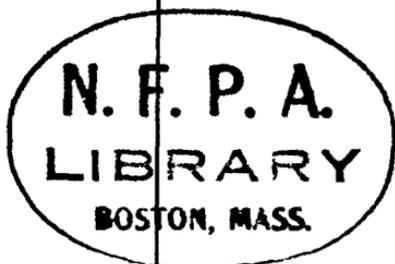


NFPA No.

231

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INDOOR GENERAL STORAGE 1965



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Units of Measurements

Units of measurements used here are U. S. standard. 1 U. S. gallon = 0.83 Imperial gallons = 3.785 liters. One foot = 0.3048 meters. One inch = 25.40 millimeters. One pound per square inch = 0.06805 atmospheres = 2.307 feet of water. One pound = 453.6 grams.

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Standard for Indoor General Storage

NFPA No. 231 — 1965

1965 Edition of No. 231

The Standard on Indoor General Storage was adopted by the 1965 Annual Meeting, held May 17-21 in Washington, D.C., on recommendation of the Committee on General Storage. This Standard replaces, in part, the Recommended Safe Practices for General Storage, NFPA No. 231, edition of 1956 and all prior editions.

The 1965 revisions are similar to those recommended to the 1963 Annual Meeting which were then referred back to the Committee for reconsideration of certain details and clearance with the Committee on Automatic Sprinklers of recommendations on water supply. A Conference Committee of the Committee on General Storage and the Committee on Automatic Sprinklers produced consistent wording adopted for the 1965 editions of the Standard for Indoor General Storage, NFPA No. 231, and the Standard for Installation of Sprinkler Systems, NFPA No. 13. The Conference Committee has been discharged with thanks.

The 1965 revisions change the title of the standard, delete former sections on Refrigerated Storage and Outdoor Storage and add an Appendix on Pallets and Palletized Storage. This Appendix was

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Paul J. Whipple, American Warehousemen's Assn.

A. B. White (SFPE), Continental Ins. Co.

prepared by a Conference Committee, first appointed in 1958, established as a Sectional Committee on Pallets in 1959 and discharged with thanks in 1963.

The section on Outdoor Storage (as it appeared in Recommended Safe Practice for General Storage, NFPA No. 231 — 1956) is published as a separate document on recommendation of the Committee and as approved by the 1965 Annual Meeting, identified as NFPA No. 231A.

Origin and Development of NFPA No. 231

The U. S. War Production Board promulgated in 1943 General Storage Specifications for Critical-Strategic Materials. These were largely based on existing NFPA standards and upon generally accepted good practice in fire protection. They were published for convenient reference in NFPA National Fire Codes for Building Construction and Equipment in 1944, and an NFPA Committee on General Storage was appointed that same year. On recommendation of that Committee, a General Storage Standard was adopted by the NFPA Annual Meeting in 1946. This covered both indoor and outdoor storage. A revision of the Standard was tentatively adopted in 1953.

In 1955 the Committee presented a draft of a new document, Recommended Safe Practices for General Storage, No. 231-T, covering Indoor Storage, Outdoor Storage and Refrigerated Warehouses. This was tentatively adopted leaving the 1946 General Storage Standard still official. With a few amendments, Recommended Safe Practices for General Storage, NFPA No. 231, was adopted in 1956. This 1965 Edition supersedes, as explained previously, the 1956 Standard.

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Standard for Indoor General Storage

NFPA No. 231 — 1965

INTRODUCTION

1. Application and Scope

(a) This standard applies to storage, 21 feet or less in height, of commodities which with their packaging and storage aids would classify as ordinary combustibles. This standard also applies to storage of commodities which with their packaging and storage aids would classify as noncombustibles regardless of storage height. This standard does not cover unpackaged bulk storage such as grain, coal or similar commodities.

Certain specific commodities introduce hazards different than contemplated by this standard. Examples are rubber tires, roll paper, and wax-coated cartons. The Authority having jurisdiction should be consulted for protection recommendations of these and materials with similar hazard.

Standards applying to specific commodities that are not included in this standard are listed in Appendix A.

(b) Ordinary combustibles piled higher than 21 feet introduce serious fire protection problems which are not within the scope of this standard. The authority having jurisdiction should be consulted for recommendations for proper safeguarding for such storage.

(c) The provisions contained in this standard apply to new buildings. They should be used as a basis for evaluating or improving arrangements, safeguards and protection at existing storage facilities or when converting existing buildings to warehouse occupancy.

(d) The provisions of this standard do not apply to Refrigerated Warehouses.

(e) This standard is not intended to apply where the cost of protection is unreasonable for the hazard or total value involved. Value estimate should include physical property and importance of stored material to continuing operations.

2. Responsibility of Management

(a) Management shall take proper consideration of the fire hazards of the various commodities handled.

(b) Consideration should be given by the owner of the commodity to preventing storage of excessive amounts of commodities in a single location subject to one fire catastrophe. In determining the amount of commodities that should be stored in a single location, consideration should be given to the economic and strategic value of the commodity to the extent that such information is readily available.

(c) The best sites for location of storage buildings have minimum exposure, adequate water supplies and hydrants for fire fighting, ready accessibility to public fire fighting organizations and freedom from flooding.

3. Definitions

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.

ORDINARY COMBUSTIBLES. This term designates commodities, packaging or storage aids which have heats of combustion (British thermal units per pound) similar to wood, cloth or paper and which produce fires that may normally be extinguished by the quenching and cooling effect of water. This type of fire is defined as a Class A fire in the Standard for the Installation of Portable Fire Extinguishers, NFPA No. 10-1965.

EXPOSURE. The exterior presence of combustibles which, if ignited, could cause damage to the storage building or its contents.

FIRE WALL. A wall designed to prevent the spread of fire, having a fire resistance rating of not less than four hours and having sufficient structural stability under fire conditions to allow collapse of construction on either side without collapse of wall.

HORIZONTAL CHANNEL. Any uninterrupted space in excess of five feet in length between horizontal layers of stored commodities. Such channels may be formed by pallets, shelving, racks or other storage arrangements.

NONCOMBUSTIBLE. This term designates commodities, packaging or storage aids which will not ignite, burn or liberate flammable gases when heated to a temperature of 1,380 degrees Fahrenheit for five minutes.

PACKAGING. This term designates any commodity wrapping, cushioning or container.

STORAGE AIDS. This term designates commodity storage devices such as shelves, pallets, dunnage, decks, platforms, trays, bins, separators and skids.

WAREHOUSE. Any building or area within a building used principally for the storage of commodities.

CHAPTER 1. CLASSIFICATION OF STORAGE

11. Type I Storage.

111. Type I storage is that in which combustible commodities or noncombustible commodities involving combustible packaging or storage aids are stored over 15 feet but not more than 21 feet high in solid piles or over 12 feet but not more than 21 feet high in piles that contain horizontal channels. (See Appendix B, Pallets and Palletized Storage.)

Minor quantities of commodities of hazard greater than ordinary combustibles may be included without affecting this general classification.

12. Type II Storage.

121. Type II storage is that in which combustible commodities or noncombustible commodities involving combustible packaging or storage aids are stored not over 15 feet high in solid piles or not over 12 feet high in piles that contain horizontal channels.

Minor quantities of commodities of hazard greater than ordinary combustibles may be included without affecting this general classification.

13. Type III Storage.

131. Type III storage is that in which the stored commodities, packaging and storage aids are noncombustible or contain only a small concentration of combustibles which are incapable of producing a fire that would cause appreciable damage to the commodities stored or to noncombustible wall, floor or roof construction. Ordinary combustible commodities in completely sealed noncombustible containers may qualify in this classification subject to the authority having jurisdiction. General commodity storage that is subject to frequent changing and storage of combustible packaging and storage aids is excluded from this category.

CHAPTER 2. BUILDING ARRANGEMENT

21. Construction.

211. One-story buildings without basement storage areas are preferable for warehouses because of greater efficiency for fire fighting and salvage operations. Long narrow buildings provide greater ease in protection and fire fighting than large square buildings. Multistory buildings may be subject to the spread of fire from lower to upper floors and water used on upper floors may cause damage on lower floors.

212. Warehouses protected according to this standard may be of any type of construction described in Standard Types of Building Construction, NFPA No. 220-1961. Newly constructed warehouses over one story in height should be of not less than three-hour fire-resistive construction.

213. Fire wall construction shall be parapeted at least three feet above the building roof, except the parapet may be omitted where the wall fits tightly to the underside of a fire-resistive roof deck. In buildings having combustible exterior walls, intersecting fire walls shall extend at least three feet beyond them or shall be continued as wing walls at least six feet in total length. Fire walls should preferably be without openings, but if openings are necessary they shall be provided with self-closing or automatic fire doors on each side of the wall. Such doors shall be suitable for openings in the particular fire wall as determined by the authority having jurisdiction and shall be types for Class A openings as defined in Standard for the Installation of Fire Doors and Windows, NFPA No. 80-1962, and installed in accordance with that standard.

214. A wall or partition separating the warehouse from other occupancy shall have a fire resistance rating sufficient to protect the warehouse from the fire exposure of the other occupancy. Door openings shall be equipped with automatic closing fire doors appropriate for the fire resistance rating of the wall or partition.

215. Sections of the warehouse occupied as boiler room, engine room, or garage shall be cut off from other sections of the warehouse by construction having a fire resistance of at least two hours.

216. Adequate access shall be provided to all portions of the premises for fire fighting purposes. Frangible wall sections for fire department or other emergency access or exit should be considered where doors are not practical.

22. Areas.

221. Fire areas of warehouses should be limited to maintain the total value of the commodity within reasonable limits yet not be too restrictive for low value commodities. Conversely, high value and vital commodities should be restricted to smaller areas than for average value commodities such as found in the usual general warehouse. The combustibility of the commodity and its packaging or storage aids should be taken into account. Other considerations are the difficulty encountered in fire fighting and salvage operations in large undivided areas.

222. Type I and Type II Storage. When protected in accordance with this standard, 50,000 square feet is considered the maximum area for average value commodities enclosed by exterior walls or a combination of exterior walls and fire walls. This can be increased or decreased depending on conditions noted in Section 221. A multistory building having three-hour fire-resistive construction at each floor with all vertical openings adequately protected shall be considered as having each floor a separate fire area. A multistory building of less than three-hour fire resistance at each floor shall be considered to be one fire area with the floor area per level being cumulative.

223. Type III Storage. Warehouses constructed and protected in accordance with this standard may be of any reasonable area.

23. Ventilation.

231. Consideration should be given to the provision of roof vents and curtain boards, particularly in large one-story warehouses where distance to exterior wall openings makes it difficult to place hose streams in service.

See Guide for Smoke and Heat Venting, NFPA No. 204-1961.

24. Protection of Stairways and Shafts.

241. Stairways and other vertical shafts shall be enclosed with construction specified in Standard Types of Building Construction, NFPA No. 220-1961, or sealed off at each floor level with construction having the same fire resistance rating as the floor.

See Building Exits Code, NFPA No. 101-1963 and Standards for the Installation of Fire Doors and Windows, NFPA No. 80-1962.

242. Where stairways are required for the exit of occupants, such stairways and doors in interior partitions enclosing stairways shall comply with the provisions of Building Exits Code, NFPA No. 101-1963.

25. Exposure Protection.

251. Adequate protection against exposure shall be provided where the warehouse or its contents are subject to damage from external fire. Depending upon the severity of the exposure, such protection should consist of parapeted masonry walls without openings, wire glass in metal framed windows and/or open sprinklers.

See Suggested Practice for Protection Against Fire Exposure of Openings in Fire-Resistive Walls, NFPA No. 80A-1925 (1960 reprint) and Standard for the Installation of Sprinkler Systems, NFPA No. 13-1965.

26. Drainage of Floors.

261. Upper floors of multistoried buildings should be made watertight and provided with floor drainage facilities.

See Suggested Good Practice for Waterproofing of Floors, Drainage, and Installation of Scuppers, NFPA No. 92-1937 (1960 reprint).

CHAPTER 3. STORAGE ARRANGEMENT

31. Piling Procedures and Precautions.

311. All commodities shall be stored, handled and piled with due regard to their fire characteristics. Storage operations involving certain specific commodities and other occupancies are covered by other standards.

Standards applying to specific commodities are listed in Appendix A.

312. Significant quantities of commodities with fire hazards greater than ordinary combustible commodities as contemplated by this standard, shall be separated from the main bulk of storage by fire walls.

313. Any commodities which may be hazardous in combination with each other shall be stored so they cannot come in contact with each other.

314. Safe floor loads shall not be exceeded. For water absorbent commodities, normal floor loads should be reduced to take into account the added weight of water which can be absorbed during fire fighting operations.

315. Type III Storage contained in warehouses with Type I and Type II storage should, where practical, be placed so as to interrupt the continuity of combustibles.

316. Commodities should be piled so as to minimize the spread of fire internally and to permit convenient access for fire fighting, salvage and removal of portions of storage. Stable piling should be maintained at all times.

317. Combustible contents should not be piled in contact with all sides of columns that are not of fire-resistive construction. This is necessary to permit sprinkler water to wet such columns during a fire to guard against premature column failure.

318. 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 inches clearance from the floor.

32. Piling Limitations.

321. Area of Piles.

3211. Storage piles should be kept as narrow as practicable consistent with operational requirements. Narrow piles enhance efficiency of fire fighting, commodity handling and salvage operations in event of fire.

3212. Depending on the value of the commodity, the combustibility, and the pile arrangement and height, the maximum pile area should be limited between 5,000 and 15,000 square feet.

322. Height of Piles.

3221. See Introduction and Chapter 1, Classification of Storage.

323. Clearance to Piles.

3231. Type I Storage. Clearance of at least 36 inches shall be maintained between sprinkler deflectors and top of storage to reduce possibility of obstruction to the distribution of water.

3232. Type II Storage. Clearance of at least 18 inches shall be maintained between sprinkler deflectors and top of storage to reduce possibility of obstruction to the distribution of water. Increased clearance up to 36 inches should be provided over large, closely packed piles of combustible cases, bales, cartons or other closely packed combustible commodities.

3233. Type III Storage. Clearance of at least 36 inches should be maintained between the top of storage and the roof or ceiling construction in order to allow sufficient space for effective use of hose streams unless the building is equipped with automatic sprinklers, or the storage is completely noncombustible. In sprin-

klered buildings, at least 18 inches clearance between sprinkler deflectors and top of storage shall be maintained.

3234. Adequate clearance shall be maintained around lights and heating units to prevent ignition of combustible commodities.

3235. A clearance of 24 inches shall be maintained around the path of travel of fire doors unless a barricade is provided, in which case no clearance is needed. Commodities shall not be stored within 36 inches of a fire door opening.

33. Piles Containing Horizontal Channels.

331. Type I and Type II Storage.

3311. Horizontal channels formed by rack arrangement should be suitably firestopped by means of a barrier at intervals of 25 feet unless additional automatic sprinklers are provided at intermediate levels to protect the storage.

3312. Horizontal channels of palletized storage should be perpendicular to the aisle. No part of such horizontal channels shall be more than 25 feet from an aisle measured along the length of the channel. It is desirable to eliminate such channels by firestopping pallets or by other means.

See Appendix B, Pallets and Palletized Storage.

34. Aisles.

341. Type I and Type II Storage. Aisles should be maintained to separate piles as noted in Section 321 with widths of aisles being at least 50 per cent of the pile heights.

342. Type III Storage. Aisles should be provided for access to all areas but not of specific widths.

343. Where possible, main and cross aisles should be located opposite window or door openings in exterior walls.

344. Wall aisles should be at least 24 inches wide in warehouses used for the storage of commodities which may swell or expand with the absorption of water.

35. Storage of Empty Combustible Pallets.

351. Type I and Type II Storage. Piles of empty pallets shall not exceed 8 feet in height, 25 feet in width and 2,000 square feet in area. Width of aisles between piles shall be not less than 8 feet.

352. Type III Storage. The storage of combustible packaging or storage aids is prohibited under this classification of storage.

CHAPTER 4. FIRE PROTECTION

41. Sprinkler Systems.

411. All warehouses having combustible roof or floor construction and all warehouses containing Type I or Type II storage shall be protected with a system of automatic sprinklers designed and installed in accordance with the Standard for the Installation of Sprinkler Systems, NFPA No. 13-1965.

See Introduction, Application and Scope.

412. Automatic sprinkler systems should be considered seriously for buildings of noncombustible or fire-resistive construction containing Type III storage unless there is definite assurance by usage that the contents will remain Type III storage.

42. Water Supplies

421. Water supplies for automatic sprinklers shall be provided in accordance with Standard for Installation of Sprinkler Systems, NFPA No. 13-1965. The following should be used to supplement information in Standard for Installation of Sprinkler Systems, NFPA No. 13-1965, Table 2111, Guide to Water Supply Requirements for Sprinkler Systems. The minimum acceptable flow from sprinklers, with reasonably uniform distribution for any area protected, should be as follows:

Type I Storage: 1,250 gallons per minute distributed over an area not exceeding 5,000 square feet to 1,800 gallons per minute distributed over an area not exceeding 6,000 square feet for at least three hours duration.

Type II Storage: 1,000 gallons per minute distributed over an area not exceeding 5,000 square feet to 1,500 gallons per minute distributed over an area not exceeding 6,000 square feet for at least two hours duration.

NOTE 1: In using these performance criteria, due consideration should be given to the type of construction, the height of piling, elevation of roof, piling methods or configuration, pile size, aisle width, venting, type of system (wet or dry), and other critical factors.

NOTE 2: For Type III Storage, see Standard for Installation of Sprinkler Systems, NFPA No. 13-1965.

422. Water supplies for hose streams shall be provided to supplement that required for automatic sprinklers. Residual pressures at yard level for the total flow required (hose streams and sprinklers)

should be sufficient to provide for proper hose streams without reducing residual pressures below those necessary for sprinklers. The water supplies shall be capable of supplying at least 750 gallons per minute for three hours for Type I storage, 500 gallons per minute for two hours for Type II storage in addition to the sprinkler demand. For locations containing several warehouses or for warehouses larger than recommended in Section 222, flows greater than listed above are desirable.

423. Where values are high, it is advisable to obtain an adequate water supply from two reliable sources.

424. Where private underground supply mains are necessary, they shall be installed in accordance with Standard for Outside Protection, NFPA No. 24-1965.

43. Manual Inside Protection.

431. Portable Fire Extinguishers.

4311. Portable fire extinguishers shall be provided at convenient conspicuously accessible locations. In locations where small hose is provided, portable fire extinguishers for Class A fires may be omitted.

Class A fires are defined in Standard for the Installation of Portable Fire Extinguishers, NFPA No. 10-1965.

432. Small Hose Systems.

4321. Small hose (1½ inch) where required by this standard shall be installed in accordance with Standard for the Installation of Sprinkler Systems, NFPA No. 13-1965 and Standard for the Installation of Standpipe and Hose Systems, NFPA No. 14-1963.

4322. Type I and Type II Storage. Sufficient small hose (1½ inch) shall be provided so that one hose stream can reach any portion of the storage area. Small hose (1½ inch) should be supplied from standpipe systems conforming to Standard for Installation of Standpipe and Hose Systems, NFPA No. 14-1963, especially when buildings are four stories or more high. In buildings three stories or less high small hose (1½ inch) may be supplied from the sprinkler system in accordance with limitations outlined in Standard for the Installation of Sprinkler Systems, NFPA No. 13-1965. Connection should be made to the sprinkler system adjacent to the one in which the hose station is located or to a system in an adjacent cut-off area. This arrangement makes it possible to keep charged hose lines in service when sprinklers are shut off after a fire.

433. Standpipe and Hose Systems.

4311. Standpipe and hose systems conforming to the requirements of Standard for the Installation of Standpipe and Hose Systems, NFPA No. 14-1963, shall be provided for buildings over three stories in height or having a floor level 75 feet or more above grade. Standpipes shall be fully equipped for fire department operations including fire department connections.

44. Hydrants.

441. Type I, Type II (and where combustible construction) Type III Storage. At locations without public hydrants, or where hydrants are inadequate, private hydrants without suction outlets shall be installed in accordance with Standard for Outside Protection, NFPA No. 24-1965.

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

45. Large Hose.

451. Large hose (2½ inch) and related equipment shall be provided unless the public fire department will provide such equipment promptly.

See Standard for Outside Protection NFPA No. 24-1965, and Standard for Installation of Standpipe and Hose Systems NFPA No. 14-1963.

452. Sufficient large hose (2½ inch) shall be provided so that the number of hose streams indicated in Section 422 will be available for either external use or internal use at the warehouse building. At least 200 feet of hose should be provided for each stream.

453. Where private hydrants are in service but will be used by public fire departments, at least 100 feet of large hose (2½ inch) and an "underwriter" playpipe should be provided for testing water supplies and for use during sprinkler impairments.

46. Fire Organization.

461. A well-trained emergency organization should be provided and procedures planned in advance. Emergency organizations should have a thorough understanding of:

(a) Storage conditions and development of fire therein, susceptibility of contents to damage by heat, water and smoke.

(b) The importance and means of summoning outside aid upon discovery of fire and the method for doing so.

(c) The importance of prompt action in the early stages of a fire so it can be isolated and attacked while visibility is relatively good.

(d) The methods of ventilating the warehouse by means of exterior windows and smoke hatches and vents.

(e) Handling of storage to complete extinguishment.

(f) Effective use of available water supplies.

(g) Handling sprinkler control valves.

(h) Use of waterproof covers to prevent water damage.

(i) Salvage procedures.

Information on emergency organization is given in the following publications:

Recommendations for Organization of Industrial Fire Loss Prevention, NFPA No. 6-1964.

Recommendations for Management Control of Fire Emergencies, NFPA No. 7-1964.

Suggestions for the Organization, Training and Equipment of Private Fire Brigades, NFPA No. 27-1955.

Recommended Practice on Salvaging Operations, NFPA No. 604-1964.

47. Alarm Service.

471. Storage facilities shall be provided with alarm service. It may be in the form of central station supervision of automatic fire detection or sprinkler waterflow alarms or watchman making recorded rounds during unattended periods. The type and extent of alarm service shall be provided as required by the authority having jurisdiction.

See Standard for the Installation, Maintenance and Use of Central Station Protective Signaling Systems for Watchman, Fire Alarm and Supervisory Service, NFPA No. 71-1964, and The Watchman, a Recommended Manual of Instruction and Duties for the Plant Watchman or Guard, NFPA No. 601-1956.

472. Where storage is highly susceptible to fire, water and smoke damage and where high unit values exist, the installation of automatic smoke detectors should also be considered because of their faster detection of fire.

473. At locations where central station service is not available and watchman service is not economically feasible, alarms should be connected to a location approved by the authority having jurisdiction where someone is on duty twenty-four hours a day.

See Standard for the Installation, Maintenance and Use of Local Protective Signaling Systems for Watchman, Fire Alarm and Supervisory Service, NFPA 72A-1964, Standard for the Installation, Maintenance and Use of Remote Station Protective Signaling Systems, NFPA No. 72C-1964, and Standard for the Installation, Maintenance and Use of Proprietary Protective Signaling Systems for Watchman, Fire Alarm and Supervisory Service, NFPA No. 72D-1965.

CHAPTER 5. EQUIPMENT

51. Mechanical Handling Equipment.

511. Power-operated industrial trucks shall be of type designated in Standard for the Use, Maintenance and Operation of Industrial Trucks, NFPA No. 505-1963, Part A, in accordance with the hazards of the location in which they are used.

512. Maintenance and operation of electric, liquid and gaseous fueled industrial trucks shall be in accordance with Standard for the Use, Maintenance and Operation of Industrial Trucks, NFPA No. 505-1963, Parts B and C.

52. Building Service Equipment.

521. Heating, lighting and service equipment shall be of approved types; installed, maintained and operated in accordance with good practice.

522. Steam lines and other heating equipment and machinery shall be installed or protected so that the stored commodities cannot come in contact with the heating elements.

523. Electrical equipment shall be installed in accordance with the provisions of the National Electrical Code, NFPA No. 70-1962.

524. Refrigeration systems, if used, shall conform to the recommendations of Safety Code for Mechanical Refrigeration, ASHRAE 15-58, ASA B9.1-1958.

The Safety Code for Mechanical Refrigeration is published by the American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc., 345 East 47th St., New York, N. Y. 10017, and may also be purchased from American Standards Association, 10 East 40th St., New York, N. Y. 10016 (1958, 16 pages. \$1).

525. Stored commodities shall not be located under liquid fuel heating equipment.

CHAPTER 6.**BUILDING MAINTENANCE AND OPERATIONS****61. Building Operations Other Than Storage.**

611. Storage operations incidental to manufacturing or processing operations with attending hazards of various degrees, will very often be found. The storage areas shall be cut off from these operations by construction having a fire resistance rating commensurate with the hazard of the exposing occupancy and the hazards of the operations shall be safeguarded in accordance with the requirements of the appropriate standards.

612. All operations incidental to storage such as repairing, re-finishing, crating or painting, as well as the storage of combustible materials used in conjunction with these operations shall be cut off by walls or partitions having a fire resistance rating commensurate with the contemplated fire exposure.

613. Metal or metal-lined containers with self-closing or automatic operated covers shall be provided for excelsior or similar packing materials.

614. Welding and cutting shall be prohibited unless supervised and stored commodities are cleared for an adequate distance and flameproofed tarpaulins are provided to catch hot sparks and metal. A close check of the area shall be maintained during and after completion of welding and cutting operations. Operating procedures shall be in accordance with Standard for Fire Prevention in Use of Cutting and Welding Processes, NFPA No. 51B-1962. Welding and cutting on existing sprinkler systems shall not be permitted, except as provided in Standard for the Installation of Sprinkler Systems, NFPA No. 13-1965.

615. Locomotives should not be allowed to enter storage areas.

616. Fumigation operations shall comply with Model Fumigation Ordinance, NFPA No. 547L-1934.

62. Waste Disposal.

621. Approved type containers for rubbish and other waste materials shall be provided as required. Containers shall be emptied and contents removed from the premises or otherwise safely disposed of at frequent intervals.

See Standards for Rubbish Handling, NFPA No. 82A-1953.

622. Incinerators, when provided, should be installed in accordance with Standard for Incinerators, NFPA No. 82-1960.

63. Smoking.

631. Smoking shall be strictly prohibited, except in locations prominently designated as smoking areas, and "No Smoking" signs shall be posted in prohibited areas.

64. Maintenance and Inspection.

641. All exterior openings in buildings should be maintained tight against the weather. Buildings shall be maintained reasonably secure against the access of unauthorized persons. In general, all openings should be protected against possible entry of sparks and flying brands.

642. Fire walls, fire doors and floors shall be maintained in good repair at all times to restrict any fire to the area of origin.

6421. It is especially important to provide protection for wall and floor openings, resulting from any construction changes, such as the installation of piping, conveyors or hoists. Suitable protection of conveyor openings is often difficult to accomplish, so it is preferable to design the structure and operations that such openings are not needed.

643. Periodic inspections, preferably weekly, should be made of all fire protective equipment, in conjunction with regular inspection of the premises. Trustworthy employees, preferably two or more, shall be selected who will alternate in making inspections and conscientiously check over the equipment and record unsatisfactory conditions on suitable forms. It is desirable that a copy of inspection reports be submitted to someone with authority to correct faulty conditions.

644. The sprinkler system and the water supplies shall be checked and maintained in accordance with Care and Maintenance of Sprinkler Systems, NFPA No. 13A-1958, where such equipment is installed.

645. Employees assigned to inspection should also check such features as general order and neatness, portable fire extinguishers, operation of fire doors, waterproof salvage covers, electrical equipment, cutting and welding equipment, industrial truck equipment, incinerators, storage, use and handling of flammable liquids, and other sources of hazards.

646. A supply of waterproof salvage covers should be maintained for use during emergency.

See Recommended Practice on Salvaging Operations, NFPA No. 604-1964.

65. Emergency Access.

651. Arrangement should be made to permit rapid entry into the premises in case of fire or other emergency of the municipal fire department, police department and other personnel as may be summoned to deal with any emergency without delay by gates, barriers, or procedures normally designed for the prevention of unauthorized access.

652. Each storage facility should be considered individually and arrangements made to acquaint the local fire department with advance knowledge of storage conditions, so that in case of fire or other emergency no time will be lost in reaching the seat of the trouble and utilizing fire protection equipment. Frequently, plans can be made available that will assist materially.

APPENDIX A

Specific standards have been prepared on the following subjects. These are published in pamphlet editions and in various volumes of the National Fire Codes published by the National Fire Protection Association, 60 Batterymarch St., Boston, Massachusetts 02110.

- No. 30-1963. Flammable and Combustible Liquids Code.
- No. 40-1962. Cellulose Nitrate Motion Picture Film.
- No. 43-1962. Pyroxylin Plastics in Warehouses and Wholesale Jobbing and Retail Stores.
- No. 44-1953. Combustible Fibres.
- No. 46-1961. Outdoor Storage of Lumber and Timber.
- No. 47-1961. Retail and Wholesale Lumber Storage Yards.
- No. 48-1961. Magnesium.
- No. 58-1965. Liquefied Petroleum Gases.
- No. 61B-1959. Prevention of Dust Explosions in Terminal Grain Elevators.
- No. 61C-1962. Prevention of Dust Explosions in Flour and Feed Mills.
- No. 64-1959. Prevention of Dust Ignitions in Country Grain Elevators.
- No. 81-1957. Fur Storage, Fumigation and Cleaning.
- No. 87-1963. Construction and Protection of Piers and Wharves.
- No. 232-1963. Protection of Records.
- No. 307-1961. Operation of Marine Terminals.
- No. 395-1965. Farm Storage of Flammable Liquids.
- No. 481-1961. Titanium.
- No. 482M-1961. Zirconium.
- No. 495-1962. Explosives and Blasting Agents.
- No. 566-1965. Bulk Oxygen at Consumer Sites.
- No. 651-1963. Aluminum Powder.
- No. 652-1959. Magnesium Powder or Dust.

APPENDIX B

PALLETS AND PALLETIZED STORAGE

The Fire Problem.

Among the many kinds and types of pallets available are rigid, open end and side types for two-way and four-way lift truck fork entry. The use of pallets and lift trucks makes high stacking of storage possible. While this may realize operating economies, it increases the fire problem.

The factors affecting the fire problem and the protection problem are (a) height of pile and (b) open horizontal pallet channels which are shielded from the distribution of water from sprinklers but which permit easy access of air.

As the height of piles and number of open channels are increased, the area of vertical and horizontal surfaces exposed to pre-heating and combustion are also increased. Height also promotes ignition of adjacent piles by radiation, because aisle widths are rarely increased when the pile height is increased. Ignition by radiation is most probable when aisles are less than 6 feet wide. Pallets can also absorb flammable liquid which further increases their combustibility. Therefore, the rates of burning and heat release are seriously affected.

When storage is piled up to 12 feet high, the challenge to sprinklers is about equal to that contemplated in Type II Storage. When piled to 21 feet high, the challenge to sprinklers is considerably greater. When adequately supplied with water, sprinklers will prevent major building damage, but fire might spread through pallet channels until a section of the pile burns out and collapses.

Firestopped pallets reduce the challenge to sprinklers by storage piled up to about 21 feet high. Fire tests, made under such conditions, indicate that sprinklers, discharging at high rates of flow, would be expected to stop lateral spread of fire. The simplest way to firestop pallets is to cap one end.

Idle pallet storage introduces another 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.