Class 3 |
| 65 | Chewing gum, cartoned or uncartoned | Class 3 |
| 66 | Produce, fresh, bulk, stored in solid plastic containers 5 gal (19 L) or less | Class 3 |
| 67 | Eggs stored in expanded polystyrene (PS) containers, cartoned | CUP |
| 68 | Snack foods (e.g., potato chips) in plasticized aluminum bags, cartoned | CUP |
| 69 | Produce, fresh, bulk, stored in solid plastic containers that hold more than 5 gal (19 L). | UUP |
| 70 | Polystyrene foam plates, cups, etc. | EP |
| Furniture and Bedding | | |
| 71 | Metal cabinets | Non-combustible |
| 72 | Metal desks with plastic tops and trim | Class 1 |
| 73 | Wood furniture (e.g. doors, frames, windows, window frames, cabinets, chairs, tables, etc.) | Class 3 |
| 74 | Comforters, quilts or duvets. Natural or synthetic | EP |

Table 2.3. Examples of Material Classification (continued)

| Item | Material | Class |
|------------------------------|---|------------------------------|
| 75 | Mattress, foam | EP |
| 76 | Polyisocyanurate foam cushions | EP |
| 77 | Upholstered furniture, containing expanded foam. | EP |
| Ignitable Liquids | | |
| 78 | Plastic containers of alcohol based hand sanitizing wipes | UP |
| 79 | Mineral spirit impregnated charcoal, cartoned or uncartoned. | UUP |
| Miscellaneous | | |
| 80 | Charcoal, cartoned or uncartoned | Class 3 |
| 81 | Fiberglass basketball backboard | Class 3 |
| 82 | Tobacco products in paperboard cartons | Class 3 |
| 83 | Polystyrene finished toy products | UP |
| 84 | Stuffed toys | EP |
| Non-Ignitable Liquids | | |
| 85 | Glass bottles or jars, filled with non-ignitable liquids | Non-combustible |
| 86 | Cardboard drink boxes (plastic-coated, wax-coated, and/or aluminum-lined) filled with non-ignitable liquid. Uncartoned or on corrugated carton trays. | Class 1 |
| 87 | Metal cans, filled with non-ignitable liquids or semi-solids. Stored on cardboard trays, in cartons, or on slipsheets (i.e. dividers). No plastic components (except plastic sheet wrap or banding). | Class 1 |
| 88 | Non-ignitable liquids in plastic containers that are 5 gal (19 l) or less | Class 1 |
| 89 | Semi-liquids (non-ignitable). Including: crushed fruits and vegetables. Stored in solid plastic containers that are 5 gal (19 l) or less | Class 1 |
| 90 | Glass bottles or jars filled with non-ignitable liquids. Stored in gridded plastic containers | Class 1 |
| 91 | Plastic bottles (<5 gal/19 l), filled with non-ignitable liquid. Stored in gridded plastic containers | Class 1 |
| 92 | Polyethylene Terephthalate (PET) bottles, filled with non-ignitable liquids. Stored in gridded plastic containers. | Class 1 |
| 93 | Cardboard drink boxes (plastic-coated, wax-coated, and/or aluminum-lined) filled with non-ignitable liquid. Cartoned. | Class 2 |
| 94 | Metal cans, filled with non-ignitable liquids or semi-solids. On plastic slipsheets (i.e. dividers) | Class 2 |
| 95 | Non-ignitable liquids or semi-liquids stored in solid plastic containers that are greater than 5 gallons (19 l) and have a wall thickness less than ¼ in (6 mm). Generally, 55 gal (208 L) drums meet this criterion. | Class 2 |
| 96 | Glass bottles or jars that are empty or filled with non-ignitable liquids, stored in solid plastic containers | UUP |
| 97 | Non-ignitable liquids or semi-liquids stored in solid plastic containers that are greater than 5 gallons (19 l) and have a wall thickness ¼ in (6 mm) or greater. | UUP |
| 98 | Plastic bottles, filled with non-ignitable liquid. Stored in solid plastic containers. | UUP |
| Nonwoven | | |
| 99 | Nonwoven finished products. Refer to Data Sheet 8-23 Rolled Nonwoven Fabric Storage for unfinished products. | UP |
| 100 | Shrink-wrapped diapers, uncartoned. | UP |
| Packaging Material | | |
| 101 | Cornstarch packaging material | Class 3 |
| 102 | Bubble wrap | UP |
| 103 | Polyethylene foam packaging material | EP |
| 104 | Polypropylene foam packaging material | EP |
| 105 | Polystyrene foam packaging material | EP |
| 106 | Phase change material | See DS 7-29, Section 2.1.3.9 |

Table 2.3. Examples of Material Classification (continued)

| Item | Material | Class |
|---------------------------|---|---------|
| Paper Products | | |
| 107 | Book signatures. Cartoned or uncartoned. | Class 2 |
| 108 | Aluminum foil laminate paper (no plastic component) | Class 3 |
| 109 | Fiberboard (cellulosic material) | Class 3 |
| 110 | Paper products: books, magazines, stationary, newspaper, paper or cardboard games. Cartoned or Uncartoned. | Class 3 |
| 111 | Paper Matches, cartoned or uncartoned. | Class 3 |
| 112 | Latex-laminated Kraft paper, sheets | Class 3 |
| 113 | Wallpaper, rolls (finished products). | Class 3 |
| 114 | Cellulosic products. Stored in cartons (e.g. paper plates, cups, towels). | Class 3 |
| 115 | Finished light weight paper products, cartoned (e.g., tissue paper). Product within carton may or may not be wrapped in plastic sheeting) | Class 3 |
| 116 | Aluminum foil laminate paper with plastic components. | CUP |
| 117 | Polyethylene-laminated Kraft paper, sheets | CUP |
| 118 | Finished light weight paper products (i.e., tissue paper) - uncartoned, wrapped or not wrapped in plastic sheeting. See Data Sheet 8-21 for storage of unfinished rolled paper. | CUP |
| Pharmaceutical | | |
| 119 | Noncombustible creams/gels in plastic containers that are 4–8 oz (0.12–0.24 l), stored in cartons. | Class 3 |
| 120 | Medicine tablets or capsules in glass jars, stored in cardboard and/or cartons. | Class 3 |
| 121 | Hypodermic needles (stainless steel) stored individually in plastic containers. Cartoned | CUP |
| 122 | Medicine tablets or capsules in plastic containers. Cartoned | CUP |
| 123 | Medicine tablets or capsules in plastic-faced foil packs. Cartoned | CUP |
| Plastic Containers | | |
| 124 | Corrugated plastic boxes filled with cardboard box flats | Class 3 |
| 125 | Plastic containers, solid, storing noncombustible solids, 1 gal (4 L) or less | CUP |
| 126 | Phenolic Resin powder in 55 gal (210 l) Plastic Drums | UUP |
| 127 | Plastic containers, solid or gridded. Storing combustible solids (that would be considered Class 1, 2, 3, or unexpanded plastics). All volumes. Completely full. | UUP |
| 128 | Plastic containers, solid. Storing noncombustible solids. > 1 gal (4 l) in volume. | UUP |
| 129 | Plastic containers, solid or gridded. Storing commodities considered expanded plastic. All volumes | UEP |
| Plastics | | |
| 130 | Phenolic plastic | Class 3 |
| 131 | Regenerated cellulosic (cellophane) | Class 3 |
| 132 | Solid silicones | Class 3 |
| 133 | Rigid polyvinyl chloride (PVC) finished products (e.g., pipes, ducts, building panels, siding) | Class 3 |
| 134 | PVC finished products, with plasticizer contents up to 20% | Class 3 |
| 135 | Polyethylene Terephthalate (PET) plastic (other than cups and bottles) | UP |
| 136 | Acrylic/epoxy traffic lane dividers | UP |
| 137 | Acrylics | UP |
| 138 | Nylons | UP |
| 139 | Plastic "flip-flop" sandals | UP |
| 140 | Plastic drip trays | UP |
| 141 | Plastic light reflectors | UP |
| 142 | Polycarbonate products | UP |
| 143 | Polyester products | UP |

Table 2.3. Examples of Material Classification (continued)

| Item | Material | Class |
|-------------------------------|--|----------------------------|
| 144 | Polyisobutylene tubing | UP |
| 145 | Polypropylene decorative ribbon or bows | UP |
| 146 | Shoes with vinyl sides, crepe soles | UP |
| 147 | Vinyl boots | UP |
| 148 | Vinyl tablecloth | UP |
| 149 | Plastic pallets, idle. (Not FM Approved). See DS 8-24 for more information. | UUP |
| 150 | Acrylonitrile-butadiene-styrene (ABS) | EP |
| 151 | Corrugated plastic | EP |
| 152 | Polyurethane foam | EP |
| 153 | Polystyrene, expanded (e.g.: egg crates, packing peanuts/chips) | EP |
| 154 | ABS | UP |
| 155 | Film, PVC Christmas garlands ("tinsel") | UP |
| 156 | PVC finished products, with plasticizer greater than 20% | UP |
| 157 | Polyvinyl chloride (PVC) insulated cable, on plastic reels. Uncartoned. | UUP |
| 158 | Pre-cured tire tread | UP |
| 159 | Rubber products (aprons, pants, gloves, boots, tire retread, ear plugs, stoppers, etc.) | UP |
| 160 | Rubber, baled crude | UP |
| 161 | Running shoes with nylon cover, rubber soles | UP |
| 162 | Running shoes with vinyl cover, rubber soles | UP |
| 163 | Santoprene (synthetic rubber) | UP |
| Powders/Granulars | | |
| 164 | Free-flowing inert materials stored in combustible bags in racks (e.g., cement, calcium chloride, clay, iron oxide, sodium chloride, sodium silicate). | Class 1 |
| 165 | Polyester/epoxy coating powder stored in cartons. | Class 3 |
| 166 | Free-flowing combustible dust (e.g., sugar or starch) stored in combustible bags or cartons. | Class 3 |
| 167 | Granular/free-flowing unexpanded plastics (e.g. polystyrene bottle caps) stored in bags or cartons. | CUP |
| 168 | Toner powder (polymer/carbon black mix) in plastic bottles. | UP |
| 169 | Free-flowing combustible metal material stored in sealed metal containers. | See DS 7-76 |
| Solid Metal Containers | | |
| 170 | Closed metal containers containing plastic materials | Class 1 |
| 171 | Plastics stored in open-top metal containers | Class 3 |
| 172 | Plastic materials stored in 5-sided solid metal container | Class 3 |
| Textiles | | |
| 173 | Clothing and textiles, natural fiber (e.g. wool, cotton) and viscose. Not hanging. See Data Sheet 8-18 for hanging garments. | Class 3 |
| 174 | Leather, finished products (e.g. shoes, jackets, gloves, bags, luggage, belts, etc.). Cartoned and uncartoned. | Class 3 |
| 175 | Yarn and thread, natural fiber and viscose (100% cellulose based) | Class 3 |
| 176 | Fibers, natural. Baled and stored in cartons | Class 3 |
| 177 | Clothing and textiles, synthetic. Not hanging. See Data Sheet 8-18 for hanging garments. Cartoned and uncartoned. | CUP |
| 178 | Spandex elastic thread | UP |
| 179 | Fabric softener sheets, wax-coated | EP |
| 180 | Synthetic yarns and fibers such as polypropylene, polyethylene, and nylon | See DS 7-1, Section 2.3.15 |
| Tools and Parts | | |
| 181 | Metal parts | Non-combustible |
| 182 | Motors, electric. Metal housing. | Non-combustible |
| 183 | Metal parts stored in cartons | Class 1 |
| 184 | Polyester/fiberglass fishing rod | CUP |

Table 2.3. Examples of Material Classification (continued)

| Item | Material | Class |
|-------------------------|--|---------|
| 185 | Plastic screwdriver handles | UP |
| 186 | Automobile bumpers | EP |
| Wax Products | | |
| 187 | Wax, dental. Finished product (in plastic container) | UP |
| 188 | Candles - see Wax, paraffin | EP |
| 189 | Natural "beeswax" | EP |
| 190 | Wax crayons | EP |
| 191 | Wax, dental. Raw material | EP |
| 192 | Wax, paraffin | EP |
| 193 | Wax-coated, polyester/nylon stripping pads | EP |
| Wire/Cable/Spool | | |
| 194 | Polyvinyl chloride (PVC) insulated cable, on metal reels | Class 1 |
| 195 | Polyvinyl chloride (PVC) insulated cables, on wood, or paper reels. | Class 3 |
| 196 | Wood spools (empty) | Class 3 |
| 197 | Rubber hose (exterior), woven metal (interior) | CUP |
| 198 | Plastic (other than PVC) insulated conductor and power cable on wood or metal reels or in cartons. | CUP |
| 199 | Film, rolled polyester on any type of reel | UP |
| 200 | Film, rolled polyethylene on any type of reel | UP |
| 201 | Wire, bare on plastic spools. Uncartoned. | UUP |
| 202 | Film, rolled polypropylene on any type of reel | UP |
| Wood Products | | |
| 203 | Noncombustible commodities stored on wood pallets. | Class 1 |
| 204 | Green wood products (e.g., plywood, bundled or stacked lumber, particleboard with moisture content greater than or equal to 20%) | Class 1 |
| 205 | Empty wood barrels (with moisture content above 8%) | Class 1 |
| 206 | Wood products (e.g., plywood, bundled or stacked lumber, particleboard, empty barrels with moisture content below 8%) | Class 3 |
| 207 | Matches, wooden matches, cartoned or uncartoned. | CUP |
| 208 | Fireplace logs, impregnated with ignitable liquids or wax. Cartoned or uncartoned. | UEP |
| 209 | Wax-covered wood chips, cartoned or uncartoned. | UEP |

2.4 Protection

2.4.1 General

2.4.1.1 Classify stored commodities based on the guidance provided in this data sheet. Protect stored commodities based on the guidance provided in Data Sheet 8-9, Storage of Class 1, 2, 3, 4, and Plastic Commodities. Base protection on the highest hazard commodity at the facility.

2.4.1.2 As an alternative to protecting the entire facility to the highest hazard commodity, segregate the highest hazard commodity from the rest of the facility and protect accordingly. Note: Keeping the highest hazard commodity properly segregated can be very difficult in normal warehouse operations.

2.4.2 Lithium-Ion (Li-ion) Batteries

2.4.2.1 Protect new li-ion cells and modules stored in open-frame rack, solid-pile or palletized storage arrangements per the guidance in Table 2.4.2.1. Protection guidance is not differentiated based on battery chemistry.

2.4.2.1.1 Protect finished products that contain li-ion cells or modules per the products commodity classification provided the following conditions are met:

- A. Ceiling height is no greater than 40 ft (12 m)
- B. Li-ion battery state of charge is $\leq 60\%$

2.4.2.1.1.1 When the ceiling is greater than 40 ft (12 m) or battery state of charge is greater than 60%, store finished products that contain li-ion cells or modules in open-frame racks; and protect with in-rack sprinklers per Section 2.4.2.2.

2.4.2.1.2 Protect used or refurbished li-ion cells or modules with in-rack sprinkler protection per Section 2.4.2.2.

Table 2.4.2.1. Protection of Lithium-Ion Cells and Modules

| Li-ion Cell/Module State of Charge | Ceiling Height | Storage Height | Storage Arrangement | Packaging | Ceiling Protection (QR sprinklers only) | In-Rack Protection |
|------------------------------------|----------------|---|---|--|---|---------------------|
| ≤ 60% | ≤ 40 ft (12 m) | Maximum 3 levels of storage up to a total height of 15 ft (4.5 m) | Open-frame rack, solid-pile or palletized | Wood crate, metal encased or corrugated carton with cellulosic and/or unexpanded plastic internal packaging only | K22.4 or K25.2 (K320 or K360) 12 @ 35 psi (2.4 bar) | NA |
| | | | | Corrugated carton with expanded plastic internal packaging | CEP per 8-9* | NA |
| | | | | Plastic external packaging | UUP per 8-9* | NA |
| | NA | Open-frame rack | Uncartoned | Per surrounding occupancy. | See Section 2.4.2.2 | |
| | > 40 ft (12 m) | | | Cartoned or uncartoned | Per surrounding occupancy. | See Section 2.4.2.2 |
| > 60% | NA | | | | | |

* Use the Data Sheet 8-9 protection table based upon the storage configuration (open-frame rack, solid-pile or palletized) and the protection option based on the ceiling height.

2.4.2.1.3 Do not allow storage above the batteries for ceiling only protection options.

2.4.2.1.4 Provide a minimum of 10 ft (3.0 m) space separation between li-ion cell or module storage areas and other combustibles when stored in solid-pile or palletized storage arrangements.

2.4.2.1.5 Store defective or damaged cells and modules outside of the building with space separation per Data Sheet 1-42, *Maximum Foreseeable Loss Limiting Factors*.

2.4.2.2. When in-rack sprinklers are required, provide plywood (minimum 3/8 in. [10 mm]) or sheet metal (minimum 22 ga. [0.7 mm]) horizontal barriers and in-rack sprinklers installed in accordance with Figures 2.4.2.2-1 and 2.4.2.2-2, depending on the rack type for storage.

1. Use a maximum vertical spacing of 12 ft (3.7 m) between barriers.
2. Do not store li-ion cells or modules above the top barrier level.
3. Design barriers without gaps in longitudinal flue spaces. A maximum gap of 3 in. (75 mm) between each barrier is permitted at the rack uprights (transverse flue) for single and double row racks.

2.4.2.2.1 Install K8.0 (K115) or K11.2 (K160), 165°F (74°C) rated, quick-response in-rack sprinklers below each barrier.

1. Design the in-rack sprinklers to provide a minimum flow of 60 gpm (227 L/min.) out of the hydraulically most remote six (6) sprinklers (e.g., three face sprinklers and three flue sprinklers in a double-row rack) if one barrier is provided, or the most remote eight (8) sprinklers (e.g., two face sprinklers and two flue sprinklers on two levels in a double-row rack) if two or more barrier levels are provided.
2. Locate face sprinklers within 6 in. (150 mm) of the rack face.

2.4.2.2.2 Do not include ceiling sprinkler demand in the hydraulic calculations for in-rack sprinklers.

2.4.2.2.3 Design ceiling sprinklers to protect the surrounding occupancy.

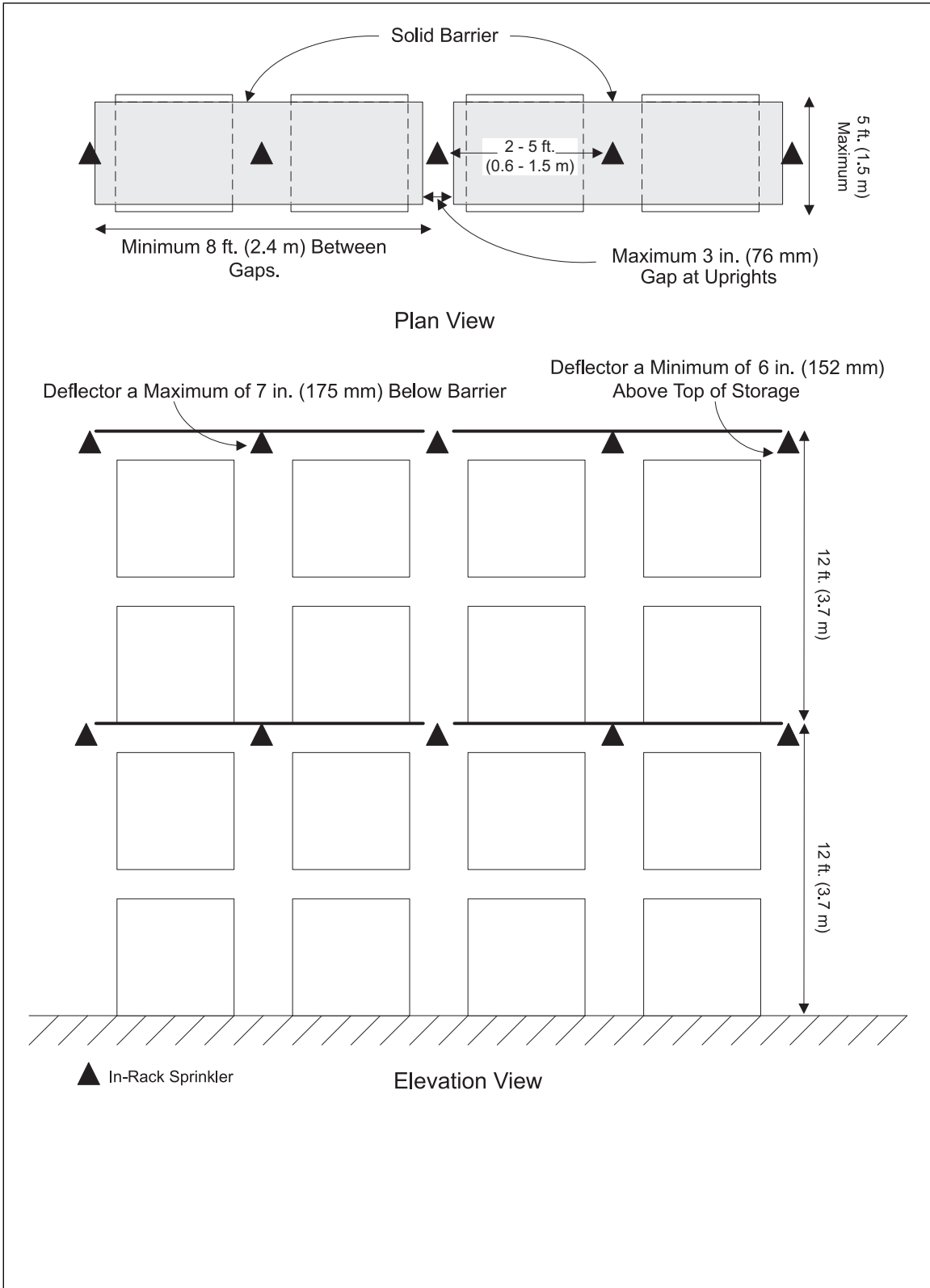


Fig. 2.4.2.2-1. Single-row rack sprinkler layout for li-ion cells or modules.

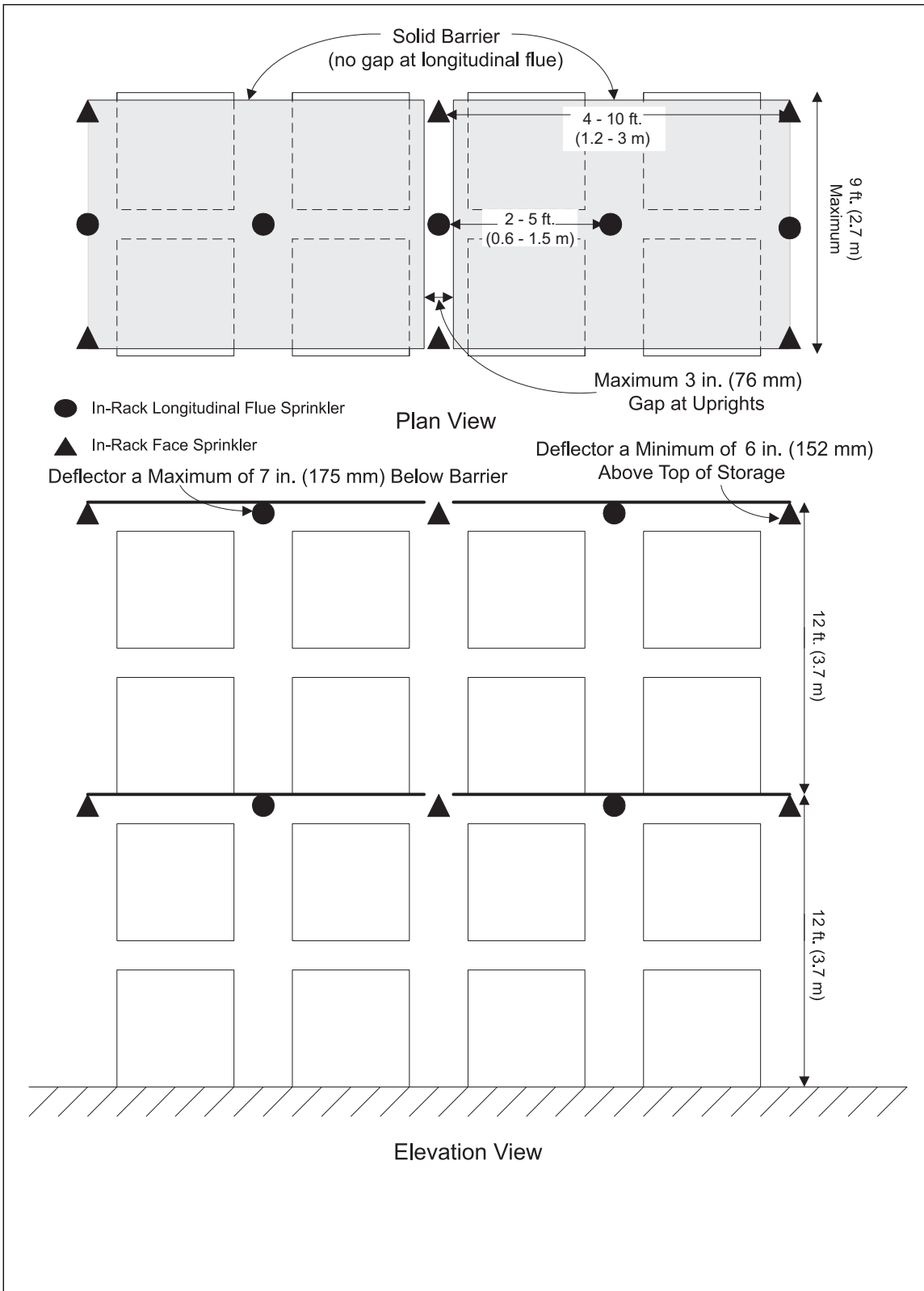


Fig. 2.4.2.2-2. Double-row rack sprinkler layout for li-ion cells or modules.

2.4.2.3 Provide a water supply capable of meeting the design sprinkler discharge flow rate plus a 250 gal./min. (946 L/min.) hose stream demand for at least 120 minutes for li-ion cell and module storage. For products with li-ion batteries, the duration may be reduced to 60 minutes.

2.4.2.4 Develop a pre-incident plan with the fire service in accordance with Data Sheet 10-1, *Pre-Incident and Emergency Response Planning*. The plan should include manual fire protection methods to be employed and a designated location outside of the facility to which damaged and impacted cells can be moved.

2.4.2.5 Develop a post-incident recovery plan that addresses the potential for reignition of li-ion batteries, as well as for the removal and disposal of any damaged or impacted cells, modules or products.

2.4.2.5.1 A fire watch should be present until all potentially damaged li-ion cells, modules or products have been removed from the area following a fire event.

2.4.3 Empty Plastic Intermediate Bulk Containers (IBCs)

2.4.3.1 Protect palletized storage of empty plastic IBCs and “recon” (reconditioning of used) empty plastic IBCs per the guidance in Table 2.4.3.1.

Table 2.4.3.1. Protection of Empty Intermediate Bulk Containers (IBCs)

| Ceiling Height | Storage Height | Pallet Material | Wet Pipe Systems | | | Dry Pipe Systems with 20 s water delivery time |
|----------------|------------------------------------|-----------------|---------------------------|-----------------------|-----------------------|--|
| | | | QR, Pendent, 160°F (70°C) | | | SR, 286°F (140°C) |
| | | | K14.0 (K200) ¹ | K22.4 (K320) | K25.2 (K360) | K25.2 (K360) |
| 30 ft (9.0 m) | 15 ft (4.5 m), maximum 3 IBCs high | Wood or Steel | 12 @ 18 psi (1.2 bar) | NA | NA | 12 @ 15 psi (1.0 bar) |
| | | Plastic | 12 @ 32 psi (2.2 bar) | | | 30 @ 15 psi (1.0 bar) |
| 40 ft (12 m) | 30 ft (9 m), maximum 6 IBCs high | Wood or Steel | NA | NA | 12 @ 40 psi (2.8 bar) | NA |
| | | Plastic | | 12 @ 60 psi (4.1 bar) | 12 @ 60 psi (4.1 bar) | |
| 45 ft (13.5 m) | 30 ft (9 m), maximum 6 IBCs high | Wood or Steel | NA | NA | 12 @ 40 psi (2.8 bar) | 12 @ 40 psi (2.8 bar) |
| | | Plastic | | | 12 @ 60 psi (4.1 bar) | 20 @ 60 psi (4.1 bar) |
| 48 ft (14.5 m) | 30 ft (9 m), maximum 6 IBCs high | Wood or Steel | NA | NA | 12 @ 75 psi (5.2 bar) | NA |
| | | Plastic | | | | |

¹ These protection options are for pendent sprinklers only.

2.4.3.2 Provide a water supply capable of meeting the design sprinkler discharge flow rate plus a 250 gal./min. (946 L/min.) hose stream demand for at least 60 minutes.

3.0 SUPPORT FOR RECOMMENDATIONS

3.1 Burning Characteristics and Testing to Assist in Determining Commodity Classification

3.1.1 Burning Characteristics

3.1.1.1 Heat of Combustion Heat of combustion is the maximum amount of energy (i.e., heat) released per unit weight of material burned. The overall hazard of a commodity is a function of its heat release rate (Btu/min or kW), which is the product of its heat of combustion (Btu/lb or kJ/kg) and burning rate (lb/min or kg/s). As the heat release rate increases, so does the hazard.

The heat of combustion of ordinary combustibles generally ranges between 6,000 and 8,000 Btu/lb (13,960 and 18,600 kJ/kg). The heat of combustion for plastics generally ranges between 12,000 and 20,000 Btu/lb (27,910 and 46,520 kJ/kg). The burning rate of a commodity is dependent on many things, but plastic

materials generally exhibit higher maximum burning rates than similarly arranged ordinary combustibles. This difference can be two to three times higher for many plastic materials.

The heat of combustion of a material sample can be determined using bench-scale testing, including the oxygen bomb calorimeter or flammability propagation apparatus (FPA). The oxygen bomb calorimeter will provide the gross heat of combustion (complete combustion), while the FPA will provide the effective heat of combustion (incomplete combustion).

3.1.1.2 Percentage of Inert Material

Inert additives are noncombustible. They are inorganic compounds that may be incorporated into resins as fillers to improve the properties of plastics. They are added to plastics during the manufacturing stage. Additives include glass, calcium carbonate, metal flakes, metallic oxides or powders, and other inorganic compounds. Inert additives in large amounts may increase the fire resistance of plastics by increasing their heat capacity and reducing their heat of combustion. The percentage of inert material is determined by burning a sample of the material in a 1500°F (815°C) furnace to complete combustion in the oxygen bomb calorimeter. Inert material corresponds to the remaining material after complete combustion (percentage of ash). The remaining material is weighed and compared to the original weight.

The heat content measured as described above is directly related to the amount of inert material present. To make a more meaningful comparison of heat contents, it is necessary to factor out the percentage of inert material from the heat of combustion measured in the bomb calorimeter. For example, if a sample had a heat of combustion of 9,000 Btu/lb (20,700 kJ/kg) and 40% inert, the actual heat content of the combustible part of the sample is:

$$(9,000 \text{ Btu/lb}) / (1.0 - 0.4) = 15,000 \text{ Btu/lb or}$$

$$(20,700 \text{ kJ/kg}) / (1.0 - 0.4) = 34,890 \text{ kJ/kg}$$

The heat content of the combustible portion of the sample is 15,000 Btu/lb (34,890 kJ/kg), which falls into the plastics range.

Intermediate-scale fire tests demonstrate that for plastic containing high percentages of inert material, the overall hazard of the plastic was not affected. The tested commodity consisted of 52% inert and 48% polyester/polystyrene, the measured heat content was in the ordinary combustible range, but fire testing demonstrated that the commodity created a hazard well above that of ordinary combustibles. The measured heat of combustion was approximately 7,000 Btu/lb (16,100 kJ/kg); typical of ordinary combustibles. After factoring out the inert percentage, the heat of combustion of the combustible material was approximately 14,500 Btu/lb (33,350 kJ/kg), typical of many plastics.

3.1.2 Bench-Scale Laboratory Tests

Bench-scale laboratory tests aid in determining commodity classification. However, these tests only provide limited information and cannot simulate the large-scale burning behavior of the tested commodity.

Results of bench-scale testing provide a simple basis for comparison between the material in question and known commodities. The results from bench-scale tests are not conclusive; therefore, results of bench-scale tests must be evaluated very conservatively. FM Global has tested materials that were difficult to burn or burned relatively slowly under bench-scale test conditions, but burned severely under large-scale conditions.

Generally, a material will burn more severely under large-scale conditions than under bench-scale conditions. If a material exhibits burning characteristics similar to a plastic commodity under bench-scale conditions, then it is likely that under large-scale conditions the material would also burn like a plastic and therefore be protected as a plastic commodity. This is an example where bench tests can eliminate the need for much more expensive large-scale tests or intermediate-scale testing under the fire products collector.

Although bench tests provide an inexpensive way of proving high combustibility, they usually are not appropriate for proving low combustibility. For example, a plastic material that has a high percentage of inert material and/or has some fire retardants added will probably burn very slowly in a bench test. It may even be difficult to get the material to burn at all. However, this does not prove the plastic material will burn very slowly under actual storage conditions. In these cases, good judgment or a larger scale test is needed to determine the commodity classification.

3.1.2.1 Oxygen Bomb Calorimeter

Bench-scale testing may be conducted in the oxygen bomb calorimeter. Characteristics, including the gross heat of combustion and the percentage of inert material, can be determined (see information on each of these characteristics above). These characteristics will help determine if the material will burn similarly to ordinary combustibles or plastics. However, these properties will not help to determine if a plastic will burn similarly to an expanded plastic or an unexpanded plastic.

A sample of the material, approximately 0.04 oz (1 g) in weight is burned in an oxygen bomb calorimeter. The bomb is a small, closed vessel filled with compressed oxygen and submerged in a specific amount of water. Ignition of the sample is made electrically via a wire. The heat released during the combustion is represented as the temperature rise in the water bath, and the heat content in Btu/lb (kJ/kg) can be determined. The heat of combustion does not take into account the storage configuration. If the material has a heat content much higher than 8,000 Btu/lb (18,400 kJ/kg), then the material is generally classified as a plastic. However, the storage arrangement will also contribute to the commodity classification.

3.1.2.2 Fire Propagation Apparatus (FPA)

Bench-scale testing may be conducted using the FPA. These tests only provide limited information and cannot simulate large-scale burning behavior of the material being tested.

The FPA can measure the following burning characteristics: effective heat of combustion, heat release rate, and critical heat flux (how much energy is needed for ignition). The FPA may also be used as a screening test and can eliminate the need for much more expensive large-scale tests or intermediate-scale testing under the fire products collector. If the results of FPA testing demonstrate that a material sample is a higher hazard than a known commodity, further testing may be avoided. However, if the results indicate a relatively low hazard when compared to a known commodity, it is likely that additional testing will be favorable.

See Data Sheet 1-4, *Fire Tests*, for a more information.

3.1.3 Fire Products Collector (FPC) Commodity Classification Tests

Although bench-scale tests are quick and relatively inexpensive, in many cases they do not provide enough information to conclusively determine the commodity classification. The FPC commodity classification tests provide a conclusive way to determine the commodity classification of most materials.







Commodity classification tests may be performed as part of risk service testing. For the Intermediate and Large-Scale Risk Service Test Protocol, see Section 3 of the Risk Service Testing Field Guide.

The FPC is a calorimeter that can measure convective heat release rates up to approximately 1,100,000 Btu/min (20 MW). The FPC measures convective and total heat release rates, generation rates of carbon monoxide and carbon dioxide, and depletion rate of oxygen. Radiative heat release and burning rates also can be determined.

The material in question is arranged on a double-row rack segment. A specially designed water applicator is installed directly above the array. The water applicator uses water nozzles designed to deliver a very uniformly distributed, predetermined amount of water (gpm/ft² or mm/min) to the top surface of the array. Water is delivered from the water applicator to the top surface array at the same time a standard response 286°F (141°C) sprinkler on a 10 x 10 ft (3 x 3 m) spacing, located 10 ft (3 m) above the array and 7 in. (178 mm) below the ceiling would actuate. The water density application does not correspond to the design density of an installed automatic sprinkler system.

Usually three tests are conducted, with the water application rate being varied between the three tests. The results are then compared to FM Global's standard commodities, which are used as benchmarks to determine the commodity classification of the tested material. All benchmark commodities are stored on wood pallets. See Table 3.1.3 for a list of FM Global's standard commodities. Most of the protection guidelines in Data Sheet 8-9 are based on large-scale fire tests using these standard commodities.

Table 3.1.3. FM Global Standard Commodities

| Class | Commodity | Figure |
|-------------------------------|---|---|
| Class 2 | Metal-lined double tri-wall cartons |  |
| Class 3 | Paper cups in compartmented cartons |  |
| Cartoned Unexpanded Plastic | Unexpanded polystyrene cups in compartmented cartons |  |
| Cartoned Expanded Plastics | Expanded polystyrene foam plates stored in corrugated cartons |  |
| Uncartoned Unexpanded Plastic | Plastic pallets |  |
| Uncartoned Expanded Plastic | Exposed foam plates |  |

3.2 Factors Affecting Commodity Classification

3.2.1 Mixed Commodities

3.2.2.1 Generally, facilities store a variety of commodities. Protect the facility for the highest hazard commodity. Do not base protection on an average of the commodities. There are a number of reasons for providing protection for the highest hazard commodity:

- A. Fire tests showed that replacing one tier of a four-tier-high rack array with a higher hazard commodity produced a hazard much higher than that of a rack filled 100% with the lower hazard commodity.
- B. Fire tests where sprinkler protection is adequate for a specific commodity will typically burn 200-300 ft² (19-28 m²) area of the commodity tested. Only a small amount of material has to burn to create relatively large sprinkler operating area (1500-2500 ft² [140-230 m²]). Increasing the hazard by introducing a more hazardous commodity may increase the burning area and potentially overtax the sprinkler system, which was designed for a lower hazard commodity.
- C. "Averaging the commodities" requires continual monitoring of the facility to ensure the concentrations of higher hazard commodities are not exceeded. In normal warehouse environments, adequate monitoring is very difficult and generally not feasible.

3.2.2 Configuration

The classification of a commodity is a function of both the material and its configuration. For example, a solid block of wood is relatively difficult to ignite and slow to burn. If, however, the wood is in a configuration that maximizes surface area and has parallel surfaces to encourage re-radiation and convection, it burns much more rapidly (e.g., idle wood pallets). The large amount of heat released under such configurations can result in a hazard beyond that normally associated with the primary material.

Furthermore, for mixed materials, the percentage of different combustibles should be considered together with packaging and configuration of different materials. If a higher or lower hazard material protects or envelops other materials, the overall classification should be adjusted accordingly.

4.0 REFERENCES

4.1 FM Global

Data Sheet 1-4, *Fire Tests*
 Data Sheet 7-29, *Storage of Ignitable Liquids*
 Data Sheet 7-31, *Storage of Aerosol Products*
 Data Sheet 7-50, *Compressed Gases in Cylinders*
 Data Sheet 8-3, *Rubber Tire Storage*
 Data Sheet 8-7, *Baled Fiber Storage*
 Data Sheet 8-9, *Storage of Class 1, 2, 3, 4 and Plastic Commodities*
 Data Sheet 8-18, *Storage of Hanging Garments*
 Data Sheet 8-21, *Roll Paper Storage*
 Data Sheet 8-22, *Storage of Baled Waste Paper*
 Data Sheet 8-23, *Rolled Nonwoven Fabric Storage*
 Data Sheet 8-24, *Idle Pallet Storage*
 Data Sheet 8-30, *Storage of Carpets*
 Data Sheet 8-33, *Carousel Storage and Retrieval Systems*
 Data Sheet 8-34, *Protection for Automatic Storage and Retrieval Systems*

4.2 Other

International Plastics Selector. *Elastomeric Materials*. 1977.

APPENDIX A GLOSSARY OF TERMS

Cell: The smallest electrochemical component that can store energy.

CEP: Cartoned expanded plastic.

Commodity: Combination of material, external packaging (e.g., container), and material handling aids (e.g., pallets). The purpose of assigning a commodity classification is to determine the proper level of fire protection. A commodity classification is dependent on how the commodity burns and how the burning commodity responds to the application of sprinkler discharge.

Container: Used for storing, handling, and transporting materials. May be constructed of wood, cardboard, or plastic. Containers may be referred to as “totes,” “crates,” “KLT”(Kleinladungstraeger), or “GLT” (Großladungstraeger).

CUP: Cartoned unexpanded plastic.

Encapsulation: A method of packaging consisting of a plastic sheet completely enclosing the sides and top of a pallet load containing a combustible commodity, or a group of combustible commodities or combustible packages. Totally noncombustible commodities on wood pallets enclosed only by a plastic sheet as described above are not considered encapsulated. The term “encapsulation” also applies to individual cartons that are enclosed on the top and sides in plastic, and to cartons waterproofed by coatings on the exterior surfaces.

The term “encapsulation” does not apply to individual plastic enclosed items inside a larger non-plastic enclosed or waterproofed container. If holes or voids in the plastic or waterproof cover on the top of the carton exceed more than half the area of the top, the term “encapsulation” does not apply.

FM Approved: Products and services that have satisfied the criteria for FM Approval. See the *Approval Guide*, an online resource of FM Approvals, for a complete listing of products and services that are FM Approved.

Module: A combination of series and parallel connected cells.

Nonignitable liquid: Any liquid or liquid mixture that will not burn. If a liquid or liquid mixture does not have a fire point, it is considered nonignitable. Ignitable liquids include flammable liquids, combustible liquids, inflammable liquids, or any other term for a liquid that will burn.

Occupancy-specific data sheet: An FM Global property loss prevention data sheet that addresses a specific occupancy hazard. Individual data sheets belong to the following data sheet series:

| Series Number | Data Sheet Subject |
|---------------|--|
| 1 | Construction |
| 2 | Sprinklers |
| 3 | Water Supply |
| 4 | Extinguishment Equipment |
| 5 | Electrical |
| 6 | Boilers and Industrial Heating Equipment |
| 7 | Hazards |
| 8 | Storage |
| 9 | Miscellaneous |
| 10 | Human Factor |
| 11 | Systems Instrumentation and Control |
| 12 | Pressure Vessels |
| 13 | Mechanical |
| 15 | Welding |
| 17 | Boiler and Machinery Miscellaneous |

Palletized: A storage arrangement that consists of materials stored on pallets. In this data sheet, when a commodity is “palletized,” wood pallets are implied unless noted otherwise.

State of Charge (SoC): The real-time amount of energy stored in the system, compared to the rated capacity. A function of voltage. The SoC could be expressed as a percentage value. This would mean that a fully charged battery would have 100% SoC, and a fully discharged battery would have 0% SoC.

Thermoplastic: Type of plastic material that become soft when sufficiently heated and then hardens when cooled, no matter how often the process is repeated. Generally, thermoplastics burn more readily than thermoset plastics.

Thermoset plastics: Type of plastic material that sets into permanent shape from the heat and pressure applied to them during manufacturing. Reheating will not soften these materials. Generally, thermoset plastics burn less readily than thermoplastics.

UEP: Uncartoned expanded plastic.

UUP: Uncartoned unexpanded plastic.

APPENDIX B DOCUMENT REVISION HISTORY

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

January 2023. Interim revision. The following changes were made:

- A. Changed the upper limit of 10% expanded plastic allowed on outer portion of product to 20% in Section 2.2.5.1C.
- B. Updated Figure 2.2.7 references and percentage of expanded plastic.
- C. Added guidance on how to treat partial packaging in Section 2.2.8.1.2.
- D. Added guidance on how to treat wooden crates for external packaging in Section 2.2.8.4.
- E. Added guidance for encapsulated product in Section 2.2.8.5.
- F. Added guidance for flexible intermediate bulk containers (i.e., bulk bags or supersacks) in Section 2.2.8.6.
- G. Clarified treatment of cardboard pallets for commodity classification in Section 2.2.9.
- H. Clarified and expanded lithium-ion battery storage guidance in Section 2.4.2.
- I. Updated empty intermediate bulk container guidance in Section 2.4.3 including Table 2.4.3.1.
- J. Updated following items in Table 2.3:
 - 1. Changed formatting to remove category column and added sub-heading rows.
 - 2. Added item 21 for melamine sheets.
 - 3. Clarified item 45 intent of 'no air spaces'.
 - 4. Removed reference to Data Sheet 7-29 in item 48, as information is now in 8-1.
 - 5. Clarified item 64 intent to be 100% full of produce.
 - 6. Added item 80 for charcoal.
 - 7. Added item 106 for phase change material guidance to reference Data Sheet 7-29.
 - 8. Added item 116 for aluminum foil laminate paper with plastic components.
 - 9. Updated item 165, polyester/epoxy coating powder, to Class 3 from CUP.
 - 10. Added item 166 for combustible dust stored in cartons or plastic bags for bulk storage.
 - 11. Added item 169 for metal powders in sealed metal containers/cans to reference Data Sheet 7-76.
 - 12. Added item 204 for green wood products.
- K. Revised figure and table numbers to align with current formatting standards.

April 2021. Interim revision. Made editorial change to commodity classification of butter and margarine in Table 2 to align with Data Sheet 7-29, *Flammable Liquid Storage in Portable Containers*.

April 2020. Interim revision. The following changes were made:

- A. Added guidance on Lithium-Ion batteries to Section 2.4.2.
- B. Added guidance on empty intermediate bulk containers (IBCs) to Section 2.4.3 (moved from OS 7-29 and updated).

C. Reorganized Section 2.0 for improved clarity.

D. Added commodity classification for electronic cigarettes.

E. Added information to Table 2 on batteries, empty IBCs, PVC-containing materials, synthetic yarns, and empty wood barrels. As a result, the numbering has changed.

April 2015. Interim revision. Table 1, *Products Stored in Plastic Containers*, was modified to be consistent with Table 2, *Examples of Material Classification*.

October 2014. Interim revision. Minor editorial changes and clarifications were made.

April 2014. The following changes were made:

A. Added Table 1, Examples of Material Classification (Section 2.4).

B. Reformatted the data sheet. Section 2.0 is limited to commodity classifications, recommendations, and Table 1. Section 3.0 includes descriptions of commodity classification tests procedures.

C. Removed references to Group A, B, and C plastics. Plastics are now classified as unexpanded or expanded.

D. Removed Commodity Class 4. Class 4 commodities are treated and protected as cartoned unexpanded plastic (CUP).

E. Changed the classification of certain materials. This is due to changes in commodity classification (e.g., Class 4 to CUP), as well as recent testing conducted at FM Global.

F. Changed the classification of some materials that were treated as noncombustible. Noncombustible materials only apply to materials that do not burn. The following are no longer considered noncombustible: wooden barrels with beer or wine; free-flowing materials stored in combustible bags on wood or FM Approved pallets; free-flowing materials that are not inert.

G. Removed guidance for oil-based liquids. Refer to Data Sheet 7-29 for recommendations on the storage of all ignitable liquids.

H. Revised recommendations throughout the document to make it clear that wood pallets and FM Approved pallets should be treated the same.

October 2013. Minor editorial changes were made.

May 2004. A clarification regarding the classification of beer and wine in wooden barrels has been incorporated into recommendations in Section 2.2.1.

May 2001. A clarification regarding the classification of beer and wine has been incorporated into section 2.2.3.2. The clarification was done so that the definitions of nonflammable liquids (Group 5 water miscible liquids) would correspond with definitions found in Data Sheet 7-29, *Flammable Liquid Storage in Portable Containers*.

May 2000. This revision of this document has been reorganized to provide a consistent format.