

1231

NFPA 1231

Standard on

Water Supplies for

Suburban and

Rural

Fire Fighting

1993 Edition



Documents

National Fire Protection Association, 1 Batterymarch Park, PO Box 9101 Quincy, MA 02269-9101
An International Codes and Standards Organization



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The Board of Directors reaffirms that the National Fire Protection Association recognizes that the toxicity of the products of combustion is an important factor in the loss of life from fire. NFPA has dealt with that subject in its technical committee documents for many years.

There is a concern that the growing use of synthetic materials may produce more or additional toxic products of combustion in a fire environment. The Board has, therefore, asked all NFPA technical committees to review the documents for which they are responsible to be sure that the documents respond to this current concern. To assist the committees in meeting this request, the Board has appointed an advisory committee to provide specific guidance to the technical committees on questions relating to assessing the hazards of the products of combustion.

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Standard on

Water Supplies for Suburban and Rural Fire Fighting

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This edition of NFPA 1231, *Standard on Water Supplies for Suburban and Rural Fire Fighting*, was prepared by the Technical Committee on Forest and Rural Fire Protection and acted on by the National Fire Protection Association, Inc. at its Annual Meeting held May 24-27, 1993, in Orlando, FL. It was issued by the Standards Council on July 23, 1993, with an effective date of August 20, 1993, and supersedes all previous editions.

The 1993 edition of this document has been approved by the American National Standards Institute.

Origin and Development of NFPA 1231

This text originally was NFPA 25, *Recommended Practices for Water Supply Systems for Rural Fire Protection*, and originally was developed by the Subcommittee on Water Supply Systems for Rural Fire Protection of the Committee on Rural Fire Protection and Prevention. It received tentative adoption in 1969 and was further amended and adopted in May 1969 as NFPA 25.

The 1975 edition represented a complete revision of the previous document. This edition underwent a title change to *Water Supplies for Suburban and Rural Fire Fighting* and was renumbered NFPA 1231.

The 1984 edition represented a complete revision to include both mandatory and advisory material.

The 1989 edition was the fourth revision and incorporated some significant changes and additions.

The 1993 edition represents a complete revision that includes both mandatory and advisory material.

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NOTE: Membership on a Committee shall not in and of itself constitute an endorsement of the Association or any document developed by the Committee on which the member serves.

Committee Scope: This Committee shall have primary responsibility for developing documents on fire protection and prevention for rural and suburban areas and forest, grass, brush, and tundra areas.

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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 8 and Appendix H.

Chapter 1 Administration

1-1* Scope. This standard identifies minimum requirements for water supplies for fire fighting purposes in rural and suburban areas in which adequate and reliable water supply systems for fire fighting purposes do not exist.

1-2 Purpose. This standard specifies minimum requirements for water supply for fire fighting purposes to protect property from fire in areas where water must be transported from a river, lake, canal, bay, stream, pond, well, cistern, or other similar source of water that is available as suction supply for fire department use. Water obtained by methods outlined in this standard can be used to supplement water for fire fighting available from hydrants on a traditional municipal-type distribution system. Likewise, a hydrant served by a water distribution system shall be permitted to be the source of supply for water that is transported to the rural fire area.

It is the intent of this standard to provide and maintain minimum water supplies for fire fighting purposes through the establishment of a cooperative working arrangement among the authority having jurisdiction, the fire department having jurisdiction, and the property owners in the jurisdiction.

This standard provides minimum requirements, and nothing herein shall be interpreted to mean that the authority having jurisdiction cannot exceed any or all of these requirements where, in the judgment of such authority having jurisdiction, additional protection is warranted.

This standard is restricted to identifying minimum requirements for water supplies for fire fighting purposes. Much information has been included in the appendixes of this standard concerning rural water supplies, hauling of water, transporting water through large diameter hose, portable pumping equipment, automatic sprinkler protection, and secondary water supply, any or all of which may comprise a rural "water system."

1-3 General.

1-3.1 The requirements of Chapters 5 and 6 are performance oriented and allow the authority having jurisdiction the option to specify how these water supplies are made available, thereby giving consideration to local conditions and need.

1-3.2 Although the water requirements developed by this standard are performance oriented, it must be emphasized that they are minimum in scope. The water available to the fire department, which may come from a single water point or multiple water points, must be delivered to the fire scene. The authority having jurisdiction shall be permitted to determine that additional water supplies are warranted. Appendix G contains secondary water supply requirements, useful where the authority having jurisdiction determines additional water supplies are desirable.

1-3.3 Fire apparatus and associated equipment are important components of the water transport process. Many alternative approaches to fulfilling this process are provided in Appendixes C, D, and E.

Apparatus shall meet the requirements outlined in NFPA 1903, *Standard for Mobile Water Supply Fire Apparatus*, and other applicable NFPA standards.

1-3.4 Fire control and extinguishment is probable only where a prompt alarm notification initiates an immediate response, which in return results in effective agent application confining the fire to the area of origin.

1-3.5 The effectiveness and reliability of fixed fire protection systems is a documented fact. Serious consideration shall be given to installation of sprinkler systems as outlined in NFPA 13, *Standard for the Installation of Sprinkler Systems*; NFPA 13D, *Standard for the Installation of Sprinkler Systems in One- and Two-Family Dwellings and Mobile Homes*; and NFPA 13R, *Standard for the Installation of Sprinkler Systems in Residential Occupancies Up to and Including Four Stories in Height*.

1-4 Definitions.

Adequate and Reliable Water Supply. A water supply that is sufficient every day of the year to control and extinguish anticipated fires in the municipality, particular building, or building group served by the water supply.

Approved. Acceptable to the "authority having jurisdiction."

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

Authority Having Jurisdiction. The "authority having jurisdiction" is the organization, office or individual responsible for "approving" equipment, an installation or a procedure.

NOTE: The phrase "authority having jurisdiction" is used in NFPA documents in a broad manner since jurisdictions and "approval" agencies vary as do their responsibilities. Where public safety is primary, the "authority having jurisdiction" may be a federal, state, local or other regional

department or individual such as a fire chief, fire marshal, chief of a fire prevention bureau, labor department, health department, building official, electrical inspector, or others having statutory authority. For insurance purposes, an insurance inspection department, rating bureau, or other insurance company representative may be the "authority having jurisdiction." In many circumstances the property owner or his designated agent assumes the role of the "authority having jurisdiction"; at government installations, the commanding officer or departmental official may be the "authority having jurisdiction."

Automatic Aid. A plan developed between two or more fire departments for immediate joint response on first alarms.

Building. Any structure erected for the support, shelter, or enclosure of persons, animals, or property of any kind.

Construction Classification Number. A series of numbers from 0.5 through 1.5 that are mathematical factors used in a formula to determine the total water supply requirements for this standard only.

Dry Hydrant. A permanent piping system, normally a drafting source, that provides access to a water source other than a municipal-type water system.

Exposure Hazard. A structure within 50 ft (15.2 m) of another building and 100 ft² (9.3 m²) or larger in area. If a structure is a Class 3 or Class 4 occupancy hazard, it is considered an exposure hazard if within 50 ft (15.2 m) of another building, regardless of size.

Fire Department Having Jurisdiction. The fire department serving the municipality, or any portion of the municipality, governed by the authority having jurisdiction. The authority having jurisdiction and the fire department having jurisdiction can be the same agency.

Labeled. Equipment or materials to which has been attached a label, symbol or other identifying mark of an organization acceptable to the "authority having jurisdiction" and concerned with product evaluation, that maintains periodic inspection of production of labeled equipment or materials and by whose labeling the manufacturer indicates compliance with appropriate standards or performance in a specified manner.

Large Diameter Hose. Fire department hose having an inside diameter of 3½ in. (89 mm) or larger.

Listed. Equipment or materials included in a list published by an organization acceptable to the "authority having jurisdiction" and concerned with product evaluation, that maintains periodic inspection of production of listed equipment or materials and whose listing states either that the equipment or material meets appropriate standards or has been tested and found suitable for use in a specified manner.

NOTE: The means for identifying listed equipment may vary for each organization concerned with product evaluation, some of which do not recognize equipment as listed unless it is also labeled. The "authority having jurisdiction" should utilize the system employed by the listing organization to identify a listed product.

Minimum Requirements for Water Supply. The smallest quantity of water supply suggested for any degree of fire control. In some fires, this supply may be suitable for protecting exposures only.

Mobile Water Supply. A vehicle designed primarily for transporting (pickup, transportation, and delivery) of water to fire emergency scenes to be applied by other vehicles or pumping equipment.

Municipality. A town, city, county, fire district, or community having powers of local self-government.

Municipal-Type Water System. A system having water pipes serving hydrants and designed to furnish, over and above domestic consumption, a minimum flow of 250 gpm (946 L/min) and 20 psi (139 kPa) residual pressure for a 2-hour duration.

Mutual Aid. A plan developed between two or more departments to render assistance to the parties of the agreement. Often the request for such aid to be rendered comes only after an initial response has been made and the fire scene status has been determined.

Normal Living Area — Dwelling. This area shall include typical rooms, such as living room, dining area, parlor, kitchen, bath, bedroom, halls, library, music room, family room, laundry room, etc., and includes any other areas that are normally heated or cooled plus attic-basement provisions, enclosed parking (garage), and storage areas.

Occupancy Hazard Classification Number. A series of numbers from three through seven that are mathematical factors used in a formula to determine total water supply requirements of this standard only.

Protected Property. Property protected by a water supply that is minimally adequate in volume and duration and by a fire department capable of using this water supply to suppress a possible fire within the property.

Secondary (Design) Water Supply. The estimated rate of flow [expressed in gpm (L/min) for a prescribed time period] that is considered necessary to control a major fire in a building or structure.

Shall. Indicates a mandatory requirement.

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

Single Water Point. The point or site at which water supply, such as a pumper with portable folding tank or dry hydrant, etc., can be located to protect a cluster of buildings, such as a subdivision or an estate.

Tanker. See "Mobile Water Supply."

Water Supply Officer (WSO). The fire department officer responsible for providing water for fire fighting purposes.

Water Tender. See "Mobile Water Supply."

Chapter 2 Structure Surveys

2-1 General.

2-1.1* The fire department having jurisdiction shall perform an on-site survey of all buildings, including type of construction, occupancies, and exposures, within the applicable jurisdiction to obtain the information needed to compute the minimum water supplies required. At the time of the on-site survey, a record shall be prepared of available water supplies. This information shall be utilized for pre-fire planning purposes as well as by the WSO.

2-1.2 Areas specified in 5-2.1, 5-3.1, 5-4.1, 5-5.1, and 5-6.1 can be surveyed as areas to determine the square footage or cubic footage and square meters or cubic meters of each structure and the distance to structural exposure hazards, but without a survey of contents.

2-1.3 These surveys can be combined with fire prevention or prefire planning inspections.

Chapter 3 Classification of Occupancy Hazard

3-1 General.

3-1.1 The fire department having jurisdiction, upon completing the survey specified in Chapter 2, shall determine the occupancy hazard classification number from the appropriate sections of this chapter.

3-1.2 Occupancy hazard classification numbers shall not be assigned to any structure not surveyed as specified in Chapter 2.

3-1.3 An occupancy hazard classification number shall not be assigned to any building where such building is protected by an automatic sprinkler system installed in accordance with applicable NFPA standards.

3-1.4* Storage of products that are potentially hazardous from the standpoint of increased fire volume, or those having an explosive nature, exists at many rural locations, and such products can exist in sufficient quantities to increase the occupancy hazard classification number of the building.

3-2* Occupancy Hazard Classification Number.

3-2.1 The occupancies listed in each section are only examples of types of occupancies for the particular classification, and these lists of examples shall not be interpreted as being exclusive. Similar occupancies shall be assigned the same occupancy hazard classification number.

3-2.2 Where more than one occupancy is present in a structure, the occupancy hazard classification number for the most hazardous occupancy shall be used for the entire structure.

3-2.3 Occupancy Hazard Classification 3.

3-2.3.1 Occupancies in this classification shall be considered SEVERE HAZARD OCCUPANCIES, where quantity and combustibility of contents are very high. Fires in these occupancies can be expected to develop very rapidly and have high rates of heat release. (*See 5-5.1.*)

3-2.3.2 Where an exposing structure is of occupancy hazard classification 3, it shall be considered an exposure hazard if within 50 ft (15.2 m), regardless of size.

3-2.3.3 Occupancy hazard classification 3 examples include:

- (a) Aircraft hangars
- (b) Cereal or flour mills
- (c) Chemical works and plants
- (d) Cotton picker and opening operations
- (e) Distilleries

- (f) Explosives and pyrotechnics manufacturing and storage
- (g) Feed and grist mills
- (h) Grain elevators and warehouses
- (i) Linseed oil mills
- (j) Lumberyards
- (k) Oil Refineries
- (l) Plastics manufacturing and storage
- (m) Saw mills
- (n) Solvent extracting
- (o) Straw or hay in bales
- (p) Varnish and paint manufacturing.

3-2.4 Occupancy Hazard Classification 4.

3-2.4.1 Occupancies in this classification shall be considered HIGH HAZARD OCCUPANCIES, where quantity and combustibility of contents are high. Fires in these occupancies can be expected to develop rapidly and have high rates of heat release.

3-2.4.2 Where an exposing structure is of occupancy hazard classification 4, it shall be considered an exposure hazard if within 50 ft (15.2 m), regardless of size.

3-2.4.3 Occupancy hazard classification 4 examples include:

- (a) Barns and stables (commercial)
- (b) Building materials
- (c) Department stores
- (d) Exhibition halls, auditoriums, and theaters
- (e) Feed stores (without processing)
- (f) Freight terminals
- (g) Mercantiles
- (h) Paper and pulp mills
- (i) Paper processing plants
- (j) Piers and wharves
- (k) Repair garages
- (l) Rubber products manufacturing and storage
- (m) Warehouses, such as those used for:
 - Furniture
 - General storage
 - Paint
 - Paper
 - Whiskey
- (n) Woodworking industries.

3-2.5 Occupancy Hazard Classification 5.

3-2.5.1 Occupancies in this classification shall be considered MODERATE HAZARD OCCUPANCIES, where quantity and combustibility of contents are moderate and stockpiles of combustibles do not exceed 12 ft (3.7 m) in height. Fires in these occupancies can be expected to develop quickly and have moderately high rates of heat release.

3-2.5.2 Occupancy hazard classification 5 examples include:

- (a) Amusement occupancies
- (b) Clothing manufacturing plants
- (c) Cold storage warehouses
- (d) Confectionery product warehouses
- (e) Farm storage buildings, such as:
 - Corn cribs
 - Dairy barns
 - Equipment sheds
- (f) Hatcheries
- (g) Laundries
- (h) Leather goods manufacturing plants
- (i) Libraries (with large stockroom areas)
- (j) Lithography shops
- (k) Machine shops
- (l) Metalworking shops
- (m) Nurseries (plant)
- (n) Pharmaceutical manufacturing plants
- (o) Printing and publishing plants
- (p) Restaurants
- (q) Rope and twine manufacturing plants
- (r) Sugar refineries
- (s) Tanneries
- (t) Textile manufacturing plants
- (u) Tobacco barns
- (v) Unoccupied buildings.

3-2.6 Occupancy Hazard Classification 6.

3-2.6.1 Occupancies in this classification shall be considered LOW HAZARD OCCUPANCIES, where quantity and combustibility of contents are moderate and stockpiles of combustibles do not exceed 8 ft (2.4 m) in height. Fires in these occupancies can be expected to develop at a moderate rate and have moderate rates of heat release.

3-2.6.2 Occupancy hazard classification 6 examples include:

- (a) Armories
- (b) Automobile parking garages
- (c) Bakeries
- (d) Barber or beauty shops
- (e) Beverage manufacturing plants
- (f) Boiler houses
- (g) Breweries
- (h) Brick, tile, and clay product manufacturing plants
- (i) Canneries
- (j) Cement plants
- (k) Churches and similar religious structures
- (l) Dairy products manufacturing and processing

- (m) Doctors' offices
- (n) Electronics plants
- (o) Foundries
- (p) Fur processing plants
- (q) Gasoline service stations
- (r) Glass and glass products manufacturing plants
- (s) Mortuaries
- (t) Municipal buildings
- (u) Post offices
- (v) Slaughterhouses
- (w) Telephone exchanges
- (x) Watch and jewelry manufacturing plants
- (y) Wineries.

3-2.7 Occupancy Hazard Classification 7.

3-2.7.1 Occupancies in this classification shall be considered LIGHT HAZARD OCCUPANCIES, where quantity and combustibility of contents are low. Fires in these occupancies can be expected to develop at a relatively low rate and have relatively low rates of heat release.

3-2.7.2 Occupancy hazard classification 7 examples include:

- (a) Apartments
- (b) Colleges and universities
- (c) Dormitories
- (d) Dwellings
- (e) Fire stations
- (f) Fraternity or sorority houses
- (g) Hospitals
- (h) Hotels and motels
- (i) Libraries (except large stockroom areas)
- (j) Museums
- (k) Nursing and convalescent homes
- (l) Offices (including data processing)
- (m) Police stations
- (n) Prisons
- (o) Schools.

Chapter 4 Classification of Construction

4-1 General.

4-1.1 The fire department having jurisdiction, upon completing the survey specified in Chapter 2, shall determine the construction classification number from the sections of this chapter.

4-1.2 For the purpose of this standard, each building surveyed shall be classified as to type of construction and shall be assigned a construction classification number. However, no dwelling shall be assigned a construction classification number higher than 1.0.

4-1.3 Construction classification numbers shall not be assigned to any structure not surveyed, as specified in Chapter 2.

4-1.4 Where more than one type of construction is present in a structure, the higher construction classification number shall be used for the entire structure.

4-1.5 Where a building is located within 50 ft (15.2 m) of the surveyed building and is 100 ft² (9.3 m²) or greater in total area, the building shall be treated as an exposure, with the water requirement as calculated in accordance with this standard multiplied by 1.5.

4-2* Construction Classification Type.

4-2.1 The construction classifications listed in this standard have been simplified for quick use. Where a more complete definition is needed, refer to NFPA 220, *Standard on Types of Building Construction*, or the local building code.

4-2.2 Type I (Fire-Resistive) Construction — Construction Classification Number 0.5. A building constructed of noncombustible materials (reinforced concrete, brick, stone, etc., and having any metal members properly “fire-proofed”) with major structural members designed to withstand collapse and to prevent the spread of fire.

4-2.3 Types II and IV (Noncombustible) and Heavy Timber Construction — Construction Classification Number 0.8. A building having all structural members (including walls, floors, and roofs) of noncombustible materials and not qualifying as fire-resistive construction.

Also, heavy timber construction in which walls are masonry, columns are 8-in. (20.3-cm) wood supports, floors are 3-in. (76-mm) tongue-and-grooved plank, and roof decks are 2-in. (51-mm) tongue-and-grooved plank. All wood beams and girders are 6 in. (15.2 cm) wide and 10 in. (25.4 cm) deep.

4-2.4* Type III (Ordinary) Construction — Construction Classification Number 1.0. Any structure having exterior walls of masonry, or other noncombustible material, in which the other structural members are wholly or partly of wood or other combustible material.

4-2.5* Type V (Wood Frame) Construction — Construction Classification Number 1.5. Any structure, other than dwellings, in which the structural members are wholly or partly of wood or other combustible material and in which the construction does not qualify as ordinary construction.

Where a dwelling is classified as wood frame construction (that is, having structural members wholly or partly of wood or other combustible material), a construction classification number of 1.0 shall be assigned.

Chapter 5 Determining Minimum Water Supplies

5-1 General.

5-1.1 The fire department having jurisdiction for structural surveys specified in Chapter 2, after completing the survey and determining the construction classification number and the occupancy hazard classification number, shall compute the minimum water supply, in gallons

(liters), needed for the structure under its authority. As the water supplies developed by this standard are minimum and in many cases are or will be suitable for exposure protection only, the authority having jurisdiction shall review the calculations to see that adequate flows are available to meet the needs indicated by the preplans.

5-2 Single Structures Without Exposure Hazards.

5-2.1* For single structures with no portion of any unattached structural exposure hazard within 50 ft (15.2 m), unless it is smaller than 100 ft² (9.3 m²), the minimum water supply, in gallons (liters), shall be determined by the total cubic footage (m³) of the structure, including any attached structures, divided by the occupancy hazard classification number determined from Chapter 3, and multiplied by the construction classification number determined from Chapter 4; or Table 5-9(a) shall be referenced.

MINIMUM WATER SUPPLY =

$$\frac{\text{Total ft}^3 \text{ (m}^3\text{) of Structure}}{\text{Occupancy Hazard Classification No.}} \times \text{Construction Classification No.}$$

5-2.1.1 The minimum water supply required for any structure, without exposure hazards, shall not be less than 2000 gal (7570 L). [See Table 5-9(b).]

5-2.1.2 The minimum water supply, as determined for any structure specified in 5-2.1 and 5-2.1.1, shall be available on the fireground at, and the fire department shall be capable of utilizing the total water supply at, the rates specified in Table 5-9(c).

5-3 Single Structures with Exposure Hazards.

5-3.1* For all single structures with unattached structural exposure hazards closer than 50 ft (15.2 m) to any portion of the dwelling and larger than 100 ft² (9.3 m²), the minimum water supply, in gallons (liters), shall be determined by the total cubic footage (m³) of the structure, including any attached structures, divided by the occupancy hazard classification number determined from Chapter 3, multiplied by the construction classification number determined by Chapter 4, and multiplied by 1.5; or Table 5-9(a) shall be referenced.

MINIMUM WATER SUPPLY =

$$\frac{\text{Total ft}^3 \text{ (m}^3\text{) of Structure}}{\text{Occupancy Hazard Classification No.}} \times \text{Construction Classification No.} \times 1.5$$

5-3.1.1 The minimum water supply required for a single structure with exposure hazards specified in 5-3.1 shall not be less than 3000 gal (11 355 L). [See Table 5-9(b).]

5-3.1.2 The minimum water supply, as determined for any structure specified in 5-3.1 and 5-3.1.1, shall be available on the fireground at, and the fire department shall be capable of utilizing the minimum water supply at, the rates specified in Table 5-9(c).

5-4 Multiple Structures — Single Water Point Without Exposure Hazards.

5-4.1* For all multiple structures with no portion of any unattached structural exposure hazard within 50 ft (15.2 m), unless it is smaller than 100 ft² (9.3 m²), the minimum

water supply, in gallons (liters), shall be determined by the total cubic footage (m^3) of the structure, including any attached structures, divided by the occupancy hazard classification number as determined by Chapter 3, multiplied by the construction classification number determined by Chapter 4; or Table 5-9.1(a) shall be referenced.

MINIMUM WATER SUPPLY =

$$\frac{\text{Total ft}^3 \text{ (m}^3\text{) of Structure}}{\text{Occupancy Hazard Classification No.}} \times \text{Construction Classification No.}$$

Where structures are close enough together that they may be served from a single water point, the water supply shall be computed from the structure having the largest minimum water supply requirement.

5-4.1.1 The minimum water supply required for multiple structures specified in 5-4.1 shall not be less than 3000 gal (11 355 L). [See Table 5-9(b).]

5-4.1.2 The minimum water supply, as determined for any structure specified in 5-4.1 and 5-4.1.1, shall be available on the fireground at, and the fire department shall be capable of utilizing the minimum water supply at, the rate specified in Table 5-9(c).

5-5 Multiple Structures — Single Water Point with Exposure Hazards.

5-5.1* For all multiple structures with unattached structural exposure hazards within 50 ft (15.2 m) of any portion of the structure and larger than 100 ft^2 (9.3 m^2), the minimum water supply, in gallons (liters), shall be determined by the cubic footage (m^3) of the structure, including any attached structures, divided by the occupancy hazard classification number determined from Chapter 3, multiplied by the construction classification number determined from Chapter 4, and multiplied by 1.5; or Table 5-9(a) shall be referenced.

MINIMUM WATER SUPPLY =

$$\frac{\text{Total ft}^3 \text{ (m}^3\text{) of Structure}}{\text{Occupancy Hazard Classification No.}} \times \text{Construction Classification No.} \times 1.5$$

5-5.1.1 The minimum water supply required for multiple structures specified in 5-5.1 shall not be less than 3000 gal (11 355 L). [See Table 5-9(b).]

5-5.1.2 The minimum water supply, as determined for any structure specified in 5-5.1 and 5-5.1.1, shall be available on the fireground at, and the fire department shall be capable of utilizing the minimum water supply at, the rate specified in Table 5-9(c).

5-6 Special Fire Protection Problems.

5-6.1* This standard is not intended to provide details for calculating an adequate amount of water for large special fire protection problems, such as bulk flammable liquid storage, bulk flammable gas storage, large varnish and paint factories, some plastics manufacturing and storage,

aircraft hangars, distilleries, refineries, lumberyards, grain elevators, large chemical plants, coal mines, tunnels, subterranean structures, and warehouses using high rack storage for flammables or pressurized aerosols. For suggested protection, consult appropriate NFPA standards.

5-7 Structures with Automatic Sprinkler Protection.

5-7.1* For any structure protected by an automatic sprinkler system that fully meets the requirements of NFPA 13, *Standard for the Installation of Sprinkler Systems*; NFPA 13D, *Standard for the Installation of Sprinkler Systems in One- and Two-Family Dwellings and Mobile Homes*; or NFPA 13R, *Standard for the Installation of Sprinkler Systems in Residential Occupancies Up to and Including Four Stories in Height*, the fire department having jurisdiction shall be permitted to waive any requirement for additional water supply required by this standard. (See Appendix F.)

5-7.1.1* The water supply for automatic sprinkler systems meeting the requirements of NFPA 13, *Standard for the Installation of Sprinkler Systems*, contemplates the use of outside hose lines; therefore, this water supply shall be available to the fire department outside the structure for manual fire fighting purposes.

5-7.1.2 Automatic sprinkler systems meeting the requirements of NFPA 13, *Standard for the Installation of Sprinkler Systems*, shall, in all cases, be provided with a fire department connection as described in NFPA 13.

5-7.2 For a structure protected by an automatic sprinkler system that does not fully meet the requirements of NFPA 13, *Standard for the Installation of Sprinkler Systems*, and NFPA 13D, *Standard for the Installation of Sprinkler Systems in One- and Two-Family Dwellings and Mobile Homes*, or NFPA 13R, *Standard for the Installation of Sprinkler Systems in Residential Occupancies Up to and Including Four Stories in Height*, the fire department having jurisdiction shall be permitted to reduce the minimum water supply required by this standard, for fire fighting purposes, in Sections 5-2, 5-3, 5-4, or 5-5, whichever is applicable.

5-8* Structures with Other Automatic Fire Suppression Systems. For any structure fully or partially protected by an automatic fire suppression system other than as specified in 5-7.1, the fire department having jurisdiction shall determine the minimum water supply required for fire fighting purposes.

5-9 Precalculated Water Supply. Table 5-9(a) provides a quick method for determining the water requirements suggested by this standard for structures without exposures. For structures with exposures, multiply the water requirements developed by Table 5-9(a) by 1.5.

Example: A farm storage building housing a barn (occupancy hazard classification 4) of ordinary construction (construction classification number 1.0) with a cubic area of 160,000 ft^3 (4480 m^3) will produce, using Table 5-9(a), a water requirement of 40,000 gal (151 400 L).

Table 5-9(a) Precalculated Minimum Water Supplies by Occupancy Hazard and Construction Classification (no exposures)

Occupancy Hazard Classification	3				4				5				6				7			
Construction Classification	0.5	0.75	1.0	1.5	0.5	0.75	1.0	1.5	0.5	0.75	1.0	1.5	0.5	0.75	1.0	1.5	0.5	0.75	1.0	1.5
Cubic Feet	Gallons				Gallons				Gallons				Gallons				Gallons			
8,000		2,000	2,667	4,000			2,000	3,000				2,400				2,000				
12,000	2,000	3,000	4,000	6,000			2,250	3,000				3,600				2,000				2,571
16,000	2,667	4,000	5,333	8,000	2,000	3,000	4,000	6,000			2,400	3,200	4,800		2,000	2,667			2,286	3,429
20,000	3,333	5,000	6,667	10,000	2,500	3,750	5,000	7,500	2,000	3,000	4,000	6,000			2,500	3,333	5,000		2,857	4,286
24,000	4,000	6,000	8,000	12,000	3,000	4,500	6,000	9,000	2,400	3,600	4,800	7,200	2,000	3,000	4,000	6,000			2,571	3,429
28,000	4,667	7,000	9,333	14,000	3,500	5,250	7,000	10,500	2,800	4,200	5,600	8,400	2,333	3,500	4,667	7,000	2,000	3,000	4,000	6,000
32,000	5,333	8,000	10,667	16,000	4,000	6,000	8,000	12,000	3,200	4,800	6,400	9,600	2,667	4,000	5,333	8,000	2,286	3,429	4,571	6,857
36,000	6,000	9,000	12,000	18,000	4,500	6,750	9,000	13,500	3,600	5,400	7,200	10,800	3,000	4,500	6,000	9,000	2,572	3,857	5,143	7,714
40,000	6,667	10,000	13,333	20,000	5,000	7,500	10,000	15,000	4,000	6,000	8,000	12,000	3,333	5,000	6,667	10,000	2,857	4,286	5,714	8,571
44,000	7,333	11,000	14,667	22,000	5,500	8,250	11,000	16,500	4,400	6,600	8,800	13,200	3,667	5,500	7,333	11,000	3,143	4,714	6,286	9,429
48,000	8,000	12,000	16,000	24,000	6,000	9,000	12,000	18,000	4,800	7,200	9,600	14,400	4,000	6,000	8,000	12,000	3,429	5,143	6,857	10,286
52,000	8,667	13,000	17,333	26,000	6,500	9,750	13,000	19,500	5,200	7,800	10,400	15,600	4,333	6,500	8,667	13,000	3,715	5,571	7,429	11,143
56,000	9,333	14,000	18,667	28,000	7,000	10,500	14,000	21,000	5,600	8,400	11,200	16,800	4,667	7,000	9,333	14,000	4,000	6,000	8,000	12,000
60,000	10,000	15,000	20,000	30,000	7,500	11,250	15,000	22,500	6,000	9,000	12,000	18,000	5,000	7,500	10,000	15,000	4,286	6,429	8,571	12,857
64,000	10,667	16,000	21,333	32,000	8,000	12,000	16,000	24,000	6,400	9,600	12,800	19,200	5,333	8,000	10,667	16,000	4,572	6,857	9,143	13,714
68,000	11,333	17,000	22,667	34,000	8,500	12,750	17,000	25,500	6,800	10,200	13,600	20,400	5,667	8,500	11,333	17,000	4,857	7,286	9,714	14,571
72,000	12,000	18,000	24,000	36,000	9,000	13,500	18,000	27,000	7,200	10,800	14,400	21,600	6,000	9,000	12,000	18,000	5,143	7,714	10,286	15,429
76,000	12,667	19,000	25,333	38,000	9,500	14,250	19,000	28,500	7,600	11,400	15,200	22,800	6,333	9,500	12,667	19,000	5,429	8,143	10,857	16,286
80,000	13,333	20,000	26,667	40,000	10,000	15,000	20,000	30,000	8,000	12,000	16,000	24,000	6,667	10,000	13,333	20,000	5,715	8,571	11,429	17,143
84,000	14,000	21,000	28,000	42,000	10,500	15,750	21,000	31,500	8,400	12,600	16,800	25,200	7,000	10,500	14,000	21,000	6,000	9,000	12,000	18,000
88,000	14,667	22,000	29,333	44,000	11,000	16,500	22,000	33,000	8,800	13,200	17,600	26,400	7,333	11,000	14,667	22,000	6,286	9,429	12,571	18,857
92,000	15,333	23,000	30,667	46,000	11,500	17,250	23,000	34,500	9,200	13,800	18,400	27,600	7,667	11,500	15,333	23,000	6,572	9,857	13,143	19,714
96,000	16,000	24,000	32,000	48,000	12,000	18,000	24,000	36,000	9,600	14,400	19,200	28,800	8,000	12,000	16,000	24,000	6,857	10,286	13,714	20,571
100,000	16,667	25,000	33,333	50,000	12,500	18,750	25,000	37,500	10,000	15,000	20,000	30,000	8,333	12,500	16,667	25,000	7,143	10,714	14,286	21,429
104,000	17,333	26,000	34,667	52,000	13,000	19,500	26,000	39,000	10,400	15,600	20,800	31,200	8,667	13,000	17,333	26,000	7,429	11,143	14,857	22,286
108,000	18,000	27,000	36,000	54,000	13,500	20,250	27,000	40,500	10,800	16,200	21,600	32,400	9,000	13,500	18,000	27,000	7,715	11,571	15,429	23,143
112,000	18,667	28,000	37,333	56,000	14,000	21,000	28,000	42,000	11,200	16,800	22,400	33,600	9,333	14,000	18,667	28,000	8,000	12,000	16,000	24,000
116,000	19,333	29,000	38,667	58,000	14,500	21,750	29,000	43,500	11,600	17,400	23,200	34,800	9,667	14,500	19,333	29,000	8,286	12,429	16,571	24,857
120,000	20,000	30,000	40,000	60,000	15,000	22,500	30,000	45,000	12,000	18,000	24,000	36,000	10,000	15,000	20,000	30,000	8,572	12,857	17,143	25,714
124,000	20,667	31,000	41,333	62,000	15,500	23,250	31,000	46,500	12,400	18,600	24,800	37,200	10,333	15,500	20,667	31,000	8,857	13,286	17,714	26,571
128,000	21,333	32,000	42,667	64,000	16,000	24,000	32,000	48,000	12,800	19,200	25,600	38,400	10,667	16,000	21,333	32,000	9,143	13,714	18,286	27,429
132,000	22,000	33,000	44,000	66,000	16,500	24,750	33,000	49,500	13,200	19,800	26,400	39,600	11,000	16,500	22,000	33,000	9,429	14,143	18,857	28,286
136,000	22,667	34,000	45,333	68,000	17,000	25,500	34,000	51,000	13,600	20,400	27,200	40,800	11,333	17,000	22,667	34,000	9,715	14,571	19,429	29,143
140,000	23,333	35,000	46,667	70,000	17,500	26,250	35,000	52,500	14,000	21,000	28,000	42,000	11,667	17,500	23,333	35,000	10,000	15,000	20,000	30,000
144,000	24,000	36,000	48,000	72,000	18,000	27,000	36,000	54,000	14,400	21,600	28,800	43,200	12,000	18,000	24,000	36,000	10,286	15,429	20,571	30,857
148,000	24,667	37,000	49,333	74,000	18,500	27,750	37,000	55,500	14,800	22,200	29,600	44,400	12,333	18,500	24,667	37,000	10,572	15,857	21,143	31,714
152,000	25,333	38,000	50,667	76,000	19,000	28,500	38,000	57,000	15,200	22,800	30,400	45,600	12,667	19,000	25,333	38,000	10,857	16,286	21,714	32,571
156,000	26,000	39,000	52,000	78,000	19,500	29,250	39,000	58,500	15,600	23,400	31,200	46,800	13,000	19,500	26,000	39,000	11,143	16,714	22,286	33,429
160,000	26,667	40,000	53,333	80,000	20,000	30,000	40,000	60,000	16,000	24,000	32,000	48,000	13,333	20,000	26,667	40,000	11,429	17,143	22,857	34,286

Note: For structures with exposures, multiply results by 1.5 for water supply requirements.

SI units: 1 gal = 3.785 L; 1 cu ft = 0.0283 m³.

Table 5-9(a) Continued

Occupancy Hazard Classification	3				4				5				6				7			
Construction Classification	0.5	0.75	1.0	1.5	0.5	0.75	1.0	1.5	0.5	0.75	1.0	1.5	0.5	0.75	1.0	1.5	0.5	0.75	1.0	1.5
Cubic Feet	Gallons				Gallons				Gallons				Gallons				Gallons			
175,000	29,167	43,750	58,333	87,500	21,875	32,813	43,750	65,625	17,500	26,250	35,000	52,500	14,583	21,875	29,167	43,750	12,500	18,750	25,000	37,500
200,000	33,333	50,000	66,667	100,000	25,000	37,500	50,000	75,000	20,000	30,000	40,000	60,000	16,667	25,000	33,333	50,000	14,286	21,429	28,571	42,857
225,000	37,500	56,250	75,000	112,500	28,125	42,188	56,250	84,375	22,500	33,750	45,000	67,500	18,750	28,125	37,500	56,250	16,071	24,107	32,143	48,214
250,000	41,667	62,500	83,333	125,000	31,250	46,875	62,500	93,750	25,000	37,500	50,000	75,000	20,833	31,250	41,667	62,500	17,857	26,786	35,714	53,571
275,000	45,833	68,750	91,667	137,500	34,375	51,563	68,750	103,125	27,500	41,250	55,000	82,500	22,917	34,375	45,833	68,750	19,643	29,464	39,286	58,929
300,000	50,000	75,000	100,000	150,000	37,500	56,250	75,000	112,500	30,000	45,000	60,000	90,000	25,000	37,500	50,000	75,000	21,429	32,143	42,857	64,286
325,000	54,167	81,250	108,333	162,500	40,625	60,938	81,250	121,875	32,500	48,750	65,000	97,500	27,083	40,625	54,167	81,250	23,214	34,821	46,429	69,643
350,000	58,333	87,500	116,667	175,000	43,750	65,625	87,500	131,250	35,000	52,500	70,000	105,000	29,167	43,750	58,333	87,500	25,000	37,500	50,000	75,000
375,000	62,500	93,750	125,000	187,500	46,875	70,313	93,750	140,625	37,500	56,250	75,000	112,500	31,250	46,875	62,500	93,750	26,786	40,179	53,571	80,357
400,000	66,667	100,000	133,333	200,000	50,000	75,000	100,000	150,000	40,000	60,000	80,000	120,000	33,333	50,000	66,667	100,000	28,571	42,857	57,143	85,714
425,000	70,833	106,250	141,667	212,500	53,125	79,688	106,250	159,375	42,500	63,750	85,000	127,500	35,417	53,125	70,833	106,250	30,357	45,536	60,714	91,071
450,000	75,000	112,500	150,000	225,000	56,250	84,376	112,500	168,750	45,000	67,500	90,000	135,000	37,500	56,250	75,000	112,500	32,143	48,214	64,286	96,429
475,000	79,167	118,750	158,333	237,500	59,375	89,063	118,750	178,125	47,500	71,250	95,000	142,500	39,583	59,375	79,167	118,750	33,929	50,893	67,857	101,786
500,000	83,333	125,000	166,667	250,000	62,500	93,751	125,000	187,500	50,000	75,000	100,000	150,000	41,667	62,500	83,333	125,000	35,714	53,571	71,429	107,143
525,000	87,500	131,250	175,000	262,500	65,625	98,438	131,250	196,875	52,500	78,750	105,000	157,500	43,750	65,625	87,500	131,250	37,500	56,250	75,000	112,500
550,000	91,667	137,500	183,333	275,000	68,750	103,126	137,500	206,250	55,000	82,500	110,000	165,000	45,833	68,750	91,667	137,500	39,286	58,929	78,571	117,857
575,000	95,833	143,750	191,667	287,500	71,875	107,813	143,750	215,625	57,500	86,250	115,000	172,500	47,917	71,875	95,833	143,750	41,071	61,607	82,143	123,214
600,000	100,000	150,000	200,000	300,000	75,000	112,501	150,000	225,000	60,000	90,000	120,000	180,000	50,000	75,000	100,000	150,000	42,857	64,286	85,714	128,571
625,000	104,167	156,250	208,333	312,500	78,125	117,188	156,250	234,375	62,500	93,750	125,000	187,500	52,083	78,125	104,167	156,250	44,643	66,964	89,286	133,929
650,000	108,333	162,500	216,667	325,000	81,250	121,876	162,500	243,750	65,000	97,500	130,000	195,000	54,167	81,250	108,333	162,500	46,429	69,643	92,857	139,286
675,000	112,500	168,750	225,000	337,500	84,375	126,563	168,750	253,125	67,500	101,250	135,000	202,500	56,250	84,375	112,500	168,750	48,214	72,321	96,429	144,643
700,000	116,667	175,000	233,333	350,000	87,500	131,251	175,000	262,500	70,000	105,000	140,000	210,000	58,333	87,500	116,667	175,000	50,000	75,000	100,000	150,000
725,000	120,833	181,250	241,667	362,500	90,625	135,938	181,250	271,875	72,500	108,750	145,000	217,500	60,417	90,625	120,833	181,250	51,786	77,679	103,571	155,357
750,000	125,000	187,500	250,000	375,000	93,750	140,626	187,500	281,250	75,000	112,500	150,000	225,000	62,500	93,750	125,000	187,500	53,571	80,357	107,143	160,714
775,000	129,167	193,750	258,333	387,500	96,875	145,313	193,750	290,625	77,500	116,250	155,000	232,500	64,583	96,875	129,167	193,750	55,357	83,036	110,714	166,071
800,000	133,333	200,000	266,667	400,000	100,000	150,001	200,000	300,000	80,000	120,000	160,000	240,000	66,667	100,000	133,333	200,000	57,143	85,714	114,286	171,429
825,000	137,500	206,250	275,000	412,500	103,125	154,688	206,250	309,375	82,500	123,750	165,000	247,500	68,750	103,125	137,500	206,250	58,929	88,393	117,857	176,786
850,000	141,667	212,500	283,333	425,000	106,250	159,376	212,500	318,750	85,000	127,500	170,000	255,000	70,833	106,250	141,667	212,500	60,714	91,071	121,429	182,143
875,000	145,833	218,750	291,667	437,500	109,375	164,064	218,750	328,125	87,500	131,250	175,000	262,500	72,917	109,375	145,833	218,750	62,500	93,750	125,000	187,500
900,000	150,000	225,000	300,000	450,000	112,500	168,751	225,000	337,500	90,000	135,000	180,000	270,000	75,000	112,500	150,000	225,000	64,286	96,429	128,571	192,857
925,000	154,167	231,250	308,333	462,500	115,265	173,439	231,250	346,875	92,500	138,750	185,000	277,500	77,083	115,625	154,167	231,250	66,071	99,107	132,143	198,214
950,000	158,333	237,500	316,667	475,000	118,750	178,126	237,500	356,250	95,000	142,500	190,000	285,000	79,167	118,750	158,333	237,500	67,857	101,786	135,714	203,571
975,000	162,500	243,750	325,000	487,500	121,875	182,814	243,750	365,625	97,500	146,250	195,000	292,500	81,250	121,875	162,500	243,750	69,643	104,464	139,286	208,929
1,000,000	166,667	250,000	333,333	500,000	125,000	187,501	250,000	375,000	100,000	150,000	200,000	300,000	83,333	125,000	166,667	250,000	71,429	107,143	142,857	214,286

Note: For structures with exposures, multiply results by 1.5 for water supply requirements.

SI units: 1 gal = 3.785 L; 1 cu ft = 0.0283 m³.

Table 5-9(b) Minimum Water Requirements (Examples)

Paragraph	Type of Occupancy	Minimum Water Requirements (gallons)
5-2.1.1	Single Structures Without Exposure Hazards	2000 (7570 L)
5-3.1.1	Single Structures with Exposure Hazards	3000 (11 335 L)
5-4.1.1	Multiple Structures — Single Water Point Without Exposure Hazards	3000 (11 335 L)
5-5.1.1	Multiple Structures — Single Water Point with Exposure Hazards	3000 (11 335 L)

Table 5-9(c) Minimum Capability of Fire Department to Transport and to Use Water

Total Water Supply Required (gallons)	Rate Water Is Available to Fireground and Fire Department's Capability for Using Water (gal/m)
up to 2499 (9459 L)	250 (946 L/min)
2500 to 9999 (9460 L to 37 849 L)	500 (1893 L/min)
10,000 to 19,999 (37 850 L to 75 699 L)	750 (2839 L/min)
20,000 or more (75 700 L)	1000 (3785 L/min)

Chapter 6 Water Supply

6-1 Water Supply for Fire Fighting. The water supplies for fire fighting purposes, as specified in Chapter 5, can be supplied from natural bodies of water and constructed sources of water. Natural bodies of water are defined as bodies of water contained by earth only and include ponds, lakes, rivers, streams, bays, creeks, springs, artesian wells, and irrigation canals. Constructed sources of water include aboveground tanks, elevated gravity tanks, livestock watering tanks, cisterns, swimming pools, wells, quarries, mines, reservoirs, aqueducts, mobile water supplies, and hydrants served by a water system. (*See Appendix B.*)

6-1.1 The surface at the water access point shall be adequate to support heavy vehicles at all times of the year. Provisions shall be made so that such water suction points are visible and usable in all weather conditions, including heavy snow or brush conditions and mud slides.

6-1.2 If a dry hydrant is located close to vehicular traffic, suitable barriers shall be constructed to protect fire fighters, equipment, and the dry hydrant.

6-2 Water Supply Transfer. The transfer of water from a water source to the scene of the fire can be done by a number of different methods. These methods include mobile water supply shuttles, pumper relays using large diameter [normally 3½-in. (89-mm) or greater] hose, pumper relays, portable piping, irrigation piping and ditching, helicopters, railroad tank cars, etc. (*See Appendixes C, D, and E.*)

6-3 Minimum Water Supply. The minimum water supply from whatever source or combination of sources shall meet the requirements of Chapter 5.

6-4* Accessibility. Water supplies for fire fighting purposes shall be accessible to fire fighting equipment. The fire department having jurisdiction shall determine, as part of its property survey, maximum safe load limits of roadways, laneways, and bridges, and determine accessibility during various climatic conditions.

6-4.1 Any means of access shall be constructed in accordance with NFPA 1141, *Standard for Fire Protection in Planned Building Groups*.

6-5 Identification. An appropriate sign shall be erected at each water point identifying the site for fire department emergency use. (*See B-1.2.11.*)

Chapter 7 Reports and Records

7-1 Plans for New Construction and Additions.

7-1.1* Where the appropriate governmental entity has building laws that require plans to be submitted for review before building construction is started, the plans shall be submitted to the fire department for review and approval.

7-1.2 Where no building laws exist or plans are not required for review, the fire department shall request the cooperation of the property owner(s) in voluntary compliance with provisions of this standard.

7-2 Requirements for the Fire Department.

7-2.1 The fire department having jurisdiction for property surveys specified in Chapter 2, after completing the survey and computing the minimum water supply required, shall notify, in writing, the authority having jurisdiction of the results of the surveys and the minimum water supplies required. In all cases, the building(s) owner(s) shall be advised of the minimum water supply required. Fire department personnel shall be available to citizens for appropriate consultation.

7-3 Requirements for Property Owners or Occupants.

7-3.1 The property owner shall notify the authority having jurisdiction in writing before any structures are erected or any alterations are made to any existing structure that will increase the total cubic footage (m³) of the structure. The property owner shall provide the authority having jurisdiction with complete written plans and drawings of any proposed structure, including all measurements, construction, intended occupancy, and a description of contents.

7-3.2 The property owner or occupant shall notify, in writing, the authority having jurisdiction before any changes are made in the contents of a structure or occupancy of a structure, other than residential occupancies, that would materially affect the occupancy hazard classification number as specified in Section 3-2. The property owner or occupant shall provide the authority having jurisdiction with a complete written report of contents or occupancy changes.

7-4 Smoke Detectors.

7-4.1* Each family living unit shall be provided with smoke detectors as required in NFPA 72, *National Fire Alarm Code*.

7-5 Changes in Automatic Sprinkler Protection.

7-5.1 The property owner or occupant shall notify the authority having jurisdiction in writing whenever any alterations are made that cause any change to an automatic sprinkler system covered in Section 5-7. The property owner or occupant shall provide the authority having jurisdiction with a complete written report of alterations to any existing sprinkler system or of installation of a new sprinkler system.

7-5.2* The property owner or occupant shall promptly notify the authority having jurisdiction whenever any automatic sprinkler system or other automatic suppression system or portion of any system is shut off or is to be out of service for any reason.

7-6 Retention of Reports. The fire department shall file all plans, reports, and surveys by street address and shall retain a copy of all reports specified in this standard.

Chapter 8 Referenced Publications

8-1 The following documents or portions thereof are referenced within this standard and shall be considered part of the requirements of this document. The edition indicated for each reference is the current edition as of the date of the NFPA issuance of this document.

8-1.1 NFPA Publications. National Fire Protection Association, 1 Batterymarch Park, P.O. Box 9101, Quincy, MA 02269-9101.

NFPA 13, *Standard for the Installation of Sprinkler Systems*, 1991 edition.

NFPA 13D, *Standard for the Installation of Sprinkler Systems in One- and Two-Family Dwellings and Mobile Homes*, 1991 edition.

NFPA 13R, *Standard for the Installation of Sprinkler Systems in Residential Occupancies Up to and Including Four Stories in Height*, 1991 edition.

NFPA 72, *National Fire Alarm Code*, 1993 edition.

NFPA 220, *Standard on Types of Building Construction*, 1992 edition.

NFPA 1141, *Standard for Fire Protection in Planned Building Groups*, 1990 edition.

NFPA 1903, *Standard for Mobile Water Supply Fire Apparatus*, 1991 edition.

Appendix A Explanatory Material

This Appendix is not a part of the requirements of this NFPA document, but is included for information purposes only.

A-1-1 In some areas, water supply systems have been installed for domestic water purposes only. These systems can be equipped with hydrants that might not be standard fire hydrants, with available volume, pressure, and duration of flow being less than needed for adequate fire fighting purposes. Where such conditions exist, this standard and appendix should be applied in water supply matters.

A-2-1.1 Information needed to compute the minimum water supplies that should be collected during the building survey includes:

(a) Area of all floors, including attics, basements, and crawl spaces.

(b) Height between floors or crawl spaces and in the attics from floor to ridgepole.

(c) Construction materials used in each building, including walls, floors, roofs, ceilings, interior partitions, stairs, etc.

(d) Occupancy (occupancies) of buildings.

(e) Occupancy (occupancies) of yard areas.

(f) Exposures to buildings and yard storage and distances between them.

(g) Fire protection systems — automatic and manual protection systems, hydrants, yard mains, and other protection facilities.

(h) On-premises water supplies, including natural and constructed sources of water.

A-3-1.4 In addition to the storage of products that are potentially hazardous from the standpoint of increased fire load, farm properties present certain inherent dangers to the rural fire fighter that are not contemplated by the urban fire fighter. Storage of products that are potentially hazardous to fire fighters from the standpoint of increased fire volume, explosion, and toxicity exists at most rural fire locations. These hazards include:

(a) Bulk storage of petroleum fuels, more frequently fuel oil, but often gasoline and propane. While some tanks are underground, many are aboveground and often located within 50 ft (15.2 m) of farm buildings.

(b) Many farmers use and store blasting agents such as dynamite, often extended with ammonium nitrate (the latter of greater explosive impact per unit weight).

(c) Nearly all farms use and store different pesticides. Some of these chemical compounds give off very toxic fumes while burning. Two compounds that are safe where used independent of each other may be very hazardous to the fire fighter where mixed together in a fire situation.

(d) Localized problems also exist in corn growing areas; for example, anhydrous ammonia is stored and used in large amounts during the early growing season.

The rural fire department needs to work with the farmer to reduce the fire and life potential hazard of these products by storing them safely. However, fire fighters of the rural fire departments should know the potential hazards presented by the products and the appropriate fire fighting precautions to be taken. The department membership should be aware of the hazards listed in (a) through (d) by means of the survey of the farm by the WSO or other inspector, and appropriate measures should be taken to protect the membership of the department from potential hazards.

A-3-2 The occupancy hazard classification number is a mathematical factor to be used in calculating minimum water supplies. The lowest occupancy hazard classification number is 3 and is assigned to the highest hazard group. The highest occupancy hazard classification number is 7 and is assigned to the lowest hazard group.

A-4-2 The construction classification number is a mathematical factor to be used in calculating minimum water supplies. The “slowest burning” or lowest hazard type of construction, fire-resistive, is construction classification number 0.5. The fastest burning or highest hazard type of construction, wood frame, is construction classification number 1.5. All dwellings should be assigned a construction classification number of 1.0 or lower where construction is noncombustible or fire-resistive.

A-4-2.4 Due to cost savings, many Type III (ordinary) and Type V (wood frame) constructed buildings can have wood trusses as a lightweight pre-engineered framing system used in the roof and floors. As long as the integrity of all members of the unit is intact, the unit is a stable building item. However, this might not be the case if one of the outer members is destroyed or damaged. If this happens during a fire, the roof or floor supported by the unit can be weakened to the point where it will be unsafe to support fire fighters.

Another weak point found in the lightweight pre-engineered truss during a fire is the joint formed by metal gussets. The use of metal gussets has reduced the cost and increased production of wood trusses; however, the metal gussets might not retain their strength and integrity where exposed to heat or fire.

Therefore, during the survey of the buildings for water requirements, fire prevention, or prefire planning purposes, the fire department should be aware of such structural fire fighting hazards, take appropriate steps to make all fire fighters aware of the condition, and plan alternate fire tactics.

A-4-2.5 See A-4-2.4.

A-5-2.1 Single Structures Without Exposure Hazards. Examples of calculating minimum water supply:

Residential:

Dwelling: 50 ft by 24 ft; 2 stories, 8 ft each; pitched roof, 8 ft from attic floor to ridgepole; wood frame construction.

$$50 \times 24 = 1200 \text{ (ft}^2\text{)}$$

$$\text{Height} = 8 + 8 + 4^* = 20 \text{ (ft)}$$

$$1200 \times 20 = 24,000 \text{ (ft}^3\text{)}$$

Occupancy hazard classification number 7 (See 3-2.7.)

Construction classification number 1.0, frame dwelling (See 4-2.5.)

$$(24,000 \div 7) \times 1.0 = 3429 \text{ gal}$$

$$\text{Minimum water supply} = 3429 \text{ gal}$$

For SI Units: 1 ft = 0.305 m; 1 ft² = 0.092 m²; 1 ft³ = 0.028 m³; 1 gal = 3.785 L.

*For pitched roofs, calculate half the distance from attic floor to ridgepole.

If a structure is of occupancy hazard classification number 3 or 4, it is considered an exposure hazard if within 50 ft, regardless of size. (See 5-3.1.) For a dwelling, the construction classification number is no larger than 1.0.

Commercial:

Farm equipment shed: 125 ft × 100 ft; height 14 ft; 1 story; flat roof; noncombustible construction.

$$125 \times 100 = 12,500 \text{ (ft}^2\text{)}$$

$$\text{Height} = 14 \text{ (ft)}$$

$$12,500 \times 14 = 175,000 \text{ (ft}^3\text{)}$$

Occupancy hazard classification number 5 (See 3-2.5.)

Construction classification number 0.75 (See 4-2.3.)

$$(175,000 \div 5) \times 0.75 = 26,250$$

$$\text{Minimum water supply} = 26,250 \text{ gal}$$

For SI Units: 1 ft = 0.305 m; 1 ft² = 0.092 m²; 1 ft³ = 0.028 m³; 1 gal = 3.785 L.

If a structure is of occupancy hazard classification number 3 or 4, it is considered an exposure hazard if within 50 ft, regardless of size.

A-5-3.1 Single Structures with Exposure Hazards. Examples of calculating minimum water supply:

Residential:

Dwelling 50 ft × 24 ft; 1 story, 8 ft high; pitched roof, 8 ft from attic floor to ridgepole; brick construction and exposed on one side by a frame dwelling with a separation of less than 50 ft and with areas greater than 100 ft².

$$50 \times 24 = 1200 \text{ (ft}^2\text{)}$$

$$\text{Height} = 8 + 4^* = 12 \text{ (ft)}$$

$$1200 \times 12 = 14,400 \text{ (ft}^3\text{)}$$

Occupancy hazard classification number 7 (See 3-2.7.)

Construction classification number 1.0, brick dwelling, (See 4-2.4.)

$$(14,400 \div 7) \times 1.0 = 2057$$

Since the dwelling is exposed by a frame dwelling, multiply by the exposure factor of 1.5

$$2057 \times 1.5 = 3086$$

Minimum water supply = 3086 gal

For SI Units: 1 ft = 0.305 m; 1 ft² = 0.092 m²; 1 ft³ = 0.028 m³; 1 gal = 3.785 L.

*For pitched roofs, calculate half the distance from attic floor to ridgepole.

If a structure is of occupancy hazard classification number 3 or 4, it is considered an exposure hazard if within 50 ft, regardless of size. For a dwelling, the construction classification number is no larger than 1.0.

A-5-4.1 Multiple Structures — Single Water Point Without Exposure Hazards. Example of calculating minimum water supply:

Assembly:

Church: 130 ft × 60 ft; height 25 ft to ridgepole (15 ft from ground to eaves, with pitched ridgepole 10 ft above the eaves); brick construction with fire-resistive constructed office building within 40 ft of church.

$$130 \times 60 = 7800 \text{ (ft}^2\text{)}$$

$$\text{Height} = 15 + \frac{10^*}{2} = 20 \text{ ft}$$

$$7800 \times 20 = 156,000 \text{ (ft}^3\text{)}$$

Occupancy hazard classification number 6 (See 3-2.6.)

Construction classification number 1.0 (See 4-2.4.)

$$(156,000 \div 6) \times 1.0 = 26,000$$

As church is exposed by a brick office building, multiply by the exposure factor of 1.5

$$26,000 \times 1.5 = 39,000$$

Minimum water supply = 39,000 gal

*For pitched roofs, calculate half the distance from attic floor to ridgepole.

The fire-resistive office building:

Office building is 175 ft × 100 ft; 2 stories, each floor 10 ft; with a flat roof.

$$175 \times 100 = 17,500 \text{ (ft}^2\text{)}$$

$$\text{Height} = 10 + 10 = 20 \text{ (ft)}$$

$$17,500 \times 20 = 350,000 \text{ (ft}^3\text{)}$$

Occupancy hazard classification number 7 (See 3-2.7.)

Construction classification 0.5 (See 4-2.2.)

$$(350,000 \div 7) \times 0.5 = 25,000$$

$$\text{Minimum water supply} = 25,000 \text{ gal}$$

As this is a multiple structure location served from a single water point with the supply computed from the structure having the larger water supply requirement, the church will control the water supply requirement.

Water supply for church = 39,000 gal

Water supply for office = 25,000 gal

Therefore, the church has the larger water supply requirement.

Minimum water supply for these multiple structures = 39,000 gal

For SI Units: 1 ft = 0.305 m; 1 ft² = 0.092 m²; 1 ft³ = 0.028 m³; 1 gal = 3.785 L.

A-5-5.1 Multiple Structures — Single Water Point with Exposure Hazards. Example of calculating minimum water supply:

A row of five dwellings, identical to the residential occupancy in A-5-2.1, except one has a brick barn measuring 80 ft by 40 ft located 35 ft from the dwelling. The barn is larger than 100 ft² in area and is closer than 50 ft to the dwelling. Therefore, the minimum water supply for this dwelling (3429 gal) should be multiplied by 1.5 for the exposure.

$$3429 \times 1.5 = 5144 \text{ gal}$$

If the dwellings and barn are to be protected by the same water supply, as is likely, the water supply should be calculated on the structure that requires the largest minimum water supply, which is the barn in this case. Thus, if the barn has no hay storage and is 25 ft in height to the pitched ridgepole, and the ridgepole is 10 ft above the eaves, the calculations would be as follows:

$$80 \times 40 = 3200 \text{ (ft}^2\text{)}$$

$$\text{Height} = 15 + 5^* = 20 \text{ (ft)}$$

$$3200 \times 20 = 64,000 \text{ (ft}^3\text{)}$$

Occupancy hazard classification number 4, for the barn with no hay storage (*See 3-2.4.*)

Construction classification number is 1.0 (*See 4-2.4.*)

$$(64,000 \div 4) \times 1.0 = 16,000$$

$$16,000 \times 1.5 \text{ (for exposure hazard - the dwelling)} = 24,000$$

$$\text{Minimum water supply} = 24,000 \text{ gal}$$

If a structure is of occupancy hazard classification number 3 or 4, it is considered an exposure hazard if within 50 ft, regardless of size.

For SI Units: 1 ft = 0.305 m; 1 ft² = 0.092 m²; 1 ft³ = 0.028 m³; 1 gal = 3.785 L.

*For pitched roofs, calculate half the distance from attic floor to ridgepole.

Farm equipment shed, identical to commercial occupancy in A-5-2.1, except with a one-story, pitched-roof dwelling measuring 50 ft by 25 ft located 45 ft from the equipment shed. The dwelling is larger than 100 ft² in area and is closer than 50 ft to the equipment shed. Therefore, the minimum water supply for the equipment shed (26,250 gal) is multiplied by 1.5.

$$26,250 \times 1.5 = 39,375 \text{ (gal)}$$

$$\text{Minimum water supply} = 39,375 \text{ gal}$$

$$\text{The total water supply for the dwelling is: } 50 \times 25 = 1250 \text{ (ft}^2\text{)}$$

$$\text{Height} = 8 + 4 = 12 \text{ (ft)}$$

$$1250 \times 12 = 15,000 \text{ (ft}^3\text{)}$$

Occupancy hazard classification number 7 (*See 3-2.7.*)

Construction classification number 1.0 (*See 4-2.5.*)

$$(15,000 \div 7) \times 1.0 = 2143 \text{ gal}$$

For SI Units: 1 ft = 0.305 m; 1 ft² = 0.092 m²; 1 ft³ = 0.028 m³; 1 gal = 3.785 L.

Since the equipment shed requires the larger minimum water supply, if these two buildings were to be protected by the same water supply, that minimum water supply would be 39,375 gal.

If a structure is of occupancy hazard classification number 3 or 4, it is considered an exposure hazard if within 50 ft, regardless of size. For a dwelling, the construction classification number is no larger than 1.0.

A-5-6.1 The fire department having jurisdiction should consider the number of fire streams needed to control a potential fire in such an occupancy, multiplying the estimated total application rate in gpm by a liberal estimate of the time in minutes (60 minutes or more) necessary to control and extinguish the fire. A review of appropriate NFPA standards is suggested, as properties having special fire protection problems are beyond the scope of this standard on rural water supplies. (*See G-1 for additional information on fire flows.*)

A-5-7.1 It is the intent of NFPA 13D, *Standard for the Installation of Sprinkler Systems in One- and Two-Family Dwellings and Mobile Homes*, and NFPA 13R, *Standard for the Installation of Sprinkler Systems in Residential Occupancies Up to and Including Four Stories in Height*, to provide additional life safety as the primary goal, with property protection as a secondary goal. NFPA, federal agencies, and private organizations are united to provide the research and to develop sprinkler protection for residential occupancies at a low cost. Researchers have developed a new sprinkler head for the residential system that has a uniform discharge density and quick response capabilities. The reports from those areas that have adopted NFPA 13D for dwellings, apartments, mobile homes, hotels, and motels show promise.

A-5-7.1.1 The fire department should employ measures to supplement the sprinkler system to ensure adequate water and pressure for efficient operation of the sprinklers and should use care not to "rob" water from the supply for the sprinklers to supply hand lines. (*See Appendix F.*)

A-5-8 Other automatic suppression systems could include foam, carbon dioxide, dry chemical, etc., installed in part or in all of the structure.

A-6-4 Accessibility to water supplies should incorporate whatever features necessary to ensure the ability for year-round travel, taking into consideration local climatic conditions and topography.

The state Department of Transportation (DOT), in most cases, can provide the fire department with a computer printout showing safe load limits for bridges located within the boundaries of any city, town, county, or fire district, etc. This information has proved invaluable to a number of fire departments in checking bridges used to carry fire equipment. (*See B-6 and B-7 for further information on access to water supplies.*)

A-7-1.1 Where a subdivision or other "planned building group" is proposed, it should be in accordance with NFPA 1141, *Standard for Fire Protection in Planned Building Groups*.

Fire and municipal officials having jurisdictional authority in areas where structures interface with wildlands should establish and enforce protective measures in accordance with generally accepted principles and applicable NFPA standards.

A-7-4.1 Smoke detectors work and are needed. In any given year, statistics reveal that well over 50 percent of all persons killed by fire die in residential fires. The encouraging news is that current estimates indicate that smoke detectors are in approximately 75 percent of the nation's homes. (See NFPA 72, *National Fire Alarm Code*.) The primary concern of the standard is with life protection, and many water-hauling fire departments have developed programs to promote the installation, maintenance, and testing of smoke detectors as a first step in saving life and property through early detection. Early detection of a fire will go a long way toward reducing the water requirements needed for fire fighting purposes and reducing the water necessary for a water-hauling fire department to transport.

A-7-5.2 When the fire department is advised of a sprinkler system impairment, every effort should be made to restore the protection to service as quickly as possible. In some cases, the property owner might be able to provide a makeshift arrangement or to secure a part that will enable the restoration of the system, either completely or with only a very small number of sprinkler heads out of service during restoration.

Appendix B Water Supply

This Appendix is not a part of the requirements of this NFPA document, but is included for information purposes only.

The following numbering system is not intended to correlate with the standard.

B-1 Water Supply.

B-1.1 General. The fire fighter operating without a water system with hydrants (or with a very limited number of hydrants) has two means of getting water: (1) from supplies on the fireground, which may be constructed or natural, or (2) from supplies transported to the scene. This appendix discusses the variety and potential of these sources.

B-1.2 Water Supply Officer (WSO). Many progressive rural fire departments depend on a WSO. The work of a properly trained and equipped WSO makes it possible for the officer supervising the actual fire attack to plan it on the basis of reliable water supply information, to coordinate the attack with the available water supplies, and to help prevent the confusion inherent in fighting a major fire when the chief officer at the scene must divert too much personal attention from the attack to the logistics of backing it up.

B-1.2.1 Duties of Water Supply Officer (WSO). The officer is designated to provide sufficient water at the fire site, to plan availability of additional water sources, and to determine water requirements at the various locations over the district. The WSO should maintain and even carry a complete set of files, which should include cards showing water points and lists of automatic and mutual aid mobile water supply apparatus available. Modern technology in optics and computers makes it feasible for even a relatively low-budget department to reduce this data to microfiche or photographic slides, which can be maintained in the fire

alarm communication center and taken to the scene of every fire and used on small, even hand-held, viewers. The WSO is, basically, the individual who implements the water supply prefire planning.

As the WSO visits neighboring fire departments, a list of all apparatus, equipment, and personnel available to the officer's department should be developed. At this time, arrangements can be developed where certain apparatus and personnel will respond under an automatic aid agreement (first alarm response) or a mutual aid agreement (called as needed), depending on the needs of the department. These needs will be dictated, of course, by the nature of the structure(s) involved.

B-1.2.2 Duties at Fire. At the fire scene, the WSO becomes the rural equivalent of the water department representative who responds to major municipal fires. The WSO's duty to maintain continuous fire streams in rural areas is frequently a very complicated task involving setting up several water hauling facilities, assembling water-carrying equipment of automatic and mutual aid departments, calculating estimated arrival times of mobile water supply apparatus, and having a thorough knowledge of available water supplies throughout a wide area of fire department jurisdiction.

B-1.2.3 Communication Coordination. In water supply operations, efficient radio communication is absolutely necessary. To develop and sustain large fire flow requires the use of several water sources as well as several drop tanks where water may be dumped. Therefore, good radio communication is necessary in readily directing mobile water supplies so that time is not lost at the fill and the dump points. To obtain this level of mobile water supplies efficiency, a radio frequency separate from that used for the fire ground operations needs to be assigned to the WSO and the water supply site and the mobile water supply apparatus. The WSO also needs to have efficient communication with the incident commander.

B-1.2.4 Duties Before the Fire. Before the fire, the WSO participates in the prefire planning and in calculating the fire flow requirements for the various buildings in the area under the department's jurisdiction.

To satisfy these water requirements, the WSO should survey the district and the surrounding areas for available water for fire fighting purposes. Water supplies might exist on the property to be protected or might need to be transported. The WSO should develop preplans and see that the fire department is kept aware of all the water supplies available to the entire area. This means close coordination between the WSO and the fire department training officer and assistance in joint water supply training sessions with neighboring fire departments. The WSO should make periodic inspections of all water supplies and structural changes in the department's jurisdiction.

The WSO or designee must meet with property owners and secure their permission to use the water supply (see B-1.2.6), to develop an all-weather road to the supply (see B-6) and to install dry hydrants (see B-5). The installation of roads to or dry hydrants in navigable water or wetlands might require a permit from appropriate local, state, or national agencies. Fire departments should contact these groups early in the planning process to avoid violations of the law.

If called upon, the WSO should be available to consult with the owner in the design of a water source on a property to be protected.

B-1.2.5 Water Source Cards. A recommended practice is to prepare individual water source cards for each water point. This is a job that lends itself ideally to computers. There may be one or more water source applicable to a given potential fireground. In addition to the computer, the water sources should be noted on a master grid map of the area. Thus, the grid map will show the index location of water source cards on which pertinent data will be noted. This data should include type of source (stream, cistern, domestic system, etc.), point of access [100 ft (30.5 m) north of barn, etc.], gallons available [flows minimum 250 gpm (946 L/min), 10,000 gal (37,850 L) storage, etc.], and any particular problem such as weather condition or seasonal fluctuations that can make a source unusable. It is good practice to attach a photograph of the water point to the card. Also, it is advisable to note an alternate source.

These water source cards should be used as the basis of regular inspections to make sure the source continues to be available and to note any improvement or deterioration of its usefulness. A program to develop additional sources as needed, including water sources for new construction as it evolves, should be an ongoing program in an alert organization.

B-1.2.6 Water Usage Agreement. The WSO should make arrangements with the owner of water supplies before a fire develops. Such agreements should be made in writing in close cooperation with the municipal, town, or county attorney. Also, it is highly desirable that the agreement be reviewed by a representative of the highway or the county road department or other persons who will build, service, and maintain the access road to the supply, including such functions as snow plowing in certain areas of the country. The property owner also should have a copy of the agreement that has been used by several fire departments with the approval of their county or town attorney. (See sample water usage agreement.)

B-1.2.7 Water Map. Each WSO should maintain a map showing the location and amount of water available at each water site. A copy of this map should be located in the fire alarm dispatcher's headquarters where such an alarm facility is available and should be carried on at least one pumper and the chief's car and by the WSO. Any problems that are encountered at the supply should be recorded.

B-1.2.8 Inspection of Water Supplies. It is the responsibility of the WSO to make inspections of all water sources available as often as conditions warrant and to note any changes in the facilities. This is particularly true during adverse weather conditions, such as droughts, very wet periods, heavy freezing, and following snowstorms.

B-1.2.9 Reliability of an Impounded Supply. For an impounded supply, cistern, tank, or storage facility, the quantity of water to be considered available is the minimum available [at not over 15-ft (4.6-m) lift] during a drought with an average 50-year frequency (certified by a registered professional engineer). The maximum rate of flow is determined by testing, using the pumper(s), hose arrangement, and dry hydrant normally used at the site.

Sample Water Usage Agreement

I, We the undersigned owner(s) of a lake or pond located at _____ do hereby grant the Anytown Fire Department permission to erect and maintain, at its expense, a dry hydrant and access roadway to said lake or pond to be utilized for emergency fire suppression purposes.

All other uses of said pond or lake shall be after notification and permission of the owners.

The Anytown Fire Department shall be responsible for any and all damages to property resulting from fire department exercises.

This contract can be cancelled at any time by written notice thirty days in advance to the Anytown Fire Department located at Scott and College Road, Anytown, U.S.A.

Owner	Date	President Anytown Fire Department
Owner	Date	Secretary Anytown Fire Department
		Chief Anytown Fire Department

B-1.2.10 Reliability of a Flowing Stream. For a supply from a flowing stream, the quantity to be considered available is the minimum rate of flow during a drought with an average 50-year frequency (certified by a registered professional engineer). The maximum rate of flow is determined by testing using the pumper(s), hose arrangement, and dry hydrant normally used at this site.

B-1.2.11 Sign. The WSO should ensure that an appropriate sign is erected at each water point identifying the site for fire department emergency use and including the name, or a number, for the water supply. Letters and numbers should be at least 3 in. (76 mm) high, with a 1/2-in. (13-mm) stroke and reflective.

B-1.2.12 Water Operations. The WSO and the training officer, in conjunction with the fire chief, should develop standard operating procedures for hauling water to fires. The standard operating procedures should be put in motion for all structural fires; however, they can be discontinued after the officer in charge has evaluated the fire and determined that water hauling capabilities will not be needed.

B-2 First-Aid Fire Protection Using On-Site Water Systems.

B-2.1 General. The individual domestic water supply system provided in many rural homes and business establishments, if properly equipped and maintained, is an

effective "first-aid fire extinguisher." For large establishments, an elevated water storage tank or reservoir connected to hydrants and standpipes could provide substantial fire streams as well.

B-2.2 Domestic Water Systems. In order for domestic (farm) water systems to provide some degree of reliability in case of fire, the pump or pumps should be placed in a fire-resistive location. The electric power supply should have the maximum protection from deenergization by fire or other cause. In some cases, standby power and pumps can be justified.

B-2.3 Delivery of First-Aid Fire Protection. For first-aid fire protection to be effective, every portion of the dwelling and outlying buildings should be within reach of a hose stream. This might require some additional pipelines beyond those needed for other purposes. A garden hose long enough to reach any point in a structure is often valuable for fire fighting use. Care should be taken so that water is drained from hose or pipes that could be subject to freezing weather.

B-2.4 In-Depth Fire Protection. To provide for in-depth fire protection, three types of water supplies might be needed: (1) first-aid via the domestic water system; (2) a bulk water supply at the property, which may be a stream, pond, elevated tank, ground-level tanks, or cistern; or (3) an area system of static water supplies with drafting points and means for transporting the water to the fire site. Alternative power supplies should be considered.

B-3 Natural Water Sources.

B-3.1 Streams. Streams, including rivers, bays, creeks, and irrigation canals, can represent a continuously flowing source of substantial capacity. Where considering water from flowing streams as potential water sources, the fire department should consider the following factors:

(a) *Flowing Capacity.* The stream should deliver water in capacities compatible with those outlined in the water requirements of this standard. (See Chapter 5.)

(b) *Climatic Characteristics.* Streams that deliver water throughout the year and are not susceptible to drought are desirable for fire protection. However, where such streams are not available, a combination of supplies might be necessary. In many sections of the country, streams cannot be relied on during drought seasons. If the stream is subject to flooding or freezing, special evolutions might be necessary to make the stream usable under such conditions. Similar circumstances might exist during wet periods or when the ground is covered with snow.

(c) *Accessibility.* A river or other source of water might not be accessible to the fire department for use during a fire. Distance and terrain from the all-weather road to the source should be such as to make the water readily available. In some cases, special equipment should be used to obtain the water. (See B-6 and Appendix E, *Portable Pumps*.) Where roadways are provided to the water supply, they should be constructed in accordance with B-6.2.

(d) *Calculating Flow of a Stream.* A simple method for estimating the flow of water in a creek is to measure the width and depth of the creek.

Drop a cork or any light floating object into the water, and determine the time it takes the cork to travel 10 ft (3.1 m). To obtain complete accuracy, the sides of the creek should be perpendicular, the bottom flat, and the floating object should not be affected by the wind. Where the sides and bottom of the stream are not uniform, the width and depth can be averaged.

Example: A creek that is 4 ft (1.2 m) wide and 6 in. (15.2 cm) deep. The flow of water is such that it takes 45 seconds for a cork to travel 1 ft (0.3 m). Therefore:

$$W \times D \times TD = \text{cubic feet ft}^3 \text{ (m}^3\text{) of water}$$

where:

$$W = \text{width} = 4 \text{ ft (1.2 m)}$$

$$D = \text{depth} = 6 \text{ in. (15.2 cm)} = \frac{1}{2} \text{ ft (0.15 m)}$$

$$TD = \text{travel distance} = 10 \text{ ft (3.1 m)}$$

$$T = \text{time in seconds} = 45 \text{ sec}$$

$$0.00223 \text{ ft}^3/\text{sec} = 1 \text{ gal}$$

$$4 \text{ (1.2 m)} \times \frac{1}{2} \text{ (0.15 m)} \times 10 \text{ (3.1 m)} = 20 \text{ ft}^3 \text{ (0.56 m}^3\text{) of water}$$

The cork takes 45 seconds to flow the 10-ft (3.1-m) distance.

$$\text{ft}^3 \text{ of water/time} = \text{ft}^3/\text{sec} \text{ (m}^3 \text{ water/time} = \text{m}^3/\text{sec)}$$

$$20/45 = 0.444 \text{ ft}^3 \text{ of water/sec (0.558/45} = 0.0124 \text{ m}^3 \text{ water/sec)}$$

$$0.444/0.00223 = 199 \text{ gpm flowing in the creek (0.0124/0.00223} = 5.56 \text{ L/min).}$$

For assistance in more accurately determining stream flow, contact the state Department of Natural Resources, Soil Conservative Service, or county agent.

B-3.2 Ponds. Ponds can include lakes or farm ponds used for watering livestock, irrigation, fish culture, recreation, or other purposes while serving a secondary function for fire protection. Valuable information concerning the design of ponds can be obtained from county agricultural agents, cooperative extension offices, county engineers, etc. Most of the factors listed in B-3.1 relative to streams are pertinent to ponds, with the following items to be considered:

(a) Minimum annual level should be adequate to meet water supply needs of the fire problem the pond serves.

(b) Freezing of a stationary water supply, contrasted with the flowing stream, presents a greater problem.

(c) Silt and debris can accumulate in a pond or lake, reducing its actual capacity, while its surface area and level remain constant. This can provide a deceptive impression of capacity and calls for at least seasonal inspections.

(d) Accessibility should always be considered. Many recreational lakes are provided with access by roads, driveways, and boat launching ramps and are available for fire department use. Some large lakes, formed by a dam on a river, might have been constructed for such purposes as to generate power, for flood control, or to regulate the flow of a river. During certain periods of the year (droughts, drawdowns, etc.), such bodies of water can have very low water levels. The water under such conditions might not be accessible to the fire department for drafting by the fire department pumping unit, even where a paved road, for boat launching, has been provided and extended into the water at normal water levels for several feet or meters. Under such conditions, other provisions should be made to make the water supply fully accessible to the fire department.

B-3.3 Other Natural Sources. These might include springs and artesian wells. Individual springs and occasional artesian water supplies exist in some areas and, again, while generally of more limited capacity, can be useful for water supply, subject to reasonable application of the factors listed for ponds and streams. In many cases, it might be necessary to form a temporary natural pool or form a pond with a salvage cover, for example, to collect water for the use of the fire department where using a spring or an artesian well.

B-4 Developed Sources of Water.

B-4.1 General. The developed sources of water supplies adapted for fire fighting are limited only to the innovative nature of the fire department. They range from cisterns, swimming pools, quarries, mines, automatic sprinkler system supplies, stationary tanks, driven wells, and dry hydrants, to situations where fire fighters have drafted water out of the basement of a burning building into which it was pumped only minutes before to fight the fire.

B-4.2 Cisterns. Cisterns are one of the oldest sources of emergency water supply, both for fire fighting and drought storage. They are very important sources of water for fire fighting, domestic consumption, and drought storage in many rural and beach areas.

Cisterns should have a minimum usable volume as determined by the authority having jurisdiction, using the methods described in Chapter 5 of this standard, and there is no real limit to the maximum capacity. A cistern should be accessible to the fire apparatus or other pumping device but should be located far enough from the hazard that personnel and equipment are not endangered.

The water level of a cistern can be maintained by rainfall, water pumped from a well, water hauled by a mobile water supply, or by the seasonal high water of a stream or river. The cistern can present a freezing problem since its surface is often relatively inaccessible and the water is stagnant. One method for minimizing freezing is to use a dry hydrant protruding into the water at a point below the local frost line.

Cisterns should be capped for safety, but they should have openings to permit inspections and use of suction hose when needed. [See *Figures B-4.6(e), B-4.6(f), and B-4.6(g).*]

B-4.3 Protection from Freezing.

If a dry hydrant is not installed in a cistern, then, depending on local conditions, a heavy pipe or a pike pole can be adequate to break an ice formation. In fact, the weight of the suction hose itself can be sufficient, provided there is no danger of damaging the strainer, the hose, or hose threads.

There are several methods of providing an ice-free surface area in a cistern or other water source. These include, but are not limited to:

- (a) Floating a log or a bale of hay or straw, etc., on the surface of the water.
- (b) Placing a partly filled, floating barrel on the surface of the water.

B-4.4 Guide to Cistern Capacity. A ready guide to the capacity of cisterns with vertical sides is provided in Table B-4.7.

B-4.5 Construction of Cisterns. Construction of cisterns is governed by local conditions of soil and material availability. Practical information can be obtained from local governmental departments or agricultural agencies.

Some engineering considerations to be used in designing cisterns include:

- (a) Base, walls, and roof should be designed for the prevailing soil conditions and for the loads encountered where heavy vehicles are parked adjacent.
- (b) If groundwater conditions are high, the cistern should not float when empty.
- (c) Suction piping should be designed to minimize whirlpooling.
- (d) Vent piping should be of sufficient size.

Maintenance factors to be considered by the fire department include the danger of silting, evaporation or other low water conditions, and the freezing problems previously discussed.

B-4.6 Cistern Specifications. Some governing bodies, where water systems are not available and water for water-hauling fire departments is inadequate, require developers to provide cisterns with all subdivisions that are constructed. As each cistern can provide fire protection for a number of buildings, the necessary capacity is rather large and represents a substantial investment. The following are specifications for cistern design and construction used by one governing body. [See *Figures B-4.6(a) through (h).*]

1. Cisterns should be located no more than 2200 feet (671 m) truck travel distance from the nearest lot line of the furthest lot.
2. The design of a cistern should be trouble-free and last a lifetime.
3. The cistern capacity should be 30,000 gallons (113 550 L) minimum, available through the suction piping system.
4. The suction piping system should be capable of delivering 1000 gpm (3800 L/min) for three quarters of the cistern capacity.
5. The design of the cistern should be submitted to the authority having jurisdiction for approval prior to construction. All plans should be signed by an acceptable registered professional engineer.
6. The entire cistern should be rated for highway loading, unless specifically exempted by the authority having jurisdiction.
7. All drawings are for estimating purposes only and are not intended for use as design.
8. Each cistern should be sited to the particular location by a registered engineer and approved by the authority having jurisdiction.
9. Cast-in-place concrete should achieve a 28-day strength of 3000 psig (20 700 kPag). It should be placed with a minimum of 4-in. (10.2-cm) slump and vibrated in a professional manner.

10. The concrete should be mixed, placed, and cured without the use of calcium chloride. Winter placement and curing should follow the accepted American Concrete Institute (ACI) codes.

11. All suction and fill piping should be American Society for Testing and Materials (ASTM) Schedule 40 steel. All vent piping should be ASTM Schedule 40 PVC with glued joints.

12. All PVC piping should have glued joints.

13. The 8 in. $\times$ 5 in. (20.3 cm $\times$ 12.7 cm) eccentric reducer is available from suppliers.

14. The final suction connection should be a minimum of 4½ in. (11.4 cm). It should be capped.

15. The filler pipe siamese should have 2½-in. (64-mm) National Standard female threads with plastic caps.

16. The entire cistern should be completed and inspected before any backfilling is done.

17. All backfill material should be screened gravel with no stones larger than 1½ in. (38 mm) and should be compacted to 95 percent ASTM 1557.

18. Bedding for the cistern should consist of a minimum of 12 in. of ¾-in. to 1½-in. crushed, washed stone, compacted. No fill should be used under stone.

19. Filler pipe siamese should be 36 in. (91.4 cm) above final backfill grade.

20. Suction pipe connection should be 20 in. to 24 in. (51 cm to 61 cm) above the level of the gravel where vehicle wheels will be located when cistern is in use.

21. Suction pipe should be supported either to top of tank or to a level below frost.

22. Base should be designed so that cistern will not float when empty.

23. Perimeter of tank at floor/wall joint should be sealed with 8-in. (20.3-cm) PVC waterstop.

24. After backfilling, tank should be protected by fencing or large stones.

25. Backfill over the tank should be:

(a) 4 ft (1.2 m) of fill; or

(b) The top and highest 2 ft (0.6 m) of sides of cistern should be insulated with vermin-resistant foam insulation, and 2 ft (0.6 m) of fill.

(c) All backfill should extend 10 ft (3.1 m) beyond the edge of the cistern, and then have a maximum 3:1 slope, loamed and seeded.

26. Bottom of suction pipe to pumper connection should not exceed 14 ft (4.25 m) vertical distance.

27. Pitch of shoulder and vehicle pad from edge of pavement to pumper suction connection should be 1 to 6 percent downgrade.

28. Shoulder and vehicle pad should be of sufficient length to permit convenient access to suction connection when pumper is set at 45 degrees to road.

29. All construction, backfill, and grading material should be in accordance with proper construction practices and acceptable to the authority having jurisdiction.

30. All horizontal suction piping should slope slightly uphill toward pumper connection.

31. Installer is responsible for completely filling cistern until accepted by the authority having jurisdiction.

(Specifications furnished by the New Boston Fire Department, New Boston, NH.)

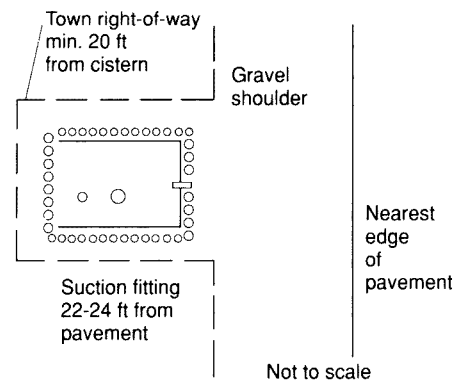


Figure B-4.6(a) Cistern site.

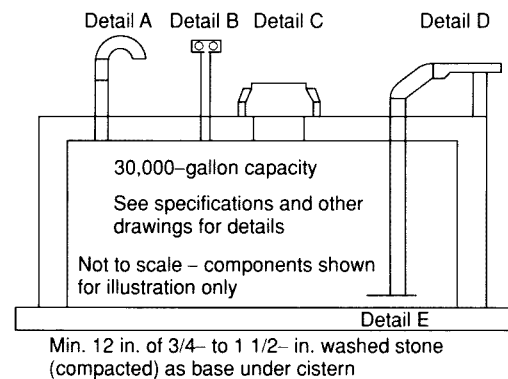


Figure B-4.6(b) Cistern.

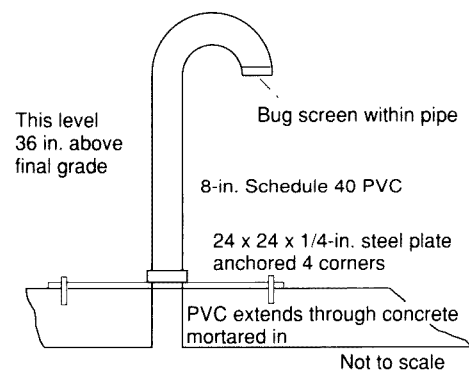


Figure B-4.6(c) Detail A — vent pipe.

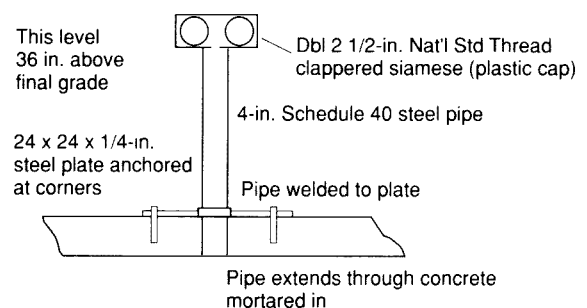


Figure B-4.6(d) Detail B — fill pipe.

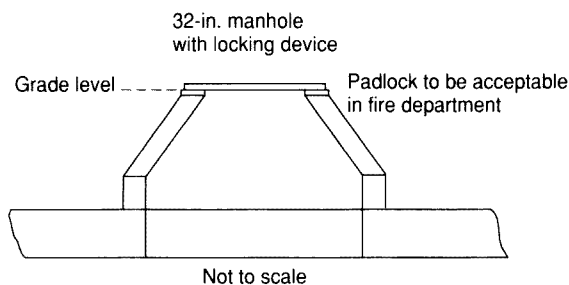


Figure B-4.6(e) Detail C — manhole.

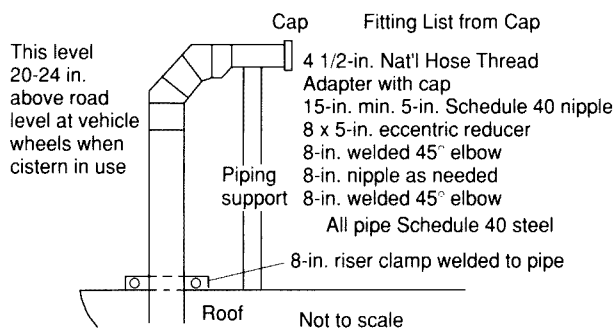


Figure B-4.6(f) Detail D — upper suction pipe.

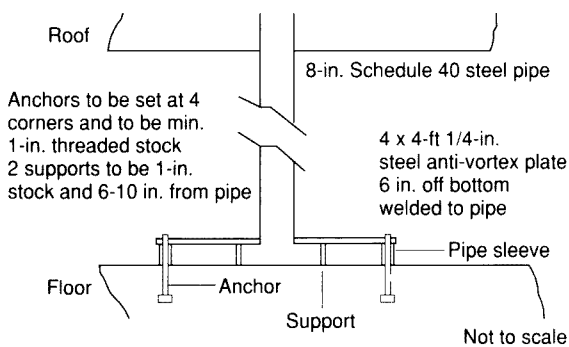


Figure B-4.6(g) Detail E — lower suction pipe.

B-4.7 Guide to Circular Cistern Capacity. A ready guide to the capacity of cisterns with vertical sides is provided in Table B-4.7.

A formula for calculating the storage capacity of a rectangular cistern is the same as the formula for "pool capacity." (See B-4.8.2.)

Table B-4.7 Cistern Storage Capacity

Inside Diameter in Feet	Storage Capacity per Foot of Depth
6 (1.8 m)	212 gal (802 L)
7 (2.1 m)	288 gal (1090 L)
8 (2.4 m)	376 gal (1423 L)
9 (2.7 m)	476 gal (1801 L)
10 (3.0 m)	588 gal (2226 L)

For SI units: 1 ft³ = 7.48 gal of water; 1 ft³ = 0.02832 m³.

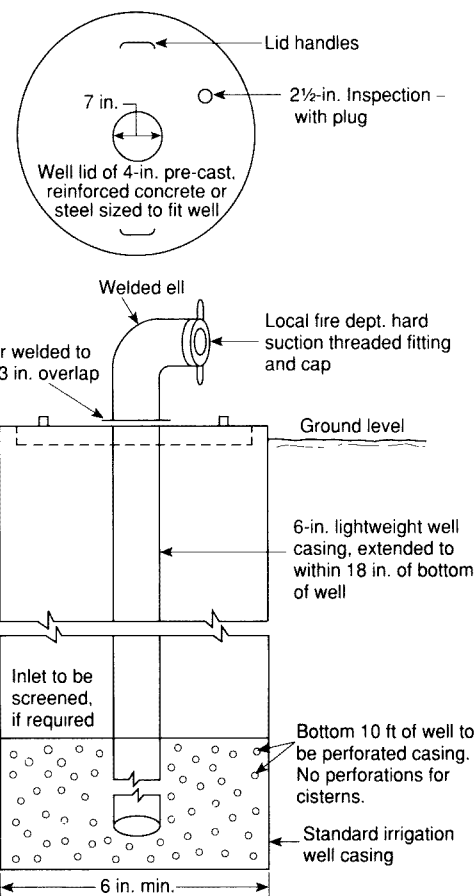


Figure B-4.6(h) Typical well (cistern) with dry hydrant installed. Same design suitable for cistern if bottom of casing is not perforated. For usable water depth, see B-4.7 warning.

WARNING: Reference is made to water depths in cisterns, swimming pools, streams, lakes, and other sources in a number of places in this appendix. It should always be remembered that the depth with which the fire fighter is concerned is the *usable* depth. In a cistern, a bottom bed of gravel protecting a dry hydrant inlet, for instance, reduces the usable depth of the area above the gravel.

B-4.8 Swimming Pools. Swimming pools are an increasingly common source of water for fire protection. Even in some areas with normally adequate hydrant water supplies, they have been a factor in providing protection, such as in cases in which water demands have exceeded availability because of wildfire disasters, etc. They provide an advantage in that they are sources of clean water, but have major drawbacks due to the weight of fire department vehicles and poor accessibility for large apparatus. There are some areas of the country in which swimming pool distribution is better than hydrant distribution. If the WSO intends to use a swimming pool as a supply of water, it is a good practice to develop these water sources through working with property owners and preplanning.

B-4.8.1 Pool Accessibility. If fire department accessibility is considered with the design of the pool, a usable water supply should be available to the fire department for supplying direct hose lines or a source of water for fire protection.