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INDOOR GENERAL STORAGE 1974

NATIONAL FIRE PROTECTION ASSOCIATION
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Standard for
Indoor General Storage

NFPA No. 231 — 1974

1974 Edition of No. 231

This edition of the Standard represents a complete revision. It was adopted at the Annual Meeting in May 1974 and supersedes the 1972 edition.

The height of storage to which this Standard applies has been increased from 25 feet to 30 feet.

Origin and Development of 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.

In 1965 this was changed from a recommended practice to a standard, and the present title was introduced. The sections of the 1965 edition pertaining to Outdoor Storage and Refrigerated Warehouses were deleted, and an Appendix on Pallets and Palletized Storage was added.

In the 1970 edition, amendments included doubling the maximum recommended area for Type I and Type II Storage, placing height limitations on empty wooden pallet storage, and reducing the water requirements for Type II Storage.

In 1972 protection requirements for empty combustible pallets and design curves for sprinkler water demands were added.

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Standard for

Indoor General Storage

NFPA No. 231 — 1974

NOTICE
An asterisk (*) preceding the number or letter designating a paragraph indicates explanatory material on that paragraph in Appendix A.

Chapter 1 Introduction

1-1. Application and Scope.

*1-1.1 This standard applies to storage of materials, representing the broad range of combustibles, 30 feet or less in height. This standard applies only to buildings protected by automatic sprinklers.

1-1.2 Storage piled higher than 30 feet is not within the scope of this standard and requires special consideration.

1-1.3 This standard does not apply to:

1-1.3.1. Storage of commodities which, with their packaging and storage aids, would be classified as noncombustible.

1-1.3.2 Unpackaged bulk materials such as grain, coal or similar commodities.

1-1.3.3 Commodities covered by other NFPA Standards except where specifically mentioned herein.

1-1.3.4 Commodities presenting special fire hazards *not* covered by specific NFPA Standards, e.g. polymeric materials (rubber and plastics), roll paper, wax coated cartons, etc.

1-1.3.5 Storage on racks.

1-1.4 This standard applies to new buildings and where converting existing buildings to storage occupancy. It may be used as a basis for evaluating existing storage facilities.

1-2. **Definitions.** Unless expressly stated elsewhere, the following terms will, for the purpose of this manual, have the meanings indicated below.

***Available Height for Storage** means 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 means storage in five-sided wood, metal or cardboard boxes not more than 6 ft. x 6 ft. x 6 ft. in dimensions 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.

Commodity means combinations of products, packing material and container.

Encapsulated means a method of packaging consisting of a plastic sheet completely enclosing the sides and top of a pallet load containing a combustible commodity or a combustible package or a group of combustible commodities or combustible packages. Totally noncombustible commodities on wood pallets enclosed only by a plastic sheet as described above are not considered to fall under this definition.

Noncombustible means commodities, packaging or storage aids which will not ignite, burn or liberate flammable gases when heated to a temperature of 1380°F for five minutes.

***Packaging** means commodity wrapping, cushioning or container.

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

Shelf Storage means storage on structures less than 30 inches deep with shelves usually two feet apart vertically and separated by approximately 30 inch aisles.

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

Chapter 2 Classification of Storage

2-1. Commodity Classification.

2-1.1 The classification of commodities applies to nonencapsulated commodities.

2-1.2 Class I commodity is defined as essentially noncombustible products on combustible pallets, or in ordinary corrugated cartons with or without single thickness dividers, or in ordinary paper wrappings with or without pallets.

Examples of Class I products are:

Metal Products. Metal disks with plastic tops and trim; electrical coils; electrical devices in their metal enclosures; pots and pans; electric motors; dry cell batteries. Metal parts, empty cans, stoves, washers, dryers, and metal cabinets.

Glass Products. Glass bottles, empty or filled with noncombustible liquids; mirrors.

Foods. Noncombustible foodstuffs and beverages. Foods in noncombustible containers; frozen foods; meats; fresh fruits and vegetables in nonplastic trays or containers; liquid dairy products in nonwax-coated paper containers or in plastic-coated paper containers; beer and wine, up to 20 percent alcohol, in metal, glass or ceramic containers in ordinary corrugated cartons.

Others. Oil-filled and other types of distribution transformers; cement in bags; electrical insulators; gypsum board; inert pigments; dry insecticides.

2-1.3 Class II commodity is defined as Class I products in slatted wooden crates, solid wooden boxes, multiple thickness paperboard cartons or equivalent combustible packaging material with or without pallets.

Examples of Class II products are: thinly coated fine wire such as radio coil wire on reels or in cartons; incandescent or fluorescent light bulbs; and Class I products if in small cartons or small packages placed in ordinary paperboard cartons; book signatures and beer or wine up to 20 percent alcohol in wood containers.

2-1.4 Class III commodity is defined as wood, paper, natural fiber cloth or products thereof with or without pallets. Products may contain a limited amount of plastics. Metal bicycles with plastic handles, pedals, seats and tires are an example of a commodity with a limited amount of plastic.

Examples of Class III products are:

Paper Products. Books; magazines; stationery; plastic-coated paper food containers; newspapers; paper or cardboard games; tissue products.

Leather Products. Shoes; jackets; gloves and luggage.

Wood Products. Doors; windows, door and window frames; combustible fiberboard; wood cabinets, furniture and other wood products.

Textiles. Natural fiber upholstered nonplastic furniture; wood or metal furniture with plastic padded and covered arm rests; mattresses without expanded plastic or rubber; absorbent cotton in cartons; natural fiber and viscose yarns, thread, and products; synthetic thread and yarn, natural fiber clothing or textile products.

Others. Tobacco products in paperboard cartons; nonflammable liquids such as soaps, detergents and bleaches in plastic containers; non-negative producing film packs in sealed tin foil wrappers in paperboard packages, combustible foods or cereal products and nonflammable pharmaceuticals.

2-1.5 Class IV commodity is defined as Class I, II or III products containing an appreciable amount of plastics in ordinary corrugated cartons and Class I, II, and III products in ordinary corrugated cartons with plastic packing with or without pallets. An example of packing material is a metal typewriter in a foamed plastic cocoon in an ordinary corrugated carton.

Examples of Class IV products are:

Small appliances, typewriters, and cameras with plastic parts; plastic backed tapes and nonviscose synthetic fabrics or clothing.

Telephones; vinyl floor tiles; wood or metal frame upholstered furniture or mattresses with plastic covering and/or padding; plastic/padded metal bumpers and dashboards; insulated conductor and power cable on wood or metal reels or in cartons; inert solids in plastic containers; and building construction insulating panels of polyurethane sandwiched between nonplastic material.

Chapter 3 Building Construction

3-1 Construction

***3-1.1** Buildings used for storage of materials, which are stored and protected in accordance with this standard, may be of any of the types described in *Standard Types of Building Construction, NFPA No. 220.*

*3-2 Emergency Smoke and Heat Venting.

3-2.1 Protection outlined in this standard applies to buildings with or without roof vents and draft curtains.

Chapter 4 Storage Arrangement

4-1 Piling Procedures and Precautions.

*4-1.1 Any commodities which may be hazardous in combination with each other shall be stored so they cannot come in contact with each other.

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

4-2 Commodity Clearance.

*4-2.1 The clearance between top of storage and sprinkler deflectors shall conform to *NFPA No. 13, Installation of Sprinkler Systems.*

4-2.2 If the commodity is stored above the lower chord of roof trusses, at least one foot clear space shall be maintained to permit wetting of the truss unless the truss is protected with one-hour fireproofing.

4-2.3 Storage clearance from ducts shall be maintained in accordance with *Blower & Exhaust Systems, NFPA No. 91 — 1973, Subsection 240.*

4-2.4 The clearance between stored materials and unit heaters, radiant space heaters, duct furnaces and flues shall not be less than three feet in all directions or 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 assure proper operation and inspection.

4-3 Aisles.

*4-3.1 Wall aisles shall be at least 24 inches wide in warehouses used for the storage of commodities which expand with the absorption of water.

*4-4 Storage of Empty Pallets.

*4-4.1 Wood pallets shall be stored in areas meeting the protection requirement of Table 4-4.1.

Table 4-4.1

Height of Wood Pallet Storage	Sprinkler Density Requirements (GPM-Min-Sq. Ft.)	Area of Sprinkler Operation (sq. ft.) 286°	165°
Up to 6′	.20	2,000	3,000
6′ to 8′	.30	2,500	4,000
8′ to 12′	.60	3,500	6,000
12′ to 20′	.60	4,500	—

*4-4.2 In buildings with exposed steel roof structures where wood pallets are stored in excess of eight feet in height, maximum sprinkler spacing shall not exceed 50 square feet per sprinkler with ½ inch orifice and 70 square feet per sprinkler with 17/31 inch orifice in order to provide protection for roof steel.

4-4.3 Empty plastic pallets shall be stored outdoors.

Chapter 5 Fire Protection

5-1 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 the *Standard for Installation of Sprinkler Systems, NFPA No. 13,* except as modified by this Chapter.

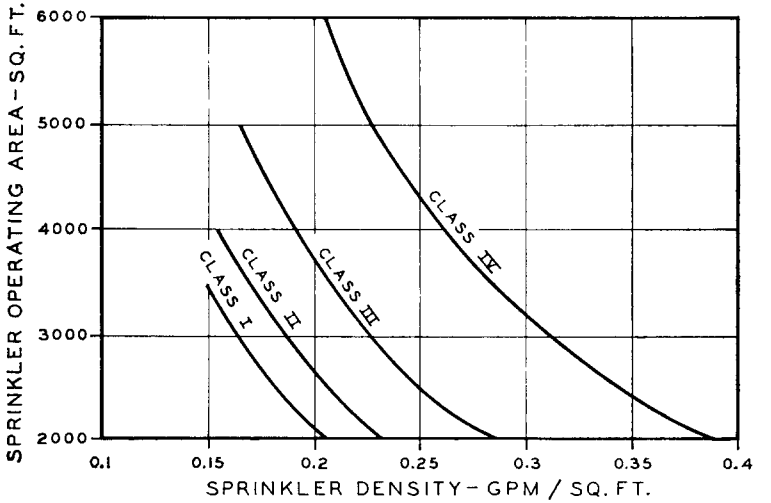

Fig. 5-1.2 Sprinkler System Design Curves

Twenty Foot-High Storage — 165° Sprinklers. For 286° sprinklers, reduce sprinkler operating area 40 percent, but to not less than 2,000 sq. ft.

***5-1.2** Sprinkler design criteria for solid pile storage over 15 feet high, palletized and bin box storage over 12 feet, and shelf storage 12 feet to 15 feet high shall be in accordance with Figures 5-1.2 and 5-2.2. The density provided for the area of application may be selected from any point on the curve applicable to the commodity, classification and arrangement of the stored commodities. It is not necessary to meet more than one point on the selected curve.

5-1.3 Bin Box and Shelf Storage over 12′ and provided with walkways at not over 12′ 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 may be in accordance with the height adjustment of Figure 5-2.2.

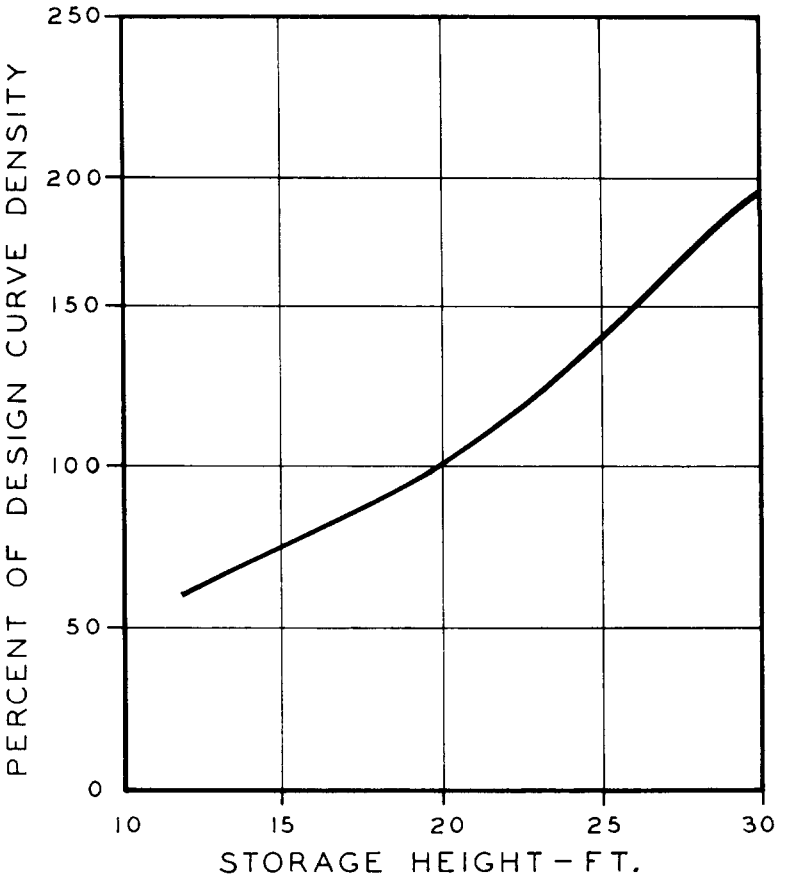

Figure 5-2.2

5-1.4 The minimum discharge from any sprinkler in the design area shall be not less than 15 gpm for any commodity class.

5-1.5 Where palletized or solid pile storage is placed on top of racks, the provisions of *NFPA No. 231C, 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.

5-1.6 In warehouses that have portions containing rack storage and other portions containing palletized solid pile bin box or shelf storage, the standard applicable to the storage configuration shall apply.

*5-2 Water Supplies.

5-2.1 Sprinkler water demand for 20-ft-high palletized storage, solid pile and bin box storage shall be in accordance with Figure 5-1.2.

5-2.2 Where storage height is less than 30 feet high, but more than 15 feet high in solid piles and 12 feet high for palletized or bin box storage, ceiling densities indicated in the design curves, based on 20-foot nominal storage height, shall be modified in accordance with Figure 5-2.2.

5-2.2.1 For shelf storage 12 feet to 15 feet high, ceiling densities indicated in the designed curves in Figure 5-1.2 shall be modified in accordance with Figure 5-2.2.

5-2.3 Where dry pipe systems are used, the areas of operation indicated in the design curves shall be increased by 30 percent. Densities shall be selected so that areas of operation, after the 30 percent increase, do not exceed the upper area limits given in the design curves.

5-2.4 Where sprinkler design density and water demand are determined by 5-1.2 and 5-2.2 at least 500 gpm shall be added to the sprinkler demand for large and small hose stream demand.

5-2.5 Water supply duration shall be:

Duration (hours)

Storage Height (ft)	Commodity Class Class I, II, & III	Class IV
Up to 20	1½	2
20 to 30	2	2½

5-3 Manual Inside Protection.

5-3.1 Portable Fire Extinguishers.

5-3.1.1 Portable fire extinguishers shall be provided in accordance with *NFPA No. 10, Standard for the Installation of Portable Fire Extinguishers.* In locations where small (1½ inch) hose is provided, up to one-half of the required complement of portable fire extinguishers for Class A fires may be omitted in storage areas.

5-3.2 Small Hose Systems.

5-3.2.1 Small hose lines (1½ inch) shall be available to reach all portions of the storage area. Such small hose may be supplied from:

(a) Outside hydrants.

(b) A separate piping system for small hose stations.

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

(d) Adjacent sprinkler systems.

5-4 Hydrants.

***5-4.1** At locations without public hydrants, or where hydrants are not within 250 feet, private hydrants shall be installed in accordance with *Standard for Outside Protection, NFPA No. 24.*

5-5 Fire Organization.

***5-5.1** 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.

5-5.2 Plant emergency organizations where provided shall be instructed and trained in the following procedures:

(a) Maintaining 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 non-up operations.

(d) Operation of 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.

Information on emergency organization is given in the following publications:

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

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

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

Recommended Practice on Salvaging Operations, NFPA No. 604.

5-5.3 A fire watch shall be maintained when the sprinkler system is not in service.

5-6 Alarm Service.

***5-6.1** Central station, auxiliary, remote station, or proprietary sprinkler waterflow alarm shall be provided. Local waterflow alarm is acceptable where standard recorded guard service is provided. (*See NFPA Nos. 71, 72A, 72B, 72C and 72D.*)

Chapter 6 Building Equipment, Maintenance and Operations

*6-1 Mechanical Handling Equipment.

***6-1.1** Industrial truck. Power operated industrial trucks shall comply with *NFPA No. 505, Standard for Powered Industrial Trucks, Including Type Designations and Areas of Use.*

6-2 Building Service Equipment

6-2.1 Electrical equipment shall be installed in accordance with the provisions of the *National Electrical Code, NFPA No. 70.*

6-2.2 Heating, air-conditioning, lighting and other service equipment shall be installed in accordance with applicable NFPA Codes, Standards, Recommended Practices, and Manuals.

6-3. Cutting and Welding Operations.

***6-3.1** When welding or cutting operations are necessary, the precautions contained in *Cutting and Welding Processes, NFPA No. 51B* shall be followed. When possible, work shall be removed to a safe area.

6-3.2 Welding, soldering, brazing, and cutting may be performed on building components which cannot be removed, provided no storage is located below and within 25 feet of the working area, and flameproof tarpaulins enclose this section. 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 manned 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.

6-4 Waste Disposal. Rubbish, trash, and other waste material shall be disposed of at regular intervals, (*See Standard for Incinerators and Rubbish Handling, NFPA No. 82 —1972, Section 80*).

6-5 Smoking. Smoking shall be strictly prohibited, except in locations prominently designated as smoking areas. "No Smoking" signs shall be posted in prohibited areas.

6-6 Maintenance and Inspection.

6-6.1 Fire walls, fire doors, and floors shall be maintained in good repair at all times.

***6-6.2** The sprinkler system and the water supplies shall be maintained and serviced.

6-7 Fumigation operations shall comply with the *Fumigation Standard, NFPA No. 57.*

***6-8** Refrigeration systems, if used, shall conform to the recommendations of *Safety Code for Mechanical Refrigeration, ASHRAE 15–70, ANSI B9.1 — 1971.*

Appendix A

This Appendix is not part of this NFPA Standard but is included for information purposes only.

A-1-1.1 Buildings of noncombustible construction having noncombustible storage do not require automatic sprinkler protection. Unsprinklered buildings of combustible construction or containing combustible storage should comply with sections of the Standard other than those applying specifically to sprinkler protection.

A-1-2 Available Height for Storage. For new sprinkler installations, maximum height of storage is the height at which commodities can be stored above the floor when the minimum required unobstructed space below sprinklers is maintained. For the evaluation of existing situations, maximum height of storage is the maximum existing if space between sprinklers and storage is equal or greater than required.

A-1-2 Container designates cartons, wrappings, etc. Approved containers or tote boxes do not of themselves create a need for automatic sprinklers unless coated with oil or grease. Containers may lose their fire-retardant properties if washed. For obvious reasons, they should not be exposed to rainfall.

A-3-1.1 With protection installed in accordance with this standard, fire protection of overhead steel and steel columns is not necessary.

Consideration should be given to subdividing large area warehouses in order to reduce the amount of merchandise that would be affected by a single fire.

It is desirable to provide walls or partitions to separate the storage area from mercantile, manufacturing or other occupancies to prevent the possibility of transmission of fire or smoke between the two occupancies.

A-3-2 Smoke removal is important to manual fire fighting and overhaul. Since most fire tests were conducted without smoke and heat venting, protection specified in Section 4-1 was developed without the use of such venting. However, venting through eaveline windows, doors, monitors gravity or mechanical exhaust systems is essential to smoke removal after control of the fire is achieved. See *Guide for Smoke and Heat Venting, NFPA No. 204.*

A-4-1.1 Where commodities of different commodity classifications are stored in the same building, the protection should be adequate for the most hazardous material. Proper protection may be also obtained by piling the more hazardous material only as high as can be properly protected by the sprinkler system. In certain cases, it may be desirable to provide walls or partitions to enclose the most

hazardous material and design the sprinkler system in the enclosure to meet the requirements of Chapter 6.

In unsprinklered buildings, pile sizes, excluding surrounding clear space should be limited as follows:

Noncombustible	No limit
Class I & II	15,000 square feet
Class III	10,000 " "
Class IV	5,000 " "

Piles should be separated by a clear space of not less than eight feet.

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 four inches clearance from the floor.

A-4-2.1 Clearance of at least 36 inches should be maintained between the top of storage and of 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.

A-4-2.5 Incandescent light fixtures should have shades or guards to prevent ignition of commodity from hot bulbs where possibility of contact with storage exists.

A-4-3.1 Storage should be separated by aisles so that piles are not more than 50 feet wide or 25 feet 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 exterior openings are few.

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.

A-4-4.1 A fire in stacks of idle wooden pallets is one of the greatest challenges to sprinklers. The undersides of the boards of the