Report of the Committee on
General Storage

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(Alt. to J. G. Gallup)
Peter Thomas, The Viking Corp., MI [M]
(Alt. to J. Golinveaux)

Nonvoting

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(Member Emeritus)
Sultan M. Javeri, AXA - AGR, France
Staff Liaison: Milosh T. Puchovsky

This list represents the membership at the time the Committee was balloted on the text of this edition. Since that time, changes in the membership may have occurred. A key to classifications is found at the back of this document.

Committee Scope: This Committee shall have primary responsibility for documents on safeguarding general warehousing and commodities stored indoors or outdoors against fire. This committee does not cover storage specifically covered by other NFPA standards.

The Report of the Technical Committee on General Storage is presented for adoption.

This Report was prepared by the Technical Committee on General Storage, and proposes for adoption amendments to NFPA 231-1995, Standard for General Storage. NFPA 231-1995 is published in Volume 5 of the 1997 National Fire Codes and in separate pamphlet form.

This Report has been submitted to letter ballot of the Technical Committee on General Storage, which consists of 28 voting members. The results of the balloting, after circulation of any negative votes, can be found in the report.
**RECOMMENDATION:** 1. Throughout the document where the terms "Standard Orifice", "Large Orifice", and "Extra Large Orifice Sprinklers" exist, replace them with "1/2 in. (12.7 mm) orifice", "17/32 in. (13.5 mm) orifice" and "5/8 in. (15.9 mm) orifice" respectively.

**SUBSTANTIATION:** 1. According to NFPA 13, which is referenced by this standard, sprinkler sizes are now identified according to their nominal orifice size and are not identified according to a generic description of their orifice size.

2. According to NFPA 13, which is referenced by this standard, sprinkler temperature ratings are identified according to the operating temperature range they fall into rather than to a specific temperature value.

**COMMITTEE ACTION:** Accept.

**NUMBER OF COMMITTEE MEMBERS ELIGIBLE TO VOTE:** 28

**VOTE ON COMMITTEE ACTION:** AFFIRMATIVE: 28

**COMMENT ON AFFIRMATIVE:**

SCHUMANN: Item #1 is OK. In item #2, ordinary temperature classification ranges from 135°F to 170°F. In standards that were developed from tests using 165°F sprinklers, do we want to allow 135°F sprinklers to be used which could have an adverse effect on the number of operating sprinklers?

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**SUBMITTER:** Kenneth E. Isman, Nat'l Fire Sprinkler Assn.

**RECOMMENDATION:** Add the word "warehouse" to Section 1-1.1 so that it reads:

"This standard shall apply to the warehouse storage of materials representing...

**SUBSTANTIATION:** To try and clarify that this document is for warehouses, not retail occupancies.

**COMMITTEE ACTION:** Reject.

**COMMITTEE STATEMENT:** The term "warehouse" is too limiting with regard to the scope of the standard. The standard is intended to cover storage areas in all types of occupancies such as in mercantile and manufacturing. The standard is not limited to warehouse applications only.

**NUMBER OF COMMITTEE MEMBERS ELIGIBLE TO VOTE:** 28

**VOTE ON COMMITTEE ACTION:** AFFIRMATIVE: 28

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**COMMITTEE STATEMENT:**

To try and clarify that this document is for warehouses, not retail occupancies.

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**SUBMITTER:** Kenneth E. Isman, Nat'l Fire Sprinkler Assn.

**RECOMMENDATION:** Revise 1-1.3(d) to include more examples and refer to specific NFPA standards.

**SUBSTANTIATION:** There is some confusion over the scope of NFPA 251 with relation to other NFPA standards such as NFPA 30. Specific statements similar to Section 1-1 of NFPA 251C would be helpful.

**COMMITTEE ACTION:** Accept in Principle.

Add the following after the existing text in 1-1.3(d):

"Storage of high hazard materials such as tires, roll paper stored on end, and flammable liquids is outside the scope of this standard. Storage of such commodities shall be protected in accordance with the provisions of NFPA 30, NFPA 30B, NFPA 40, NFPA 58, NFPA 231C, NFPA 231D, NFPA 251F, NFPA 232, NFPA 490, and NFPA 495."

**COMMITTEE STATEMENT:** The Technical Committee agrees with the submitter's intent and has added specific reference standards.

**NUMBER OF COMMITTEE MEMBERS ELIGIBLE TO VOTE:** 28

**VOTE ON COMMITTEE ACTION:** AFFIRMATIVE: 28

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**COMMITTEE STATEMENT:**

"Two such structures located back-to-back also constitutes shelf storage."

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**SUBSTANTIATION:** Back-to-back shelf storage configuration is a very common practice. It is unclear if back-to-back shelf storage falls within the scope of NFPA 231 or not.

**COMMITTEE ACTION:** Reject.

**COMMITTEE STATEMENT:** Placing two shelf units, as defined by the standard, in a back-to-back configuration could result in a shelf unit with a width in excess of 30 in. A shelf with a depth in excess of 30 in. is not considered shelf storage by the standard.

**NUMBER OF COMMITTEE MEMBERS ELIGIBLE TO VOTE:** 28

**VOTE ON COMMITTEE ACTION:** AFFIRMATIVE: 28

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**COMMITTEE STATEMENT:**

Replace Chapter 2 including all appendix items with the following text:

Chapter 2 Classification of Storage

2-1* Commodity Classification.

2-1.1 General.

2-1.1.1 Commodity classification and the corresponding protection requirements shall be determined based on the make up of individual storage units (i.e., unit load, pallet load).

Commodity classification is governed by the type and amounts of materials -e.g., metal, paper, wood, plastics - involved in a product and its primary packaging. However, in a storage or warehousing situation it is also affected by such factors as the material of the main storage or shipping container, the amount of air space and the location of the more hazardous materials within the container. For example, a Group A plastic product enclosed in a 5- or 6-sided metal container could be considered Class II; while a ceramic product heavily wrapped in tissue paper and placed in a corrugated carton could be Class III.

2-1.1.2 Mixed Commodities.

Protection requirements shall not be based on the overall commodity mix in a fire area. Mixed commodity storage shall be protected by the requirements for the highest classified commodity and storage arrangement.

Exception No. 1: Up to 10 pallet loads of a higher hazard commodity, within the scope of this standard, may be present in an area not exceeding 40,000 sq ft. The higher hazard commodity must be randomly dispersed with no adjacent loads in any direction (including diagonally). If the ceiling protection is based on Class I or II commodities, then the allowable number of pallet loads for Class IV or Group A Plastics shall be reduced to 5.

Exception No. 2: When the higher hazard material can be confined to a designated area and properly protected for that area.

2-1.2 Pallet Types.

When loads are palletized, the use of wooden or metal pallets is assumed in the classification of commodities. When plastic pallets are used, the classification of the commodity unit shall be increased one class (i.e., Class III will become class IV and Class IV will become Group A Plastics). No increase is required for Group A Plastic commodity.

Exception: When specific test data is available, the results of this data will take precedence in determining classification of commodities.

2-1.3* Commodity Classes.

2-1.3.1* Class I commodity is defined as noncombustible products that are:

(a) placed directly upon wooden pallets or,

(b) in single layer corrugated cartons, with or without single thickness cardboard dividers, with or without pallets or,

(c) shrink-wrapped or paper-wrapped as a unit load with or without pallets.
2-1.3.2* Class II commodity is defined as noncombustible products that are in slatted wooden crates, solid wood boxes, multiple-layered corrugated cartons or equivalent combustible packaging material, with or without pallets.

2-1.3.3* Class III commodity is defined as products fashioned from wood, paper, natural fibers or Group C plastics with or without cartons, boxes or crates and with or without pallets. Such products may contain a limited amount (5% by weight or volume) of Group A or B Plastics.

2-1.3.4* Class IV commodity is defined as products, with or without pallets that:

(a) are constructed partially or totally of Group B plastics or,

(b) consist of free-flowing Group A plastic materials or,

(c) contain within themselves or their packaging an appreciable amount (5% to 15% by weight or 5% to 25% by volume) of Group A plastics. The remaining materials may be metal, wood, paper, natural or synthetic fibers, Group B or Group C plastics.

2-1.4 Classification of Plastics, Elastomers, and Rubber.

Plastics, elastomers, and rubber shall be classified as Group A, Group B, or Group C.

The following categories are based on unmodified plastic materials. The use of fire- or flame-retarding modifiers or the physical form of the material could change the classification.

2-1.4.1* Group A.

- ABS (acrylonitrile-butadiene-styrene copolymer)
- Acetal (polyformaldehyde)
- Acrylic (polymethyl methacrylate)
- Butyl rubber
- EPM (ethylene - propylene rubber)
- FRP (fiberglass reinforced polyester)
- Natural rubber (if expanded)
- Nitrile rubber (acrylonitrile-butadiene rubber)
- PET (thermoplastic polyester)
- Polybutadiene
- Polycarbonate
- Polyester elastomer
- Polylethylene
- Polypropylene
- Polystyrene
- Polyurethane
- PVC (polyvinyl chloride - highly plasticized, with plasticizer content greater than 20%) (rarely found)
- SAN (styrene acrylonitrile)
- SBR (styrene-butadiene rubber)

2-1.4.2 Group B.

- Cellulose (cellulose acetate, cellulose acetate butyrate, ethyl cellulose)
- Chloroprene rubber
- Fluoroplastics (ECTFE - ethylene-chlorotrifluoro-ethylene copolymer; ETFE - ethylene-tetrafluoroethylene-copolymer; FEP - fluorinated ethylene-propylene copolymer)
- Natural Rubber (not expanded)
- Nylon (nylon 6, nylon 6/6)
- Silicone rubber

2-1.4.3 Group C.

- Fluoroplastics (PCTFE - polychlorotrisfluoroethylene; PTFE - polytetrafluoroethylene)
- Melamine (melamine formaldehyde)
- Phenolic
- PVC (polyvinyl chloride - flexible - PVC's with plasticizer content up to 20%)
- PVDC (polyvinylidene chloride)
- PVDF (polyvinylidene fluoride)
- PVB (polyvinyl fluoride)
- Urea (urea formaldehyde)

APPENDIX ITEMS

A-2-1 Specifying the type, amount and arrangement of combustibles for any commodity classification is essentially an attempt to define the potential fire severity, based on its burning characteristics so the fire may be successfully controlled by the prescribed sprinkler protection for that commodity class. In real life, however, many storage arrays will not fit precisely into one of the fundamental classifications thus requiring the user to make judgments after comparing each classification to the storage conditions at hand. With the thousands of products possible in storage arrays, it becomes impossible to define in words all the possible variations that could be acceptable in any class. As an alternative, to help the user, the Committee has classified a variety of common products in Appendix A, based on judgment, loss experience and fire test results.

Appendix A-2-1.3 is an alphabetized listing of commodities with corresponding classifications.

Appendix A-2-1.3.1 through A-2-1.4.1 gives examples of commodities all within a given class.

A-2-1.3 Alphabetized Listing of Commodity Classes

<table>
<thead>
<tr>
<th>Commodity</th>
<th>Commodity Class</th>
</tr>
</thead>
<tbody>
<tr>
<td>AEROSOLS (cartoned or uncartoned):</td>
<td>Class III</td>
</tr>
<tr>
<td>ALCOHOLIC BEVERAGES (cartoned or uncartoned):</td>
<td></td>
</tr>
<tr>
<td>- up to 20% alcohol; in metal, glass or ceramic containers</td>
<td>Class I</td>
</tr>
<tr>
<td>- up to 20% alcohol in wood containers</td>
<td>Class II</td>
</tr>
<tr>
<td>AMMUNITION (small arms, shotgun):</td>
<td></td>
</tr>
<tr>
<td>- packaged, cartoned</td>
<td>Class IV</td>
</tr>
<tr>
<td>APPLIANCES, Major (i.e., stoves, refrigerators):</td>
<td></td>
</tr>
<tr>
<td>- not packaged, no appreciable plastic exterior trim</td>
<td>Class I</td>
</tr>
<tr>
<td>- corrugated, cartoned, (no appreciable plastic trim)</td>
<td>Class II</td>
</tr>
<tr>
<td>BAKED GOODS (cookies, cakes, pies):</td>
<td></td>
</tr>
<tr>
<td>- frozen, packaged in cartons (Note 1)</td>
<td>Class II</td>
</tr>
<tr>
<td>- packaged, in cartons</td>
<td>Class III</td>
</tr>
<tr>
<td>BARLEY, RICE, OATS:</td>
<td></td>
</tr>
<tr>
<td>- packaged, in cartons</td>
<td>Class III</td>
</tr>
<tr>
<td>BATTERIES:</td>
<td></td>
</tr>
<tr>
<td>- in blister pack in cartons</td>
<td>Class I</td>
</tr>
<tr>
<td>- in cartons</td>
<td>Class II</td>
</tr>
<tr>
<td>- filled (Note 2)</td>
<td>Group A Plastics</td>
</tr>
<tr>
<td>- truck or larger</td>
<td>Class I</td>
</tr>
<tr>
<td>- empty or filled (Note 2)</td>
<td></td>
</tr>
<tr>
<td>BEANS (dried):</td>
<td></td>
</tr>
<tr>
<td>- packaged, cartoned</td>
<td>Class III</td>
</tr>
<tr>
<td>BOTTLES/JARS: Empty, cartoned</td>
<td></td>
</tr>
<tr>
<td>- glass</td>
<td>Class I</td>
</tr>
<tr>
<td>- plastic PET (polystyrene terephthalate)</td>
<td>Class IV</td>
</tr>
<tr>
<td>Filled noncomb. powders</td>
<td></td>
</tr>
<tr>
<td>- glass, cartoned</td>
<td>Class I</td>
</tr>
<tr>
<td>- plastic, cartoned (1,000 lbs)</td>
<td>Class IV</td>
</tr>
<tr>
<td>- plastic (other than PET) (any size)</td>
<td>Group A Plastics</td>
</tr>
<tr>
<td>Filled noncomb. liquids</td>
<td></td>
</tr>
<tr>
<td>- glass, cartoned</td>
<td>Class I</td>
</tr>
<tr>
<td>- plastic, cartoned (less than 5 gallons)</td>
<td>Group A Plastics</td>
</tr>
<tr>
<td>- plastic, open or solid plastic crates (Note 3)</td>
<td></td>
</tr>
<tr>
<td>Filled noncomb. powders</td>
<td></td>
</tr>
<tr>
<td>- plastic, cartoned or uncartoned (1,000 lbs)</td>
<td>Group A Plastics</td>
</tr>
<tr>
<td>- plastic, solid plastic crates</td>
<td>Group A Plastics</td>
</tr>
<tr>
<td>- plastic, open plastic crates</td>
<td>Group A Plastics</td>
</tr>
<tr>
<td><strong>BOXES, CRATES:</strong></td>
<td></td>
</tr>
<tr>
<td>-------------------</td>
<td>-----------------</td>
</tr>
<tr>
<td>- empty, wood, solid walls</td>
<td>Class II</td>
</tr>
<tr>
<td>- empty, wood, slatted (Note 4)</td>
<td>Outside of Scope</td>
</tr>
<tr>
<td><strong>BREAD (wrapped cartoned):</strong></td>
<td></td>
</tr>
<tr>
<td><strong>BUTTER:</strong></td>
<td></td>
</tr>
<tr>
<td>- whipped spread</td>
<td>Class III</td>
</tr>
<tr>
<td><strong>CANDLES (packaged, cartoned):</strong></td>
<td></td>
</tr>
<tr>
<td>- treat as expanded plastic</td>
<td>Group A Plastics</td>
</tr>
<tr>
<td><strong>GANDY (packaged, cartoned):</strong></td>
<td></td>
</tr>
<tr>
<td><strong>CANNED FOODS (in ordinary cartons):</strong></td>
<td></td>
</tr>
<tr>
<td><strong>CANS (metal):</strong></td>
<td></td>
</tr>
<tr>
<td>- empty</td>
<td>Class I</td>
</tr>
<tr>
<td><strong>CARPET TILES (cartoned):</strong></td>
<td></td>
</tr>
<tr>
<td><strong>CARTONS:</strong></td>
<td></td>
</tr>
<tr>
<td>- Corrugated</td>
<td>Class III</td>
</tr>
<tr>
<td>- unassembled (neat piles)</td>
<td>Class IV</td>
</tr>
<tr>
<td>- partially assembled</td>
<td>Group A Plastics</td>
</tr>
<tr>
<td>- Wax coated, single walled</td>
<td></td>
</tr>
<tr>
<td><strong>CEMENT (bagged):</strong></td>
<td></td>
</tr>
<tr>
<td><strong>CEREALS (packaged, cartoned):</strong></td>
<td></td>
</tr>
<tr>
<td><strong>CHARCOAL (bagged):</strong></td>
<td></td>
</tr>
<tr>
<td>- standard</td>
<td>Class III</td>
</tr>
<tr>
<td><strong>CHEESE:</strong></td>
<td></td>
</tr>
<tr>
<td>- packaged, cartoned</td>
<td>Class III</td>
</tr>
<tr>
<td>- wheels, cartoned</td>
<td>Class III</td>
</tr>
<tr>
<td><strong>CHEWING GUM (packaged, cartoned):</strong></td>
<td></td>
</tr>
<tr>
<td><strong>CHOCOLATE (packaged, cartoned):</strong></td>
<td></td>
</tr>
<tr>
<td><strong>CLOTH (cartoned or not):</strong></td>
<td></td>
</tr>
<tr>
<td>- natural fiber, viscose (Note 5)</td>
<td>Class III</td>
</tr>
<tr>
<td>- synthetic</td>
<td>Class IV</td>
</tr>
<tr>
<td><strong>COCOA PRODUCTS (packaged, cartoned):</strong></td>
<td></td>
</tr>
<tr>
<td><strong>COFFEE:</strong></td>
<td></td>
</tr>
<tr>
<td>- canned, cartoned</td>
<td>Class I</td>
</tr>
<tr>
<td>- packaged, cartoned</td>
<td>Class III</td>
</tr>
<tr>
<td><strong>COFFEE BEANS (bagged):</strong></td>
<td></td>
</tr>
<tr>
<td><strong>COTTON:</strong></td>
<td></td>
</tr>
<tr>
<td>- packaged cartoned</td>
<td>Class III</td>
</tr>
<tr>
<td><strong>DIAPERS:</strong></td>
<td></td>
</tr>
<tr>
<td>- cotton, linen</td>
<td>Class III</td>
</tr>
<tr>
<td>- disposable with plastics &amp; non-woven fabric (in cartons)</td>
<td>Class IV</td>
</tr>
<tr>
<td>- disposable with plastics &amp; non-woven fabric (uncartonned), plastic wrapped</td>
<td>Group A Plastics</td>
</tr>
<tr>
<td><strong>DRIED FOODS (packaged, cartoned):</strong></td>
<td></td>
</tr>
<tr>
<td><strong>FERTILIZERS (bagged):</strong></td>
<td></td>
</tr>
<tr>
<td>- phosphates</td>
<td>Class I</td>
</tr>
<tr>
<td>- nitrates</td>
<td>Class II</td>
</tr>
<tr>
<td><strong>FIBERGLASS INSULATION:</strong></td>
<td></td>
</tr>
<tr>
<td>- paper-backed rolls (bagged or unbagged)</td>
<td>Class IV</td>
</tr>
<tr>
<td><strong>FILE CABINETS (metal):</strong></td>
<td></td>
</tr>
<tr>
<td>- cardboard box or shroud</td>
<td>Class I</td>
</tr>
<tr>
<td><strong>FISH OR FISH PRODUCTS:</strong></td>
<td></td>
</tr>
<tr>
<td>- Frozen</td>
<td>Class I</td>
</tr>
<tr>
<td>- non-wax, non-plastic packaging</td>
<td>Class II</td>
</tr>
<tr>
<td>- waxed-paper containers, cartoned</td>
<td>Class III</td>
</tr>
<tr>
<td>- boxed or barreled</td>
<td>Class II</td>
</tr>
<tr>
<td>- plastic trays, cartoned</td>
<td>Class III</td>
</tr>
<tr>
<td>- canned</td>
<td>Class I</td>
</tr>
<tr>
<td>- cartoned</td>
<td>Class III</td>
</tr>
<tr>
<td><strong>FROZEN FOODS:</strong></td>
<td></td>
</tr>
<tr>
<td>- non-wax, non-plastic packaging</td>
<td>Class II</td>
</tr>
<tr>
<td>- waxed-paper containers, cartoned</td>
<td>Class III</td>
</tr>
<tr>
<td>- plastic trays</td>
<td>Group A Plastics</td>
</tr>
<tr>
<td><strong>FRUIT (fresh):</strong></td>
<td></td>
</tr>
<tr>
<td>- non-plastic trays or containers,</td>
<td>Class I</td>
</tr>
<tr>
<td>- with wood spacers</td>
<td>Class I</td>
</tr>
<tr>
<td><strong>FURNITURE:</strong></td>
<td></td>
</tr>
<tr>
<td>- Wood</td>
<td>Class III</td>
</tr>
<tr>
<td>- no plastic coverings or foam plastic cushioning</td>
<td>Class IV</td>
</tr>
<tr>
<td>- with plastic coverings</td>
<td>Group A Plastics</td>
</tr>
<tr>
<td>- with foam plastic cushioning</td>
<td></td>
</tr>
<tr>
<td><strong>ICE CREAM</strong></td>
<td></td>
</tr>
<tr>
<td><strong>LEATHER GOODS:</strong></td>
<td></td>
</tr>
<tr>
<td><strong>LEATHER HIDES (baled):</strong></td>
<td></td>
</tr>
<tr>
<td><strong>LIGHT FIXTURES (non-plastic):</strong></td>
<td></td>
</tr>
<tr>
<td>- cartoned</td>
<td>Class II</td>
</tr>
<tr>
<td><strong>LIGHTERS (butane):</strong></td>
<td></td>
</tr>
<tr>
<td>- blister-packed, cartoned</td>
<td>Group A Plastics</td>
</tr>
<tr>
<td>- loose in large containers (Level 3 Aerosol)</td>
<td>Outside of Scope</td>
</tr>
<tr>
<td><strong>MARGARINE:</strong></td>
<td></td>
</tr>
<tr>
<td>- up to 50% oil (in paper or plastic containers)</td>
<td>Class III</td>
</tr>
<tr>
<td>- between 50% and 80% oil (in any packaging)</td>
<td>Group A Plastics</td>
</tr>
<tr>
<td><strong>MATCHES (packaged, cartoned):</strong></td>
<td></td>
</tr>
<tr>
<td>- paper</td>
<td>Group A Plastics</td>
</tr>
<tr>
<td>- wood</td>
<td>Group A Plastics</td>
</tr>
<tr>
<td><strong>MATTRESSES:</strong></td>
<td></td>
</tr>
<tr>
<td>- standard (box spring)</td>
<td>Group A Plastics</td>
</tr>
<tr>
<td>- foam (in finished form)</td>
<td>Class III</td>
</tr>
<tr>
<td><strong>MEAT, MEAT PRODUCTS:</strong></td>
<td></td>
</tr>
<tr>
<td>- bulk</td>
<td>Class I</td>
</tr>
<tr>
<td>- canned, cartoned</td>
<td>Class I</td>
</tr>
<tr>
<td>- frozen, non-waxed, non-plastic containers</td>
<td>Class I</td>
</tr>
<tr>
<td>- frozen, waxed-paper containers</td>
<td>Class II</td>
</tr>
<tr>
<td>- frozen, expanded plastic trays</td>
<td>Group A Plastics</td>
</tr>
<tr>
<td><strong>METAL DESKS:</strong></td>
<td></td>
</tr>
<tr>
<td>- with plastic tops and trim</td>
<td>Class I</td>
</tr>
<tr>
<td><strong>MILK:</strong></td>
<td></td>
</tr>
<tr>
<td>- non-wax paper containers</td>
<td>Class I</td>
</tr>
<tr>
<td>- waxed paper containers</td>
<td>Class I</td>
</tr>
<tr>
<td>- plastic containers</td>
<td>Class I</td>
</tr>
<tr>
<td>- containers in plastic crates</td>
<td>Group A Plastics</td>
</tr>
<tr>
<td><strong>MOTORS:</strong></td>
<td></td>
</tr>
<tr>
<td>- electrical</td>
<td>Class I</td>
</tr>
<tr>
<td><strong>NAIL POLISH:</strong></td>
<td></td>
</tr>
<tr>
<td>- 1-2 oz glass cartoned</td>
<td>Class IV</td>
</tr>
<tr>
<td>- 1-2 oz plastic bottles-cartoned</td>
<td>Group A Plastics</td>
</tr>
<tr>
<td><strong>NUTS:</strong></td>
<td></td>
</tr>
<tr>
<td>- canned, cartoned</td>
<td>Class I</td>
</tr>
<tr>
<td>- packaged, cartoned</td>
<td>Class III</td>
</tr>
<tr>
<td>- bagged</td>
<td>Class III</td>
</tr>
<tr>
<td>NFPA 231 — A98 ROP</td>
<td></td>
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<tr>
<td>---------------------</td>
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</tbody>
</table>

**PAINTS (friction top cans, cartoned)**
- water-based (latex) Class I
- oil based Class IV

**PAPER PRODUCTS:**
- books; magazines; stationery; plastic-coated paper food containers; newspapers, cardboard games or cartoned tissue products Class III
- tissue products, uncartoned & plastic wrapped Group A Plastics

**PAPER, ROLLED**
- In racks or on side (INCLUDED IN NFPA 231C)
  - medium or heavyweight Class III
  - lightweight Class IV
- In racks (INCLUDED IN NFPA 231C) Class III
- angle, synthetic Class IV

**PAPER, WAXED (packaged in cartons)** Class IV

**PHARMACEUTICALS:**
- glass bottles, cartoned Class II
- plastic bottles, cartoned Class IV
- Natural or synthetic Class II

**PHOTOGRAPHIC:**
- motion picture or bulk rolls of film in polyethylene, polyethylene or metal cans, polyethylene bagged in cardboard boxes Class III
- 35 MM in metal film cartridges in polyethylene cans in cardboard boxes Class III
- paper, in sheets, bagged in polyethylene, in cardboard boxes Class III
- roll film in polycarbonate plastic cassettes, bulk wrapped in cardboard boxes. Class IV

**PLASTIC CONTAINERS:**
- non-combustible liquids or semi-liquids in plastic containers less than 5 gallon capacity. Class I
- non-combustible liquids or semi-liquids in plastic containers larger than 5 gallons Class II
- combustible or non-combustible solids in plastic containers and empty plastic containers Class II

**POLYURETHANE:**
- cartoned or uncartoned expanded Group A Plastics

**PULP AND PAPER:**
- canned, cartoned Class I
- frozen, non-wax non-plastic containers Class I
- frozen, (on paper or expanded plastic trays) Class II

**POWDERS (ordinary combustibles - free flowing):**
- in paper bags (i.e., flour, sugar, etc.) Class II

**PVA (polyvinyl alcohol) resins:**
- bagged Class IV

**PVC (polyvinyl chloride):**
- flexible (e.g., pipe, pipe fittings) Class III
- rigid (e.g., pipe, pipe fittings) Class III
- bagged resins Class III

**RAGS (baled):**
- natural fibers Class III
- synthetic fibers Class IV

**RUBBER:**
- natural, blocks in cartons Class IV
- synthetic Group A Plastics

**SALT:**
- bagged Class I
- packaged, cartoned Class II

**SHINGLES:**
- asphalt coated fiberglass Class III
- asphalt impregnated felt Class IV

**SHOCK ABSORBERS:**
- metal dust cover Class III
- plastic dust cover Class III

**SIGNATURES (book, magazines):**
- solid array on pallet Class II

**SKIS:**
- wood Class III
- foam core Class IV

**STUFFED TOYS (foam or synthetic):** Group A Plastics

**SYRUP:**
- drummed (metal containers) Class I
- barreled, wood Class II

**TEXTILES:**
- natural fiber clothing or textile products Group A Plastics
  - 50/50 Blend or less
  - thread, yarn on wood or paper spools
  - thread, yarn on plastic spools
  - baled fiber
  - Greater than 50/50 Blend
    - thread, yarn on wood or paper spools
    - fabrics
    - baled fiber
    - thread, yarn on plastic spools
    - Rayon and Nylon
    - baled fiber
    - thread, yarn on wood or paper spools
    - fabrics
    - thread, yarn on plastic spools

**TRANSFORMERS (dry & oil filled):** Class I

**VINYL COATED FABRIC:**
- cartoned Group A Plastics

**VINYL FLOOR COVERINGS:**
- tiles in cartons Class IV
- rolled Group A Plastics

**WAX COATED paper; cups, plates:**
- boxed or packaged inside cartons Group A Plastics
  (emphasis is on packaging)
- loose inside large cartons Class IV

**WAX (paraffin, blocks, cartoned):** Group A Plastics

**WIRE:**
- bare wire on metal spools on wood Class I
- bare wire on wood or cardboard spools on wood Class II
- bare wire on metal, wood or cardboard Class II
  - spools in cardboard boxes on wood
  - single or multiple PVC covered wire on metal spools on wood
  - insulated - (PVC) cable on large wood
  - metal spools on wood
  - bare wire on plastic spools in cardboard boxes on wood Class II
  - single or multiple (PVC) covered wire on plastic spools in cardboard boxes on wood Class IV
  - single, multiple, or power cables (PVC) on large plastic spools Class IV
  - bulk storage of empty plastic spools Group A Plastics
WOOD PRODUCTS:
- solid piles, lumber, plywood, particle board, pressboard (smooth ends & edges) Class II
- spools (empty) Class III
- toothpicks, clothespins, hangars in cartons Class III
- doors, windows, wood cabinets & furniture Class III
- patterns Class IV

NOTES:
1. Presumes product is in a plastic-coated package in a corrugated carton. If packaged in a metal foil, it may be considered Class I.
2. Most batteries have a polypropylene case and, if stored empty, should be treated as a Group A plastic. Truck batteries, even when filled, should be considered a Group A plastic because of the thicker walls.
3. As the openings in plastic crates become larger, the commodity behaves more like Class III. Conversely, as the openings become smaller, the product makeup behaves more like a plastic.
4. Should be treated as idle pallets.
5. Tests conducted clearly indicated synthetics or synthetic blends are considered greater than Class III.
6. When liquor is stored in glass containers in racks, it should be considered a Class III Commodity. When it is palletized, it should be considered a Class IV Commodity.

A-2.1.5.1 Examples of Class I Commodities.

ALCOHOLIC BEVERAGES (cartoned or uncartoned):
- up to 20% alcohol; in metal, glass or ceramic containers

APPLIANCES, Major (i.e., - stoves, refrigerators):
- not packaged; no appreciable plastic exterior trim

BATTERIES:
Dry Cells - packaged in cartons
Automobile - filled (Note 1)

BOTTLES/JARS:
Empty, cartoned - glass;
Filled noncomb. liquids - glass, cartoned,
- plastic, cartoned (less than 5 gallon) filled noncomb. powders - glass, cartoned

CANNED FOODS (in ordinary cartons)

CANS (metal)
- empty

CEMENT (bagged)

FERTILIZERS (bagged):
- phosphates

FILE CABINETS (metal):
- cardboard box or shroud

FISH OR FISH PRODUCTS (frozen):
- non-wax, non-plastic packaging

FISH OR FISH PRODUCTS (canned):
- cartoned

FROZEN FOODS:
- non-wax, non-plastic packaging

FRUIT (fresh):
- non-plastic trays or containers,
- with wood spacers

ICE CREAM

MEAT, MEAT PRODUCTS:
- bulk
- canned, cartoned
- frozen, non-waxed, non-plastic containers

METAL DESKS:
- with plastic tops and trim

MILK:
- non-wax paper containers
- waxed paper containers
- plastic containers

MOTORS:
- electrical

NUTS:
- canned, cartoned

PAINTS (friction top cans, cartoned):
- water-based (latex)

PLASTIC CONTAINERS:
- non-combustible liquids or semi-liquids in plastic containers less than 5 gallon capacity.

POULTRY PRODUCTS:
- canned, cartoned
- frozen, non-wax non-plastic containers

SALT:
- bagged

SYRUP:
- drummed (metal containers)

TRANSFORMERS (dry & oil filled)

WIRE:
- bare wire on metal spools on wood skids

A-2.1.5.2 Examples of Class II Commodities

ALCOHOLIC BEVERAGES:
- up to 20% alcohol in wood containers

APPLIANCES (major, e.g., - stoves):
- corrugated, cartoned, (no appreciable plastic trim)

BAKED GOODS (cookies, cakes, pies)
- frozen, packaged in cartons (Note 2)

BATTERIES: Dry Cells - in blister pack in cartons

BOXES, CRATES:
- empty, wood, solid walls

FERTILIZERS (bagged):
- nitrates

FISH OR FISH PRODUCTS (frozen):
- waxed-paper containers, cartoned
- boxed or barreled

FROZEN FOODS:
- waxed-paper containers, cartoned

LEATHER HIDES (baled)

LIGHT FIXTURES (non-plastic)
- cartoned

MARBLE (artificial sinks, countertops)
- cartoned, crated

MEAT, MEAT PRODUCTS:
- frozen, waxed-paper containers
- frozen, expanded plastic trays

PHARMACEUTICALS:
- Pills, powders:
- glass bottles, cartoned
- Non-flammable liquids:
- glass bottles, cartoned

PHOTOGRAPHIC:
- motion picture or bulk rolls of film in polycarbonate, polyethylene or metal cans, polyethylene bagged in cardboard boxes.

PLASTIC CONTAINERS:
NFPA 231 — A98 ROP

- non-combustible liquids or semi-liquids in plastic containers larger than 5 gallons

POULTRY PRODUCTS:
- frozen, (on paper or expanded plastic trays)

POWders (ordinary combustibles - free flowing):
- in paper bags (i.e., flour, sugar, etc.)

SALT:
- packaged, cartoned

SHock Absorbers:
- metal dust cover

SIGNATURES (book, magazines):
- solid array on pallet

SyrUp:
- barreled, wood

WIRE:
- bare wire on wood or cardboard spools on wood skids
- bare wire on metal, wood or cardboard spools in cardboard boxes on wood skids
- single or multiple PVC covered wire on metal spools on wood skids
- insulated - (PVC) cable on large wood or metal spools on wood skids

WOOD PRODUCTS (solid piles):
- lumber, plywood, particle board, pressboard (smooth ends & edges)

A-2.1.3.5 Examples of Class III Commodities.

AEROSOLS (cartoned or uncartoned):
- Level 1

BAKED GOODS (cookies, cakes, pies):
- packaged, in cartons

BARLEY, RICE, OATS:
- packaged, in cartons

BEANS (dried):
- packaged, cartoned

BREAD (wrapped cartoned)
- whipped spread

CANDY (packaged, cartoned)

CARTONS (corrugated):
- unassembled (neat piles)

CEREALS (packaged, cartoned)

CHARCOAL (bagged):
- standard

CHEESE:
- packaged, cartoned
- wheels, cartoned

CHEWING GUM (packaged, cartoned)

CHOCOLATE (packaged, cartoned)

CLOTH (cartoned or not):
- natural fiber, viscose

COCOA PRODUCTS (packaged, cartoned)

COFFEE:
- packaged, cartoned

COFFEE BEANS (bagged)

COTTON:
- packaged cartoned

DIAPERS:
- cotton, linen

DRIED FOODs (packaged, cartoned)

FISH OR FISH PRODUCTS (frozen):
- plastic trays, cartoned

FROZEN FOODs:
- plastic trays

FURNITURE:
- wood (no plastic coverings or foam plastic cushioning)

LEATHER GOODS:

MARGARINE:
- up to 50% oil (in paper or plastic containers)

MATTRESSES:
- standard (box spring)

NUTS:
- packaged, cartoned
- bagged

PAPER PRODUCTS:
- books; magazines; stationery; plastic-coated paper food containers; newspapers, cardboard games or cartoned tissue products

PAPER, ROLLED (in racks or on side) [INCLUDED IN NFPA 231C ONLY]

PHOTOGRAPHIC:
- 35 MM in metal film cartidges in polystyrene cans in cardboard boxes
- paper, in sheets, bagged in polystyrene, in cardboard boxes

PVC (polyvinyl chloride):
- flexible (e.g., cable jackets, plasticized sheets)
- rigid (e.g., pipe, pipe fittings)
- bagged resins

RAGS (baled):
- natural fibers

SHINGLES:
- asphalt coated fiberglass

SHock Absorbers:
- plastic dust cover

SKIS:
- wood

TEXTILES:
- natural fiber clothing or textile products
- Synthetics (except rayon and nylon):
  - 50/50 Blend or less
  - thread, yarn on wood or paper spools
- fabrics

TOBACCO PRODUCTS:
- in paperboard cartons

WOOD PRODUCTS:
- spools (empty)
- toothpicks, clothespins, hangars in cartons
- doors, windows, wood cabinets & furniture

A-2.1.3.4 Examples of Class IV Commodities.

AMMUNITION (small arms, shotgun):
- packaged, cartoned

BOTTLES/JARS: Empty, cartoned
- plastic PET (polyethylene terephthalate)
- filled noncomb, powders
- plastic, cartoned (< 1 gallon)

CARTONS (corrugated):
- partially assembled

489
CLOTH (cartoned or not):
- synthetic (Note 3)

DIAPERS:
- disposable with plastics & non-woven fabric (in cartons)

FIBERGLASS INSULATION:
- paper backed rolls (bagged or unbagged)

FURNITURE - Wood:
- with plastic coverings

LIQUOR (100 proof or less, one gallon or less, cartoned):
- glass (palletized) (Note 4)
- plastic bottles

MATCHES (packaged, cartoned):
- paper

NAIL POLISH:
- 1-2 oz glass cartoned

PAINTS (friction top cans, cartoned):
- oil based

PAPER, ROLLED (in racks):
- lightweight (INCLUDED IN NFPA 251C ONLY)

PAPER, WAXED (packaged in cartons)

PHARMACEUTICALS (pills, powders):
- plastic bottles, cartoned

PHOTOGRAPHIC:
- roll film in polycarbonate plastic cassettes, bulk wrapped in cardboard boxes.

PVA (polyvinyl alcohol) resins:
- bagged

RAGS (baled):
- synthetic fibers

RUBBER:
- natural, blocks in cartons

SHINGLES:
- asphalt impregnated felt

SKIS:
- foam core

TEXTILES:
- synthetics (except rayon and nylon):
  - 50/50 Blend or less
  - thread, yarn on plastic spools
  - greater than 50/50 Blend
  - thread, yarn on wood or paper spools
  - fabrics
- Rayon and Nylon:
  - baled fiber
  - thread, yarn on wood or paper spools
  - fabrics

VINYL FLOOR COVERINGS:
- tiles in cartons

WAX COATED paper, cups, plates:
- boxed or packaged inside cartons (emphasis is on packaging)

WIRE:
- bare wire on plastic spools in cardboard boxes on wood skids
- single or multiple (PVC) covered wire on plastic spools in cardboard boxes on wood skids
- single, multiple, or power cables (PVC) on large plastic spools

WOOD PRODUCTS:
- patterns

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A-2.1.4.1 Examples of Group A Plastic Commodities.

BATTERIES: Truck or Larger
- empty or filled (Note 1)

BOTTLES/JARS: Empty, Cartoned
- plastic (other than PET) (any size)
  - filled noncomb. liquids
  - plastic, open or solid plastic crates (Note 5)
  - plastic cartoned or uncartoned (>1 gallon)
  - plastic, solid plastic crates
  - plastic, open plastic crates

CANDLES (packaged, cartoned):
- treat as expanded plastic

CARPET TILES (cartoned)

DIAPERS:
- disposable with plastics & non-woven fabric (uncartonned), plastic wrapped

FURNITURE - Wood:
- with foam plastic cushioning

LIGHTERS (butane):
- blister-packed, cartoned

MARGARINE:
- between 50% and 80% oil (in any packaging)

MATCHES (packaged, cartoned):
- wood

MATTRESSES:
- foam (in finished form)

MILK:
- containers in plastic crates

NAIL POLISH:
- 1-2 oz plastic bottles-cartoned

PAPER PRODUCTS:
- tissue products, uncartoned & plastic wrapped

PLASTIC CONTAINERS:
- combustible or non-combustible solids in plastic containers and empty plastic containers

POLYURETHANE:
- cartoned or uncartoned expanded

RUBBER:
- synthetic

STUFFED TOYS (foam or synthetic)

TEXTILES:
- synthetics (except rayon and nylon):
  - 50/50 Blend or less
  - baled fiber
  - greater than 50/50 Blend
  - baled fiber
  - thread, yarn on plastic spools
  - Rayon and Nylon
  - thread, yarn on plastic spools

VINYL COATED FABRIC:
- cartoned

VINYL FLOOR COVERINGS:
- rolled

WAX COATED paper, cups, plates
- loose inside large cartons

WAX (paraffin, blocks, cartoned)
WIRE:
- bulk storage of empty plastic spools

Examples of Commodities Outside the Scope of this Standard

BOXES, CRATES:
- empty, wood, studded (Note 6)

LIGHTERS (butane):
- loose in large containers (Level 3 Aerosol)

NOTES:
1. Most batteries have a polypropylene case and, if stored empty, should be treated as a Group A plastic. Truck batteries, even when filled, should be considered a Group A plastic because of the thicker walls.
2. Presumes product is in a plastic-coated package in a corrugated carton. If packaged in a metal foil, it may be considered Class I.
3. Tests conducted clearly indicated synthetics or synthetic blends are considered greater than Class III.
4. When liquor is stored in glass containers in racks, it should be considered a Class II Commodities when it is palletized, it should be considered a Class IV Commodity.
5. As the openings in plastic crates become larger, the commodity behaves more like Class III. Conversely, as the openings become smaller, the product makeup behaves more like a plastic.
6. Should be treated as idle pallets.

SUBSTANTIATION: Review of data over the past 2 years has prompted the Committee to expand upon the commodity classifications. Information has also been added regarding the protection of mixed commodities.

COMMITTEE ACTION: Accept

NUMBER OF COMMITTEE MEMBER ELIGIBLE TO VOTE: 28

VOTE ON COMMITTEE ACTION:

AFFIRMATIVE: 28

COMMENT ON AFFIRMATIVE:

SCHUHANN: Under batteries, the words "Dry cells" should be in the commodity column not the commodity class column. Under barley, rice and oats should have their own entries. Under bottles/jars, all items filled with noncombustible powders should be together. Under candles, expanded Group A plastic should be in the commodity class column.

231.6 (3-2): Reject

SUBMITTER: Mark Chubb, Southeastern Assoc. of Fire Chiefs REMARKS:

Revise text as follows:

3-2.4 Emergency Smoke and Heat Venting. Protection outlined in this standard shall apply to buildings with or without roof vents and draft curtains. Where roof vents and draft curtains or mechanical smoke exhaust are installed, the effect of smoke and heat venting on automatic sprinkler operation shall be taken into account. Designs using these fire protection features in combination with one another shall be based on engineering judgment and recognized good practice.

3-2.1.1 Where installed, smoke and heat vents shall not operate prior to activation of the automatic sprinkler system. Heat responsive devices used to open smoke and heat vents shall have a temperature rating not less than 45°F (25°C) higher than the temperature rating of sprinkler heat sensitive elements, and a response time index (RTI) at least equal to, but not more than 3 times greater than the sprinkler RTI.

3-2.1.2 Manual release shall permit the smoke and heat vents to be operated remotely. Manual release devices shall be installed in a location acceptable to the authority having jurisdiction.

3-2.2 Smoke and Heat Vent Location. Smoke and heat vents shall be located so that no portion of the vent opening is directly above or within 8 in. (203mm) of sprinklers.

3-2.3 Mechanical Smoke Exhaust. Engineered mechanical smoke exhaust shall be an acceptable alternate to smoke and heat vents.

3-2.3.1 Mechanical smoke exhaust fans shall be automatically actuated by the automatic sprinkler system or by heat detectors having operating characteristics equivalent to those described in 3-2.1.1. Individual manual controls of each fan unit shall also be provided.

3-2.3.2 Wiring for operation and control of smoke exhaust fans shall be connected ahead of the main disconnect and protected against exposure to temperatures in excess of 100°F (55°C) for a period of not less than 15 minutes.

3-2.3.3 Controls shall be located so as to be immediately accessible to the fire service from the exterior of the building and protected against interior fire exposure by separation assemblies having a fire resistance rating not less than 1-hour when tested in accordance with NFPA 251.

3-2.4 Draft Curtains Not Required. Draft curtains need not be installed in buildings protected by ESFR sprinkler systems.

SUBSTANTIATION: The provisions of NFPA 231 are referenced throughout the United States as minimum requirements for the design of fire protection systems to high-piled combustible stock. Two of the three model building codes referencing this standard also require smoke and heat vents or mechanical smoke exhaust (see 411.1 of the Standard Building Code© and Chapter 56 of the Standard Prevention Code© and Article 81 of the Uniform Fire Code™). Continuing controversy surrounding the combined use of these fire protection features has prompted significant debate and ongoing research activities here and abroad to identify technical concerns, quantify the interaction between these systems, and develop technical tools to aid designers in employing these technologies. In the interim, however, additional guidance is needed to ensure the confidence of users and the safety of buildings built under these code requirements and NFPA 231.

The proposed requirements were originally developed by private industry and have been successfully processed through the Southern Building Code Congress International Southeastern Association of Fire Chiefs code development system. They constitute minimal design guidance for situations where the two fire protection systems are in use in conjunction with one for protection of life or property.

The proposed requirements (3-2) complement the existing text by advising users of the need to consider the possible interactions between the systems and consult sources of engineering guidance and good practice in developing designs using these technologies. Nothing in the proposed requirements would make the installation of smoke and heat vents or mechanical smoke exhaust mandatory where they are not already required by model building and fire codes.

Automatic operating capability (proposed 3-2.1.1 and 3-2.3.1) is required to mitigate the need for firefighters to attempt vertical ventilation of the fire by placing firefighters at risk on the roof above a fire in a rapid response facility. Mandatory requirements (proposed 3-2.1.1 and 3-2.3.1) ensures that vents remain under the control of the fire service without placing firefighters at-risk. Automatic and manual venting also affords an opportunity to mitigate fire damage in the event the fire overwhelms the capabilities of the automatic sprinkler system.

The exception to automatic operation requirements for buildings protected with ESFR sprinkler systems does not currently appear in the model codes (proposed 3-2.1.1). However, this approach is commonly used and accepted by code officials enforcing these requirements. (At the time the current smoke and heat venting requirements were developed, ESFR technology was not available.)

The proposed new provisions (3-2.1.1) regarding automatic operation and location are intended to prevent the operation of vents prior to sprinklers, possibly compromising the effectiveness of sprinkler protection. The temperature rating and RTI values specified have been rooted by the Southern Association of Fire Chiefs’ Ad Hoc Committee on Smoke and Heat Venting using the computer programs LAVENT and DETACT-T2 to ensure that sprinklers will operate later than sprinklers but not too late to ensure vents provide life safety or property protection benefits.

The location of vents with respect to sprinklers (proposed 3-2.1) is intended to ensure that sprinkler spray does not obstruct vents.

Testing conducted by Factory Mutual Research Corporation has indicated that draft curtains may significantly affect the operation of sprinklers where storage areas transact draft curtain boundaries (see Group, J.M.A. "Large-Scale Fire Tests of Rack
COMMITTEE ACTION: Reject.

COMMITTEE STATEMENT: No data exists which clearly allows evaluation of the interaction between heat/smoke vents and automatic sprinklers for the protection of storage occupancies. A test program being conducted by the National Fire Protection Research Foundation is currently underway and should provide additional data on this subject.

NUMBER OF COMMITTEE MEMBERS ELIGIBLE TO VOTE: 28
VOTE ON COMMITTEE ACTION: AFFIRMATIVE: 28

231-7 - (3-2 Exception (New) and A-3-2): Accept in Principle in Part

SUBMITTER: Kenneth E. Isman, Nat'l Fire Sprinkler Assn.
RECOMMENDATION: Add a new exception to 3-2 and replace A-3-2 as follows:

A-3-2 Exception:

Exception: Where local codes require heat and smoke vents in buildings protected by ESFR sprinklers, the vents shall be manually operated, or have an operating mechanism with a standard response fusible element rated no less than 280°F. Drop vents out shall not be permitted.

COMMITTEE ACTION: Accept in Principle in Part.

1. Revise the proposed Exception to Section 3-2 to read as follows:

Exception: Where local codes require heat and smoke vents in buildings protected by ESFR sprinklers, the vents shall be manually operated, or have an operating mechanism with a standard response fusible element rated no less than 280°F. Drop vents out shall not be permitted.

2. Reject the proposed appendix material to A-3-2.

COMMITTEE STATEMENT:

1. Data indicates that smoke/heat vents which operate prior to the activation of ESFR sprinklers can have a negative impact on the performance of the ESFR sprinklers.

2. This material is not specific to ESFR sprinklers.

NUMBER OF COMMITTEE MEMBERS ELIGIBLE TO VOTE: 28
VOTE ON COMMITTEE ACTION: AFFIRMATIVE: 27
NEGATIVE: 1

EXPLANATION OF NEGATIVE:

KROMAN: I could accept the use of 360°F auto vents in the exception, but I cannot support the use of 280°F links.

Committee Statement #1 (correctly) states that auto smoke/heat vents which operate before ESFR heads can have a negative impact on performance. Joe Hanks mentioned that no full scale ESFR tests were done with auto vents, but small and intermediate testing showed that auto venting will indeed interfere with ESFR effectiveness.

FM modeling evidently showed that 360°F links would be acceptable, and FMDS 2.2 states that if local codes require auto vents, use 360°F links; but it also states if local codes don't permit 360°F links, the use of 280°F links is acceptable. Certainly, FM is free to determine protection criteria for their own needs. But should this Committee accept this when the empirical evidence seems to indicate this could result in a negative impact on ESFR performance.

The wording in FMDS implies that the use of 280°F rated links is acceptable solely because some authorities having jurisdiction require it. This is a legitimate concern on the part of end users and needs to be addressed, perhaps by adding additional explanatory material in the Appendix about the known relationship between ESFR and auto vents. However, by allowing the use of 280°F links in the Exception to 3-2, this Committee has formally sanctioned their use. This is a peculiar stance on the part of the Committee, which usually insists on complete test data before changing protection criteria.

Furthermore, what if intermediate temperature ESFR heads are promoted due to ambient temperatures above 100°F? With 212°F ESFR heads and 286°F auto vents, is the Committee confident that ESFR effectiveness is not negatively impacted?

It seems to me the prudent course is to wait until the NFPRF's project on auto venting is complete. The actual test results from that project will offer more definitive data on the use of auto vents, including their interaction with ESFR sprinklers.

231-3 - (Table 4-4.2.1): Accept

SUBMITTER: Technical Committee on General Storage

RECOMMENDATION: Delete the words "Polyethylene Solid Deck Idle Pallets" from the title of the table.

SUBSTANTIATION: This Table is to apply only to wood pallets with exceptions referenced in other sections.

COMMITTEE ACTION: Accept.

NUMBER OF COMMITTEE MEMBERS ELIGIBLE TO VOTE: 28
VOTE ON COMMITTEE ACTION: AFFIRMATIVE: 28

231-9 - (4.4.1.2, 4.4.2.1 Exception No. 3): Accept

SUBMITTER: Technical Committee on General Storage

RECOMMENDATION: 1. In the first paragraph of 4.4.1.2 add the words "Table 8-1, or Table 9-1" in between the words "Table 4-4.2.1" and "unless", so it reads:

"Pallets, where stored indoors, shall be protected as indicated in Table 4-4.1.2, Table 8-1 or Table 9-1, unless the following conditions are met:" 2. Add an Exception No. 3 to 4.4.2.1 as follows:

Exception No. 3: Indoor storage of plastic pallets shall be permitted to be protected in accordance with Table 9-1.

SUBSTANTIATION: Data indicates that ESFR sprinklers are effective for the protection of certain indoor storage arrangements of idle wood and plastic pallets. Other data indicates that large drop sprinklers are effective for the protection of certain indoor storage arrangements of idle wood pallets.

COMMITTEE ACTION: Accept.

NUMBER OF COMMITTEE MEMBERS ELIGIBLE TO VOTE: 28
VOTE ON COMMITTEE ACTION: AFFIRMATIVE: 27
ABSTENTION: 1

EXPLANATION OF ABSTENTION:

McPhee: The reference to Table 9-1 in 4.4.1.2 and the new Exception No. 3 to 4.4.2.1 is questioned.

From my notes of the March meeting, I have no record of any proposal or discussion that Table 9-1 on ESFR be expanded to cover storage of idle wood or plastic pallets. Table 8-1 already had a reference to this type of storage so the reference to Table 8-1 here is appropriate.

I have to presume that this was justified through the Committee discussion based simply on comparisons of existing density/storage height provisions already in the standard for idle pallet storage protected by standard or large drop sprinklers, e.g., Table 4-4.1.2; Section 4.4.2.2; and Table 8-1.
pallets shall be permitted to be protected in accordance with Section 4-4.4.1.2.

**SUBSTANTIATION:** Open deck plastic pallets are now available which have ignition, fire growth, and fire spread characteristics which represent an equivalent or lower fire hazard compared to idle wood pallets. Likewise, the sprinkler protection required to control/suppress a fire in idle pallet storage for these new materials is equivalent or less than that specified in Section 4-4.1.2.

Because idle wood pallets are considered as a special type of hazard, specific protection criteria has been established in Section 4-4.1.2 and Table 4-4.1.2. It follows that if pallets of other construction materials have a demonstrated equivalent or lesser hazard, these newer technology materials should be recognized.

To be consistent with the current NFPA and Model Code emphasis on performance based approaches, the proposal uses performance-based language instead of specifying particular materials. The required protection for this baseline hazard is established in Section 4-4.1.2 and Table 4-4.1.2.

**COMMITTEE ACTION:** Accept in Principle in Part.

1. Reject part (a) of the submitter's Proposal.
2. Add a new Exception No. 4 as indicated by part b of the submitter's Proposal with the following changes:
   - Add the words "and is listed for such equivalency" between the words "idle wood pallets" and "shall be permitted".

   The Exception should read:
   - Exception No. 4: Indoor storage of non-wood pallets having a demonstrated fire hazard which is equal to or less than idle wood pallets and is listed for such equivalency shall be permitted to be protected in accordance with Section 4-4.1.2.

   **COMMITTEE STATEMENT:** Although pallets are not currently listed, the Technical Committee believes that there is a need to reference an evaluation methodology which can identify those non-wood pallets which when stored idle do not present a more severe hazard than do the storage of idle wood pallets. The change to the proposed Exception No. 3 does not make it necessary to accept part a of the submitter's Proposal.

**NUMBER OF COMMITTEE MEMBERS ELIGIBLE TO VOTE:** 28

**VOTE ON COMMITTEE ACTION:**

**AFFIRMATIVE:** 28

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**COMMITTEE ACTION:** Accept

**NUMBER OF COMMITTEE MEMBERS ELIGIBLE TO VOTE:** 28

**VOTE ON COMMITTEE ACTION:**

**AFFIRMATIVE:** 28

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**COMMITTEE ACTION:** Accept

**NUMBER OF COMMITTEE MEMBERS ELIGIBLE TO VOTE:** 28

**VOTE ON COMMITTEE ACTION:**

**AFFIRMATIVE:** 28

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231-11 - (4-4.2, A-4.4-2.1): Accept

**SUBMITTER:** Technical Committee on General Storage

**RECOMMENDATION:** 1. In Exception No. 2 to A-4.2.1 add the words "storage of" between the words "indoor" and "nonexpanded polyethylene," so it reads:

   - Exception No. 2: Indoor storage of nonexpanded polyethylene solid deck pallets shall be permitted to be protected in accordance with 4-4.1.2.

   2. Relocate the text of A-4.4.2 as the second paragraph of A-4.4.

   Remove * from 4-4.2.

   3. In existing A-4.4.2, in the first line replace the word "and" with "or" so it reads:

   "A fire in stacks of idle plastic or wooden pallets."

**SUBSTANTIATION:** These changes are editorial.

**COMMITTEE ACTION:** Accept.

**NUMBER OF COMMITTEE MEMBERS ELIGIBLE TO VOTE:** 28

**VOTE ON COMMITTEE ACTION:**

**AFFIRMATIVE:** 28

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231-12 - (4-4.2.5(a)(5) Exception): Accept

**SUBMITTER:** Kenneth E. Isman, Nat'l Fire Sprinkler Assn.

**RECOMMENDATION:** In Section 4-4.2.2(a)(5), add an additional sentence to read:

   "Flow from these sprinklers shall be permitted to be omitted from the sprinkler system demand for hydraulic calculations."

**SUBSTANTIATION:** Confusion exists as to how to treat these sprinklers. In the Report on Proposals for the 1995 edition, a proposal to require 30 gpm was rejected. Without any other information, we have been telling people to treat these sprinklers similar to those under obstructions. Clear information in NFPA 231 would be helpful.

**COMMITTEE ACTION:** Accept

**NUMBER OF COMMITTEE MEMBERS ELIGIBLE TO VOTE:** 28

**VOTE ON COMMITTEE ACTION:**

**AFFIRMATIVE:** 28

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231-13 - (4-5): Reject

**SUBMITTER:** Kenneth E. Isman, Nat'l Fire Sprinkler Assn.

**RECOMMENDATION:** Replace Section 4-5 (including the note) as follows:

4.5 Flammable and Combustible Liquids. General storage warehouses shall be permitted to store a limited quantity of flammable and combustible liquids in accordance with Section 4-5 of NFPA 30.

**SUBSTANTIATION:** NFPA 30 has been dramatically revised and handles the storage of flammable and combustible liquids quite well. Another alternative to this paragraph would be to lift sections of NFPA 30 using the NFPA extract policy.

**COMMITTEE ACTION:** Reject.

**COMMITTEE STATEMENT:** Data indicates that the sprinkler protection required by this standard would be inadequate for the protection of flammable liquids.

**NUMBER OF COMMITTEE MEMBERS ELIGIBLE TO VOTE:** 28

**VOTE ON COMMITTEE ACTION:**

**AFFIRMATIVE:** 28

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231-14 - (5.1.5): Reject

**SUBMITTER:** Samuel Vanover, New Orleans, LA

**RECOMMENDATION:** Sprinklers shall only be recognized when installed to a maximum height to which they have been tested and listed.

**SUBSTANTIATION:** Most sprinklers have only been tested by UL for a ceiling height of 18 ft. Most sprinklers have only been tested by FM for a ceiling height of 30 ft. There is no scientific data to support sprinkler effectiveness above the tested height. To not recognize sprinkler limitations is to mislead the public.

**COMMITTEE STATEMENT:** Testing at UL, FM and other testing laboratories has not been limited to ceiling heights of 18 ft and 30 ft. There is data which demonstrates that sprinklers perform adequately beyond the ceiling heights indicated in the submitter's substantiation.

**NUMBER OF COMMITTEE MEMBERS ELIGIBLE TO VOTE:** 28

**VOTE ON COMMITTEE ACTION:**

**AFFIRMATIVE:** 28
SUBMISSION: Gary W. Ponte, The Reliable Automatic Sprinkler Co., Inc.

RECOMMENDATION: Accept in Principle.

SUBSTANTIATION: A VELO Sprinkler can control fires at lower operating pressures than existing sprinklers allowed under this standard; which is an improved method of fire protection. Attached is a copy of UL Listing Report 96 NK25107 which details extensive successful testing this sprinkler has had in full scale fire testing.

COMMITTEE ACTION: Accept in Principle.

REVISE THE EXCEPTION TO READ:

Exception No. 8: The use of 3/4 in. (19.0 mm) orifice sprinklers shall be permitted where listed for such use and where installed at a minimum design pressure of 7 psi (0.5 bar).

COMMITTEE STATEMENT: 1. NFPA 13, which is referenced by this standard, identifies sprinklers according to their nominal orifice size and not according to a generic description of the sprinkler's orifice size.

2. Identifying the minimum 7 psi pressure is not necessary because NFPA 13, which is referenced by this standard, requires sprinklers to operate at a minimum operating pressure of 7 psi unless some higher operating pressure is otherwise noted.

COMMITTEE ACTION: Revise the Exception to read:

Exception No. 8: The use of 3/4 in. (19.0 mm) orifice sprinklers shall be permitted where listed for such use.

COMMITTEE STATEMENT: 1. NFPA 13, which is referenced by this standard, identifies sprinklers according to their nominal orifice size and not according to a generic description of the sprinkler's orifice size.

2. Identifying the minimum 7 psi pressure is not necessary because NFPA 13, which is referenced by this standard, requires sprinklers to operate at a minimum operating pressure of 7 psi unless some higher operating pressure is otherwise noted.

COMMITTEE ACTION: Accept in Principle.

COMMITTEE STATEMENT: To be consistent with the language used throughout the document.

NUMBER OF COMMITTEE MEMBERS ELIGIBLE TO VOTE: 28

VOTE ON COMMITTEE ACTION:

AFFIRMATIVE: 28

NEGATIVE: 2

EXPLANATION OF NEGATIVE:

OLISEWICZ: In my opinion, the need for separation by fire resistive construction was not demonstrated by the substantiation for this change. In addition, the proposal did not provide any substantiation for the 1 hr duration.

VICTOR: The Exception should read:

Exception: When separated by at least one-hour rated fire resistive construction which is continuous from floor to ceiling of the storage area.

5-1.7 Where non-storage spaces have lower ceilings than the storage portion of the building, the space above this drop ceiling shall be sprinklered unless it complies with the rules of NFPA 13 for allowable unsprinklered concealed spaces. Where the area above a drop ceiling is sprinklered, the sprinkler system shall conform to the rules of Section 5-1.6 or its exception.

COMMITTEE ACTION: Add an exception to 5-1.6 and a new 5-1.7 as follows:

5-1.6 (no change):

Exception: When separated by at least one-hour rated fire resistive construction which is continuous from floor to ceiling of the storage area.

COMMITTEE STATEMENT: To be consistent with the language used throughout the document.

NUMBER OF COMMITTEE MEMBERS ELIGIBLE TO VOTE: 28

VOTE ON COMMITTEE ACTION:

AFFIRMATIVE: 20

NEGATIVE: 8

EXPLANATION OF NEGATIVE:

OLISEWICZ: In my opinion, the need for separation by fire resistive construction was not demonstrated by the substantiation for this change. In addition, the proposal did not provide any substantiation for the 1 hr duration.

VICTOR: The Exception should read:

Exception: When separated by at least one-hour rated fire resistive construction which is continuous from floor to ceiling of the storage area.

I agree that there should be a separation between the two areas in order to allow for the omission of the 15 ft requirement. However, I don't feel that a 1 hr rated partition, with the protected openings and all other construction features that go along with such a rating, is necessary. NFPA 13 does not require rated separations between different occupancy classifications. Also, in accordance with NFPA 13, to omit sprinklers in a non-combustible concealed space, the space does not require a rated wall or ceiling.

STATEMENT: The Committee agrees that specific criteria is necessary to evaluate new sprinkler devices, however the Technical Committee does not specifically agree with the criteria offered by the proposal. A task group has been established to study this issue and propose language. Also see Committee Statement on Proposal 231-15 (Log #10).

COMMITTEE ACTION: Accept the submitters Proposal with the following change:

Add a new 5-1.7 as follows:

5-1.7 Special sprinklers that are intended for the protection of specific hazards or construction features shall be permitted where such devices have been evaluated and listed for performance under the following conditions:

(a) Fire tests related to the intended hazard

(b) Distribution of the spray pattern with respect to wetting of floors and walls

(c) Distribution of the spray pattern with respect to obstruction

(d) Evaluation of the thermal sensitivity of the sprinkler

(e) Performance under horizontal or sloped ceilings

(f) Area of design.

These sprinklers shall be limited to orifice size and temperature ratings per NFPA 13 and the protection area shall not exceed 0.38 m² (175 ft²).

SUBSTANTIATION: New technology in fire sprinklers for high-piled storage occupancies is progressing rapidly. The standard as it exists restricts new technology unless specifically approved by each and every authority having jurisdiction in accordance with 1-1.4. This restricts the use of new technology which could increase the level of protection and reduce the cost of the installed system. This proposal would allow new technology to progress while providing guidance similar to NFPA 13.

COMMITTEE ACTION: Reject.

COMMITTEE STATEMENT: The Committee agrees that specific criteria is necessary to evaluate new sprinkler devices, however the Technical Committee does not specifically agree with the criteria offered by the proposal. A task group has been established to study this issue and propose language. Also see Committee Statement on Proposal 231-15 (Log #10).

NUMBER OF COMMITTEE MEMBERS ELIGIBLE TO VOTE: 28

VOTE ON COMMITTEE ACTION:

AFFIRMATIVE: 28

STATEMENT: The Committee agrees that specific criteria is necessary to evaluate new sprinkler devices, however the Technical Committee does not specifically agree with the criteria offered by the proposal. A task group has been established to study this issue and propose language. Also see Committee Statement on Proposal 231-15 (Log #10).

COMMITTEE ACTION: Accept the submitters Proposal with the following change:

Add a new 5-1.7 as follows:

5-1.7 Special sprinklers that are intended for the protection of specific hazards or construction features shall be permitted where such devices have been evaluated and listed for performance under the following conditions:

(a) Fire tests related to the intended hazard

(b) Distribution of the spray pattern with respect to wetting of floors and walls

(c) Distribution of the spray pattern with respect to obstruction

(d) Evaluation of the thermal sensitivity of the sprinkler

(e) Performance under horizontal or sloped ceilings

(f) Area of design.

These sprinklers shall be limited to orifice size and temperature ratings per NFPA 13 and the protection area shall not exceed 0.38 m² (175 ft²).

SUBSTANTIATION: New technology in fire sprinklers for high-piled storage occupancies is progressing rapidly. The standard as it exists restricts new technology unless specifically approved by each and every authority having jurisdiction in accordance with 1-1.4. This restricts the use of new technology which could increase the level of protection and reduce the cost of the installed system. This proposal would allow new technology to progress while providing guidance similar to NFPA 13.

COMMITTEE ACTION: Reject.

COMMITTEE STATEMENT: The Committee agrees that specific criteria is necessary to evaluate new sprinkler devices, however the Technical Committee does not specifically agree with the criteria offered by the proposal. A task group has been established to study this issue and propose language. Also see Committee Statement on Proposal 231-15 (Log #10).

NUMBER OF COMMITTEE MEMBERS ELIGIBLE TO VOTE: 28

VOTE ON COMMITTEE ACTION:

AFFIRMATIVE: 28

STATEMENT: The Committee agrees that specific criteria is necessary to evaluate new sprinkler devices, however the Technical Committee does not specifically agree with the criteria offered by the proposal. A task group has been established to study this issue and propose language. Also see Committee Statement on Proposal 231-15 (Log #10).

COMMITTEE ACTION: Accept the submitters Proposal with the following change:

Add a new 5-1.7 as follows:

5-1.7 Special sprinklers that are intended for the protection of specific hazards or construction features shall be permitted where such devices have been evaluated and listed for performance under the following conditions:

(a) Fire tests related to the intended hazard

(b) Distribution of the spray pattern with respect to wetting of floors and walls

(c) Distribution of the spray pattern with respect to obstruction

(d) Evaluation of the thermal sensitivity of the sprinkler

(e) Performance under horizontal or sloped ceilings

(f) Area of design.

These sprinklers shall be limited to orifice size and temperature ratings per NFPA 13 and the protection area shall not exceed 0.38 m² (175 ft²).

SUBSTANTIATION: New technology in fire sprinklers for high-piled storage occupancies is progressing rapidly. The standard as it exists restricts new technology unless specifically approved by each and every authority having jurisdiction in accordance with 1-1.4. This restricts the use of new technology which could increase the level of protection and reduce the cost of the installed system. This proposal would allow new technology to progress while providing guidance similar to NFPA 13.

COMMITTEE ACTION: Reject.

COMMITTEE STATEMENT: The Committee agrees that specific criteria is necessary to evaluate new sprinkler devices, however the Technical Committee does not specifically agree with the criteria offered by the proposal. A task group has been established to study this issue and propose language. Also see Committee Statement on Proposal 231-15 (Log #10).

NUMBER OF COMMITTEE MEMBERS ELIGIBLE TO VOTE: 28

VOTE ON COMMITTEE ACTION:

AFFIRMATIVE: 28

STATEMENT: The Committee agrees that specific criteria is necessary to evaluate new sprinkler devices, however the Technical Committee does not specifically agree with the criteria offered by the proposal. A task group has been established to study this issue and propose language. Also see Committee Statement on Proposal 231-15 (Log #10).
COMMITTEE ACTION: Reject.
COMMITTEE STATEMENT: See Committee Action and Statement on Proposal 231.19 (Log #1).

NUMBER OF COMMITTEE MEMBERS ELIGIBLE TO VOTE: 28
VOTE ON COMMITTEE ACTION: AFFIRMATIVE: 28

231-21 - (6-1.2): Reject
SUBMITTER: Kenneth E. Isman, Nat'l Fire Sprinkler Assn.
RECOMMENDATION: Make 6-1.2 an exception to 6-1.1(c), clarify the maximum height limitation, clarify which storage height to use for the 6-2.2.4 adjustment and put a picture in the appendix.
SUBSTANTIATION: Section 6-1.2 appears to contradict Section 6-1.1(c). The only way that this makes sense is to make it an exception to the height limitation. It would also appear from the current text that storage can go up indefinitely as long as there is a walkway every 12 ft vertically. It is also not clear if the designer is to take the storage height adjustment for 12 ft or for the total storage height.
COMMITTEE ACTION: Reject.
COMMITTEE STATEMENT: See Committee Statement on Proposal 231.19 (Log #1).
NUMBER OF COMMITTEE MEMBERS ELIGIBLE TO VOTE: 28
VOTE ON COMMITTEE ACTION: AFFIRMATIVE: 28

231-22 - (6-2): Accept
SUBMITTER: Kenneth E. Isman, Nat'l Fire Sprinkler Assn.
RECOMMENDATION: Revise the title from "Water Supplies" to "Protection Criteria".
SUBSTANTIATION: The title water supplies has caused some confusion. Even though the end result of Section 6-2 is to calculate a water supply demand (which is compared to the available supply), no-one seems to get the connection for this title.
COMMITTEE ACTION: Accept.
NUMBER OF COMMITTEE MEMBERS ELIGIBLE TO VOTE: 28
VOTE ON COMMITTEE ACTION: AFFIRMATIVE: 28

231-23 - (6-2.2.1) and Table 6-2.2.1: Accept
SUBMITTER: Kenneth E. Isman, Nat'l Fire Sprinkler Assn.
RECOMMENDATION: Replace Section 6-2.2.1 with the following section and Table.

6-2.2.1 Sprinkler demand criteria for storage 12 ft or less in height shall be in accordance with Table 6-2.2.1. All other requirements of this standard shall apply to such storage.

<table>
<thead>
<tr>
<th>Commodity</th>
<th>Storage Height</th>
<th>Sprinkler Protection Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class I</td>
<td>Up to 12 ft</td>
<td>NFPA 13 - Ordinary Hazard Group 1</td>
</tr>
<tr>
<td>Class II</td>
<td>Up to 8 ft</td>
<td>NFPA 13 - Ordinary Hazard Group 1</td>
</tr>
<tr>
<td>Class III</td>
<td>Over 8 to 12 ft</td>
<td>NFPA 13 - Ordinary Hazard Group 2</td>
</tr>
<tr>
<td>Class IV</td>
<td>Up to 12 ft</td>
<td>NFPA 13 - Ordinary Hazard Group 2</td>
</tr>
</tbody>
</table>

SUBSTANTIATION: To be consistent with the Section 5-2.3.2.2 of NFPA 13 which was changed due to specific fire tests.
COMMITTEE ACTION: Accept.

Make the following editorial changes:
1. Add a title to the proposed Table 6-2.2.1 to read as follows: "Table 6-2.2.1 Sprinkler Protection of Class I through IV Commodities Stored 12 ft or less in Height"
2. In the proposed language to section 6-2.2.1, change the term "demand criteria" to "protection criteria". Section 6-2.2.1 will now read:
6-2.2.1 Sprinkler protection for storage 12 ft or less in height shall be in accordance with Table 6-2.2.1. All other requirements of this standard shall apply to such storage.

NUMBER OF COMMITTEE MEMBERS ELIGIBLE TO VOTE: 28
VOTE ON COMMITTEE ACTION: AFFIRMATIVE: 28

231-24 - (Figure 6-2.2.2 Note): Accept
SUBMITTER: Kenneth E. Isman, Nat'l Fire Sprinkler Assn.
RECOMMENDATION: Delete the notes under Figure 6-2.2.2.
SUBSTANTIATION: The first note incorrectly references Figure 6-2.2.3 and both notes are unnecessary given the figure titles.
COMMITTEE ACTION: Accept.
NUMBER OF COMMITtee MEMBERS ELIGIBLE TO VOTE: 28
VOTE ON COMMITTEE ACTION: AFFIRMATIVE: 28

231-25 - (7.1.3 and 7.1.4): Accept
SUBMITTER: Kenneth E. Isman, Nat'l Fire Sprinkler Assn.
RECOMMENDATION: Replace the last sentence of Sections 7-1.3 and 7.1.4 with the sentence: "See Chapter 6 for protection of these storage commodities with spray sprinklers.
SUBSTANTIATION: Protection criteria for Class III and IV commodities belongs in Chapter 6, not Chapter 7.
COMMITTEE ACTION: Accept.
NUMBER OF COMMITTEE MEMBERS ELIGIBLE TO VOTE: 28
VOTE ON COMMITTEE ACTION: AFFIRMATIVE: 28

231-26 - (7.2): Accept
SUBMITTER: Kenneth E. Isman, Nat'l Fire Sprinkler Assn.
RECOMMENDATION: Revise the title of 7-2 from "Water Supplies" to "Protection Criteria".
SUBSTANTIATION: The title water supplies has caused some confusion. Even though the end result of Section 7-2 is to calculate a water supply demand (which is compared to the available supply), no-one seems to get the connection for this title.
COMMITTEE ACTION: Accept.
NUMBER OF COMMITTEE MEMBERS ELIGIBLE TO VOTE: 28
VOTE ON COMMITTEE ACTION: AFFIRMATIVE: 28

231-27 - (7.2.2): Accept in Principle in Part
SUBMITTER: Kenneth E. Isman, Nat'l Fire Sprinkler Assn.
RECOMMENDATION: Delete all of the notes to Table 7-2.2 and revise 7-2.2 as follows:
7-2.2 Design areas and densities shall be selected for the appropriate storage configuration from Table 7-2.2. The columns A, B, C, D and E correspond to the protection required by the Decision Tree (Figure 7-1.1).
7-2.2.1 EH-2 in Table 7-2.2 refers to area/density selection from NFPA 15 - Ordinary Hazard Group 2.
7-2.2.2 EH-1 in Table 7-2.2 refers to area/density selection from NFPA 13 - Extra Hazard Group 1.
7-2.2.3 EH-2 in Table 7-2.2 refers to area/density selection from NFPA 13 - Extra Hazard Group 2.
7-2.2.4 NA in Table 7-2.2 indicates that storage configuration is not allowed.
7-2.2.5 For Table 7-2.2, the design areas are a minimum of 2500 sq. ft.

Exception No. 1: Where Table 7-2.2 allows densities and areas to be selected in accordance with NFPA 15 - Ordinary Hazard Group 2, any area/density from that curve shall be acceptable.

Exception No. 2: For closed arrays, the area shall be permitted to be reduced to 2000 sq. ft.
7-2.2.6 Interpolation of densities between storage heights shall be permitted. Interpolation of roof/ceiling heights shall not be permitted.

7-2.2.7 Where Table 7-2.2 requires densities of 0.4 gpm/sq ft or greater, 17/32 or 5/8 in. orifice spray sprinklers shall be used.

7-2.2.8 High temperature spray sprinklers shall be used.

Exception: Where Table 7-2.2 allows densities and areas to be selected in accordance with NFPA 13 - Ordinary Hazard Group 2, Extra Hazard Group 1 or Extra Hazard Group 2; ordinary temperature sprinklers shall be permitted.

Also replace “N/A” in Table 7-2.2 with “NA”.

SUBSTANTIATION: A number of changes and clarifications were made with this proposal. The first is to satisfy the NFPA style manual that requirements not be in notes.

The terms large orifice and extra large orifice have been eliminated because NFPA 13 eliminated them as definitions of sprinklers.

The remaining changes are for clarity, but should not effect the requirements of Chapter 7.

COMMITTEE ACTION: Accept in Principle in Part.

Make the following changes to the submitter's Proposal:

1. Do not add proposed 7-2.2.1, 7-2.2.2, 7-2.2.3 as indicated by the Proposal, but instead maintain as Note 2 as proposed by item 5 of Committee Proposal 231-29 (Log #CP1).
2. Do not add 7-2.2.4 as indicated by the Proposal.
3. For proposed 7-2.2.5 see item 6 of Committee Proposal 231-29 (Log #CP1).
4. For proposed 7-2.2.6 see item 7 of Committee Proposal 231-29 (Log #CP1).
5. For proposed 7-2.2.7 see item 8 of Committee Proposal 231-29 (Log #CP1).
6. Do not add proposed 7-2.2.8.
7. Add the following as the last paragraph to existing A-7.2.2.2:

- The Table is based on tests that were conducted primarily with high temperature rated 17/32 in. orifice sprinklers. Other tests have demonstrated that where sprinklers are used with orifices greater than 17/32 in., ordinary temperature sprinklers are acceptable.

COMMITTEE STATEMENT: 1. Existing Notes 1 through 3 are aids in applying Table 7-2.2. They are not requirements and should not be listed in the body of the standard.

2. The designation “NA” will no longer be used in Table 7-2.2.

See item 1 of Committee Proposal 231-29 (Log #CP1).

3. See Committee Proposal 231-29 (Log #CP1).

4. See Committee Proposal 231-29 (Log #CP1).

5. See Committee Proposal 231-29 (Log #CP1).

6. Add a new Section 7-2.2.1 to read as follows:

“Exception No. 2: For closed arrays, the area shall be permitted to be reduced to 2900 sq ft. Densities shall be based upon the 2500 sq ft design area except as permitted for closed arrays. The ‘up to’ in the table is intended to aid in the interpolation of densities between storage heights. Interpolation of ceiling/roof heights shall not be permitted.”

VOTE ON COMMITTEE ACTION:

AFFIRMATIVE: 28

VOTE ON COMMITTEE ACTION:

AFFIRMATIVE: 28

(98-29) (Log #25)

COMMITTEE STATEMENT: 1. Revise Table 7-2.2 as follows:

2. Add a new Note 1 to read as follows:

Note 1: Minimum clearance between sprinkler deflector and top of storage shall be maintained as required.

3. Do not add proposed 7-2.2.2.

4. Delete existing Notes 1 through 5.

5. Renumber existing Note 6 as Note 2.

6. Renumber existing Note 7 as Note 3.

7. Add a new Section 7-2.2.1 to read as follows:

“Where Table 7-2.2 requires densities of 0.4 gpm/sq ft or greater, 1/2 in. (12.7 mm) orifice sprinklers shall not be permitted.”

8. Add a new Section 7-2.2.2 to read as follows:

“Where Table 7-2.2 requires densities of 0.4 gpm/sq ft or greater, 1/2 in. (12.7 mm) orifice sprinklers shall not be permitted.”

9. Add a second sentence to Section 7-2.1 after item (d) as follows:

“Where the distance between roof/ceiling height and top of storage exceeds 20 feet, provide protection needed for the storage height which would result in a 20 ft distance between the roof/ceiling height and top of storage.”

SUBSTANTIATION: A major difficulty in applying 7-2.2 is that interpolation of densities/areas between storage heights is permitted but interpolation of ceiling/roof heights is not. As a result there are certain storage arrangements in which a density cannot be properly obtained from the table. An example includes 17 ft high storage in a 20 ft high building. While Table 7-2.2 offers criteria for 15 ft storage in a 20 ft building no criteria exists for 20 ft high storage in a 20 ft high building. In order to obtain a second point for interpolation, criteria for 20 ft storage in a 25 ft high building would need to be used. However, Note 3 of the table does not allow for interpolation between these two points.

The task group proposes the table be revised as indicated. By adding the phrase “up to” in the roof/ceiling column, the second interpolation value can be obtained. Using the 17 ft high storage in a 20 ft high building example, the criteria for 20 ft storage in a building with a roof/ceiling up to 25 ft can now be used as the second data point. Additionally, the task group proposes that the table include criteria for larger clearances for arrangements where storage heights are relatively low when compared to building height. Upon reviewing existing information about sprinkler performance, storage heights and roof/ceiling heights, the task group believes that with relatively low storage heights (up to 15 ft high) the existing densities are adequate. With these

<table>
<thead>
<tr>
<th>Storage Hght</th>
<th>Roof/Ceiling Ht</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>up to 25</td>
<td>OH-2</td>
<td>0.2</td>
<td>EH-2</td>
<td>0.3</td>
<td>EH-2</td>
</tr>
<tr>
<td>12</td>
<td>up to 15</td>
<td>0.2</td>
<td>0.6</td>
<td>0.6</td>
<td>0.5</td>
<td>EH-2</td>
</tr>
<tr>
<td>&gt;15 to 20</td>
<td>0.3</td>
<td>0.8</td>
<td>0.7</td>
<td>0.45</td>
<td>0.35</td>
<td>0.45</td>
</tr>
<tr>
<td>&gt;20 to 25</td>
<td>0.4</td>
<td>0.9</td>
<td>0.7</td>
<td>0.5</td>
<td>0.35</td>
<td>0.45</td>
</tr>
<tr>
<td>&gt;25 to 30</td>
<td>0.5</td>
<td>1.2</td>
<td>0.85</td>
<td>0.6</td>
<td>0.45</td>
<td>0.7</td>
</tr>
<tr>
<td>&gt;30 to 35</td>
<td>0.6</td>
<td>1.2</td>
<td>0.85</td>
<td>0.7</td>
<td>0.5</td>
<td>1.1</td>
</tr>
</tbody>
</table>

MEMBERS ELIGIBLE TO VOTE: 28

VOTE ON COMMITTEE ACTION:

AFFIRMATIVE: 28

(98-29) (Log #CP1)
lower storage heights, fire loads are reduced. The higher ceilings limit plume momentum from the developing fire. Additionally, where required sprinkler densities exceed 0.4 gpm per sq ft, large orifice or extra large orifice sprinklers must still be used. These sprinklers produce larger water droplets which have sufficient momentum to penetrate the fire plume.

Existing Notes to Table 7-2.2 were removed as requirements should be located in the body of the standard. With regard to item 5, any sprinkler with an orifice size larger than 1/2 in. and which has been accepted for use by this Committee for storage applications is to be used where discharge densities of 0.4 gpm/sq ft or greater are used. This requirement was previously limited to 5/8 in. orifice sprinklers.

**COMMITTEE ACTION:** Accept.

**NUMBER OF COMMITTEE MEMBERS ELIGIBLE TO VOTE:** 28

**VOTE ON COMMITTEE ACTION:**

**AFFIRMATIVE:** 28

**COMMENT ON AFFIRMATIVE:**

**SCHUMANN:** Revisions to table are OK. The protection for 12 ft storage in a 20 ft building in Column E seems inadequate. From an analysis of the protection given in Table 7-2.2, it seems that stable arrays require more protection than unstable arrays. Also exposed requires more than cartoned. The "*" items below do not seem to follow that thought process.

**COLUMN D Expanded, Cartoned, Unstable .4/2500**

**COLUMN C Expanded, Exposed, Unstable .5/2500**

**COLUMN B Expanded, Cartoned, Unstable .4/2500 (EH2)**

**COLUMN A Nonexpanded, Exposed, Cartoned, Unstable .5/2500**

**COLUMN C Nonexpanded, Cartoned, Stable .5/2500**

**COLUMN E Nonexpanded, Exposed, Stable .4/2500 (EH2)**

---

**COMMITTEE STATEMENT:** The Table currently addresses the application of large drop sprinklers for the protection of general storage. It is not appropriate to include information which is outside the scope of NFPA 231.

**NUMBER OF COMMITTEE MEMBERS ELIGIBLE TO VOTE:** 28

**VOTE ON COMMITTEE ACTION:**

**AFFIRMATIVE:** 28

---

**281-33 - (Table 8-1): Accept**

**SUBMITTER:** Kenneth E. Isman, Nat'l Fire Sprinkler Assn.

**RECOMMENDATION:** Delete Note 2 and all references in the Table. Replace the references to note 2 with the actual number of sprinklers which would be required if that pressure were selected.

**SUBSTANTIATION:** The purpose of the Table is to tell people how many sprinklers to calculate. It would be much easier if people could get that information directly from the table without having to go to a confusing note and guess what it means.

**COMMITTEE ACTION:** Accept.

**NUMBER OF COMMITTEE MEMBERS ELIGIBLE TO VOTE:** 28

**VOTE ON COMMITTEE ACTION:**

**AFFIRMATIVE:** 28

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**281-34 (Log #28) Recommendation:**

<table>
<thead>
<tr>
<th>Configuration</th>
<th>Commodity</th>
<th>Maximum Storage Height</th>
<th>Maximum Building Height</th>
</tr>
</thead>
<tbody>
<tr>
<td>Palletized</td>
<td>Class I, II or III</td>
<td>25 ft</td>
<td>35 ft</td>
</tr>
<tr>
<td>Palletized</td>
<td>Class IV</td>
<td>20 ft</td>
<td>30 ft</td>
</tr>
<tr>
<td>Palletized</td>
<td>Unexpanded Plastics</td>
<td>20 ft</td>
<td>30 ft</td>
</tr>
<tr>
<td>Palletized</td>
<td>Idle Wood Pallets</td>
<td>20 ft</td>
<td>30 ft</td>
</tr>
<tr>
<td>Solid Piled</td>
<td>Class I, II, III</td>
<td>20 ft</td>
<td>30 ft</td>
</tr>
<tr>
<td>Solid Piled</td>
<td>Class IV</td>
<td>20 ft</td>
<td>30 ft</td>
</tr>
<tr>
<td>Solid Piled</td>
<td>Unexpanded Plastics</td>
<td>20 ft</td>
<td>30 ft</td>
</tr>
</tbody>
</table>

**SUBSTANTIATION:** To clarify that the "ft" applied to storage heights and to clarify which number to use for 20 ft high storage.

**COMMITTEE ACTION:** Accept.

Editorially add "ft" after the dimension "5" so it reads:

7-2.4 Water supply duration (sprinkler demand plus hose streams) shall be 2-hour duration where storage heights are 5 ft to 20 ft and 2.5-hr duration where storage heights are over 20 ft up to 25 ft.

**NUMBER OF COMMITTEE MEMBERS ELIGIBLE TO VOTE:** 28

**VOTE ON COMMITTEE ACTION:**

**AFFIRMATIVE:** 28

---

**281-32 - (Table 8-1): Reject**

**SUBMITTER:** Forrest Weir, Arlington, VA

**RECOMMENDATION:** Revise Table 8-1 of NFPA 231 to include coverage of any all of the additional commodity hazards shown in related Table A-5-3.4 of NFPA 13, Installation of Sprinkler Systems.

**SUBSTANTIATION:** The purpose of this proposal is to lift the hazard criteria shown in Table A-5-3.4 above the level of merely asterisk or explanatory materials. The record protection criteria, for instance, is based on 1980 Factory Mutual records fire tests using large-drop sprinklers.

**COMMITTEE ACTION:** Reject.

**COMMITTEE STATEMENT:** The Table currently addresses the application of large drop sprinklers for the protection of general storage. It is not appropriate to include information which is outside the scope of NFPA 231.

**NUMBER OF COMMITTEE MEMBERS ELIGIBLE TO VOTE:** 28

**VOTE ON COMMITTEE ACTION:**

**AFFIRMATIVE:** 28

---

**281-33 - (Table 8-1): Accept**

**SUBMITTER:** Kenneth E. Isman, Nat'l Fire Sprinkler Assn.

**RECOMMENDATION:** Revise Table as follows:

**SUBSTANTIATION:** Clarifies how to deal with multiple hazards which are currently in the same row. For instance, there are people who interpret the 1995 edition as saying that solid piled Class IV commodities are unlimited in height while only unexpanded plastics are limited to 20 ft. Also clarifies the clearance issue. Currently, if someone stores up to 20 ft in a 30 ft building, they are okay. But if they remove 5 ft of storage, they are protecting 15 ft with 15 ft clearance which violates the standard.

**COMMITTEE ACTION:** Accept.

**NUMBER OF COMMITTEE MEMBERS ELIGIBLE TO VOTE:** 28

**VOTE ON COMMITTEE ACTION:**

**AFFIRMATIVE:** 28

---
<table>
<thead>
<tr>
<th>Configuration</th>
<th>Commodity</th>
<th>Maximum Storage Height</th>
<th>Maximum Building Height</th>
</tr>
</thead>
<tbody>
<tr>
<td>Palletized</td>
<td>Class I, II or III</td>
<td>25 ft</td>
<td>35 ft</td>
</tr>
<tr>
<td>Palletized</td>
<td>Class IV</td>
<td>20 ft</td>
<td>30 ft</td>
</tr>
<tr>
<td>Palletized</td>
<td>Unexpanded Plastics</td>
<td>20 ft</td>
<td>30 ft</td>
</tr>
<tr>
<td>Palletized</td>
<td>Expanded Plastics</td>
<td>18 ft</td>
<td>25 ft</td>
</tr>
<tr>
<td>Palletized</td>
<td>Idle Wood Pallets</td>
<td>20 ft</td>
<td>30 ft</td>
</tr>
<tr>
<td>Solid Piled</td>
<td>Class I, II, III</td>
<td>20 ft</td>
<td>30 ft</td>
</tr>
<tr>
<td>Solid Piled</td>
<td>Class IV</td>
<td>20 ft</td>
<td>30 ft</td>
</tr>
<tr>
<td>Solid Piled</td>
<td>Unexpanded Plastics</td>
<td>20 ft</td>
<td>30 ft</td>
</tr>
</tbody>
</table>

COMMITTEE STATEMENT: Data indicates that large drop sprinklers are effective for palletized storage of expanded plastics stored up to 18 ft high in a 26 ft building.

NUMBER OF COMMITTEE MEMBERS ELIGIBLE TO VOTE: 28

COMMENT ON AFFIRMATIVE: SCHUMANN: The plastic commodities should be indicated as cartoned or exposed.

COMMITTEE ACTION: 

VOTE ON COMMITTEE ACTION: AFFIRMATIVE: 28

COMMITTEE STATEMENT: More specific to the intent of the table.

RECOMMENDATION: 

SUBSTANTIATION: 

NUMBER OF COMMITTEE MEMBERS ELIGIBLE TO VOTE: 28

AFFIRMATIVE: 28

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231-35 - (Table 8-1): Accept

SUBMITTER: Kenneth E. Isman, Nat'l Fire Sprinkler Assn.

RECOMMENDATION: 

SUBSTANTIATION: 

COMMITTEE ACTION: Accept

VOTE ON COMMITTEE ACTION: AFFIRMATIVE: 28

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231-36 - (8-2): Accept in Principle in Part

SUBMITTER: Kenneth E. Isman, Nat'l Fire Sprinkler Assn.

RECOMMENDATION: 

SUBSTANTIATION: 

COMMITTEE ACTION: Accept in Principle in Part

VOTE ON COMMITTEE ACTION: AFFIRMATIVE: 27 NEGATIVE: 1

EXPLANATION OF NEGATIVE: 

VICTOR: I disagree with committee action on item #5 of the submitter's recommendation. A preaction system installed in accordance with NFPA 13 for any other occupancy is treated as a wet system for hydraulic calculation purposes. If the 231 committee wants to address their concern about water delivery time to the calculated area, then address the detection/actuation system. I recommend the following new language be added:

"The detection system shall be designed to ensure actuation of the deluge valve before any sprinklers are opened."
NFPA 231 — A98 ROP

231-38 (Log #7): Accept in Principle in Part.

SUBMITTER: James Golinveaux, Metal Building Manufacturers

RECOMMENDATION: Revise table as follows:

(table shown below)

SUBSTANTIATION: For 35 ft of storage, many buildings exceed 40 ft ceiling limitation of ESFR sprinklers.

Note: Supporting material is available for review at NFPA Headquarters.

COMMITTEE ACTION: Accept in Principle in Part.

Accept proposed Table 9-1 with the following changes as shown below:

1. Remove the last column entitled "commodity limitation" and delete proposed Note 2.
2. Move Note 1 into a new Section 9-1.1.
3. Add "idle wood and plastic pallets in two locations as indicated on the revised figure.
4. Revise the column heading entitled "Maximum Height of Building" to read "Maximum Roof/Ceiling Height of Building" and delete the reference to Note 1.

COMMITTEE STATEMENT:

1. The "Commodity Limitation" column and Note 2 are being removed because the limitations they address are contained in the table.

2. Note 1 is being moved as requirements should be located in the body of the standard. See Proposal 231-37 (Log #51).

3. Data indicates that ESFR sprinklers are effective for certain arrangements of idle pallet storage.

4. This provides consistency with the remainder of the document.

NUMBER OF COMMITTEE MEMBERS ELIGIBLE TO VOTE: 28

VOTE ON COMMITTEE ACTION:

AFFIRMATIVE: 26
NEGATIVE: 1
ABSTENTION: 1

EXPLANATION OF NEGATIVE:

SCHUMANN: No test data presented to include idle wood or plastic pallets.

No test data presented to include exposed (uncartonated) plastics.

Test data for 35 ft high storage in a 45 ft high building is incomplete. No chronology given for Test #4 (9-18-96). Test #5 chronology indicates flame persists for 2 min 40 sec. No further comment on presence or absence of fire at test was terminated at 15 min. No conclusions can be made.

231-38 (Log #7) Committee Action:

Table 9-1 ESFR Sprinkler Data

<table>
<thead>
<tr>
<th>Type of Storage</th>
<th>Commodity</th>
<th>Maximum Height of Storage (ft) (m)</th>
<th>Maximum Height of Building (See Note 1.) (ft (m))</th>
<th>Nominal K factor</th>
<th>Sprinkler Design Pressure (bars)</th>
<th>Commodity Limitation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Palletized and solid pile storage (no open-top containers or solid shelves)</td>
<td>Cartoned unexpanded plastic; cartoned expanded plastic; uncartoned unexpanded plastic; and Class I, II, III, or IV commodities, either encapsulated or unencapsulated</td>
<td>25 (7.6)</td>
<td>30 (9.1)</td>
<td>13.5-14.5</td>
<td>50 (3.4)</td>
<td></td>
</tr>
<tr>
<td>Cartoned or or uncartoned, unexpanded plastic; and Class I, II, III, or IV commodities, either encapsulated or unencapsulated</td>
<td>35 (10.7)</td>
<td>40 (12.2)</td>
<td>13.5-14.5</td>
<td>75 (5.2)</td>
<td>(See Note 2)</td>
<td></td>
</tr>
<tr>
<td>Cartoned or or uncartoned, unexpanded plastic; and Class I, II, III, or IV commodities, either encapsulated or unencapsulated</td>
<td>35 (10.7)</td>
<td>40 (12.2)</td>
<td>13.5-14.5</td>
<td>75 (5.2)</td>
<td>(See Note 2)</td>
<td></td>
</tr>
<tr>
<td>Cartoned or or uncartoned, unexpanded plastic; and Class I, II, III, or IV commodities, either encapsulated or unencapsulated; and Class I, II, III, or IV commodities, either encapsulated or unencapsulated; and Class I, II, III, or IV commodities, either encapsulated or unencapsulated</td>
<td>55 (16.7)</td>
<td>45 (13.8)</td>
<td>13.5-14.5</td>
<td>50 (3.4)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

NOTE 1: Maximum building height shall be measured to the underside of the roof deck or ceiling.

NOTE 2: Only ESFR sprinklers specifically listed for 45-ft (13.8-m) high buildings shall be used in buildings higher than 30 ft (9.1-m) up to 45 ft (13.8-m).

---

231-38 (Log #7) Recommendation:

Table 9-1 ESFR Sprinkler Data

<table>
<thead>
<tr>
<th>Type of Storage</th>
<th>Commodity</th>
<th>Maximum Height of Storage (ft) (m)</th>
<th>Maximum Roof/Ceiling Height of Building (ft (m))</th>
<th>Nominal K factor</th>
<th>Sprinkler Design Pressure (bars)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Palletized and solid pile storage (no open-top containers or solid shelves)</td>
<td>Cartoned unexpanded plastic; cartoned expanded plastic; uncartoned unexpanded plastic; and Class I, II, III, or IV commodities, either encapsulated or unencapsulated; and Class I, II, III, or IV commodities, either encapsulated or unencapsulated</td>
<td>25 (7.6)</td>
<td>30 (9.1)</td>
<td>13.5-14.5</td>
<td>50 (3.4)</td>
</tr>
<tr>
<td>Cartoned or or uncartoned, unexpanded plastic; and Class I, II, III, or IV commodities, either encapsulated or unencapsulated; and Class I, II, III, or IV commodities, either encapsulated or unencapsulated</td>
<td>35 (10.7)</td>
<td>40 (12.2)</td>
<td>13.5-14.5</td>
<td>75 (5.2)</td>
<td></td>
</tr>
<tr>
<td>Cartoned or or uncartoned, unexpanded plastic; and Class I, II, III, or IV commodities, either encapsulated or unencapsulated; and Class I, II, III, or IV commodities, either encapsulated or unencapsulated; and Class I, II, III, or IV commodities, either encapsulated or unencapsulated</td>
<td>55 (16.7)</td>
<td>45 (13.8)</td>
<td>13.5-14.5</td>
<td>50 (3.4)</td>
<td></td>
</tr>
</tbody>
</table>
EXPLANATION OF ABSTENTION:
McPhee: The reference to "idle wood and plastic pallets" in Table 9-1 is questioned.
From my notes of the March meeting I have no record of any proposal or discussion that Table 9-1 on ESFR be expanded to cover storage of identical or plastic pallets. Table 8-1 already had a reference to this type of storage so the continued reference in Table 8-1 is still appropriate.
I have to presume that this was justified through the Committee comment/discussion based simply on comparisons of existing density/storage height provisions already in the standard for idle pallet storage protected by standard or large drop sprinklers, e.g., Table 4-4.1.2; Section 4-4.2.2; and Table 8-1.

EXPLANATION OF ABSTENTION: 
McPhee: The reference to "idle wood and plastic pallets" in Table 9-1 is questioned.
From my notes of the March meeting I have no record of any proposal or discussion that Table 9-1 on ESFR be expanded to cover storage of identical or plastic pallets. Table 8-1 already had a reference to this type of storage so the continued reference in Table 8-1 is still appropriate.
I have to presume that this was justified through the Committee comment/discussion based simply on comparisons of existing density/storage height provisions already in the standard for idle pallet storage protected by standard or large drop sprinklers, e.g., Table 4-4.1.2; Section 4-4.2.2; and Table 8-1.

RECOMMENDATION: 
Add new text as follows:
Section 9-2.5 E.S.F.R. sprinklers shall be ordinary temperature rated sprinklers.
Exception No. 1: E.S.F.R. sprinklers located in proximity to heat sources.
Exception No. 2: E.S.F.R. sprinklers located under skylights.
Exception No. 3: When ambient temperatures (ceiling) is continuously or intermittently greater than 100°F, intermediate temperature heads will be installed.

SUBSTANTIATION: Per NFPA 231G, Section 10-2.5 addresses temperature ratings for E.S.F.R. Currently this section does not address temperature ratings. The temperature ratings will be consistent with NFPA 231C. The new proposal would add a third exception addressing ambient temperatures exceeding 100°F. Non air conditioned buildings have ambient temperatures exceeding 100°F. Factory Mutual Standard 224, Guideline for E.S.F.R. sprinklers, allows intermediate temperature sprinkler heads when ceiling temperatures exceed 100°F. This addition will allow the use of intermediate rated E.S.F.R. sprinkler heads within structures.

COMMITTEE ACTION: \textbf{Reject.}
COMMITTEE STATEMENT: The information proposed by the submitter is adequately addressed by section 4-4.6.4 of NFPA 13 which is referenced by NFPA 231. The rules for temperature ratings of ESFR sprinklers are not modified by NFPA 231.

NUMBER OF COMMITTEE MEMBERS ELIGIBLE TO VOTE: \textbf{28}
VOTE ON COMMITTEE ACTION: \textbf{Affirmative: 28}

231-39 - (A-6-2.2.6) (New): \textbf{Reject}
SUBMITTER: \textbf{Kenneth E. Isman, Nat'l Fire Sprinkler Assn.}
RECOMMENDATION: Insert a new appendix note as follows:
A-6-2.2.6 The metal construction and face area limitations apply to bin-box storage as well as shelf storage.

SUBSTANTIATION: Existing text is ambiguous. It could be read that these requirements only apply to shelf storage.
COMMITTEE ACTION: \textbf{Accept in Principle.}

Do not accept the proposed appendix but instead revise 6-2.2.6 as follows:
A-6-2.2.6 The area of application shall be permitted to be reduced by 50 percent, provided the minimum requirements of Chapter 5 are met.

COMMITTEE STATEMENT: The Committee agrees that the existing text is ambiguous but believes that revising the body of the standard is more appropriate.

NUMBER OF COMMITTEE MEMBERS ELIGIBLE TO VOTE: \textbf{28}
VOTE ON COMMITTEE ACTION: \textbf{Affirmative: 26}
NEGATIVE: \textbf{2}

EXPLANATION OF NEGATIVE: 
Kroman: The proposed new text appears to be typo error.
My notes showed the Committee close to wording 6-2.2.6 to "For bin boxes constructed of metal with a face not exceeding 16 sq ft, and for closed shelves..." (remainder of section to remain as is).
Schumann: If 6-2.2.6 were revised as shown (improperly identified as A-6-2.2.6) the context of the existing 6-2.2.6 would be lost. Revise 6-2.2.6 as follows:

EXPLANATION OF NEGATIVE: 
Kroman: The proposed new text appears to be typo error.
My notes showed the Committee close to wording 6-2.2.6 to "For bin boxes constructed of metal with a face not exceeding 16 sq ft, and for closed shelves..." (remainder of section to remain as is).
Schumann: If 6-2.2.6 were revised as shown (improperly identified as A-6-2.2.6) the context of the existing 6-2.2.6 would be lost. Revise 6-2.2.6 as follows:

"For metal bin boxes and metal closed shelves with a face area not exceeding 16 ft² (1.5 m²), the area of sprinkler density application shall be permitted to be reduced by 50 percent, provided the minimum requirements of Chapter 5 are met."

231-41 - (Appendix B): \textbf{Accept}
SUBMITTER: Technical Committee on General Storage
RECOMMENDATION: Replace the text of Appendix B as follows:
Example 1: Storage is Expanded-Carton-Stable, 15 ft high in a 20 ft building.
Answer 1: Column E - Design Density = 0.45 gpm/sq ft.
Example 2: Storage is Nonexpanded-Unstable, 15 ft high in a 20 ft building.
Answer 2: Column A - Design Density is listed as 0.25, however, it is also possible that the storage may be 12 ft in this 20 ft building which would require 0.3. Unless the owner can guarantee that the storage will always be 15 ft, the Design Density = 0.3 gpm/sq ft.
Example 3: Storage is a Nonexpanded-Stable 15 ft fixed height unit load, one high, in an 18 ft building.
Answer 3: Column A - Design Density is 0.25 gpm/sq ft. Note that this does not go up to 0.3 like the previous example because of the use of a fixed height unit load. It will never be 12 ft. It will always be 15 ft or nothing.
Example 4: Storage is Expanded-Exposed-Unstable, 20 ft high in a 27 ft building.
Answer 4: Column C - Design Density = 0.7. Note that other lower storage heights should also be checked, but they reveal the same, or lower, densities (0.7 and 0.6) so the Design Density remains at 0.7 gpm/sq ft.
Example 5: Expanded-Carton-Stable, 17 ft high in 32 ft building.
Answer 5: Column D - 15 ft storage in a 32 ft building would be 0.55 20 ft storage in a 32 ft building would be 0.70
Interpolation for 17 ft storage is as follows:
0.7 - 0.55 = 0.15
0.15/(20 - 15) = 0.03
0.03 x (17 - 15) = 0.06
0.55 + 0.06 = 0.61
Design Density = 0.61 gpm/sq ft
Example 6: Storage is Expanded-Exposed-Stable, 22 ft storage in 23.5 ft building.
Answer 6: Column B - Could interpolate between 0.6 and 0.75, however, this would be a moot point since the density for 15 ft storage in this 23.5 ft building would be 0.8. Unless the owner can guarantee 22 ft storage, the Design Density = 0.8 gpm/sq ft. If the owner can, in some way acceptable to the authority having jurisdiction guarantee 22 ft storage, the interpolation would yield a Design Density of 0.66 gpm/sq ft.
Example 7: Storage is Nonexpanded-Stable-Exposed, 13.5 ft high in 15 ft building.
Answer 7: Column E - 12 ft storage in a 15 building would be 0.05
15 ft storage in a 15 ft building would be 0.45
Interpolation for 13.5 ft storage is as follows:
0.45 - 0.4 = 0.05
0.05/(15 - 12) = 0.017
0.017 x (13.5 - 12) = 0.026
0.4 + 0.026 = 0.426
Design Density = 0.426 gpm/sq ft
SUBSTANTIATION: As Table 7-2.2 was revised, the current example is no longer valid. The committee wished to provide other examples in applying table 7-2.2.
COMMITTEE ACTION: \textbf{Accept.}

NUMBER OF COMMITTEE MEMBERS ELIGIBLE TO VOTE: \textbf{28}
VOTE ON COMMITTEE ACTION: \textbf{Affirmative: 28}
The following draft of NFPA 231, Standard for General Storage, 1998, incorporates the Committee Actions on the Public and Committee Proposals which make up the Report on Proposals and which appear on the preceding pages. The draft is presented only as an aid to the reviewer.

NATIONAL FIRE PROTECTION ASSOCIATION

NFPA 231
Standard for General Storage
1998 Edition

NOTICE: An asterisk (*) following the number or letter designating a paragraph indicates explanatory material on that paragraph in Appendix A. Information on referenced publications can be found in Chapter 11 and Appendix D.

Chapter 1 Introduction

1-1 Scope.

1-1.1 This standard shall apply to the storage of materials representing the broad range of combustibles, including plastics that are stored palletized, solid-piled, in bin boxes, or on shelves. Exception: Miscellaneous storage shall be permitted to be protected in accordance with NFPA 13, Standard for the Installation of Sprinkler Systems.

1-1.2 Outdoor Storage of a Broad Range of Combustibles. See Appendix C.

1-1.3 This standard shall not apply to the following:

(a) Unsprinklered buildings.

(b) Storage of commodities that, with their packaging and storage aids, would be classified as noncombustible.

(c) Unpackaged bulk materials such as grain, coal, or similar commodities.

(d) Inside or outside storage of commodities covered by other NFPA standards, except where specifically mentioned herein (e.g., pyrolyxin plastics). Storage of high hazard materials such as freon roll paper stored on end, and flammable liquids outside the scope of this standard. Storage of such commodities shall be protected in accordance with the provisions of NFPA 30, Flammable and Combustible Liquids Code; NFPA 308, Code for the Manufacture and Storage of Aerosol Products; NFPA 40, Standard for the Storage and Handling of Cellulose Nitrate Motion Picture Film; NFPA 58, Standard for the Storage and Handling of Liquefied Petroleum Gases; NFPA 231C, Standard for Rack Storage of Materials; NFPA 231D, Standard for Storage of Rubber Tires; NFPA 231E, Standard for the Storage of Roll Paper; NFPA 232, Standard for the Protection of Records; NFPA 430, Code for the Storage of Liquid and Solid Oxidizers; and NFPA 490, Code for the Storage of Ammonium Nitrate (ROP 231-3).

(e) Storage on racks.

1-1.4 Nothing in this standard intends to restrict new technologies or alternate arrangements, provided the level of safety prescribed by the standard is not reduced.

1-2 Retroactivity Clause. The provisions of this document shall be considered necessary to provide a reasonable level of protection from loss of life and property from fire. They reflect situations and the state of the art at the time the standard was issued. Unless otherwise noted, it is not intended that the provisions of this document be applied to facilities, equipment, structures, or installations that were existing or approved for construction or installation prior to the effective date of this document.

Exception: In those cases where it is determined by the authority having jurisdiction that the existing situation involves a distinct hazard to life or property, this standard shall apply.

13 Definitions. Unless expressly stated elsewhere, for the purpose of this standard, the terms in this section shall be defined as follows:

Array. Closed Array. A storage arrangement where air movement through the pile is restricted because of 6 in. (152 mm) or less vertical flues.

Open Array.* A storage arrangement where air movement through the pile is enhanced because of vertical flues larger than 6 in. (152 mm).

Available Height for Storage.* The maximum height at which commodities can be stored above the floor and still maintain adequate clearance from structural members and the required clearance below sprinklers.

Bin Box Storage. Storage in five-sided wood, metal, or cardboard boxes with open face on the aisles. Boxes are self-supporting or supported by a structure so designed that little or no horizontal or vertical space exists around boxes.

Ceiling Height. The distance between the floor and the underside of the ceiling (or roof deck) within the storage area.

Clearance. The distance from the top of storage to the ceiling deflector.

Commodity. Combinations of products, packaging material, and container.

Compartimented.* The rigid separation of the products in a container by dividers that form a stable unit under fire conditions.

Container (shipping, master, or outer container).* A receptacle strong enough, by reason of material, design, and construction, to be shipped safely without further packaging.

Early Suppression Fast Response (ESFR) Sprinklers. A listed ESFR sprinkler is a thermostressive device designed to react at a predetermined temperature by automatically releasing a stream of water or distributing it in a specified pattern and quantity over a designated area so as to provide early suppression of a fire where installed on the appropriate sprinkler piping.

Encapsulated.* A method of packing consisting of a plastic sheet completely enclosing the sides and top of a pallet load containing a combustible commodity or combustible packages.

Expanded (foamed or cellular) Plastics. Those plastics, the density of which is reduced by the presence of numerous small cavities (cells), interconnecting or not, dispersed throughout their mass.

Exposed Group A Plastic Commodities. Those plastics not in packaging or coverings that absorb water or otherwise appreciably retard the burning hazard of the commodity (paper wrapped or encapsulated, or both, should be considered exposed).

Free-Flowing Plastic Materials. Those plastics that fall out of their containers during a fire, fill flue spaces, and create a smothering effect on the fire. Examples: powder, pellets, flakes, or random-packed small objects (e.g., razor blade dispensers, 1-oz to 2-oz [28-g to 57-g] bottles).

Large Drop Sprinkler. A listed large drop sprinkler is characterized by a K factor between 110 and 115 and a proven ability to meet prescribed penetration, cooling, and distribution criteria prescribed in the large drop sprinkler examination requirements. The deflector/discharge characteristics of the large drop sprinkler generate large drops of such size and velocity as to enable effective penetration of the high-velocity fire plume.

Miscellaneous Storage. Storage that does not exceed 12 ft (3.7 m) in height and is incidental to another occupancy use group as defined in NFPA 13, Standard for the Installation of Sprinkler Systems. Such storage shall not constitute more than 10 percent of the building area or 4000 ft² (372 m²) of the sprinklered area, whichever is greater. Such storage shall not exceed 1000 ft² (93 m²) in one pile or area, and each such pile or area shall be separated from other storage areas by at least 25 ft (7.6 m).

Noncombustible. Commodities, packaging, or storage aids that do not ignite, burn, or liberate flammable gases when heated to a temperature of 1380°F (749°C) for 5 minutes.
Packaging. A commodity wrapping, cushioning, or container.

Palletized Storage. Storage of commodities on pallets or other storage aids that form horizontal spaces between tiers of storage.

Pile Stability.*

Subtle Piles.* Those arrays where collapse, spillage of content, or leaning of stacks across flue spaces is not likely to occur soon after initial fire development.

Unstable Piles.* Those arrays where collapse, spillage of contents, or leaning of stacks across flue spaces occurs soon after initial fire development.

Roof Height. The distance between the floor and the underside of the roof deck within the storage area.

Shall. Indicates a mandatory requirement.

Sprinkler Temperature Rating.

(a) Ordinary-temperature-rated sprinklers include temperature ratings between 135°F and 170°F (57°C and 77°C).

(b) High-temperature-rated sprinklers include temperature ratings between 250°F and 300°F (121°C and 140°C).

Storage Aids. Commodity storage devices, such as pallets, dunnage, separators, and skids.

Unit Load. A pallet load or module held together in some manner and normally transported by material-handling equipment.

Chapter 2 Classification of Storage

2-1* Commodity Classification.

2.1.1* General.

2.1.1.1* Commodity classification and the corresponding protection requirements shall be determined based on the makeup of individual storage units (i.e., unit load, pallet load).

2.1.1.2 Mixed Commodities. Protection requirements shall not be based on the overall commodity mix in a fire area. Mixed commodity storage shall be protected by the requirements for the highest classified commodity and storage arrangement.

Exception No. 1: Up to 10 pallet loads of a higher hazard commodity, within the scope of this standard, shall be permitted to be present in an area not exceeding 40,000 ft² (3716 m²). The higher hazard commodity must be randomly dispersed with no adjacent loads in any direction (including diagonally). If the grading protection is based on Class I or II commodities, then the allowable number of pallet loads for Class IV or Group A plastics shall be reduced to five.

Exception No. 2: When the higher hazard material can be confined to a designated area and properly protected for that area.

2.1.2 Pallet Types. When loads are palletized, the use of wooden or metal pallets shall be assumed in the classification of commodities. When plastic pallets are used, the classification of the commodity unit shall be increased one class (i.e., Class III will become Class IV and Class IV will become Group A plastics). No increase shall be required for Group A plastic commodity.

Exception: When specific test data is available, the results of this data will take precedence in determining classification of commodities.

2-1.3* Commodity Classes.

2.1.3.1* Class I commodity shall be defined as noncombustible products that meet one of the following criteria:

(a) Placed directly on wooden pallets

(b) In single layer corrugated cartons, with or without single thickness cardboard dividers, with or without pallets

(c) Shrink-wrapped or paper-wrapped as a unit load with or without pallets

2.1.3.2* Class II commodity shall be defined as noncombustible products that are in slotted wooden crates, solid wood boxes, multiple-layered corrugated cartons, or equivalent combustible packaging material, with or without pallets.

2.1.3.3* Class III commodity shall be defined as products fashioned from wood, paper, natural fibers, or Group C plastics with or without cartons, boxes, or crates and with or without pallets. Such products shall be permitted to contain a limited amount (5 percent by weight or volume) of Group A or B plastics.

2.1.3.4* Class IV commodity shall be defined as products, with or without pallets, that meet one of the following criteria:

(a) Constructed partially or totally of Group B plastics.

(b) Consist of free-flowing Group A plastic materials.

(c) Contain within themselves or their packaging an appreciable amount (5 percent to 15 percent by weight or 5 percent to 25 percent by volume) of Group A plastics. The remaining materials shall be permitted to be metal, wood, paper, natural or synthetic fibers, or Group B or Group C plastics.

2.1.4 Classification of Plastics, Elastomers, and Rubber. Plastics, elastomers, and rubber shall be classified as Group A, Group B, or Group C.

The following categories are based on unmodified plastic materials. The use of fire- or flame-retarding modifiers or the physical form of the material could change the classification.

2.1.4.1* Group A.

ABS (acrylonitrile-butadiene-styrene copolymer)
Acetal (polyformaldehyde)
Acrylic (poly(methyl methacrylate))
Butyl rubber
EPDM (ethylene-propylene rubber)
FRP (fiberglass reinforced polyester)
Natural rubber (if expanded)
Nitrile rubber (acrylonitrile-butadiene rubber)
PET (thermoplastic polyester)
Polybutadiene
Poly carbonate
Poly (vinylidene fluoride)
Polypropylene
Polystyrene
Polyurethane
PVC (polyvinyl chloride — highly plasticized, with plasticizer content greater than 20 percent) (rarely found)
SAN (styrene acrylonitrile)
SBR (styrene-butadiene rubber)

2.1.4.2 Group B.

Cellulosics (cellulose acetate, cellulose acetate butyrate, ethyl cellulose)
Chloroprene rubber
Fluoroplastics (ECTFE — ethylene-chlorotrifluoro-ethylene copolymer; ETFE — ethylene-tetrafluoroethylene-copolymer; FEP — fluorinated ethylene-propylene copolymer)
Nitrile rubber (not expanded)
Nylon (nylon 6, nylon 6/6)
Silicone rubber
2.1.4.3 Group C.

Fluoroplastics (PCTFE — polychlorotrifluoroethylene; PTFE — polytetrafluoroethylene)
Melamine (melamine formaldehyde)
Phenolic
PVC (polvinyl chloride — flexible — PVCs with plasticizer content up to 20 percent)
PVDC (polystyrenul chloride)
PVDF (polivinylidene fluoride)
PVF (polivinyl fluoride)
Urea (urea formaldehyde)

Chapter 3 Building Construction

3-1.4.3 Group C.

Fluoroplastics (PCTFE — polychlorotrifluoroethylene; PTFE — polytetrafluoroethylene)
Melamine (melamine formaldehyde)
Phenolic
PVC (polvinyl chloride — flexible — PVCs with plasticizer content up to 20 percent)
PVDC (polystyrenul chloride)
PVDF (polivinylidene fluoride)
PVF (polivinyl fluoride)
PVC (polyvinyl chloride — flexible)

Chapter 4 Storage Arrangement

4-1 Piling Procedures and Precautions.

4-1.1 Any commodities that are hazardous in combination with each other shall be stored so they cannot come into contact with each other.

4-1.2 Safe floor loads shall not be exceeded. For water-absorbing commodities, normal floor loads shall be reduced to account the added weight of water that can be absorbed during fire-fighting operations.

4-2.1 The clearance between top of storage and sprinkler deflectors shall conform to NFPA 15, Standard for the Installation of Sprinkler Systems, except as modified by this standard.

4-2.2 If the commodity is stored above the lower chord of roof trusses, at least 1 ft (30.5 cm) of clearance space shall be maintained to permit wetting of the truss unless the area is protected with 1-hr fireproofing.

4-2.3 Storage clearance from ducts shall be maintained in accordance with NFPA 91, Standard for Exhaust Systems for Air Conveying of Materials, Section 2-18.

4-2.4 The clearance between stored materials and unit heaters, radiant space heaters, duct furnaces, and flues shall not be less than 3 ft (0.9 m) in all directions shall be in accordance with the clearances shown on the approval agency label.

4-2.5 Clearance shall be maintained to lights or light fixtures to prevent possible ignition.

4-2.6 Sufficient clearance shall be maintained around the path of fire door travel to ensure proper operation and inspection.

4-3 Aisles.

4-3.1 Wall aisles shall be at least 24 in. (61 cm) wide in warehouses used for the storage of commodities that expand with the absorption of water.

4-3.2 Aisles shall be maintained to retard the transfer of fire from one pile to another and to permit convenient access for fire fighting, salvage, and removal of storage.

4-4 Storage of Idle Pallets.

4-4.1 Wood Pallets.

4-4.1.1* Pallets shall be stored outside or in a detached structure.

Exception: Indoor pallet storage shall be permitted in accordance with 4-4.1.2.

4-4.1.2* Pallets, where stored indoors, shall be protected as indicated in Table 4-4.1.2, Table 8-3, and Table 9-1 unless the following conditions are met: (ROP 231-10)

(a) Pallets shall be stored no higher than 6 ft (1.8 m).

(b) Each pallet pile of no more than four stacks shall be separated from other pallet piles by at least 6 ft (1.4 m) of clear space or 25 ft (7.6 m) of commodity.

4-4.2 Plastic Pallets (ROP 231-11).

4-4.2.1 Plastic pallets shall be stored outside or in a detached structure.

Exception No. 1: Indoor plastic pallet storage shall be permitted in accordance with 4-4.2.2.

Exception No. 2: Indoor storage of nonexpanded polyethylene solid deck pallets shall be permitted to be protected in accordance with 4-4.1.2.

(ROP 231-11)

Exception No. 3: Indoor storage of plastic pallets shall be permitted to be protected in accordance with Table 9-1. (ROP 231-10)

Exception No. 4: Indoor storage of non-wood pallets having a demonstrated fire hazard that is equal to or less than idle wood pallets and is listed for such equivalency shall be permitted to be protected in accordance with 4-4.1.2. (ROP 231-10)

4-4.2.2 Plastic pallets where stored indoors shall be protected as follows:

(a) Where stored in cutoff rooms the following shall apply:

(1) The cutoff rooms shall have at least one exterior wall.

(2) The plastic pallet storage shall be separated from the remainder of the building by 3-hr-rated fire walls.

(3) The storage shall be protected by sprinklers designed to deliver 0.60 gpm/ft² [0.41 (L/s)/m²] for the entire room or by high-expansion foam and sprinklers as indicated in Section 5-2.

(4) The storage shall be piled no higher than 12 ft (3.7 m).

(5) Any steel columns shall be protected by 1-hr fireproofing or a sidewall sprinkler directed to one side of the column at the top or at the 15-ft (4.6-m) level, whichever is lower. Flow from these sprinklers shall be permitted to be omitted from the sprinkler system demand for hydraulic calculations. (ROP 231-12)

Table 4-4.1.2 Protection for Indoor Storage of Wood Idle Pallets (ROP 231-8)

<table>
<thead>
<tr>
<th>Height of Pallet Storage (ft)</th>
<th>Sprinkler Density Requirements (gpm/ft² [L/s/m²])</th>
<th>Area of Sprinkler Demand (ft² [m²])</th>
</tr>
</thead>
<tbody>
<tr>
<td>6 to 8 [1.8 to 2.4]</td>
<td>.50 [.14]</td>
<td></td>
</tr>
<tr>
<td>8 to 12 [2.4 to 3.7]</td>
<td>.60 [.18]</td>
<td></td>
</tr>
<tr>
<td>12 to 20 [3.7 to 6.1]</td>
<td>.80 [.25]</td>
<td>2500 [229]</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3500 [325]</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4500 [418]</td>
</tr>
</tbody>
</table>

Table 4-4.1.2 Protection for Indoor Storage of Wood Idle Pallets (ROP 231-8)

<table>
<thead>
<tr>
<th>Temperature Rating</th>
<th>High Temperature (°F)</th>
<th>Ordinary Temperature (°F)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2000 [186]</td>
<td>5000 [279]</td>
</tr>
<tr>
<td></td>
<td>2500 [229]</td>
<td>4000 [272]</td>
</tr>
<tr>
<td></td>
<td>3500 [325]</td>
<td>6000 [357]</td>
</tr>
<tr>
<td></td>
<td>4500 [418]</td>
<td></td>
</tr>
</tbody>
</table>

(ROP 231-1)
NFPA 231 — A98 ROP

(b) Where stored without cutoffs from other storage the following shall apply:

1. Plastic pallet storage shall be piled no higher than 4 ft (1.2 m).

2. Sprinkler protection shall employ high-temperature-rated sprinklers.

3. Each pallet pile of no more than two stacks shall be separated from other pallet piles by at least 8 ft (2.4 m) of clear space or 25 ft (7.6 m) of stored commodity.

45° Flammable and Combustible Liquids. Only limited quantities of flammable and combustible liquids shall be permitted in general storage warehouses. Any such storage shall be segregated from other stored combustible material.

Chapter 5 Fire Protection — General

54 Automatic Sprinkler Systems.

5-1.1 Sprinkler systems installed in buildings used for solid pile, bin box, shelf, or palletized storage shall be in accordance with NFPA 13, Standard for the Installation of Sprinkler Systems.

Exception: Where modified by this standard.

5-1.2 The design density shall not be less than 0.15 gpm/ft² (0.10 L/s/m²), and the design area shall not be less than 2000 ft² (186 m²) for wet systems or 2600 ft² (242 m²) for dry systems for any commodity, class, or group.

5-1.2.1 The sprinkler design density for any given area of operation for a Class III or Class IV commodity, calculated in accordance with Chapter 6, shall not be less than the density for the corresponding area of operation for Ordinary Hazard Group 2 in NFPA 15, Standard for the Installation of Sprinkler Systems.

5-1.2.2 The water supply requirements for sprinklers only shall be based on the actual calculated demand for the hazard in accordance with Chapter 6, Chapter 7, Chapter 8, or Chapter 9, depending on the type of sprinkler selected and the commodity being protected.

5-1.3 Where palletized or solid pile storage is placed on top of racks, the provisions of NFPA 231C, Standard for Rack Storage of Materials, shall apply to the entire height of storage with regard to sprinkler requirements and water supplies for ceiling and rack sprinklers.

5-1.4 In warehouses with areas containing rack storage, and other areas containing palletized, solid pile, bin box, or shelf storage, the standard applicable to the storage configuration shall apply.

5-1.5 Standard response 1/2-in. (12.7-mm) orifice sprinklers shall be permitted at the discretion of the property having jurisdiction.

Exception No. 1: Use of these curves in tables 5-1 through 5-5 and tables 5-1 through 5-9 shall be permitted if the sprinkler system is protected by a high-temperature-rated sprinkler orifice with an initial flow rate of 0.5 gpm/ft² (0.33 L/s/m²) orifice sprinklers shall be permitted when listed for such use. (ROP 15-16)

Exception No. 2: Use of 1/4-in. (6.35-mm) orifice sprinklers shall be permitted where listed for such use. (ROP 21-17)

5-1.6 In buildings occupied in part for storage, within the scope of this standard, the required sprinkler protection shall extend 15 ft (4.6 m) beyond the perimeter of the storage area.

Exception: Where separated by at least 1-hr rated fire-resistive construction that is continuous from floor to roof/ceiling of the storage area. (ROP 251-17)

5-1.7 Where non-storage spaces have lower ceilings than the storage portion of the building, the space above this drop ceiling shall be sprinklered unless it complies with the rules of NFPA 13, Standard for the Installation of Sprinkler Systems, for allowable un lubricated, concealed spaces. Where the area above a drop ceiling is sprinklered, the sprinkler system shall conform to the rules of 5-1.6 or its exception. (ROP 251-17)

52 High-Expansion Foam.

5-2.1 High-expansion foam systems installed in addition to automatic sprinklers shall be installed in accordance with NFPA 11A, Standard for Medium- and High-Expansion Foam Systems.

Exception: Where modified by this standard.

5-2.2 High-expansion foam used to protect the idle pallets shall have a maximum fill time of 4 minutes.

5-2.3 High-expansion foam systems shall be automatic in operation.

5-2.4 Detectors for high-expansion foam systems shall be listed and shall be installed at no more than one-half listed spacing.

5-2.5 Detection systems, concentrate pumps, generators, and other system components essential to the operation of the system shall have an approved standby power source.

5-2.6 A reduction in ceiling density to one-half that required for Class I through Class IV commodities, idle pallets, or plastics (using the secondary demand point) shall be permitted without revising the design area, but shall be not less than 0.15 gpm/ft² (0.10 L/s/m²).

55 Manual Inside Protection.

55.1 Small Hose Systems. Small hose lines (11/4 in. [38 mm]) shall be available to reach all portions of the storage area, giving due consideration to accessible configuration with maximum anticipated storage in place. Such small hose shall be supplied from one of the following:

(a) Outside hydrants

(b) A separate standpipe for small hose stations

(c) Valved hose connections on sprinkler risers where such connections are made upstream of sprinkler control valves

(d) A standpipe system

55.2 Portable Fire Extinguishers. Portable fire extinguishers shall be provided in accordance with NFPA 10, Standard for Portable Fire Extinguishers. Use of the required complement of portable fire extinguishers for Class A fires shall be permitted to be omitted in storage areas where fixed small hose lines (11/4 in. [38 mm]) are available to reach all portions of the storage area.

55.3 Hydrants. At locations without public hydrants, or where hydrants are not within 250 ft (76.2 m), private hydrants shall be installed in accordance with NFPA 24, Standard for the Installation of Private Fire Service Mains and Their Appurtenances.

55.4 Fire Organization.

55.4.1 Arrangements shall be made to permit rapid entry into the premises by the municipal fire department, police department, or other authorized personnel in case of fire or other emergency.

55.4.2 Plant emergency organizations, where provided, shall be instructed and trained in the following procedures:

(a) Maintenance of the security of the premises

(b) Means of summoning outside aid immediately in an emergency

(c) Use of hand extinguishers and hose lines on small fires and mop-up operations

(d) Operation of the sprinkler system and water supply equipment

(e) Use of material-handling equipment while sprinklers are operating to effect final extinguishment

(f) Supervision of sprinkler valves after system is turned off so that system can be reactivated if rekindling occurs

(g) Need for breathing apparatus

(h) Proper operation of emergency smoke and heat venting systems where these have been provided

55.5 A fire watch shall be maintained when the sprinkler system is not in service.

55.6 Alarm Service. A central station, auxiliary, remote station, or proprietary sprinkler waterflow alarm shall be provided. A local waterflow alarm shall be permitted where recorded guard service is provided.
Chapter 6*  Fire Protection for Commodity Classes I through IV - Spray Sprinklers

6-1 General.

6-1.1 Class I through Class IV commodities of the following configurations protected by spray sprinklers shall be in accordance with this chapter:

(a) Nonencapsulated commodities that are solid pile, palletized, or bin box storage up to 30 ft (9.1 m) in height

(b) Nonencapsulated commodities on shelf storage up to 15 ft (4.6 m) in height

(c) * Encapsulated commodities that are solid pile, palletized, bin box, or shelf storage up to 15 ft (4.6 m) in height

6-1.2 Bin box and shelf storage over 12 ft (3.7 m) and provided with walkways at not over 12-ft (3.7-m) vertical intervals shall be provided with automatic sprinklers under the walkways as well as at the ceiling. The design density for ceiling and walkway sprinklers shall be permitted to be in accordance with the height adjustment of Figure 6-2.2.4.

62 Protection Criteria. (ROP 231-22)

6-2.1 The water supply shall be capable of providing the sprinkler system demand determined in accordance with 6-2.3, including the hose stream demand of 6-2.4 for the duration requirements of 6-2.5.

6-2.2 The area and density for the hydraulically remote area shall be determined as specified in 6-2.2.1 through 6-2.2.7.

6-2.2.1 Sprinkler protection criteria for storage 12 ft (3.66 m) or less in height shall be in accordance with Table 6-2.2.1. All other requirements of this standard shall apply to such storage. (ROP 231-23)

<table>
<thead>
<tr>
<th>Class</th>
<th>Storage Height</th>
<th>Sprinkler Protection Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class I</td>
<td>Up to 12 ft</td>
<td>NFPA 13 - Ordinary Hazard Group 1</td>
</tr>
<tr>
<td>Class II</td>
<td>Up to 8 ft</td>
<td>NFPA 13 - Ordinary Hazard Group 2</td>
</tr>
<tr>
<td>Class III</td>
<td>Over 8 ft to 12 ft</td>
<td>NFPA 13 - Ordinary Hazard Group 2</td>
</tr>
<tr>
<td>Class IV</td>
<td>Up to 12 ft</td>
<td>NFPA 13 - Ordinary Hazard Group 2</td>
</tr>
</tbody>
</table>

6-2.2.2 Where using ordinary temperature-rated sprinklers, a single point shall be selected from the appropriate commodity curve on Figure 6-2.2.2.

6-2.2.3 Where using high temperature-rated sprinklers, a single point shall be selected from the appropriate commodity curve on Figure 6-2.2.3.

Figure 6-2.2.2 Sprinkler system design curves, 20-ft (6.1-m) high storage - ordinary temperature-rated sprinklers.

Figure 6-2.2.3 Sprinkler system design curves, 20-ft (6.1-m) high storage - high temperature-rated sprinklers.

6-2.2.4 The densities selected in accordance with 6-2.2.2 or 6-2.2.3 shall be modified in accordance with Figure 6-2.2.4 without revising the design areas.

Figure 6-2.2.4 Ceiling sprinkler density vs. storage height.

6-2.2.5 Where dry-pipe systems are used, the areas of operation indicated in the design curves shall be increased by 30 percent.

6-2.2.6 The area of application shall be permitted to be reduced by 50 percent, provided the minimum requirements of Chapter 5 are met. (ROP 231-40)

6-2.2.7 The final area and density shall not be less than the minimum specified in Chapter 5.

6-2.3 Given the area and density determined in accordance with 6-2.2, the fire sprinkler system shall be hydraulically calculated in accordance with NFPA 13, Standard for the Installation of Sprinkler Systems.
NFPA 231 — A98 ROP

6-2.5 Water supply duration shall be in accordance with Table 6-2.5.

<table>
<thead>
<tr>
<th>Storage Height (ft/m)</th>
<th>Commodity Class</th>
</tr>
</thead>
<tbody>
<tr>
<td>over 12 (3.7) up to 20 (6.1)</td>
<td>Classes I, II, and III</td>
</tr>
<tr>
<td>over 20 (6.1) up to 30 (9.1)</td>
<td>Class IV</td>
</tr>
</tbody>
</table>

68 High-Expansion Foam. See Section 5-2.

Chapter 7 Fire Protection for Plastic and Rubber Commodities — Spray Sprinklers

7-1* General. See Appendix B.

7-1.1* Plastics stored up to 25 ft (7.62 m) in height protected by spray sprinklers shall be in accordance with Chapter 7. The decision tree (Figure 7-1.1) shall be used to determine the protection in each specific situation.

7-1.2* Factors affecting protection requirements such as closed/open array, clearance between storage and sprinklers, and stable/unstable piles, shall be applicable only to storage of Group A plastics. The factors contained in 7-2.1, A-7-2.1, and Appendix B shall be given serious consideration prior to determining the final protection requirements. This decision tree also shall be used to determine protection for commodities that are not wholly Group A plastics but contain such quantities and arrangements of the same that they are deemed more hazardous than Class IV commodities.

7-1.3 Group B plastics and free-flowing Group A plastics shall be protected in the same manner as a Class IV commodity. See Chapter 6 for protection of these storage commodities with spray sprinklers. (ROP 231-25)

7-1.4 Group C plastics shall be protected in the same manner as a Class III commodity. See Chapter 6 for protection of these storage commodities with spray sprinklers. (ROP 231-25)

7-2 Protection Criteria. (ROP 231-26)

7-2.1* The design of the sprinkler system shall be based on those conditions that routinely or periodically exist in a building that create the greatest water demand. These conditions include the following:

(a) Pile height
(b) Clearance

(c) Pile stability
(d) Array

Where the distance between roof/ceiling height and top of storage exceeds 20 ft (6.1 m), protection shall be provided for the storage height that would result in a 20 ft (6.1 m) distance between the roof/ceiling height and top of storage. (ROP 231-26)

7-2.2* Design areas and densities shall be selected for the appropriate storage configuration from Table 7-2.2. The columns A, B, C, D, and E correspond to the protection required by the decision tree (Figure 7-1.1). (ROP 231-27)

7-2.2.1 For Table 7-2.2, the design areas are a minimum of 2500 ft² (232 m²).

Exception No. 1: Where Table 7-2.2 allows densities and areas to be selected in accordance with NFPA 13, Standard for the Installation of Sprinkler Systems, Ordinary Hazard Group 2, any area/density from that curve shall be acceptable.

Exception No. 2: For closed arrays, the area shall be permitted to be reduced to 2000 ft² (186 m²).

(ROP 231-29)

7-2.2.2 Interpolation of densities between storage heights shall be permitted. Densities shall be based upon the 2500 ft² (232 m²) design area except as permitted for closed arrays. The “up to” in the table is intended to add in the interpolation of densities between storage heights. Interpolation of ceiling/roof heights shall not be permitted.

(ROP 231-29)

7-2.2.3 Where Table 7-2.2 requires densities of 0.4 gpm/ft² [0.27 (L/s)/m²] or greater, 1/8 in. (12.7-mm) orifice sprinklers shall not be permitted. (ROP 231-29)

7-2.3 Where sprinkler protection has been designed for Group A plastics, at least 500 gpm (32 L/s) shall be added to the density area demand for hose streams.

7-2.4 Water supply duration (sprinkler demand plus hose stream) shall be 2 hr duration where storage heights are 5 ft to 20 ft (1.5 m to 6.1 m) and 2/3 hr duration where storage heights are over 20 ft (6.1 m to 7.6 m). (ROP 231-31)

7-2.5 Where dry-pipe systems are used for Group A plastics, the operating area shall be increased by 30 percent without revising the density.

Figure 7-1.1 Decision tree.

NOTE: Cartons that contain Group A plastic material shall be permitted to be treated as Class IV commodities under the following conditions:

(a) there shall be multiple layers of corrugation or equivalent outer material that would significantly delay fire involvement of the Group A plastic, and
(b) the amount and arrangement of Group A plastic material within an ordinary carton would not be expected to significantly increase the fire hazard.
Chapter 8 Fire Protection — Large Drop Sprinklers

8.1 General.

8.1.1 Large drop sprinklers shall be permitted for use with the hazards listed in Table 8-1.

8.2 Protection Criteria. (ROP 231-36)

8.2.1 Sprinkler water demand for large drop sprinklers shall be in accordance with Table 8-1.

8.2.2 A minimum of 500 gpm (32 L/s) shall be added to the sprinkler demand for combined large and small hose stream demand.

8.2.3 Water supply duration shall be as indicated in Table 8-1.

8.2.4 Where large drop sprinklers are installed under open wood joist construction, their minimum operating pressure shall be 50 psi (3.4 bar). (ROP 231-36)

8.2.5 All requirements contained in NFPA 13, Standard for the Installation of Sprinkler Systems, pertaining to large drop sprinklers shall apply. Exception: Where modified by this standard.

8.2.6 For the purpose of using Table 8-1, preaction systems shall be classified as dry pipe systems. (ROP 231-36)

8.2.7 For wet pipe systems, ordinary, intermediate, or high-temperature sprinklers shall be used. For dry pipe systems, high-temperature sprinklers shall be used. (ROP 231-36)
<table>
<thead>
<tr>
<th>Configuration</th>
<th>Commodity</th>
<th>Maximum Storage Height</th>
<th>Maximum Building Height</th>
<th>Type of System</th>
<th>25 (1.7)</th>
<th>50 (3.4)</th>
<th>75 (5.2)</th>
<th>Hose Stream Demand (gpm (dm³/min))</th>
<th>Water Supply Duration (hr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Palletized</td>
<td>Class I, II or III</td>
<td>25 ft (7.6 m)</td>
<td>35 ft (10.7 m)</td>
<td>Wet</td>
<td>15</td>
<td>15</td>
<td>15</td>
<td>500 (1900)</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Dry</td>
<td>25</td>
<td>25</td>
<td>25</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Palletized</td>
<td>Class IV</td>
<td>20 ft (6.1 m)</td>
<td>30 ft (9.1 m)</td>
<td>Wet</td>
<td>20</td>
<td>15</td>
<td>15</td>
<td>500 (1900)</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Dry</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Palletized</td>
<td>Unexpanded plastics</td>
<td>20 ft (6.1 m)</td>
<td>30 ft (9.1 m)</td>
<td>Wet</td>
<td>25</td>
<td>15</td>
<td>15</td>
<td>500 (1900)</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Dry</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Palletized</td>
<td>Expanded plastics</td>
<td>18 ft (5.5 m)</td>
<td>26 ft (7.9 m)</td>
<td>Wet</td>
<td>NA</td>
<td>15</td>
<td>15</td>
<td>500 (1900)</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Dry</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Palletized</td>
<td>Idle wood pallets</td>
<td>20 ft (6.1 m)</td>
<td>30 ft (9.1 m)</td>
<td>Wet</td>
<td>15</td>
<td>15</td>
<td>15</td>
<td>500 (1900)</td>
<td>1 1/2</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Dry</td>
<td>25</td>
<td>25</td>
<td>25</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Solid piled</td>
<td>Class I, II, III</td>
<td>20 ft (6.1 m)</td>
<td>30 ft (9.1 m)</td>
<td>Wet</td>
<td>NA</td>
<td>15</td>
<td>15</td>
<td>500 (1900)</td>
<td>1 1/2</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Dry</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Solid piled</td>
<td>Class IV</td>
<td>20 ft (6.1 m)</td>
<td>30 ft (9.1 m)</td>
<td>Wet</td>
<td>15</td>
<td>15</td>
<td>15</td>
<td>500 (1900)</td>
<td>1 1/2</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Dry</td>
<td>25</td>
<td>25</td>
<td>25</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Solid piled</td>
<td>Unexpanded plastics</td>
<td>20 ft (6.1 m)</td>
<td>30 ft (9.1 m)</td>
<td>Wet</td>
<td>NA</td>
<td>15</td>
<td>15</td>
<td>500 (1900)</td>
<td>1 1/2</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Dry</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

NA: Not allowed. (ROP 231-35)
NFPA 231 — A98 ROP

Chapter 9 Fire Protection — Early Suppression Fast Response (ESFR) Sprinklers

9.1 General.

9.1.1 ESFR sprinklers shall be permitted for the protection of commodities in accordance with Table 9-1.

<table>
<thead>
<tr>
<th>Type of Storage</th>
<th>Commodity</th>
<th>Maximum Height of Storage ft (m)</th>
<th>Maximum Roof/Ceiling Height of Building ft (m)</th>
<th>Nominal K factor</th>
<th>Sprinkler Design Pressure psi (bars)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Palletized and solid pile storage (no open-top containers or solid shelves)</td>
<td>1. Cartoned unexpanded plastic; 2. Cartoned expanded plastic; 3. Uncartonned unexpanded plastic; 4. Class I, II, III, or IV commodities encapsulated or unencapsulated; 5. Idle wood or plastic pallets</td>
<td>25 (7.6)</td>
<td>30 (9.1)</td>
<td>13.5-14.5</td>
<td>50 (3.4)</td>
</tr>
<tr>
<td></td>
<td>1. Cartoned or uncartoned, unexpanded plastic; 2. Class I, II, III, or IV commodities, encapsulated or unencapsulated</td>
<td>35 (10.7)</td>
<td>40 (12.2)</td>
<td>13.5-14.5</td>
<td>75 (5.2)</td>
</tr>
</tbody>
</table>

(ROP 231-38)

9.1.2 Maximum building height shall be measured to the underside of the roof deck or ceiling. (ROP 231-38)

9.1.3* ESFR sprinklers shall be permitted for use in buildings with the following types of roof construction:

(a) Smooth ceiling
(b) Bar joist
(c) Beam and girder
(d) Panel

9.1.4 Roof slope shall not exceed 1 in 12.

9.2 Water Supplies.

9.2.1 The design area shall consist of the most hydraulically demanding area of 12 sprinklers, consisting of four sprinklers on each of three branch lines. The design shall include a minimum of 960 ft² (89.2 m²).

9.2.2 A minimum of 250 gpm (946 L/min) shall be added to the sprinkler demand for combined large and small hose streams.

9.2.3 Water supply duration shall be at least 1 hour.

9.2.4 ESFR sprinklers shall be limited to wet-pipe systems.

93 Sprinkler System Design.

93.1 All requirements contained in NFPA 13, Standard for the Installation of Sprinkler Systems, shall apply.

Exception: Where modified by this standard.

Chapter 10 Building Equipment, Maintenance, and Operations

104 Mechanical Handling Equipment.

104.1* Industrial Trucks. Power-operated industrial trucks shall comply with NFPA 505, Fire Safety Standard for Powered Industrial Trucks Including Type Designations, Areas of Use, Conversions, Maintenance, and Operation.

104.2 Building Service Equipment.

104.2.1 Electrical equipment shall be installed in accordance with the provisions of NFPA 70, National Electrical Code®.

104.3 Cutting and Welding Operations.

104.3.1* Where welding or cutting operations are necessary, the requirements of NFPA 51B, Standard for Fire Prevention in Use of Cutting and Welding Processes, shall apply. Where possible, work shall be removed to a safe area.

104.3.2 Welding, soldering, brazing, and cutting shall be permitted to be performed on building components that cannot be removed, provided no storage is located below and within 25 ft (7.6 m) of the working area and flameproof tarpaulins enclose this area. During any of these operations, the sprinkler system shall be in service. Extinguishers suitable for Class A fires with a minimum rating of 2A and charged and attended inside hose lines, where provided, shall be located in the working area. A fire watch shall be maintained during these operations and for not less than 30 minutes following completion of open-flame operation.

104.4 Waste Disposal. Rubbish, trash, and other waste material shall be disposed of at regular intervals.

104.5 Smoking. Smoking shall be strictly prohibited. “No Smoking” signs shall be posted in prohibited areas.

Exception: Smoking shall be permitted in locations prominently designated as smoking areas.

104.6 Maintenance and Inspection.

104.6.1 Fire walls, fire doors, and floors shall be maintained in good repair at all times.

104.6.2 The sprinkler system and the water supplies shall be inspected, tested, and maintained in accordance with NFPA 25, Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems.

104.7 Refrigeration Systems. Refrigeration systems, if used, shall conform to ASHRAE 15, Safety Code for Mechanical Refrigeration.

509
Chapter 11 Referenced Publications

11.1 The following documents or portions thereof are referenced within this standard as mandatory requirements and shall be considered part of the requirements of this standard. The edition indicated for each referenced mandatory document is the current edition as of the date of the NFPA issuance of this standard. Some of these mandatory documents might also be referenced in this standard for specific informational purposes and, therefore, are also listed in Appendix D.

11.1-1 NFPA Publications. National Fire Protection Association, 1 Batterymarch Park, P.O. Box 9101, Quincy, MA 02269-9101.


NFPA 40, Standard for the Storage and Handling of Cellulose Nitrate Motion Picture Film, 1997 edition.


Appendix A Explanatory Material

This appendix is not a part of the requirements of this NFPA document but is included for informational purposes only.

A-1-3 Array, Open. Fire tests conducted to represent a closed array utilized 6-in. (152-mm) longitudinal flues and no transverse flues. Fire tests conducted to represent an open array utilized 12-in. (305-mm) longitudinal flues.

A-1-3 Available Height for Storage. For new sprinkler installations, maximum height of storage is the height at which commodities can be stored above the floor where the minimum required unobstructed space below sprinklers is maintained. For the evaluation of existing situations, maximum height of storage is the maximum existing height, if space between sprinklers and storage is equal to or greater than required.

A-1-3 Compartmented. Cartons used in most of the Factory Mutual-sponsored plastic tests involved an ordinary 200-lb (90.7-kg) test of outside corrugated cartons with five layers of vertical pieces of corrugated carton used as dividers on the inside. There were also single horizontal pieces of corrugated carton between each layer. Other tests sponsored by the Society of Plastics Industry, Industrial Risk Insurers, Factory Mutual, and Kemper used two vertical pieces of carton (not corrugated) to form an "X" in the carton for separation of product. This was not considered compartmented, as the pieces of carton used for separations were flexible (not rigid), and only two pieces were in each carton.

A-1-3 Container. The term container includes items such as cartons and wrappings. Fire-retardant containers or tote boxes do not of themselves create a need for automatic sprinklers unless coated with oil or grease. Containers can lose their fire-retardant properties if washed. For obvious reasons, they should not be exposed to rainfall.

A-1-3 Encapsulated. Banding (i.e., stretch-wrapping) around the sides only of a pallet load is not considered to be encapsulation.

A-1-3 Pile Stability. Pile stability performance has been shown to be a difficult factor to judge prior to being subjected to an actual fire. In the test work completed, compartmented cartons (see A-1-2, Compartmented) have been shown to be stable under fire conditions. Those tests on cartons that were not compartmented tended to be unstable under fire conditions.

A-1-3 Stable Piles. Storage on pallets, compartmented storage, and plastic components that are held in place by materials that do not deform readily under fire conditions are examples of stable storage.

A-1-3 Unstable Piles. Leaning stacks, crushed bottom cartons, reliance on combustible bands for stability are examples of potential pile instability under a fire condition. An increase in pile height tends to increase instability.

A-2-1.1 Specifying the type, amount and, arrangement of combustibles for any commodity classification is essentially an attempt to define the potential fire severity, based on its burning characteristics, so the fire can be successfully controlled by the potential sprinkler protection for that commodity class. In real life, however, many storage arrays will not fit precisely into one of the fundamental classifications, thus requiring the user to make judgments after comparing each classification to the storage conditions at hand. With the thousands of products possible in storage arrays, it becomes impossible to define in words all the possible variations that could be acceptable in any class. As an alternative, to help the user, the Technical Committee on General Storage has classified a variety of common products in Appendix A, based on judgment, loss experience, and fire test results.

Table A-2-1 lists examples of commodities that are outside the scope of this standard.

Table A-2-1 Examples of Commodities Outside the Scope of this Standard

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boxes</td>
<td>Empty, wood, slatted¹</td>
</tr>
<tr>
<td>Lighters</td>
<td>Loose in large containers (Level 3 aerosol)</td>
</tr>
</tbody>
</table>

¹ Should be treated as idle pallets.
### Table A-2-1.3 Alphabetized Listing of Commodity Classes

<table>
<thead>
<tr>
<th>Commodity</th>
<th>Class</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Aerosols</strong></td>
<td></td>
</tr>
<tr>
<td>Cartoned or uncartoned</td>
<td></td>
</tr>
<tr>
<td>- Level 1</td>
<td>Class III</td>
</tr>
<tr>
<td><strong>Alcoholic Beverages</strong></td>
<td></td>
</tr>
<tr>
<td>Cartoned or uncartoned</td>
<td></td>
</tr>
<tr>
<td>- Up to 20% alcohol in metal, glass, or ceramic containers</td>
<td>Class II</td>
</tr>
<tr>
<td>- Up to 20% alcohol in wood containers</td>
<td>Class I</td>
</tr>
<tr>
<td><strong>Ammunition</strong></td>
<td></td>
</tr>
<tr>
<td>Small arms, shotgun</td>
<td></td>
</tr>
<tr>
<td>- Packaged, cartoned</td>
<td>Class IV</td>
</tr>
<tr>
<td><strong>Appliances, Major (i.e., stoves, refrigerators)</strong></td>
<td></td>
</tr>
<tr>
<td>- Not packaged, no appreciable plastic exterior trim</td>
<td>Class I</td>
</tr>
<tr>
<td>- Corrugated, cartoned, (no appreciable plastic trim)</td>
<td>Class II</td>
</tr>
<tr>
<td><strong>Baked Goods</strong></td>
<td></td>
</tr>
<tr>
<td>Cookies, cakes, pies</td>
<td></td>
</tr>
<tr>
<td>- Frozen, packaged in cartons¹</td>
<td>Class II</td>
</tr>
<tr>
<td>- Packaged, in cartons</td>
<td>Class III</td>
</tr>
<tr>
<td><strong>Barley, Rice, Oats</strong></td>
<td></td>
</tr>
<tr>
<td>- Packaged, in cartons</td>
<td>Class III</td>
</tr>
<tr>
<td><strong>Batteries:</strong></td>
<td></td>
</tr>
<tr>
<td>Dry cells</td>
<td></td>
</tr>
<tr>
<td>- Packaged in cartons</td>
<td>Class I</td>
</tr>
<tr>
<td>- In blister pack in cartons</td>
<td>Class IV</td>
</tr>
<tr>
<td>Automobile</td>
<td></td>
</tr>
<tr>
<td>- Filled¹</td>
<td>Class I</td>
</tr>
<tr>
<td>- Truck or larger</td>
<td>Class II</td>
</tr>
<tr>
<td>- Empty or filled²</td>
<td>Group A plastics</td>
</tr>
<tr>
<td><strong>Beans:</strong></td>
<td></td>
</tr>
<tr>
<td>Dried</td>
<td></td>
</tr>
<tr>
<td>- Packaged, cartoned</td>
<td>Class III</td>
</tr>
<tr>
<td><strong>Bottles/Jars</strong></td>
<td></td>
</tr>
<tr>
<td>Empty, cartoned</td>
<td></td>
</tr>
<tr>
<td>- Glass</td>
<td>Class I</td>
</tr>
<tr>
<td>- Plastic PET (polylethylene terephthalate)</td>
<td>Class IV</td>
</tr>
<tr>
<td>Filled noncombustible powders</td>
<td>Group A plastics</td>
</tr>
<tr>
<td>- Glass, cartoned</td>
<td>Class I</td>
</tr>
<tr>
<td>- Plastic, cartoned (&lt; 1 gallon)</td>
<td>Class IV</td>
</tr>
<tr>
<td>Filled noncombustible liquids</td>
<td>Group A plastics</td>
</tr>
<tr>
<td>- Glass, cartoned</td>
<td>Class I</td>
</tr>
<tr>
<td>- Plastic, cartoned (less than 5 gallon)</td>
<td>Class IV</td>
</tr>
<tr>
<td>- Plastic, open or solid plastic crates</td>
<td>Group A plastics</td>
</tr>
<tr>
<td>Filled noncombustible powders</td>
<td>Group A plastics</td>
</tr>
<tr>
<td>- Glass, cartoned</td>
<td>Class I</td>
</tr>
<tr>
<td>- Plastic, solid plastic crates</td>
<td>Group A plastics</td>
</tr>
<tr>
<td>- Plastic, open plastic crates</td>
<td>Group A plastics</td>
</tr>
<tr>
<td><strong>Boxes, Crates</strong></td>
<td></td>
</tr>
<tr>
<td>Empty, wood, solid walls</td>
<td>Class II</td>
</tr>
<tr>
<td>- Empty, wood, slatted³</td>
<td>Outside of scope</td>
</tr>
<tr>
<td><strong>Bread</strong></td>
<td></td>
</tr>
<tr>
<td>Wrapped cartoned</td>
<td>Class III</td>
</tr>
<tr>
<td><strong>Butter</strong></td>
<td></td>
</tr>
<tr>
<td>Whipped spread</td>
<td>Class III</td>
</tr>
<tr>
<td><strong>Candles</strong></td>
<td></td>
</tr>
<tr>
<td>Packaged, cartoned</td>
<td>Group A plastics</td>
</tr>
<tr>
<td>- Treat as expanded plastic</td>
<td>Class III</td>
</tr>
<tr>
<td><strong>Candy</strong></td>
<td></td>
</tr>
<tr>
<td>Packaged, cartoned</td>
<td>Class III</td>
</tr>
<tr>
<td><strong>Canned Foods</strong></td>
<td></td>
</tr>
<tr>
<td>In ordinary cartons</td>
<td>Class I</td>
</tr>
<tr>
<td><strong>Cartons:</strong></td>
<td></td>
</tr>
<tr>
<td>Cartons</td>
<td></td>
</tr>
<tr>
<td>- Corrugated</td>
<td></td>
</tr>
<tr>
<td>- Unassembled (neat piles)</td>
<td>Class III</td>
</tr>
<tr>
<td>- Partially assembled</td>
<td>Class IV</td>
</tr>
<tr>
<td>- Wax coated, single walled</td>
<td>Group A plastics</td>
</tr>
<tr>
<td><strong>Cement</strong></td>
<td></td>
</tr>
<tr>
<td>Bagged</td>
<td>Class I</td>
</tr>
<tr>
<td><strong>Cereals</strong></td>
<td></td>
</tr>
<tr>
<td>Packaged, cartoned</td>
<td>Class III</td>
</tr>
<tr>
<td><strong>Charcoal</strong></td>
<td></td>
</tr>
<tr>
<td>Bagged</td>
<td>Class III</td>
</tr>
<tr>
<td>- Standard</td>
<td>Class IV</td>
</tr>
<tr>
<td><strong>Cheese</strong></td>
<td></td>
</tr>
<tr>
<td>- Packaged, cartoned</td>
<td>Class III</td>
</tr>
<tr>
<td>- Wheels, cartoned</td>
<td>Class III</td>
</tr>
<tr>
<td>- Cheese</td>
<td></td>
</tr>
<tr>
<td><strong>Chewing Gum</strong></td>
<td></td>
</tr>
<tr>
<td>Packaged, cartoned</td>
<td>Class III</td>
</tr>
<tr>
<td><strong>Chocolate</strong></td>
<td></td>
</tr>
<tr>
<td>Packaged, cartoned</td>
<td>Class III</td>
</tr>
<tr>
<td><strong>Coffee</strong></td>
<td></td>
</tr>
<tr>
<td>- Canned, cartoned</td>
<td>Class I</td>
</tr>
<tr>
<td>- Packaged, cartoned</td>
<td>Class III</td>
</tr>
<tr>
<td><strong>Coffee Beans</strong></td>
<td></td>
</tr>
<tr>
<td>Bagged</td>
<td>Class III</td>
</tr>
<tr>
<td><strong>Cotton</strong></td>
<td></td>
</tr>
<tr>
<td>- Packaged, cartoned</td>
<td>Class III</td>
</tr>
<tr>
<td><strong>Diapers</strong></td>
<td></td>
</tr>
<tr>
<td>- Cotton, linen</td>
<td>Class I</td>
</tr>
<tr>
<td>- Disposable with plastics &amp; nonwoven fabric (in cartons)</td>
<td>Class IV</td>
</tr>
<tr>
<td>- Disposable with plastics &amp; nonwoven fabric (uncartoned), plastic wrapped</td>
<td>Group A plastics</td>
</tr>
<tr>
<td><strong>Dried Foods</strong></td>
<td></td>
</tr>
<tr>
<td>Packaged, cartoned</td>
<td>Class III</td>
</tr>
<tr>
<td><strong>Fertilizers</strong></td>
<td></td>
</tr>
<tr>
<td>Bagged</td>
<td></td>
</tr>
<tr>
<td>- Phosphates</td>
<td>Class I</td>
</tr>
<tr>
<td>- Nitrates</td>
<td>Class II</td>
</tr>
<tr>
<td><strong>Fiberglass Insulation</strong></td>
<td></td>
</tr>
<tr>
<td>- Paper-backed rolls (bagged or unbagged)</td>
<td>Class IV</td>
</tr>
<tr>
<td><strong>File Cabinets</strong></td>
<td></td>
</tr>
<tr>
<td>Metal</td>
<td></td>
</tr>
<tr>
<td>- Cardboard box or shroud</td>
<td>Class I</td>
</tr>
<tr>
<td><strong>Fish or Fish Products</strong></td>
<td></td>
</tr>
<tr>
<td>Frozen</td>
<td></td>
</tr>
<tr>
<td>- Nonwax, nonplastic packaging</td>
<td>Class I</td>
</tr>
<tr>
<td>- Waxed paper containers, cartoned</td>
<td>Class II</td>
</tr>
<tr>
<td>- Boxed or barreled</td>
<td>Class II</td>
</tr>
</tbody>
</table>

¹ May be class I, III, or IV, depending on fill material.
² May be class I, III, or IV, depending on fill material.
³ May be class I, III, or IV, depending on fill material.
NFPA 231 — A98 ROP

- Plastic trays, cartoned
  - Cartoned
  - Waxed-paper containers, cartoned
  - Frozen trays

Fruit
  - Fresh
  - Nonplastic trays or containers
  - With wood spacers

Furniture
  - Wood
    - No plastic coverings or foam plastic cushioning
    - With plastic coverings
    - With foam plastic cushioning

Ice Cream
- Cartoned

Leather Goods
- Cartoned

Light Fixtures
- Nonplastic
  - Cartoned

Lighters
- Butane
  - Blister-packed, cartoned
  - Loose in large containers (Level 3 aerosol)

Liquor
  - 40% alcohol or less, one gallon or less, cartoned
  - Glass (palletized)
  - Plastic bottles

Marble
- Artificial sinks, countertops
  - Cartoned, crated

Margarine
- Up to 50% oil (in paper or plastic containers)
  - Between 50% and 80% oil (in any packaging)

Matches
- Packaged, cartoned
  - Paper
  - Wood

Mattresses
- Standard (box spring)
  - Foam (in finished form)

Meat, Meat Products
- Bulk
  - Canned, cartoned
  - Frozen, waxed-paper containers
  - Frozen, expanded plastic trays

Metal Desks
- With plastic tops and trim

Milk
- Nonwax paper containers
  - Waxed paper containers
  - Plastic containers
  - Containers in plastic crates

Motors
- Electrical

Nail Polish
- 1 oz to 2 oz glass, cartoned
- 1 oz to 2 oz plastic bottles, cartoned

Nuts
- Canned, cartoned
- Packaged, cartoned
- Bagged

Paints
- Friction top cans, cartoned
- Water-based (latex)
- Oil-based

Paper Products
- Books, magazines, stationery, plastic-coated paper food containers, or cartoned tissue products
- Tissue products, uncartoned and plastic wrapped

Paper, Wax
- Packaged in cartons

Pharmaceuticals
- Pills, powders
  - Glass bottles, cartoned
  - Plastic bottles, cartoned

- Nonflammable liquids
  - Glass bottles, cartoned

Photographic Film
- Motion pictures, bulk rolls of film in polycarbonate, polyethylene, or metal casings
  - Polyethylene in cardboard boxes

Polyurethane
- Cartoned or uncartoned expanded

Poultry Products
- Canned, cartoned
- Frozen, nonwax nonplastic containers
  - Frozen (on paper or expanded plastic trays)

Powders
- Ordinary combustibles — free flowing
  - In paper bags (i.e., flour, sugar, etc.)

PVA (polyvinyl alcohol) Resins
- Bagged

Rags
- Baled
  - Natural fibers
  - Synthetic fibers

512
Rubber
- Natural, blocks in cartons: Class IV
- Synthetic: Group A plastics

Salt
- Bagged: Class I
- Packaged, cartoned: Class II

Shingles
- Asphalt-coated fiberglass: Class III
- Asphalt-impregnated felt: Class IV

Shock Absorbers
- Metal dust cover: Class II
- Plastic dust cover: Class III

Signatures
- Book, magazines: Class II
- Solid array on pallet: Class III

Skis
- Wood: Class III
- Foam core: Class IV

Stuffed Toys
- Foam or synthetic: Group A plastics

Syrup
- Drummed (metal containers): Class I
- Barreled, wood: Class II

Textiles
- Natural fiber clothing or textile products: Class III
- Synthetic (except rayon and nylon) 50/50 blend or less: Class III
- Fabric: Class IV
- Baled fiber: Group A plastics
- Greater than 50/50 blend:
  - Thread, yarn on wood or paper spools: Class IV
  - Fabric: Group A plastics
  - Baled fiber: Group A plastics
  - Thread, yarn on plastic spools: Group A plastics

Vinyl Coated Fabric
- Cartoned: Group A plastics

Vinyl Floor Coverings
- Tiles in cartons: Class IV
- Loose inside large cartons: Group A plastics

Wax-Coated Paper
- Cartoned: Group A plastics

Wax
- Paraffin, blocks, cartoned: Group A plastics

Wire
- Bare wire on metal spools on wood skids: Class I
- Bare wire on wood or cardboard spools on wood skids: Class II
- Single or multiple PVC-covered wire on wood skids: Class II

Wood Products
- Solid piles: Class II
- Doors, windows, wood cabinets, and furniture: Class III
- Patterns: Class IV

Tobacco Products
- In paperboard cartons: Class III

Transformers
- Dry and oil-filled: Class I

Vinyl Floor Coverings
- Cartoned: Class IV

Vinyl Floor Coverings
- Tiles in cartons: Group A plastics
- Loose inside large cartons: Group A plastics

Wax
- Paraffin, blocks, cartoned: Group A plastics

Wax-Coated Paper
- Cartoned: Group A plastics

Waxes
- Cartoned: Group A plastics

Wax
- Paraffin, blocks, cartoned: Group A plastics

Wood Products
- Solid piles: Class II
- Doors, windows, wood cabinets, and furniture: Class III
- Patterns: Class IV

Wax
- Paraffin, blocks, cartoned: Group A plastics

Wire
- Bare wire on metal spools on wood skids: Class I
- Bare wire on cardboard spools on wood skids: Class II
- Bare wire on metal, wood, or cardboard spools in cardboard boxes on wood skids: Class II
- Single or multiple PVC-covered wire on wood skids: Class II

Wood Products
- Solid piles: Class II
- Doors, windows, wood cabinets, and furniture: Class III
- Patterns: Class IV

NOTES:
1. Presumes product is in a plastic-coated package in a corrugated carton. If packaged in a metal foil, it can be considered Class I.
2. Most batteries have a polyethylene case and if stored empty should be treated as a Group I plastic. Truck batteries, even when filled, should be considered a Group A plastic because of the thicker walls.
3. As the openings in plastic plates become larger, the commodity becomes more like Class III. Conversely, as the openings become smaller the product's makeup behaves more like a plastic.
4. Should be treated as idle pallets.
5. Tests conducted clearly indicated synthetics or synthetic blends are considered greater than Class III.
6. When liquid is stored in glass containers in racks, it should be considered a Class III commodity; when it is palletized, it should be considered a Class IV commodity.

Alcoholic Beverages
- Cartoned or uncartoned
- Up to 20% alcohol in metal, glass, or ceramic containers

Appliances, Major (i.e., stoves, refrigerators)
- Not packaged, no appreciable plastic exterior trim

Batteries
- Dry cells: packaged in cartons
- Automobile: filled

Bottles/Jars
- Empty, cartoned
- Glass
- Filled noncombustible liquids
- Plastic, cartoned (less than 5 gallon)
- Filled noncombustible powders

Canned Foods
- In ordinary cartons

Cans
- Metal
- Empty

Coffee
- Canned, cartoned

Fertilizers
- Bagged
- Phosphates
File Cabinets
- Metal
  - Cardboard box or shroud

Fish or Fish Products
- Frozen
  - Nonwax, nonplastic packaging

Fish or Fish Products
- Canned
  - Cartoned

Frozen Foods
- Nonwax, nonplastic packaging

Fruit
- Fresh
  - Nonplastic trays or containers
  - With wood spacers

Ice Cream

Meat, Meat Products
- Bulk
- Canned, cartoned
- Frozen, nonwaxed, nonplastic containers

Metal Desks
- With plastic tops and trim

Milk
- Nonwax paper containers
- Waxed paper containers
- Plastic containers

Motors
- Electrical

Nuts
- Canned, cartoned

Paints
- Friction-top cans, cartoned
  - Water-based (latex)

Plastic Containers
- Noncombustible liquids or semiliquids in plastic containers less than 5 gallon capacity

Poultry Products
- Canned, cartoned
- Frozen, nonwax nonplastic containers

Salt
- Bagged

Syrup
- Drummed (metal containers)

Transformers
- Dry and oil-filled

Wire
- Bare wire on metal spools on wood skids

NOTE:
1. Most batteries have a polypropylene case and if stored empty should be treated as a Group A plastic. Truck batteries, even when filled, should be considered a Group A plastic because of the thicker walls.

A-2-1.3.2

Table A-2-1.3.2 Examples of Class II Commodities

<table>
<thead>
<tr>
<th>Alcoholic Beverages</th>
<th>- Up to 20% alcohol in wood containers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Appliances, major (e.g., stoves)</td>
<td>- Corrugated, cartoned (no appreciable plastic trim)</td>
</tr>
<tr>
<td>Baked Goods</td>
<td>Cookies, cakes, pies</td>
</tr>
<tr>
<td>Batteries</td>
<td>Dry cells, in blister pack in cartons</td>
</tr>
<tr>
<td>Boxes, Crates</td>
<td>- Empty, wood, solid walls</td>
</tr>
<tr>
<td>Fertilizers</td>
<td>- Bagged</td>
</tr>
<tr>
<td>Fish or Fish Products</td>
<td>- Nitrates</td>
</tr>
<tr>
<td>Frozen</td>
<td>- Waxed-paper containers, cartoned</td>
</tr>
<tr>
<td>- Boxed or barreled</td>
<td></td>
</tr>
<tr>
<td>Frozen Foods</td>
<td>- Waxed-paper containers, cartoned</td>
</tr>
<tr>
<td>Leather Hides</td>
<td>Bale</td>
</tr>
<tr>
<td>Light Fixtures</td>
<td>- Nonplastic</td>
</tr>
<tr>
<td>- Cartoned</td>
<td></td>
</tr>
<tr>
<td>Marble</td>
<td>Artificial sinks, countertops</td>
</tr>
<tr>
<td>- Cartoned, covered</td>
<td></td>
</tr>
<tr>
<td>Meat, Meat Products</td>
<td>- Frozen, waxed-paper containers</td>
</tr>
<tr>
<td>- Frozen, expanded plastic trays</td>
<td></td>
</tr>
<tr>
<td>Photographic Film</td>
<td>- Motion picture or bulk rolls of film in polycarbonate, polyethylene, or metal cans; polyethylene bagged in cardboard boxes</td>
</tr>
<tr>
<td>Plastic Containers</td>
<td>- Noncombustible liquids or semiliquids in plastic containers larger than 5 gallons</td>
</tr>
<tr>
<td>Poultry Products</td>
<td>- Frozen (on paper or expanded plastic trays)</td>
</tr>
<tr>
<td>Powders (ordinary combustibles — free flowing)</td>
<td>- In paper bags (i.e., flour, sugar, etc.)</td>
</tr>
<tr>
<td>Salt</td>
<td>- Bagged, cartoned</td>
</tr>
<tr>
<td>Shock Absorbers</td>
<td>- Metal dust cover</td>
</tr>
<tr>
<td>Signatures</td>
<td>Book, magazines</td>
</tr>
<tr>
<td>- Solid array on pallet</td>
<td></td>
</tr>
<tr>
<td>Syrup</td>
<td>- Barreled, wood</td>
</tr>
<tr>
<td>Wire</td>
<td>- Bare wire on wood or cardboard spools on wood skids</td>
</tr>
<tr>
<td>- Bare wire on metal, wood, or cardboard spools in cardboard boxes on wood skids</td>
<td></td>
</tr>
<tr>
<td>- Single or multiple PVC covered wire on metal spools on wood skids</td>
<td></td>
</tr>
<tr>
<td>- Insulated (PVC) cable on large wood or metal spools on wood skids</td>
<td></td>
</tr>
<tr>
<td>Wood Products</td>
<td>Solid piles</td>
</tr>
<tr>
<td>- Lumber, plywood, particle board, pressboard (smooth ends and edges)</td>
<td></td>
</tr>
</tbody>
</table>
NOTE:

Presumes product is in a plastic-coated package in a corrugated carton. If packaged in a metal foil, it can be considered Class I.

A-2-1.3.3 Examples of Class III Commodities

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aerosols</td>
<td>Cartoned or uncartoned</td>
</tr>
<tr>
<td>Baked Goods</td>
<td>Cookies, cakes, pies</td>
</tr>
<tr>
<td></td>
<td>- Packaged, in cartons</td>
</tr>
<tr>
<td>Barley, Rice, Oats</td>
<td>- Packaged, in cartons</td>
</tr>
<tr>
<td>Beans</td>
<td>Dried</td>
</tr>
<tr>
<td></td>
<td>- Packaged, cartoned</td>
</tr>
<tr>
<td>Bread</td>
<td>Wrapped, cartoned</td>
</tr>
<tr>
<td>Butter</td>
<td>Whipped spread</td>
</tr>
<tr>
<td>Candy</td>
<td>Packaged, cartoned</td>
</tr>
<tr>
<td>Cartons</td>
<td>Corrugated</td>
</tr>
<tr>
<td></td>
<td>- Unassembled (neat piles)</td>
</tr>
<tr>
<td>Cereals</td>
<td>Packaged, cartoned</td>
</tr>
<tr>
<td>Charcoal</td>
<td>Bagged</td>
</tr>
<tr>
<td></td>
<td>- Standard</td>
</tr>
<tr>
<td>Cheese</td>
<td>Packaged, cartoned</td>
</tr>
<tr>
<td></td>
<td>- Wheels, cartoned</td>
</tr>
<tr>
<td>Chocolate</td>
<td>Packaged, cartoned</td>
</tr>
<tr>
<td>Cloth</td>
<td>Cartoned or not</td>
</tr>
<tr>
<td></td>
<td>- Natural fiber, viscose</td>
</tr>
<tr>
<td>Cocoa Products</td>
<td>Packaged, cartoned</td>
</tr>
<tr>
<td>Coffee</td>
<td>Packaged, cartoned</td>
</tr>
<tr>
<td>Coffee Beans</td>
<td>Bagged</td>
</tr>
<tr>
<td>Cotton</td>
<td>Packaged, cartoned</td>
</tr>
<tr>
<td></td>
<td>- Cotton, linen</td>
</tr>
<tr>
<td>Dried Foods</td>
<td>Packaged, cartoned</td>
</tr>
<tr>
<td>Fish or Fish Products</td>
<td>Frozen</td>
</tr>
<tr>
<td></td>
<td>- Plastic trays, cartoned</td>
</tr>
<tr>
<td>Frozen Foods</td>
<td>Plastic trays</td>
</tr>
</tbody>
</table>

A-2-1.3.4 Examples of Class IV Commodities

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ammunition</td>
<td>Small arms, shotgun</td>
</tr>
<tr>
<td></td>
<td>- Packaged, cartoned</td>
</tr>
<tr>
<td>Bottles/Jars</td>
<td>Empty, cartoned</td>
</tr>
<tr>
<td></td>
<td>- Plastic PET (polyethylene terephthalate)</td>
</tr>
<tr>
<td></td>
<td>Filled noncombustible powders</td>
</tr>
<tr>
<td></td>
<td>- Plastic, cartoned (&lt; 1 gallon)</td>
</tr>
<tr>
<td>Cartons</td>
<td>Corrugated</td>
</tr>
<tr>
<td></td>
<td>- Partially assembled</td>
</tr>
<tr>
<td>Furniture</td>
<td>Wood (no plastic coverings or foam plastic cushioning)</td>
</tr>
<tr>
<td>Leather Goods</td>
<td></td>
</tr>
<tr>
<td>Margarine</td>
<td>Up to 50% oil (in paper or plastic containers)</td>
</tr>
<tr>
<td>Mattresses</td>
<td>Standard (box spring)</td>
</tr>
<tr>
<td>Nuts</td>
<td>Packaged, cartoned</td>
</tr>
<tr>
<td></td>
<td>Bagged</td>
</tr>
<tr>
<td>Paper Products</td>
<td>Books, magazines, stationery, plastic-coated paper food containers, newspapers, cardboard games, or cartoned tissue products</td>
</tr>
<tr>
<td>Paper, Rolled</td>
<td>In racks or on side</td>
</tr>
<tr>
<td></td>
<td>- Medium or heavyweight</td>
</tr>
<tr>
<td>Photographic</td>
<td>Film</td>
</tr>
<tr>
<td></td>
<td>- 85 mm in metal film cartridges in polyethylene cans in cardboard boxes</td>
</tr>
<tr>
<td></td>
<td>- Paper, in sheets, bagged in polyethylene, in cardboard boxes</td>
</tr>
<tr>
<td>PVC (polystyrene)</td>
<td>- Rigid (e.g., pipe, pipe fittings)</td>
</tr>
<tr>
<td></td>
<td>- Bagged ready</td>
</tr>
<tr>
<td>Paper</td>
<td>Rolled</td>
</tr>
<tr>
<td></td>
<td>- Natural fibers</td>
</tr>
<tr>
<td>Shingles</td>
<td>Asphalt-coated fiberglass</td>
</tr>
<tr>
<td>Shock Absorbers</td>
<td>Plastic dust cover</td>
</tr>
<tr>
<td>Skis</td>
<td>Wood</td>
</tr>
<tr>
<td>Textiles</td>
<td>Natural fiber clothing or textile products</td>
</tr>
<tr>
<td></td>
<td>Synthetic (except rayon and nylon)</td>
</tr>
<tr>
<td>Tobacco Products</td>
<td>In paperboard cartons</td>
</tr>
<tr>
<td>Wood Products</td>
<td>Spools (empty)</td>
</tr>
<tr>
<td></td>
<td>Toothpicks, clothespins, hangers in cartons</td>
</tr>
<tr>
<td></td>
<td>Doors, windows, wood cabinets, and furniture</td>
</tr>
</tbody>
</table>

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NFPA 231 — A98 ROP

Cloth
- Cartoned or not
  - Synthetic

Diapers
- Disposable with plastics and nonwoven fabric (in cartons)

Fiber Glass Insulation
- Paper-backed rolls
  - Bagged or unbagged

Furniture
- Wood
  - With plastic coverings

Liquor
- 100 proof or less, one gallon or less, cartoned
  - Glass (palletized)
  - Plastic bottles

Matches
- Packaged, cartoned
  - Paper

Nail Polish
- 1 oz to 2 oz glass, cartoned

Paints
- Friction top cans, cartoned
  - Oil-based

Paper, Waxed
- Paper-backed rolls

Paper Products
- Tissue products, uncartoned and plastic wrapped

Photographic
- Roll film in polycarbonate plastic cassettes, bulk wrapped in cardboard boxes

PVA (polyvinyl alcohol) Resins
- Bagged

Rags
- Baled
  - Synthetic fibers

Rubber
- Natural, blocks in cartons

Singles
- Asphalt-impregnated felt

Skis
- Foam core

Textiles
- Synthetics (except rayon and nylon)
  - 50/50 blend or less
  - Thread, yarn on plastic spools
  - Fabric
  - Rayon and nylon
  - Baled fiber
  - Thread, yarn on wood or paper spools
  - Fabrics

Vinyl Floor Coverings
- Tiles in cartons

Wax-Coated Paper
- Medium or packaged inside cartons (emphasis is on packaging)

Wire
- Bare wire on plastic spools in cardboard boxes on wood skids
  - Single or multiple (PVC) covered wire on plastic spools in cardboard boxes on wood skids

Wood Products
- Patterns

NOTES:
1 Tests conducted clearly indicated synthetics or synthetic blends are considered greater than Class III.
2 When liquor is stored in glass containers in racks, it should be considered a Class III commodity; when it is palletized, it should be considered a Class IV commodity.

A-2.1.4.1

Table A-2.1.4.1 Examples of Group A Plastic Commodities

<table>
<thead>
<tr>
<th>Commodities</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Batteries</td>
<td>Truck or larger</td>
</tr>
<tr>
<td></td>
<td>- Empty or filled</td>
</tr>
<tr>
<td>Bottles/Jars</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Empty, cartoned</td>
</tr>
<tr>
<td></td>
<td>- Plastic (other than PE or any size)</td>
</tr>
<tr>
<td></td>
<td>Filled noncombustible liquids</td>
</tr>
<tr>
<td></td>
<td>- Plastic, open or solid plastic crates</td>
</tr>
<tr>
<td></td>
<td>Filled noncombustible powders</td>
</tr>
<tr>
<td></td>
<td>- Plastic, solid plastic crates</td>
</tr>
<tr>
<td></td>
<td>- Plastic, open plastic crates</td>
</tr>
<tr>
<td>Candles</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Disposed with plastics and nonwoven fabric (uncartonated),</td>
</tr>
<tr>
<td></td>
<td>- Plastic wrapped</td>
</tr>
<tr>
<td>Furniture</td>
<td>Wood</td>
</tr>
<tr>
<td></td>
<td>- With foam plastic cushioning</td>
</tr>
<tr>
<td>Lighters</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Butane</td>
</tr>
<tr>
<td></td>
<td>- Blister-packed, cartoned</td>
</tr>
<tr>
<td>Margarine</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Between 50% and 80% oil (in any packaging)</td>
</tr>
<tr>
<td>Matches</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Packaged, cartoned</td>
</tr>
<tr>
<td></td>
<td>- Wood</td>
</tr>
<tr>
<td>Milk</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Containers in plastic crates</td>
</tr>
<tr>
<td>Nail Polish</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- 1 oz to 2 oz plastic bottles, cartoned</td>
</tr>
<tr>
<td>Paper Products</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Tissue products, uncartoned and plastic wrapped</td>
</tr>
<tr>
<td>Plastic Containers</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Combustible or noncombustible solids in plastic containers</td>
</tr>
<tr>
<td></td>
<td>and empty plastic containers</td>
</tr>
<tr>
<td>Polyurethane</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Cartoned or uncartoned expanded</td>
</tr>
<tr>
<td>Rubber</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Synthetic</td>
</tr>
</tbody>
</table>

PREPRINT
A-4.1.2 Commodities that are particularly susceptible to water damage should be stored on skids, Dunnage, pallets, or elevated platforms in order to maintain at least 4 in. (10.2 cm) clearance from the floor.

A-4.2.2 Protection for exposed steel structural roof members might be needed and should be provided as indicated by the authority having jurisdiction.

A-4.2.5 Incandescent light fixtures should have shades or guards to prevent the ignition of commodity from hot bulbs where possibility of contact with storage exists.

A-4.3.2 Storage should be separated by aisles so that piles are not more than 50 ft (15.2 m) wide or 25 ft (7.6 m) wide if they abut a wall. Main and cross aisles should be located opposite window or door openings in exterior walls. This is of particular importance in buildings where few exterior openings exist. Aisle width should be at least 8 ft (2.4 m). In judging the adequacy of existing sprinkler protection, aisle spacing and frequency should be given consideration.

A-4.4 Idle pallet storage introduces a severe fire condition. Stacking idle pallets in piles is the best arrangement of combustibles to promote rapid spread of fire, heat release, and complete combustion. After pallets are used for a short time in warehouses, they dry out and edges become frayed and splintered. In this condition they are subject to easy ignition from a small ignition source. Again, high piling increases considerably both the challenge to sprinklers and the probability of involving a large number of pallets when fire occurs. Therefore, it is preferable to store pallets outdoors where possible.

A fire in stacks of idle plastic or wooden pallets is one of the greatest challenges to sprinklers. The undersides of the pallets create a dry area on which fire can grow and expand to other dry or partially wet areas. The process of jumping to other dry, closely located, parallel, combustible surfaces continues until the fire burns through the top of the stack. Once this happens, very little water is able to reach the base of the fire. The only practical method of stopping a fire in a large concentration of pallets with ceiling sprinklers is by means of prewetting. In high stacks, this cannot be done without abnormally high water supplies. The storage of empty wood pallets should not be permitted in an unsprinklered warehouse containing other storage. (ROP 231-11)

A-4.4.1 See Table A-4.4.1.

A-4.4.2 No additional protection is necessary, provided the requirements of 4.4.1.2(a) and (b) are met.

A-4.5 For further information, see Chapter 4 of NFPA 30, Flammable and Combustible Liquids Code.

A-5.3.1(d) For further information on adjacent sprinkler systems, see NFPA 13, Standard for the Installation of Sprinkler Systems.

A-5.4 At windowless warehouses and where windows are scant, hydrants should be located at or in the vicinity of entrances.

### Table A-44.11 Recommended Clearance Between Outside Idle Pallet Storage and Building

<table>
<thead>
<tr>
<th>Wall Type</th>
<th>Openings</th>
<th>Under 200 Pallets</th>
<th>200 to 500 Pallets</th>
<th>500 to 2000 Pallets</th>
</tr>
</thead>
<tbody>
<tr>
<td>Masonry None</td>
<td></td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Wired glass with outside sprinklers and 1-hr doors</td>
<td>0</td>
<td>10 (3.0)</td>
<td>20 (6.1)</td>
<td></td>
</tr>
<tr>
<td>Wired or plain glass with outside sprinklers and 1/4-hr doors</td>
<td>10 (3.0)</td>
<td>20 (6.1)</td>
<td>30 (9.1)</td>
<td></td>
</tr>
<tr>
<td>Wood or metal with outside sprinklers</td>
<td>20 (6.1)</td>
<td>30 (9.1)</td>
<td>50 (15.2)</td>
<td></td>
</tr>
</tbody>
</table>

### Table A-44.12 Fire resistance protection comparable to that of the wall also should be provided for combustible eave lines, vent openings, etc.

### Table A-44.13 Fire, smoke, and water protection comparable to that of the wall also should be provided for combustible eave lines, vent openings, etc.

### Table A-44.14 Manual outside open sprinklers generally are not a reliable means of protection unless property is attended to at all times by plant emergency personnel.
Manual fire-fighting operations in a storage warehouse are not a substitute for sprinkler operation. The sprinkler system should be kept in operation during manual firefighting operations until visibility has cleared so that the fire can be seen clearly and the extent of fire reduced to a stage that needs only mopping up. It is essential that charged hose lines be available before venting is started because of a possible increase in fire intensity. Where a sprinkler valve has been closed, a responsible person should remain at the valve so it can be opened promptly if necessary. The water supply for the sprinkler system should be augmented where possible and care exercised so that the water supply for the sprinkler system is not rendered ineffective by the use of excessive hose streams.

Where a private fire brigade is provided, sufficient large hose (2½ in. [64 mm]) and related equipment should be available.

Information on emergency organization and preincident planning is provided in the following publications:

NFPA Industrial Fire Brigades Training Manual
NFPA 600, Standard on Industrial Fire Brigades
NFPA 1420, Recommended Practice for Pre-Incident Planning for Warehouse Occupancies

For further information, see NFPA 72, National Fire Alarm Code.

The following procedure should be followed in determining the proper density and area as specified in Chapter 6.

(a) Determine the commodity class.

(b) Select the density and area of application from Figure 6-2.2.2 or Figure 6-2.2.3.

(c) Adjust the required density for storage height in accordance with Figure 6-2.2.4.

(d) Increase the operating area by 30 percent in accordance with 6-2.2.5 where a dry-pipe system is used.

(e) Satisfy the minimum densities and areas as indicated in 5-1.2 and 5-1.2.1.

Example:

Storage — greeting cards in boxes on pallets
Height — 22 ft (6.7 m)
Clearance — 6 ft (1.8 m)
Sprinklers — ordinary temperature (ROP 231-1)
System type — dry

(a) Classification — Class III

(b) Selection of density/area — 0.15 gpm/ft² [0.014 (L/s)/m²] over 3000 ft² (363 m²) [0.14 (L/s)/m²] over 2700 ft² (276 m²) from Figure 6-2.2.2.

(c) Adjustment for height of storage using Figure 6-2.2.4 —

\[
1.15 \times 0.225 = 0.259 \text{ gpm/ft}^2 \quad \text{(rounded up to 0.26 gpm/ft}^2)\]

(d) Adjustment of area of operation for dry system — 1.3 \times 3000 \text{ ft}^2 = 9000 \text{ ft}^2 (363 m²)

(e) Confirmation that minimum densities and areas have been achieved

In 5-1.2, the minimum design density for a dry sprinkler system is 0.15 gpm/ft² over 3000 ft² [0.10 (L/s)/m² over 242 m²] (this has been satisfied) for Class III.

Paragraph 5-1.2.1 refers to Ordinary Hazard Group 2 of NFPA 13, Standard for the Installation of Sprinkler Systems. That density at 3000 ft² (293 m²) is 0.17 gpm/ft² (0.12 (L/s)/m²) (this minimum has been satisfied); 3000 ft² \times 1.3 = 3900 ft² (363 m²), 0.17 gpm/ft² over 3900 ft² (0.12 (L/s)/m²) over 363 m².

The design density and area of application equals 0.26 gpm/ft² [0.18 (L/s)/m²] over 3900 ft² (363 m²).

Full-scale tests show no appreciable difference in the number of sprinklers that open for either nonencapsulated or encapsulated products up to 15 ft (4.6 m) high. Test data is not available for encapsulated products stored higher than 15 ft (4.6 m). However, in rack storage tests involving encapsulated storage 20 ft (6 m) high, increased protection was needed over that for nonencapsulated storage.

The protection specified in Chapter 6 contemplates a maximum of 10-ft (3-m) clearances from top of storage to sprinkler deflectors for storage heights of 15 ft (4.6 m) and higher.

Recommended water supplies anticipate successful sprinkler operation. Because of the small but still significant number of uncontrolled fires in sprinklered properties, which have various causes, there should be an adequate water supply available for fire department use.

The densities and area of application have been developed from fire test data. Most of these tests were conducted with 1½-in. (13.5-mm) orifice sprinklers and 80 ft² or 100 ft² (7.4 m² or 9.3 m²) sprinkler spacing. These and other tests have indicated that, with densities of 0.40 gpm/ft² [0.27 (L/s)/m²] and higher, better results are obtained with 1½-in. (13.5-mm) orifice and 70 ft² or 100 ft² (7.4 m² or 9.3 m²) sprinkler spacing than where using 1½-in. (12.7-mm) orifice sprinklers at 50-ft (4.6-m) spacing. A discharge pressure of 100 psi (690 kPa) was used as a starting point on one of the fire tests. It was successful, but has a 1½-ft (0.5-m) clearance between the top of storage and ceiling sprinklers. A clearance of 10 ft (3.0 m) could have produced a different result due to the tendency of the higher pressure to atomize the water and the greater distance that the fire water droplets had to travel to the burning fuel. (ROP 231-1)

Two direct comparisons between ordinary-temperature and high-temperature-rated sprinklers are possible:

(a) With nonexpanded polyethylene terephthalate (PET) bottles in corrugated cartons, a 5-ft (0.5-m) clearance, and the same density, approximately the same number of sprinklers operated (9 at high temperature versus 7 at ordinary temperature). (ROP 231-1)

(b) With exposed, expanded polystyrene meat trays, a 9.5-ft (3-m) clearance, and the same density; three times as many ordinary-temperature-rated sprinklers operated as did high-temperature-rated sprinklers (11 at high temperature versus 3 at ordinary temperature). (ROP 231-1)

The cartoned plastics requirements of this standard are based to a great extent on test work that used a specific commodity — 16-oz (0.47-L) polystyrene plastic jars individually separated by thin corrugated carton stock within a large corrugated carton [3½ in. (8.9 cm) of carton stock].

Figure A-7-1.1(a) Corrugated carton containing individually separated plastic jars.

Other Group A plastic commodities can be arranged in cartons so that they are separated by multiple thicknesses of carton material. In such arrangements, less plastic becomes involved in the fire at any one time. This could result in a less vigorous fire that can be controlled by Class IV commodity protection. Other situations exist in which the plastics component is surrounded by several layers of less hazardous material and is therefore temporarily protected or insulated from a fire involving adjacent plastic products. Such conditions also could produce a less vigorous fire and be successfully handled by Class IV protection. (See Figure A-7-1.1(b)).
The decision to protect as a Class IV commodity, however, should be made only based on experienced judgment and only with an understanding of the consequences of underprotecting the storage segment.

A-7.1.2 There are few storage facilities in which the commodity mix or storage arrangement remains constant, and a designer should be aware that the introduction of different materials can change protection requirements considerably. Design should be based on higher densities and areas of application, and the various reductions allowed should be applied cautiously. For evaluation of existing situations, however, the allowances can be quite helpful.

A-7.2.1 An evaluation for each field situation should be made to determine the worst applicable height-clearance relationship that can be expected to appear in a particular case. Fire tests have shown that considerably greater demands occur where clearance is less than 10 ft (3.0 m) as compared to 5 ft (0.9 m), and where a pile is stable as compared to an unstable pile. Since a system is designed for a particular clearance, the system could be inadequate or becomes inadequate because of the packaging or arrangement is changed so that stable piling is created where unstable piling existed. Recognition of these conditions is essential to avoid installation of protection that is inadequate or becomes inadequate because of changes.

No tests were conducted simulating a peaked roof configuration. However, it is expected that the principles of Chapter 7 still apply. The worst applicable height-clearance relationship that can be expected to occur should be found, and protection should be designed for it. If storage is all at the same height, the worst height-clearance relationship creating the greatest water demand would occur under the peak. If commodities are stored higher under the peak, the various height-clearance relationships should be tried and the one creating the greatest water demand used for designing protection.

A-7.2.2 Test data is not available for all combinations of commodities, storage heights, and clearances. Some of the protection criteria in this standard are based on extrapolations of test data for other commodities and storage configurations, as well as available loss data.

For example, there is very limited test data for storage of expanded plastics higher than 20 ft (6 m). The protection criteria in this standard for expanded plastics higher than 20 ft (6 m) are extrapolated from test data for expanded plastics storage 20 ft (6 m) and less in height and test data for unexpanded plastics above 20 ft (6 m).

Further examples can be found in the protection criteria for clearances up to 15 ft (4.6 m). Test data is limited for clearances greater than 10 ft (3.0 m). It should be assumed that, if protection is adequate for a given storage height in a building of a given height, the same protection will protect storage of any lesser height in the same building. For example, protection adequate for 20-ft (6.1-m) storage in a 30-ft (9.1-m) building [10 ft (3.0 m) clearance] would also protect 15-ft (4.5-m) storage in a 30-ft (9.1-m) building [15 ft (4.5 m) clearance]. Therefore, the protection criteria in Table 7-2-2 for 15 ft (4.5 m) clearance are based on the protection criteria for storage 5 ft (1.5 m) higher than the indicated height with 10-ft (3.0-m) clearance.

Table 7-2.2 is based on tests that were conducted primarily with high-temperature-rated, 17°F/sq-in. (13.5-mm) orifice sprinklers. Other tests have demonstrated that where sprinklers are used with orifices greater than 17°F/sq in. (13.5 mm), ordinary temperature sprinklers are acceptable. (ROP 231-27)

A-7.2.5 Wet systems are recommended for storage occupancies. Dry-pipe systems should be permitted only where it is impractical to provide heat.

A-9.1 ESFR sprinklers were designed to respond quickly to growing fires and deliver heavy discharge to suppress fires rather than to control them. ESFR sprinklers should not be relied upon to provide suppression if they are used outside these design parameters.

A-9.1.3 Storage in single-story or multistory buildings can be permitted, provided the maximum ceiling/roof height as specified in Table 9-1 is satisfied for each storage area.

A-92 Design parameters were determined from a series of full-scale fire tests conducted as a joint effort between Factory Mutual Research Corporation and the National Fire Protection Research Foundation. (Copies of the test reports are available from the NFPRF.)

A-10.1 Locomotives should not be allowed to enter storage areas.

A-10.1.1 Industrial trucks, using gas or liquid fuel should be refueled outside of the storage building at a location designated for that purpose.

A-10.3.1 The use of soldering, cutting, or brazing torches in the storage area introduces a severe fire hazard. The use of mechanical fastening and mechanical saws or cutting wheels is recommended.

Appendix B Example Determining Protection Criteria for Plastic and Rubber Commodities

This appendix is not a part of the requirements of this NFPA document but is included for informational purposes only.

Appendix B explains and provides an example of the method and procedure to follow in using this standard to determine proper protection for Group A plastics. (See Chapter 7.)

Table B Metric Conversion Factors for Examples

<table>
<thead>
<tr>
<th>To convert from</th>
<th>to Multiply</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>feet (ft)</td>
<td>meter (m)</td>
<td>0.3048</td>
</tr>
<tr>
<td>square feet (ft²)</td>
<td>meter/square m (m²</td>
<td>0.0929</td>
</tr>
<tr>
<td>gal/min (gpm)</td>
<td>liter/second (L/s)</td>
<td>0.0631</td>
</tr>
<tr>
<td>gal per min/ft² (gpm/ft²)</td>
<td>liter per second/m² (L/s/m²)</td>
<td>0.079</td>
</tr>
</tbody>
</table>

Example 1. Storage is expanded-cartoned-stable, 15 ft (4.57 m) high in a 20-ft (6.1-m) building.

Answer 1. Column E -- design density = 0.45 gpm/ft² [0.31 (L/s)/m²].

Example 2. Storage is nonexpanded-unstable, 15 ft (4.57 m) high in a 20-ft (6.1-m) building.

Answer 2. Column A -- design density is listed as 0.25 gpm/ft² [0.17 (L/s)/m²], however, it is also possible that the storage can be 12 ft (3.66 m) in this 20-ft (6.1-m) building, which would require 0.3 [0.2 (L/s)/m²]. Unless the owner can guarantee that the storage will always be 15 ft (4.57 m), the design density = 0.3 gpm/ft².

Example 3. Storage is a nonexpanded-stable 15-ft (4.57-m) fixed-height unit load, one high, in an 18-ft (5.5-m) building.

Answer 3. Column A -- design density is 0.25 gpm/ft² [0.17 (L/s)/m²], however, it is also possible that the storage can be 12 ft (3.66 m) in this 20-ft (6.1-m) building, which would require 0.3 [0.2 (L/s)/m²]. Unless the owner can guarantee that the storage will always be 15 ft (4.57 m), the design density = 0.3 gpm/ft².

Example 4. Storage is expanded-exposed-unstable, 20-ft (6.1-m) high in a 27-ft (8.2-m) building.

Answer 4. Column C -- design density = 0.7 gpm/ft² [0.48 (L/s)/m²]. Note that other lower storage heights should also be checked, but they reveal the same, or lower, densities (0.7 and 0.6).
C1 General.

C1.1 The hazards of exposure to outdoor storage from ignitable sources and exposing fires and the infinite variety of conditions under which such exposures can occur render impossible the formulation of any single table, formula, or set of rules that can cover all conditions adequately.

C1.2 Recommendations contained in this appendix are for the protection of outdoor storage of commodities covered by the standard. (See Section 1-1.)

C1.3 In general, the provision of automatic fire protection is impractical for outdoor storage. As a result, emphasis must be placed upon the following:

(a) Control of potential ignition sources, such as from exposing buildings, transformers, yard equipment, refuse burners, overhead power lines, and vandals

(b) Elimination of adverse factors such as trash accumulations, weeds, and brush

(c) Provision of favorable physical conditions, such as limited pile sizes, low storage heights, wide aisles, and possible use of fire-retardant covers (e.g., tarpaulins)

(d) The rapid and effective application of manual fire-fighting efforts by the provision of fire alarms, strategically located hydrants, and adequate hose houses or hose reels

C1.4 Outdoor storage should be avoided in most cases but is recognized as a necessity in many industries.

C1.4.1 Outdoor storage is acceptable for materials that are:

(a) Of low fire hazard, not requiring protection even if located indoors

(b) Of sufficiently low value that a potential loss would not justify the utilization of building space

(c) Of such severe fire hazard that indoor protection is impractical when balanced against potential loss

(d) Of large volume and bulk, making it impractical to construct and protect a building to house the storage

C1.4.2 Where materials that normally would be stored in buildings are stored outdoors in temporary emergencies, it is recommended that special precautions be taken for their safeguard and that they be moved to a storage warehouse as soon as possible.

C1.5 Standards that address outdoor storage of specific commodities are found in Chapter 11.

C2 Responsibility of Management.

C2.1 It is the responsibility of management to properly consider the hazards of the various materials handled. Protection requirements and storage arrangements vary with the combustibility of the materials. Management should determine any special precautions that should be followed for the types of material stored. The care, cleanliness, and maintenance exercised by management determine the relative fire safety in the storage area.

C2.2 Consideration should be given by management to proper storage of materials in order to prevent the undue concentration of quantities of such materials in a single location, subject to one catastrophe. The owner must determine the amount of such material that should be stored in a single location are not only dependent upon the dollar value of the commodity but also upon the total supply and availability of the material. The impact of the loss of the storage upon the ability to continue production should be considered.

C3 Site.

C3.1 In selecting a site for outdoor storage, preference should be given to a location that can provide the following:

(a) Adequate municipal fire and police protection

(b) An adequate public water system with hydrants suitably located for protection of the storage

(c) Adequate all-weather roads for fire department apparatus response

(d) Sufficient clear space from buildings or from other combustible storage that constitutes an exposure hazard

(e) Absence of flood hazard

(f) Adequate clearance space between storage piles and any highways, bridges, railroads, and woodlands

(g) Topography as level as possible to provide storage stability

C3.2 The entire site should be surrounded by a fence or other suitable means to prevent access of unauthorized persons. An adequate number of gates should be provided in the surrounding fence or other barriers to permit ready access of fire apparatus.

C4 Material Piling.

C4.1 Materials should be stored in unit piles as low in height and small in area as is consistent with good practice for the materials stored. The maximum height should be determined by the stability of pile, effective reach of hose streams, combustibility of the commodity, and ease of pile breakdown under fire or mop-up conditions. Long narrow piles are preferred over large square piles to facilitate manual fire fighting. (The short dimension increases the effectiveness of hose streams and ease pile breakdown.)

C4.2 Aisles should be maintained between individual piles, between piles and buildings, and between piles and the boundary line of the storage site. Sufficient driveways having the width of at least 15 ft (4.57 m) should be provided to allow the travel of fire equipment to all portions of the storage area. Aisles should be at least twice the pile height to reduce the spread of fire from pile to pile and to allow ready access for fire fighting, emergency removal of material, or salvage purposes.
C4.3 As the commodity class increases in combustibility or where storage could be ignited easily from radiation, wider aisles should be provided. Smaller unit piles might be an alternative to wider aisles if yard space is limited.

C4.4 For outdoor idle pallet storage, see Section 4-4 and A-4-4.1.1 of this standard. Separation between piles of idle pallets and other yard storage should be as specified in Table C4.4.

<table>
<thead>
<tr>
<th>Pile Size</th>
<th>Minimum Distance in ft (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fewer than 50 pallets</td>
<td>20 (6)</td>
</tr>
<tr>
<td>50-200 pallets</td>
<td>30 (9.1)</td>
</tr>
<tr>
<td>More than 200 pallets</td>
<td>50 (15.2)</td>
</tr>
</tbody>
</table>

C4.5 Boundary posts with signs designating piling limits should be provided to indicate yard area, roadway, and aisle limits.

C5 Buildings and Other Structures.

C5.1 Yard storage, particularly storage of commodities in the higher heat release category, should have as much separation as is practical from important buildings and structures, but not less than that offered by NFPA 80A, Recommended Practice for Protection of Buildings from Exterior Fire Exposures.

C5.1.1 As guidance in using NFPA 80A, Recommended Practice for Protection of Buildings from Exterior Fire Exposures, to establish clear spaces, the following classification of severity with commodity classes of this standard should be used on the basis of 100 percent openings representing yard storage:

(a) Light Severity. Commodity Class I
(b) Moderate Severity. Commodity Class II
(c) Interpolate between moderate and severe severity for Commodity Class III
(d) Severe Severity. Commodity Class IV and Class A plastics

NOTE: The guidelines of C5.1.1 apply to the equivalent commodity classes of this standard. The severity of the exposure building or structure also should be a consideration when establishing a clear space.

C6 Yard Maintenance and Operations.

C6.1 The entire storage site should be kept free from accumulation of unnecessary combustible materials. Vegetation should be kept cut low. Procedures should be provided for weed control and the periodic cleanup of the yard area.

C6.2 Adequate lighting should be provided to allow supervision of all parts of the storage area at night.

C6.3 All electrical equipment and installations should conform to the provisions of NFPA 70, National Electrical Code.

C6.4 No heating equipment should be located or used within the storage area. Salamanders, braziers, portable heaters, and other open fires should not be used.

C6.5 Smoking should be prohibited, except in locations prominently designated as smoking areas. “No Smoking” signs should be posted in prohibited areas.

C6.6 Welding and cutting operations should be prohibited in the storage area, unless in compliance with NFPA 51B, Standard for Fire Prevention in Use of Cutting and Welding Processes.

C6.7 Tarps used for protection of storage against the weather should be of fire-resistant fabric.

C6.8 Locomotives from which glowing particles could be emitted from exhaust stacks should not be permitted in the yard.

C6.9 Motorized vehicles using gasoline, diesel fuel, or liquefied petroleum gas as fuel should be garaged in a separate, detached building.

C6.9.1 Storage and handling of fuel should conform with NFPA 30, Flammable and Combustible Liquids Code, and NFPA 58, Standard for the Storage and Handling of Liquefied Petroleum Gases.

C6.9.2 Repair operations should be conducted outside the yard unless a separate masonry wall building is provided. Vehicles should not be greased, repaired, painted, or otherwise serviced in the yard. Such work should be conducted in conformity with NFPA 88B, Standard for Repair Garages.

C7 Fire Protection.

C7.1 Provisions should be made for promptly notifying the public fire department and private fire brigade (if available) in case of fire or other emergency.

C7.2 Hydrants should be spaced to provide a sufficient number of hose streams. (See NFPA 24, Standard for the Installation of Private Fire Service Mains and Their Appurtenances.)

C7.2.1 Provisions should be made to permit the direction of an adequate number of hose streams on any pile or portion of the storage area that could be involved in fire. It is recommended that, unless adequate protection is provided by the municipal fire department, sufficient hose and other equipment should be kept on hand at the storage property, suitably housed, and provision should be made for trained personnel available to put it into operation.

C7.2.2 Hydrants and all fire-lighting equipment should be accessible for use at all times. No temporary storage should be allowed to obstruct access to fire-lighting equipment, and any accumulation of snow or obstructing material should be removed promptly.

C7.3 Monitor nozzles should be provided at strategic points where large quantities of highly combustible materials are stored or where average amounts of combustible materials are stored in inaccessible locations.

C7.4 Fire extinguishers of an appropriate type should be placed at well-marked, strategic points throughout the storage area so that one or more portable fire extinguisher units can be made available quickly for use at any point. Where the climate is such that there is a danger of freezing, suitable extinguishers for freezing temperatures should be used. For guidance in the type and use of extinguishers refer to NFPA 10, Standard for Portable Fire Extinguishers.

C8 Guard Service.

C8.1 Guard service should be provided and continuously maintained throughout the yard and storage area at all times while the yard is otherwise unoccupied. The responsibilities and the training of guards should be as specified in NFPA 601, Standard for Security Services in Fire Loss Prevention. It is recommended that there be some suitable means of supervising guard activities to ensure that required rounds are made at regular intervals.

C8.2 The value of strategically placed watchtowers in large yards where a guard stationed at a point of advantage can keep the entire property under observation should be considered. It is recommended that such watchtowers be connected to the alarm system for prompt notification of fire.

Appendix D Referenced Publications

D-1 The following documents or portions thereof are referenced within this standard for informational purposes only and are thus not considered part of the requirements of this standard unless also listed in Chapter 11. The edition indicated here for each reference is the current edition as of the date of the NFPA issuance of this standard.

D-1.1 NFPA Publications. National Fire Protection Association, 1 Batterymarch Park, P.O. Box 9101, Quincy, MA 02269-9101.

NFPA 231 — A98 ROP


NFPA 1420, Recommended Practice for Pre-Incident Planning for Warehouse Occupancies, 1993 edition.