NFPA No.

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WATER SUPPLIES FOR SUBURBAN AND RURAL FIRE FIGHTING 1975

NATIONAL FIRE PROTECTION ASSOCIATION
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Standard on

Water Supplies for Suburban and Rural Fire Fighting

NFPA 1231–1975

1975 Edition of Standard 1231

This 1975 edition of Standard 1231 (formerly NFPA No. 25) supersedes the 1969 edition, and was officially adopted at the National Fire Protection Association Fall Meeting, held in Pittsburgh, Pennsylvania, on November 18, 1975.

Origin and Development of NFPA Standard 1231

This text originally was NFPA No. 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 1968, and was further amended and adopted in May, 1969 as NFPA No. 25.

Under committee reorganization, this Standard is now the responsibility of the Sectional Committee on Suburban and Rural Fire Departments.

This 1975 edition is the second edition of this Standard, and represents a complete revision of the previous document to include both mandatory and advisory material. This 1975 edition has also had a title change and is now titled, *Water Supplies for Suburban and Rural Fire Fighting.*

Under a new system for renumbering and reclassifying NFPA public fire protection standards, this document was renumbered to NFPA Standard 1231 in July, 1975, during the Technical Committee Documentation period.

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Interpretation Procedure of the Committee on Suburban and Rural Fire Departments

Those desiring an interpretation shall supply the Chairman with five identical copies of a statement in which shall appear specific reference to a single problem, paragraph, or section. Such a statement shall be on the business stationery of the inquirer and shall be duly signed.

When applications involve actual field situations they shall so state and all parties involved shall be named.

The Interpretations Committee will reserve the prerogative to refuse consideration of any application that refers specifically to proprietary items of equipment or devices. Generally inquiries should be confined to interpretation of the literal text or the intent thereof.

Requests for interpretations should be addressed to the National Fire Protection Association, 470 Atlantic Avenue, Boston, MA 02210.

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Standard on Water Supplies for

Suburban and Rural Fire Fighting

NFPA 1231–1975

Chapter 1 Administration

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

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. The purpose of this Standard is to specify minimum requirements for water supply for fire fighting that will provide a reasonable degree of protection to life and property from fire in areas without approved, piped water systems with hydrants attached.

It is the intent of this Standard that the authority having jurisdiction, the fire department having jurisdiction, property owners in the jurisdiction, and any other responsible agencies shall work together to provide and maintain these minimum water supplies for fire fighting purposes.

The requirements of this Standard are minimum, and nothing herein shall be interpreted to mean that the authority having jurisdiction cannot exceed any or all of these requirements.

1-3 General.

1-3.1 The requirements of Chapters 4 and 5 of this Standard are performance oriented and allow the authority having jurisdiction the option of how to make these water supplies available, with consideration given to local conditions.

1-4 Definitions.

1-4.1 The definitions included in this Section shall be for the purpose of defining terms only for this Standard.

1-4.1.1 Authority Having Jurisdiction. The governmental entity that has the power to adopt and enforce, or order enforcement of, ordinances, or regulations, or both.

1-4.1.2 Fire Department Having Jurisdiction. The fire department serving the area, or any portion of the area, governed by the authority having jurisdiction. The authority having jurisdiction and the fire department having jurisdiction may be the same agency.

1-4.1.3 Occupancy Hazard Classification Number. A series of numbers from 3 through 7 that are mathematical factors used only in a formula to determine total water supply requirements of this Standard.

1-4.1.4 Structure. Any building erected for the support, shelter, or enclosure of persons, animals, or property of any kind.

Chapter 2 Structure Surveys

2-1 General.

*2-1.1 The fire department having jurisdiction shall perform an on-site survey of all structures, including the occupancy (occupancies) and contents, within the applicable jurisdiction to obtain the information needed to compute the total water supplies required.

2-1.2 Residential areas specified in 4-2.1, 4-3.1, 4-4.1.1, and 4-4.2.1 may be surveyed as an area to determine square footage or cubic footage of each structure and distance to structural exposure hazards, but without a survey of contents.

2-1.3 These surveys may 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 2-1.1 or 2-1.2, whichever is applicable, shall determine the Occupancy Hazard Classification Number from the sections of this chapter.

3-1.2 Occupancy Hazard Classification Numbers shall not be assigned to any structure not surveyed as specified in 2-1.1 or 2-1.2, whichever is applicable.

*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 Number 3.

3-2.3.1 Occupancies in this classification are 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.

3-2.3.2 Occupancy Hazard Classification Number 3 *examples* include:

Aircraft Hangars
Chemical Works and Plants
Cotton Picker and Opening Operations
Distilleries
Explosives and Pyrotechnics Manufacturing and Storage
Linoleum and Oil Cloth Manufacturing
Linseed Oil Mills
Oil Refineries
Plastics Manufacturing and Storage
Solvent Extracting
Varnish and Paint Manufacturing

3-2.4 Occupancy Hazard Classification Number 4.

3-2.4.1 Occupancies in this classification are 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 Occupancy Hazard Classification Number 4 *examples* include:

- Department Stores
- Exhibition Halls
- Feed Mills
- Flour Mills
- Paper and Pulp Mills
- Paper Process Plants
- Piers and Wharves
- Repair Garages
- Tire Manufacturing and Storage
- Warehouses, such as:
  - paper
  - furniture
  - paint
  - department store
  - general storage
  - whiskey
- Wood Machining

3-2.5 Occupancy Hazard Classification Number 5.

3-2.5.1 Occupancies in this classification are considered MODERATE HAZARD OCCUPANCIES, where quantity and combustibility of contents are moderate and stockpiles of combustibles do not exceed 12 feet 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 Number 5 *examples* include:

- Cereal Mills
- Clothing Manufacturing
- Cold Storage Warehouses
- Confectionery Products Warehouses
- Farm Storage Buildings, such as:
  - hay barns
  - dairy barns
  - equipment sheds
  - corn cribs

Grain Elevators and Warehouses
Leather Goods Manufacturing
Libraries (with large stock room areas)
Lithographing
Machine Shops
Mercantiles
Metal Working
Pharmaceutical Manufacturing
Printing and Publishing
Restaurants
Rope and Twine Manufacturing
Shoe Manufacturing
Sugar Refining
Tanneries
Textile Manufacturing
Tobacco Barns
Wood Product Assembly

3-2.6 Occupancy Hazard Classification Number 6.

3-2.6.1 Occupancies in this classification are considered LOW HAZARD OCCUPANCIES, where quantity and combustibility of contents are moderate and stockpiles of combustibles do not exceed 8 feet 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 Number 6 *examples* include:
Automobile Parking Garages
Bakeries
Beverage Manufacturing
Boiler Houses
Breweries
Brick, Tile, and Clay Products
Canneries
Cement Plants
Churches
Dairy Products Manufacturing and Processing
Electric Generating Stations
Electronics Plants
Foundries
Fur Processing
Glass and Glass-products Manufacturing
Laundries
Slaughterhouses

Steel Mills
Theaters and Auditoriums
Watch and Jewelry Manufacturing
Waterworks Manufacturing
Wineries

3-2.7 Occupancy Hazard Classification Number 7.

3-2.7.1 Occupancies in this classification are 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 Number 7 *examples* include:

Apartments
Colleges and Universities
Dormitories
Dwellings
Hospitals
Hotels and Motels
Libraries (except large stock room areas)
Museums
Nursing and Convalescent Homes
Offices (including data processing)
Prisons
Schools

Chapter 4 Determining Total Water Supplies

4-1 General.

4-1.1 The fire department having jurisdiction for structural surveys specified in 2-1.1 and 2-1.2, after completing the survey and determining the Occupancy Hazard Classification Number, shall compute the total water supply, in gallons, needed for the structure or area.

4-1.2 Where structures are close enough in an area that they may be served by a single water supply that meets the requirements of 4-2.2, 4-3.3, 4-3.4, 4-4.1.2, or 4-4.2.4, whichever is applicable, the single water supply shall be computed on the largest structure in the area, or the structure with the lowest Occupancy Hazard Classification Number (highest hazard), whichever requires the larger total water supply. (*See Appendix A-4-4.2.1.*)

4-1.3 The total water supply computed for an area as specified in 4-1.2 shall not be less than 3,000 gallons.

4-2 Single- and Two-family Dwellings, 1,200 Square Feet and Under.

4-2.1 For single- and two-family dwellings only, not greater than 1,200 square feet in total area including any attached structures, and with no portion of any unattached structural exposure hazard closer than 50 feet unless it is smaller than 100 square feet, the total water supply shall not be less than 2,000 gallons.

4-2.2 The total water supply specified in 4-2.1 shall be available on the fire ground at a rate of not less than 500 gpm. The fire department shall be capable of utilizing the total water supply at a rate of not less than 500 gpm.

4-3 All Structures Except Dwellings Specified in 4-2.1.

*4-3.1 For all structures with no portion of any unattached structural exposure hazard closer than 50 feet unless it is smaller than 100 square feet, the total water supply in gallons shall be determined by the total cubic footage of the structure, including any attached structures, divided by the Occupancy Hazard Classification Number determined from Chapter 3.

4-3.2 The total water supply required for any structure specified in 4-3.1 shall not be less than 2,000 gallons.

4-3.3 The total water supply, from 2,000 gallons through 19,999 gallons, as determined for any structure specified in 4-3.1, shall be available on the fire ground at a rate of not less than 500 gpm. The fire department shall be capable of utilizing the total water supply at a rate of not less than 500 gpm.

4-3.4 The total water supply for 20,000 gallons or more, as determined for any structure specified in 4-3.1, shall be available on the fire ground at a rate of not less than 1,000 gpm. The fire department shall be capable of utilizing the total water supply at a rate of not less than 1,000 gpm.

* 4-3.5 For special fire protection problems other than structural, such as bulk flammable liquid and bulk flammable gas storage, the fire department having jurisdiction shall determine the water supply required for fire fighting purposes.

4-4 Structures with Exposure Hazards.

4-4.1 Single- and Two-family Dwellings, 1,200 Square Feet and Under.

4-4.1.1 For single- and two-family dwellings only, not greater than 1,200 square feet in total area including any attached structures, and with structural exposure hazard closer than 50 feet to any portion of the dwelling and larger than 100 square feet, the total water supply shall be not less than 3,000 gallons.

4-4.1.2 The total water supply specified in 4-4.1.1 shall also meet the requirements specified in 4-2.2.

4-4.2 All Structures Except Dwellings Specified in 4-4.1.1.

* 4-4.2.1 For all structures with unattached structural exposure hazards closer than 50 feet to any portion of the structure and larger than 100 square feet, the total water supply, in gallons, shall be determined by the total cubic footage of the structure, including any attached structures, divided by the Occupancy Hazard Classification Number determined from Chapter 3, and that quotient multiplied by 1.5.

4-4.2.2 The fire department having jurisdiction shall have the authority to allow variances to the requirements of 4-4.2.1 where specific individual conditions may require lesser amounts of water for exposure protection.

4-4.2.3 The total water supply required for any structure specified in 4-4.2.1 or 4-4.2.2 shall not be less than 3,000 gallons.

4-4.2.4 The total water supply specified in 4-4.2.1 or 4-4.2.2 shall also meet the requirements of 4-3.3 or 4-3.4, whichever is applicable.

4-4.2.5 For severe structural exposure hazards, bulk flammable liquid or bulk flammable gas storage as an exposure hazard, or different exposure hazard conditions other than those covered in Section 4-4, the fire department having jurisdiction shall determine the additional water supply required for exposure protection.

4-5 Structures with Automatic Sprinkler Protection.

4-5.1 For any structure fully protected by an automatic sprinkler system that meets the requirements of NFPA Standard 13, Sprinkler Systems, 1975, and, in addition, meets the requirements of 4-5.1.1, 4-5.1.2, and 4-5.1.3, the fire department having jurisdiction may waive any requirement for additional water supply required by this Standard.

4-5.1.1 Automatic sprinkler systems referred to in 4-5.1 shall be fully supervised, including water flow, and all signals shall be transmitted directly to a central station or a fire alarm center.

4-5.1.1.1 The central station shall meet the requirements of NFPA Standard 71, *Central Station Signaling Systems,* 1974.

4-5.1.1.2 Fire alarm centers shall meet the requirements of NFPA Standard 73, *Public Fire Service Communications,* 1975.

4-5.1.1.3 Transmission of all alarm and supervisory signals to other than central stations shall meet the requirements of NFPA Standard 72B, *Auxiliary Protective Signaling Systems,* 1975; NFPA Standard 72C, *Remote Station Protective Signaling Systems,* 1975; NFPA Standard 72D, *Proprietary Protective Signaling Systems,* 1975; whichever is applicable.

*4-5.1.2 The water supply for automatic sprinkler systems referred to in 4-5.1 shall be available outside the structure to the fire department for fire fighting purposes, and shall also meet the requirements of 4-3.3 or 4-3.4, whichever is applicable.

4-5.1.3 Automatic sprinkler systems referred to in 4-5.1 shall, in all cases, be provided with a fire department connection as described in NFPA Standard 13, *Sprinkler Systems,* 1975, Section 2-7.

4-5.2 For any structure protected by an automatic sprinkler system that does not meet the requirements of 4-5.1, the fire department having jurisdiction may reduce up to 50 percent of the total water supply for fire fighting purposes required by Section 4-3 or 4-4 of this Standard, whichever is applicable.

4-5.2.1 The water supply for automatic sprinkler systems referred to in 4-5.2 shall be in addition to the water supply for fire fighting purposes required by this Standard.

4-6 Structures with Other Automatic Fire Suppression Systems.

4-6.1 For any structure fully or partially protected by an automatic fire suppression system other than automatic sprinkler systems specified in Section 4-5, the fire department having jurisdiction shall determine the total water supply required for fire fighting purposes.

Chapter 5 Water Supply

5-1 The total water supplies required for fire fighting purposes, as specified in Chapter 4, may be supplied from various sources, including rivers, streams, irrigation canals, lakes, ponds, wells, cisterns, swimming pools, livestock watering tanks, tanks, tankers, or a combination of sources; and may be obtained within practical distances by use of various methods, including relay pumping operations using multiple lines or large diameter hose, or tanker shuttles.

5-2 The total water supply, from whatever source or combination of sources, shall meet the requirements of 4-2.2, 4-3.2, 4-3.4, 4-4.1.2, or 4-4.2.4, whichever is applicable.

***5-3 Accessibility.** Water supplies for fire fighting purposes shall be accessible to fire fighting equipment.

Chapter 6 Reports

6-1 Requirements for the Fire Department.

6-1.1 The fire department having jurisdiction for structural surveys specified in 2-1.1 and 2-1.2, after completing the survey and computing the total water supply required, shall notify, in writing, the authority having jurisdiction of the results of the surveys, the Occupancy Hazard Classification Numbers, and the total water supplies required. In cases of water supply deficiencies, the building owner (building(s) owners) shall also be so notified.

6-1.2 When notified of changes specified in 6-2.1, 6-2.2, 6-2.3, and 6-2.4, the fire department shall review planned changes or alterations or both to determine if total water supply requirements will change, and shall notify, in writing, the authority having jurisdiction and the building owner (building(s) owners) of any changes in the total water supply required.

6-1.3 The fire department shall retain a copy of all reports specified in 6-1.1, 6-1.2, 6-2.1, 6-2.2, 6-2.3, and 6-2.4.

6-2 Requirements for Property Owners or Occupants.

6-2.1 The property owner shall notify, in writing, the fire department having jurisdiction whenever any plans are made to erect any structure. The property owner shall provide for the fire department having jurisdiction complete written plans and drawings of any proposed structure, including all measurements, intended occupancy, and contents.

6-2.2 The property owner shall notify, in writing, the fire department having jurisdiction whenever any plans are made to alter any existing structure, and this alteration would increase the total cubic footage of the structure. The property owner shall provide the fire department having jurisdiction with complete written plans and drawings of the proposed alterations, including all measurements, intended occupancy, and contents.

6-2.3 The property owner, or occupant, or both shall notify, in writing, the fire department having jurisdiction whenever any changes are planned to be made to the contents of a structure, other than residential occupancies, that would materially affect the content load, flammability of contents, or other content changes that may change the Occupancy Hazard Classification

Number as specified in Section 3-2. The property owner, or occupant, or both shall provide the fire department having jurisdiction with a complete written report of content changes planned, including the type and amount.

6-2.4 The property owner, or occupant, or both shall notify, in writing, the fire department having jurisdiction whenever any alterations are planned that would cause any change to an automatic sprinkler system covered in Section 4-5. The property owner, or occupant, or both shall provide the fire department having jurisdiction with a complete written report of planned alterations to any existing sprinkler system, or the installation of a new sprinkler system.

6-2.5 The property owner, or occupant, or both shall promptly notify the fire department having jurisdiction whenever any automatic sprinkler system, or portion of any system, is shut off, or is to be shut off, for any reason.

Appendix A

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

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

(a) Area of all floors and cellar.

(b) Height including cellar, each floor, and attic, from attic floor to ridge pole.

(c) Occupancy (occupancies), contents, exposures, distance to exposure hazards, automatic fire suppression systems.

A-3-2 The Occupancy Hazard Classification Number is a mathematical factor to be used in calculating total water supplies. The lowest Occupancy Hazard Classification Number is 3 and is assigned to the highest hazard grouping. The highest Occupancy Hazard Classification Number is 7 and is assigned to the lowest hazard grouping.

A-4-3.1 Examples of Calculating Total Water Supply.

(a) Residential:

Dwelling: 50 feet by 25 feet; 2 stories, 8 feet each; pitched roof, 8 feet from attic floor to ridge pole.

$25 \times 50 = 1{,}250$ (square feet)
Heights $8 + 8 + 4^* = 20$ (feet)
$1{,}250 \times 20 = 25{,}000$ (cubic feet)
Occupancy Hazard Classification Number 7
$25{,}000 \div 7 = 3{,}571$
TOTAL WATER SUPPLY = 3,571 gallons

*For pitched roofs, figure half the distance from attic floor to ridge pole.

(b) Industrial:

Printing plant: 125 feet by 100 feet; height 14 feet; 1 story; flat roof.

$125 \times 100 = 12{,}500$ (square feet)
Height = 14 (feet)
$12{,}500 \times 14 = 175{,}000$ (cubic feet)
Occupancy Hazard Classification Number 5
$175{,}000 \div 5 = 35{,}000$
TOTAL WATER SUPPLY = 35,000 gallons

(c) Assembly:

Church: 130 feet by 60 feet; height 25 feet to ridge pole; ridge pole 10 feet above the eaves.

130 × 60 = 7,800 (square feet)
Height 15 + 5 = 20 (feet)
7,800 × 20 = 156,000 (cubic feet)
Occupancy Hazard Classification Number 6
156,000 ÷ 6 = 26,000
TOTAL WATER SUPPLY = 26,000 gallons

A-4-3.5 The fire department having jurisdiction could consider the number of fire streams required to control a potential fire in such an occupancy, multiplying the estimated total application rate in gpm by a liberal estimate of time in minutes (60 minutes or more) required to control and extinguish the fire.

A-4-4.2.1 Examples of Calculating Total Water Supplies.

(a) Residential:

Dwelling same as A-4-3.1(a) only with a barn measuring 80 feet by 40 feet located 40 feet from dwelling. The barn is larger than 100 square feet in area and is closer than 50 feet to the dwelling. Therefore, the total water supply for the dwelling (3,571 gallons) must be multiplied by 1.5.

3,571 × 1.5 = 5356.5
TOTAL WATER SUPPLY = 5,357 gallons

If the dwelling and barn are to be protected by the same water supply, as they most likely would be, the water supply must be calculated on the structure that requires the larger total water supply (*see 4-1.2*) which would be the barn in this case. Thus, if the barn is 25 feet in height to the ridge pole, and the ridge pole is 10 feet above the eaves, the calculations would be as follows:

80 × 40 = 3,200 (square feet)
Height 15 + 5 = 20 (feet)
3,200 × 20 = 64,000 (cubic feet)
Occupancy Hazard Classification Number 5 (for the barn)
64,000 ÷ 5 = 12,800
12,800 × 1.5 (for exposure hazard — the dwelling) = 19,200
TOTAL WATER SUPPLY = 19,200 gallons

(b) Industrial:

Printing plant same as A-4-3.1(b), only with an office building measuring 75 feet by 30 feet located 30 feet away from the printing plant. The office building is larger than 100 square feet in area and is closer than 50 feet to the print shop. Therefore, the total water supply for the print shop (35,000 gallons) must be multiplied by 1.5.

35,000 × 1.5 = 52,500 gallons

TOTAL WATER SUPPLY = 52,500 gallons

Whereas the print shop requires the larger total water supply (*see 4-1.2*), if these two buildings were to be protected by the same water supply, that total water supply would be the 52,500 gallons.

(c) Assembly:

Church same as A-4-3.1(c), only with a dwelling measuring 50 feet by 25 feet located 45 feet from the church. The dwelling is larger than 100 square feet in area and is closer than 50 feet to the church. Therefore, the total water supply for the church (26,000 gallons) must be multiplied by 1.5.

26,000 × 1.5 = 39,000

TOTAL WATER SUPPLY = 39,000 gallons

Whereas the church requires the larger total water supply (*see 4-1.2*), if these two buildings were to be protected by the same water supply, that total water supply would be the 39,000 gallons.

A-4-5.1.2 The fire department should take 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.

A-5-3 Accessibility to water supplies should incorporate whatever features necessary to ensure year round travel taking into consideration local climatic conditions and topography. See Appendix B-1-5 for further information on access roadways to water supplies.

Appendix B

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

B-1-1 Introduction. The fire fighter operating without a water system with hydrants has two means of getting water: from supplies on the fire ground, which may be natural or man-made, or from supplies transported to the scene. This Appendix discusses the variety and potential of these sources and some of the methods used to move the water from the source to the fire.

B-1-2 Natural Water Sources.

B-1-2.1 Streams. The stream represents a continuously flowing source of possibly substantial capacity. Factors for the fire department to determine when considering water from flowing streams as potential water sources include the following:

(a) Flowing Capacity: The stream should deliver water in capacities compatible with those outlined in the water requirements of this Standard.

(b) Climatic Characteristics: The stream should deliver water throughout the year and should not be susceptible to drought. If the stream is subject to freezing, it must be made useful even under such conditions.

(c) Accessibility: Suction points for pumper, portable pump, floating pump or other equipment must be available and must be maintained. Seasonal fire department inspection is desirable. Distance and terrain from the contemplated fire ground to the stream must be such as to make the water readily available.

B-1-2.2 Ponds. Ponds may be natural or man-made for watering livestock, irrigation, fish culture, recreation or other purposes and may serve a secondary function for fire protection. Most of the factors listed in B-1-2.1 (a) through (c) relative to streams are pertinent to ponds also with the following additional items to be checked:

(a) Minimum annual level must 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 may accumulate in a pond, reducing its actual capacity, while its surface area and level remain constant. This may provide a deceptive impression of capacity and calls for at least a seasonal inspection.

B-1-2.3 Other Natural Sources. These might include springs, artesian water supplies, and lakes. Individual springs and occasional artesian water supplies exist in some areas and, again, while generally of more limited capacity, may be useful for water supply subject to reasonable application of the factors listed for ponds and streams. Lakes have the same guidelines as to accessibility, weather, etc., as ponds.

B-1-3 Man-Made Sources of Water.

B-1-3.1 General. The sources of water supply adapted by man for fire fighting are limited only to the innovative nature of the fire department. They range from cisterns, swimming pools, stationary tanks and "dry hydrants" to the occasions when fire fighters have drafted water out of the basement of a fire building into which it was pumped to fight fire only minutes before.

B-1-3.2 Cisterns. Cisterns are one of man's oldest sources of emergency water supply, both for fire fighting and drought storage. They are very important sources of water in many rural areas. A few major cities still have portions of old, major cistern supplies still available to their fire departments.

Cisterns should have a minimum usable volume of 3,000 gallons (with minimum size ideally determined for fire protection requirements by methods described elsewhere in this Standard). They should be accessible to the fire truck, or other pumping device, and be located far enough from the structure they protect not to be endangered by a fire in that structure. They may be designed, as may other sources, to store rain water as well as water from other sources. They may require filling by tank truck. They offer an obvious method of augmenting the supply of a seasonally lowered stream or pond. They present a freezing problem more severe than some other sources in that their surface is often relatively inaccessible. The fire fighter must be prepared to break the frozen surface or the cistern must be built so as not to be subject to problems of freezing. One method is to use a dry hydrant protruding into the water level at a point below the local frost-free depth. Cisterns should be capped for safety, but they should have openings adequate to permit inspection, use of suction hose if it is needed, and ready determination of available capacity by measuring depth.

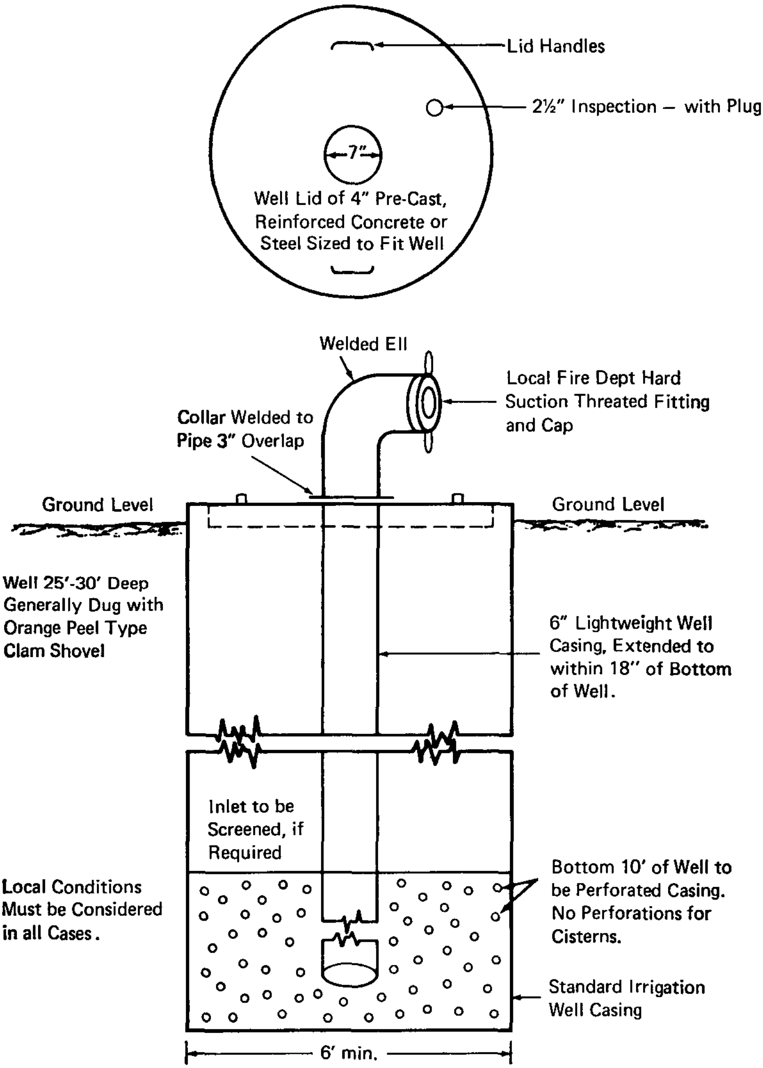


Figure B-1-3.2. Typical well (cistern) with dry hydrant installed. Same design suitable for cistern if bottom of casing is not perforated.

B-1-3.3 Protection from Freezing. A heavy pipe, or a pike pole, may be adequate to break an ice formation, depending on local weather conditions. The weight of the suction hose itself may make it a practical tool providing there is no danger of damage to the hose or its strainer.

Provision of an ice-free water surface area in a cistern or the other water sources mentioned in this Appendix may be provided by, but is not limited to:

(a) Floating a bale of hay, straw, etc., on the surface of the water.

(b) Placing a barrel filled with nonflammable antifreeze on the surface of the water.

B-1-3.4 Guide to Cistern Capacity. A ready guide to cistern capacity for cisterns with vertical sides.

Table B-1-3.4
Cistern Storage Capacity

Inside Diameter in Feet	Storage Capacity per Foot of Depth
6	212 gallons
7	288 gallons
8	376 gallons
9	476 gallons
10	588 gallons

WARNING: Reference is made to water depths in cisterns, swimming pools and other sources in a number of places in this Appendix. The fire fighter should always remember that the depth with which he is concerned is the *usable* depth. In a cistern, a bottom bed of gravel protecting a dry hydrant inlet or outlet, for instance, decreases the usable depth to the area above the gravel. A pump suction requires a submergence below the water surface, depending upon the rate of pumping, to prevent the formation of a vortex. Therefore, pumping rates must be adjusted as the water level is lowered. This factor must be considered when estimating the effective rate that water can be drawn from all suction supplies.

Construction of cisterns is governed by local conditions of soil and material availability. Practical information can be obtained from local governmental agricultural agencies. Maintenance factors to be considered by the fire department include the danger of siltation, evaporation loss or other low water conditions, and freezing problems previously discussed.

B-1-3.5 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 instances in which water demands have exceeded availability because of wildfire disasters, etc. They have an advantage in that they are sources of clean water and have a limited hardstand of cement on which to place pumps, but have a major drawback in poor accessibility for large apparatus. There are some areas of the country now in which "swimming pool distribution" is closer than hydrant distribution. It is good practice for fire departments to make these water sources useful.

B-1-3.6 Pool Accessibility. Most swimming pools are built in areas requiring security fencing or walls and these present a problem of accessibility. Fences and walls, depending on construction, are susceptible to forceable entry by cutters, sledgehammers, etc.; but in most cases the better solution to problems of accessibility is in use of long lengths of suction hose, portable pumps, dry hydrants (*see Figure B-1-4.2A*), or properly spaced gates. Portable (or floating) pumps, rigged for large volume delivery at limited pressures, delivering water to fire department pumpers are usually ideal where accessibility problems exist. (*See also Figure B-1-7.6.*) A swimming pool virtually under the eaves of a burning house may be a very poor location from which to pump, and care in selection of the exact location from which to pump is important. Pumping from a neighboring pool, if it is close enough, is frequently preferable to pumping from the pool of the burning house. Lines, in some cases, may be laid from the pool of one house through the living section, and out the door to the burning house. This may provide a better source of water than pumping from the pool of the fire building if there are problems of fire exposure, work area, etc.

B-1-3.7 Pool Capacity. A short-form method of estimating pool capacity is:

A = length times width in feet with these dimensions estimated, or rounded off if pool is of stylized construction.

B = estimated average depth in feet, from water line.

$A \times B \times 7.5$ = estimated capacity (in gallons).

Consideration should be given for more suction hose on engines working in areas dependent on swimming pools. Fast rigging of such suction hose demands special training. Using long lengths of hose over walls and other obstacles typical of swimming pools demands techniques other than those used for drafting from ponds or streams. Adequate prefire planning requires knowledge of individual pools so that the method of obtaining water to the property is known. Lightweight suction hose can be advantageous for this purpose.

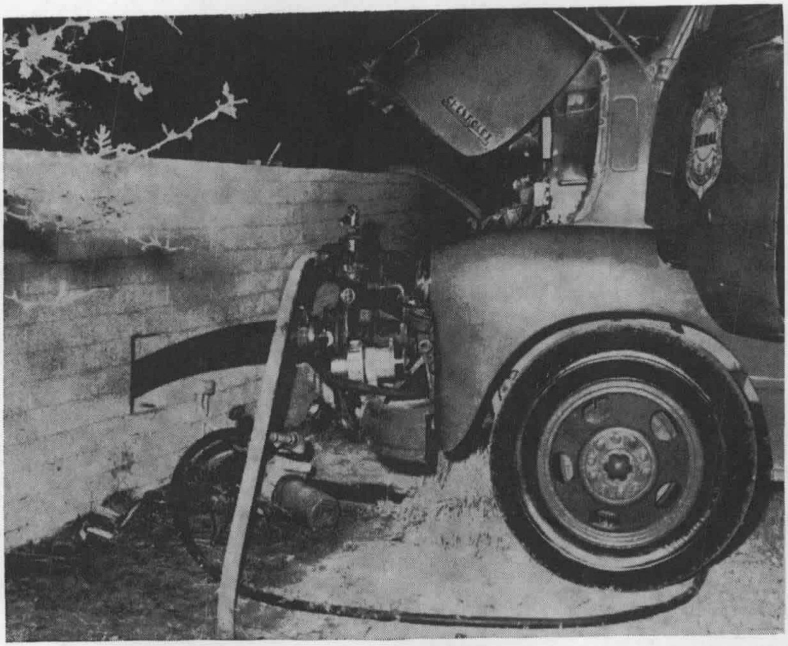


Figure B-1-3.6. Pool Accessibility. Opening in wall designed for suction access permits rapid use of swimming pool water supply.
(Photo by Rural/Metro Fire Department, AZ)

B-1-3.8 Care in Use of Pools. Care must be exercised to be sure structural damage will not be done to a pool if it is drained for fire fighting. Some pools are compacted earth covered by a plastic surfacing, or light-guage metal panels placed against such earth or a special fill. Such pools may collapse internally if emptied. It may be possible to use a limited portion of such water sources but not possible to use the entire depth apparently available. It may be prudent not to use the pool at all.

Lightly built cement, gunite or poured concrete pools may present danger of structural damage, cracking, or collapse when drained. There is a further possibility that a pool in extremely wet soil will tend to float upwards when drained, and fire fighting operations might contribute additional water to this already high water table, making the problem worse.

The fire chief may study various methods of pool construction within the area he serves and consult with the builders of these pools.

B-1-3.9 Driven Wells. In areas with suitable soil conditions, for instance, those of a very sandy nature, it may be possible to use driven wells to obtain water for fire fighting. These wells are, in essence, pipes, usually with perforations about the base to permit entry of water, driven into the ground. From the threaded pipe head (or a fitting attached to the body of the pipe) a pump connection may be made to draft water much as from a dry hydrant. Material on this technique is available from the U.S. Forest Service. A high water table is a prerequisite to use of this method. Fire fighting units in areas conducive to this technique should have the necessary equipment for such installations.

B-1-4 Dry Hydrants.

B-1-4.1 General. The use of natural water sources and man-made water sources requires an understanding of dry hydrant construction. The dry hydrant provides a ready means of suction supply without the longer time often involved in drafting directly out of a swimming pool, cistern, etc. Although most rural fire departments are equipped to draft water directly from farm ponds or streams, and all should be, a hydrant beside an all-weather road is preferable.

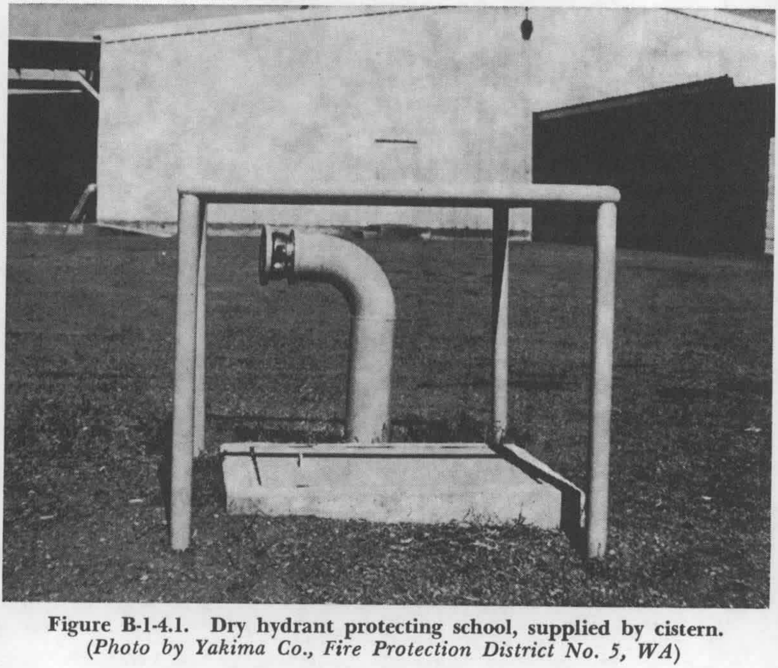
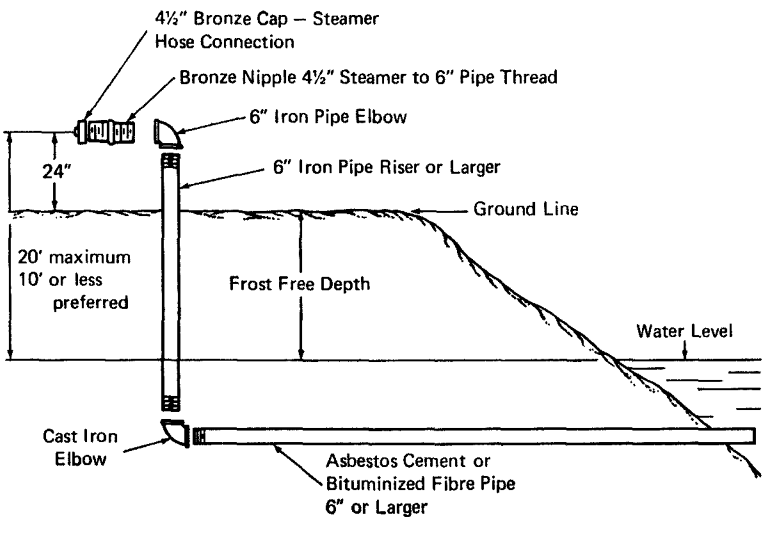


Figure B-1-4.1. Dry hydrant protecting school, supplied by cistern. (*Photo by Yakima Co., Fire Protection District No. 5, WA*)

B-1-4.2 Dry Hydrant Construction. Depending upon the desired flow, the distance to the water, and the difference in elevation between the hydrant and water source, a 6-inch or larger pipe is necessary. The pipe should be approved for the use and installed to manufacturer's standards. It should be laid between hydrant and pond or stream as shown in Figures B-1-4.2 A and B-1-4.2B. The pipe must be laid at a frost-free depth, down to six feet or more in northern states or other severe weather areas.



Exploded view of dry hydrant construction.

Figure B-1-4.2A. Dry hydrant construction.

Table B-1-4.2 may be used to determine pipe size of a given hydrant line basing the flow upon 10 psi or 20 feet of head.

Table B-1-4.2
Gallons per Minute Flow at 20 Feet of Head on Typical 6″ Pipe[1]

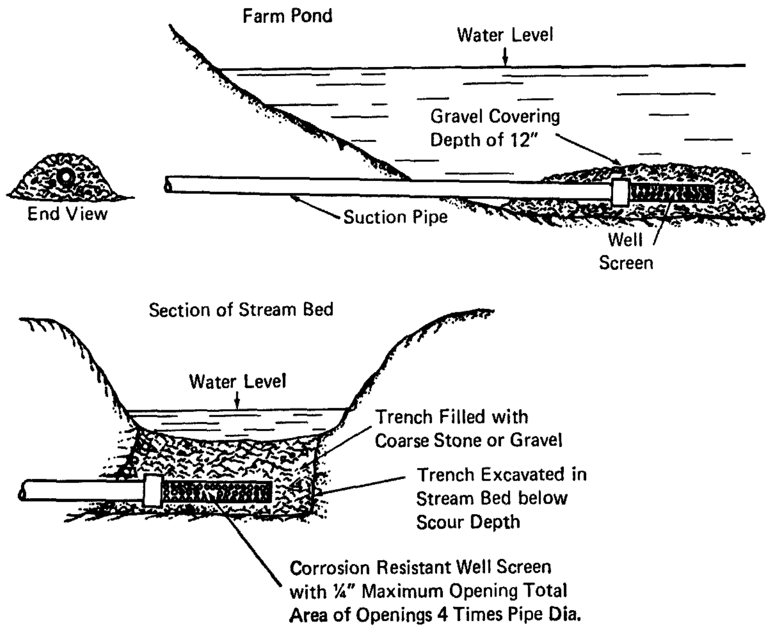
Length	Bituminous Fiber or Steel (C = 120)	Cast Iron (C = 110)	Asbestos Cement (C = 130)
25′	3,400	3,060	3,650
50′	2,300	2,100	2,500
100′	1,600	1,475	1,700
500′	660	615	720
1000′	460	425	495

1 Based upon the Hazen-Williams formula with estimated values of C. Courtesy of Dr. Gilbert Levin.

A strainer is needed for the suction end of the pipe line to keep foreign materials out of the pipe. A strainer may be purchased or constructed by boring 1/4-inch holes through the pipe. The holes should be spaced on 1/2-inch centers, with at least 12 rows drilled. The end of the pipe should be plugged, placed with the strainer at the deepest portion of the pond or other water source, and raised up off the bottom about 2 feet so it will always be above any silt that may accumulate.

The strainer should be covered with crushed rock to exclude marine growth and to prevent mechanical damage. For a dry hydrant, the pipe should be laid at a minimum slope (2 or 3 inches per 100 feet) up to the hydrant riser. For a pressure hydrant, the pipe should be sloped downhill to the hydrant riser and be fitted with a gate valve. Where the supply line passes through the dike of the pond, anti-seep collars should be attached to the pipe to prevent water from seeping and channeling beside the pipe. The riser on a dry hydrant should be exposed above ground approximately 24 inches.

For stream bed installations, the strainer must be buried deep enough to prevent the scouring action of the stream, during periods of high runoff, from exposing the strainer and tearing it loose from the supply pipe. An estimate of proper depth should be obtained from a hydraulic engineer, university extension service, or the U.S. Soil Conservation Service. [*See Figure B-1-4.2B.*]



Details of screen layout — pond and stream sites.

Figure B-1-4.2B. Details of screen layout — pond and stream sites.

B-1-4.3 Maintenance of Dry Hydrant. These facilities require periodic checking, testing, and maintenance. Checking and testing should be a part of fire department training and drills. Thorough inspection of private properties should reveal any deterioration in the water supply situation in ponds, streams, or cisterns.

Particular attention should be given to streams and bypass ponds. They need frequent removal of debris, dredging or excavation of silt, and protection from erosion. The hydrant should be tested at least annually with a pumper, at a maximum designed flow rate, with records kept of each test. Tests of this kind will not only verify proper condition but will keep the line and strainer clear of silt and the water supply available for any fire emergency.

The pond should be maintained as free of aquatic growth as possible. USDA Farmer's Bulletin, "Waterweed Control on Farms and Ranches," is a source of good information on this subject. At times, it may be necessary to drain the pond to control this growth.

Inspection procedures should include safety items such as posting warning signs, seeing that life preservers, ropes, etc., are available. Particular attention should be given to local authority regulations governing such water points.

B-1-4.4 Useful Depth of Water Sources. Careful note must be made of the fact that installation of dry hydrants as noted in previous sections may call for care in measuring water storage capacities. The useful depth of a cistern with a dry hydrant installation, for instance, is from the minimum foreseeable low-water surface level to the top of the suction strainer, not to the bottom of the cistern. A pump suction requires a submergence below the water surface depending upon the rate of pumping to prevent the formation of a vortex. Therefore, pumping rates must be adjusted as the water level is lowered. This factor must be considered when estimating the effective rate that water can be drawn from all suction supplies.

B-1-5 Access Roadways to Water Supplies.

B-1-5.1 General. A water supply can be made useless by the fire department's inability to reach it. Table B-1-5.1 details considerations which should be followed in considering access.

Table B-1-5.1
Recommendations for Roads to Water Supplies

Width:	Roadbed — 12 feet. Tread — 8 feet. Shoulders — 2 feet.
Alignment:	Radius centerline curvature — 50 feet.
Gradient:	Sustained grade — 8 percent.
Side Slopes:	All cut and fill slopes to be stable for the soil involved.
Drainage:	Bridges, culverts or grade dips at all drainageway crossings. Roadside ditches deep enough to provide drainage. Special drainage facilities (tile, etc.) at all seep areas and high water table areas.
Surface:	Treatment as required for year-round travel.
Erosion Control:	Erosion control measures as needed to protect road ditches, cross drains, and cut and fill slopes.
Load Carrying Capacity:	Adequate to carry maximum vehicle load expected.

B-1-6 On-site Water Systems.

B-1-6.1 General. The individual 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, a large elevated water storage tank or reservoir connected to hydrants and/or standpipes could provide substantial fire streams as well. A pressure tank of adequate size could also provide substantial fire streams.

To provide for fire protection in depth, three types of water supplies may 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, or cistern, and (3) an area system of static water supplies with drafting points.

For domestic water systems to have 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 being deenergized by fire or other cause.

For first-aid fire protection, every portion of the dwelling and outlying buildings should be within reach of a hose stream. This may 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 use. Care should be taken so that water is drained from hose or pipes that could be subject to freezing weather.

Excellent publications on rural water systems including design criteria are available from the United States Department of Agriculture.

B-1-7 Portable Pumping Equipment.

B-1-7.1 General. Except for direct drafting by pumpers, the use of portable pumps is perhaps the most common method of moving water for fire fighting from a source to the fire ground.

A portable pump in the fire service means a pump which can be carried to a source by fire fighters, sometimes over difficult terrain. When put into operation it should supply sufficient water to rapidly fill tank trucks and supply pumpers at the fire scene or fire fighting hose lines. Heavier pumps, perhaps trailer or truck-mounted, or otherwise made mobile, are valuable, but used less commonly.

The National Fire Protection Association has Standard No. 1921, *Portable Pumping Units*, 1975, which sets forth specifications to be followed when obtaining portable pumps. It classifies these pumps by their capacities and operating pressures for use in the fire service.

(a) *Small Volume — Relatively High Pressure.* This pumping unit shall be capable of pumping 15 to 20 gpm at 200 psi pressure through a one-inch discharge outlet while taking suction through a one and one-half inch suction inlet. This class of portable pumps is especially useful to fire departments for forest fire fighting which frequently requires long 1½-inch hose lines and pumping uphill in rugged terrain.

(b) *Medium Volume — Medium Pressure.* This pumping unit shall be capable of discharging 60 gpm at 90 psi pressure and 125 gpm at 60 psi pressure through a one- and one-half inch discharge outlet while taking suction through a two and one-half inch suction inlet. This class of portable pump has limited utility for small structural fires and can supply a good ½-inch stream through 250 feet of 1½-inch hose. It can be used to fill booster tanks or be used with 2½-inch hose to move water a long distance.

(c) *Large Volume — Relatively Low Pressure.* This pumping unit shall be capable of supplying 125 gpm at 60 psi pressure and 30 gpm at 20 psi pressure through a two and one-half inch discharge outlet while taking suction through a three inch suction inlet. This class of portable pumping unit is frequently used for tank filling when a pumper cannot get close to a source of water. It is also suitable for dewatering cellars, manholes, and other areas where water has accumulated.

Among the common types of pumps used are:

B-1-7.2 Gear Pumps. Gear pumps (high pressure, low volume) are of positive displacement type with gears having very close tolerances between gears and case. They may be used safely in clear water only. Dirty water will cause damage to gears and case. They are not very useful for tank filling or relay work as they are generally of low capacity in the lighter models.

They are very good for fire fighting where high pressures are desired. These pumps have a shorter life span than the centrifugal type, are widely used by the U.S. Forest Service and are easily packed on the back. They should never be operated without water and must be equipped with a relief valve.

B-1-7.3 Piston Pumps. Piston pumps (high pressure, low volume) are operated by a piston, sleeve, or cylinder with two check valves. They can be either single or double action with one or more cylinders. They are positive displacement type and must be operated with clean water. They are usually high pressure pumps. Piston-type pumps are limited to small capacities and weigh more than centrifugal or gear pumps. They are capable of very high lift.

B-1-7.4 Low Pressure Centrifugal Pumps. The low pressure centrifugal portable pumps (high volume) generally are rated at 200 to 300 gpm and capable of discharge at pressures of 50 psi to 80 psi. Usually these pumps will not discharge rated capacities when operating with suction lift in excess of 5 feet.

Some of these pumps do not use running rings or seal rings. These types do not have close tolerance so may be used in dirty water where some debris or abrasives are encountered. These pumps require little maintenance.

Other brands of portable pumps in this category do have water or seal rings which will not hold up as long when pumping water containing substantial amounts of abrasive materials.

At lower discharge pressures, this type pump may deliver larger volumes which at times have been metered at over 400 gpm at very low discharge pressures and high pump rpm's. (Example: Relay from portable pump into fire pump on apparatus.)

Operation of these pumps depends on centrifugal force to move water and they are very effective for relay operations to pumpers or for booster tank or tanker filling. There are no special operating problems to watch out for and the pump will not heat up as rapidly as others if run without water.

B-1-7.5 High Pressure Centrifugal Pumps. High pressure portable pumps (small volume) generally have a small capacity with an average of 30 to 40 gallons per minute discharge and operating pressures in the 125 to 150 pounds per square inch range.

The impeller is usually geared twice as fast as the engine to get the pressure at single stage. This type uses running rings or seal rings the same as larger fire pumpers and usually incorporates closed volutes in the impeller.

B-1-7.6 Floating Pumps. A more recent development in portable pumps is the floating pump which primes and pumps automatically when placed in water. This type of pump is constructed to sit inside a float which resists breakage and needs no maintenance. Some entire units weigh under 50 pounds including fuel and provide from 60 to 90 minutes of operating time from the 5-quart fuel tank.

The pump serves a need for a lightweight, easy to operate, portable fire pump which may be placed in the water and does not need suction hose or strainers.

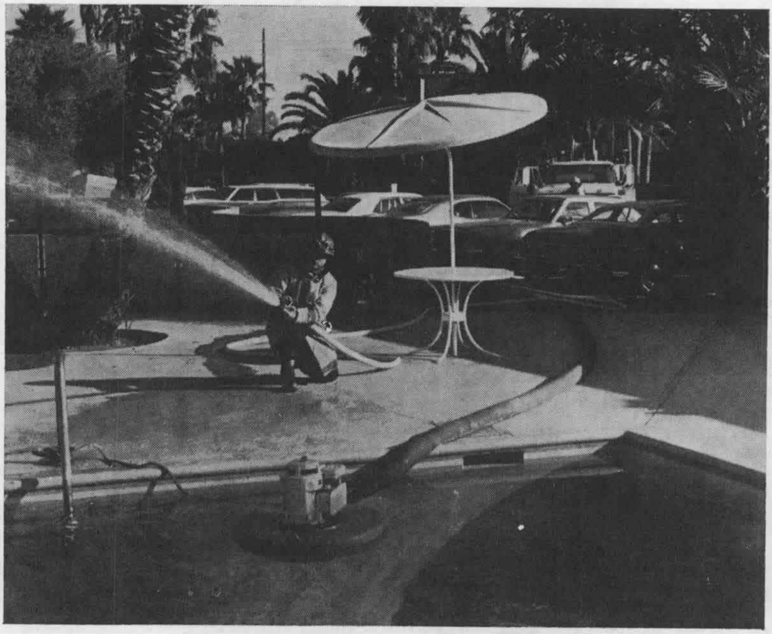


Figure B-1-7.6. Floating 500 GPM pump in swimming pool supplying fire department pumper (in background) through large diameter hose.

B-1-7.7 High-lift Pumps. The high-lift pump is a small, portable pump which uses water to drive a water motor, which in turn drives an impeller and pumps water to high elevations into a fire pumper for relay into hose lines for fire fighting.

The high-lift pump is designed to obtain a water supply from a river, lake, stream, swimming pool, etc., when not accessible by a pumper or conventional portable pump for drafting operations.

The water used to power the water motor of a high-lift pump is taken from the booster tank of the pumper and discharged at high pressure through the fire pump into the hose to the high-lift pump water motor. This, in turn, drives the water motor which is connected to the high-lift pump impeller, thus forcing volumes of water back into the intake side of the fire pump and on into the fire fighting hose lines.

High-lift pumps may be hooked into hose lines and lowered or tossed into water sources at the lower levels without fire fighting personnel having to go down to set the pump.

B-1-7.8 Dewatering Type Pumps. Dewatering pumps are pumps specifically designed to handle muddy, sandy, or otherwise contaminated water. Some are built to handle spherical solids up to 1½ inches in diameter. These pumps could be used in the fire service to pump water out of basements, tubs, or catchalls during salvage operations.

B-1-7.9 Diaphragm Pump. The diaphragm pump uses a piston type action employing a diaphragm which moves water with each stroke and is capable of handling trashy water without damaging the pump.

B-1-8 Methods of Using Portable Pumps.

B-1-8.1 General. The many problems of supplying water in rural areas can frequently be overcome through the use of the proper portable pump. Many departments, through area pre-fire planning, locate water sources where portable pumps can be used for filling tankers or for supplying fire fighting hose lines.

It is important to evaluate the many uses that can be made of various types of portable pumps. The fire fighter should use this knowledge to apply sound judgment decisions to the types of pumps and uses he will make of them in supplying water through portable pumps at the fire scene.

Departments should, when locating pumping sites for portable pumps, determine whether the site is available year round or whether it can only be used certain times of the year. Further determination should be made as to availability under weather conditions anticipated and, if such conditions may make their use difficult, to prepare the sites for all-weather utilization.

Centrifugal pumps are usually preferred over other types because of their ability to handle dirt and abrasives with less damage and because of their desirable volume-pressure ratio. Similarly, four-cycle engines are considered more suitable for fire service use, although two-cycle or the new turbine driven pumps may be used.

B-1-8.2 Uses of Pumps. Portable pumps can be used in single or multiple combinations to accomplish many of the following:

(a) Supplying fire fighting hose lines.

(b) Relaying water from a source in a variety of combinations or hook-ups.

(c) As a means for filling truck tanks when no fire pumper is available.

(d) Dewatering operations.

(e) Pump-and-roll operations.

A few of the ways in which a fire department may make use of portable pumps are:

B-1-8.3 Pumping Directly onto the Fire. The portable pump may be used to pump water into hose lines directly onto a fire. They may be carried to nearby sources of water, out of reach of regular fire apparatus. Where these water sources are close to the fire, only small amounts of hose are needed and may be quickly carried into position for quick attack on the fire.

An effective portable pump for this purpose would need to be of at least a medium volume type with enough discharge pressure to give an effective fire fighting stream.

An example of this type of operation is:

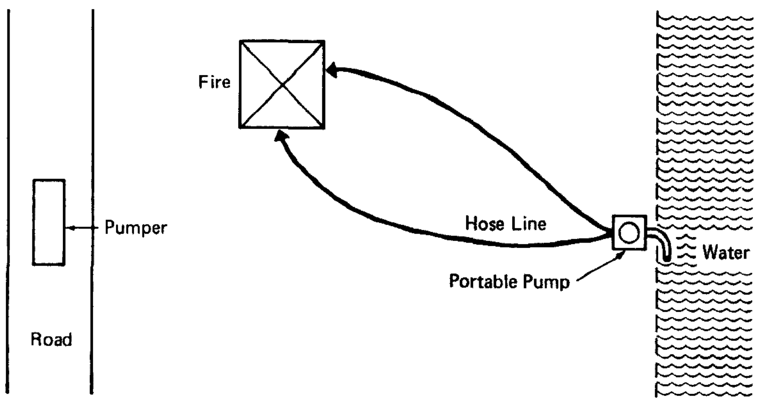


Figure B-1-8.3. Pumping directly onto the fire.

B-1-8.4 Single Relay from Portable Pump to Pumpers. Under conditions when a normal fire truck cannot get to a source of water, portable pumps of larger gallonage and low pressure type have proven to be very satisfactory when used to relay water to pumpers. This becomes feasible at greater distance from water as large diameter hose, for instance, is used.

A single portable pump often can supply enough water to keep a pumper supplied with good fire streams. The portable pump may be at the water source and a line (lines) laid from the portable pump to the pumper.

One of the big advantages of the portable pump is that it can be placed close to the water supply for operation at minimum lift and minimum friction loss in the suction hose, provided adequate size suction hose is used.

Regular pumpers can accept water from portable pumps and increase water pressure for fire streams or use the water in a combination of fire streams and booster tank filling.

A method commonly used is for a pumper to lay hose lines from the fire to the water supply and start pumping from the booster tank into the hose line and onto the fire while the portable pump is being placed and water supply and hose lines from portable to the regular pumper are being hooked up.

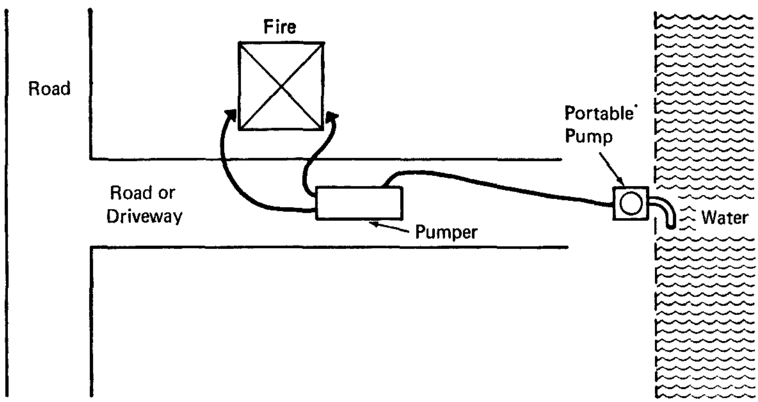


Figure B-1-8.4. Single relay from portable pump to pumper.

B-1-8.5 Double Relay from Portable Pumps to Pumper. When a single relay to pumpers is not adequate and more volume is needed, two or more low pressure, high volume pumps can be placed at the water supply and double lines using siamese or multiple intakes at pumpers may be used for more volume according to circumstances.

Under other circumstances it may be necessary to set one portable pump at the water supply and if distance is too great for the single pump to furnish water to the regular pumper, a second portable pump may be connected into the feed line and used to boost pressure or volume in the relay line. If one low pressure and one high pressure portable pump are used to relay through a long line, the low pressure pump should be placed at the water supply.

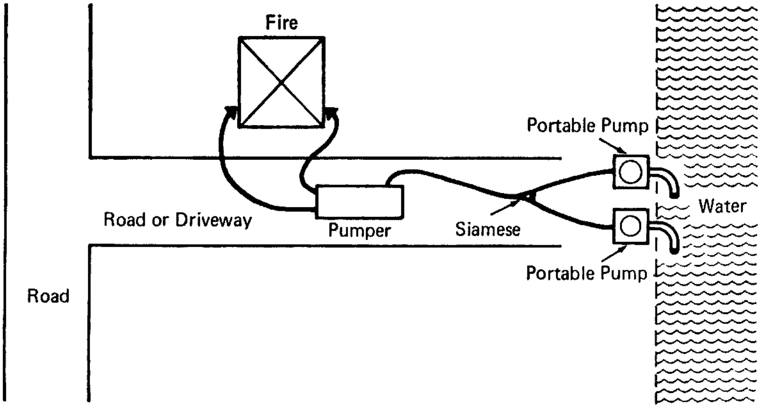


Figure B-1-8.5. Double relay from portable pumps to pumper.

B-1-8.6 Portable Pump Relay from Hydrant to Pumper. In unusual situations, for instance, if a second pumper will not arrive for some time or is not available, or if a hydrant is available but the distance is too great for a forward lay to be effective and it is not possible to make a reverse lay, the use of a high volume portable pump to relay from the hydrant to the pumper should be effective.

The portable pump is dropped off at the hydrant and connected to the hydrant with hard or soft suction hose while a 2½-inch or larger hose line is being laid by the pumper and the fire attacked from booster tank water supply. Supply line to pumper is connected to the discharge of the portable pump. The portable pump, operating with the help of hydrant pressure, will move large volumes of water.

At least one department incorporates a 750 gpm "portable" pump and a conventional 1,250 gpm midship pump on one pumper to use a modification of the evolution immediately above in both hydranted and unhydranted areas. The portable pump is mounted on components of a fork lift attached to the truck back of the rear axle. The pump is then dropped off at the water supply, 4-inch lines are laid to the scene of the fire and the midship pump boosts pressures to those required. Similarly, in a hydranted area, the unit may drop off its portable pump at the closest hydrant to the fire going into the fire ground, lay 4-inch line to a "portable hydrant" in front of the fire, and continue laying 4-inch line to the next usable hydrant, where the midship pump is connected. In this manner the unit can lay 1,300 feet of 4-inch hose between two quarter-mile hydrants (or other water sources) in three minutes with two or three men, rapidly developing 2,000 gpm of water at the fire scene.

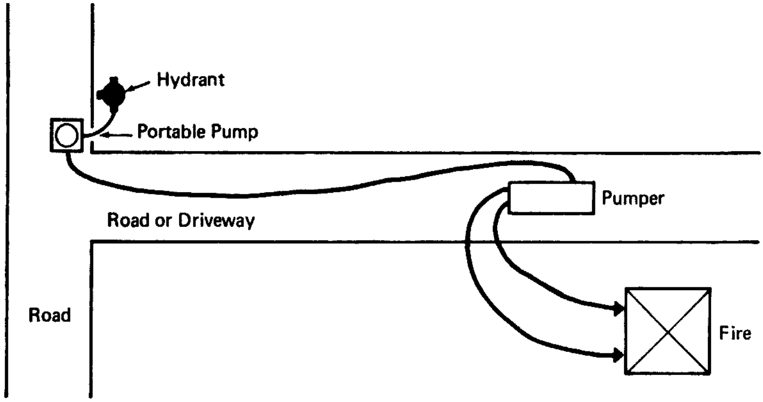


Figure B-1-8.6. Portable pump relay from hydrant to pumper.

B-1-8.7 Use of Portable Pumps to Fill Tankers or Booster Tanks. Often the water supply in rural areas is beyond the reach of hose lines and tankers must be used to relay water to the pumper or pumpers working at a fire. Portable pumps placed at the water supply can be used to fill tankers for the shuttle to the fire if no faster method of filling is available. Note in this context warnings about proper venting and pump suction size elsewhere in this Appendix.

It is not prudent to put the discharge line from portable pumps into the tops of booster tanks or tankers unless no other way is possible. Placing lines into tops of tankers or booster tanks is a slow way of filling the tank and may be dangerous to men working on apparatus. Hooking the portable pump discharge line directly into intake piping of large pumpers or tankers has proven to be the quickest and safest method of filling tanks.

Any of the portable pumps may be used for filling tankers, but the low pressure, high volume type pumps will do the job quicker than others. When pumping into tanks, strainers should be used to prevent passage of trash and debris.

B-1-8.8 Fire Fighting from Tanker in Motion. A number of departments have installed pipes or hard suction lines from their tankers to portable pumps, so they can pump from the tank into discharge lines while the tanker is in motion. The portable pump may be quickly disconnected and taken off the tanker for use in other locations. This use is particularly effective for grain, grass and brush fires as it provides uniform pressures regardless of the gear the vehicle may require to negotiate the terrain. Since rigging a hard suction line from a pump to the vehicle carrying that pump is frequently awkward, it may be essential to carry a specially prepared length of hard suction hose for this purpose or to otherwise prepare the vehicle or the pump to make the evolution rapid and practical.

B-1-8.9 Summary of Portable Pump Evolutions. There are many choices which a fire department may make in deciding what size and type of portable pump will best fill its needs.

Consideration must be given to the capabilities of the pumps and the uses to which the pumps will be put.

B-1-9 Hose for Rural/Suburban Water Supply: Large Diameter Hose.

B-1-9.1 The advent of large diameter hose as an accepted tool of fire fighting has major significance in the field of rural/suburban water supply. NFPA has held that for practical purposes large diameter hose is that with an inside diameter of 3½ inches or larger. The lower friction loss characteristics of such hose increases the usable distance between water source and fire. The department now ruling out water sources more than 1,000 feet from a potential fire ground in its planning may find that 3,000 feet or greater can become a reasonable distance when taking advantage of large diameter hose.

Large diameter hose is available in either single- or double-jacketed construction in the following sizes: 3½″, 4″, 4½″, 5″, and 6″. The advantages of single-jacketed hose are lighter weight, flexibility, ease of handling, additional hose load capabilities, and cost.

The basic reason larger diameter hose moves water may be explained by studying the carrying capacities and friction loss factors of various sizes of hose. The following tables demonstrate these characteristics.

Table B-1-9.1A

	2½″	3″	3½″	4″	4½″	5″	6″
2½″	1	.617	.413	.29	.213	.161	0.1
3″	1.62	1	.667	.469	.345	.261	.162
3½″	2.42	1.5	1	.704	.515	.391	.243
4″	3.44	2.13	1.42	1	.735	.556	.345
4½″	4.69	2.90	1.94	1.36	1	.758	.469
5″	6.20	3.83	2.56	1.8	1.32	1	.619
6″	10	6.19	4.12	2.9	2.13	1.61	1

This table shows the relative carrying capacities of hose, 2½ inches to 6 inches in diameter, for the same friction loss. The values in the table are based upon the Hazen-Williams Equation.

Table B-1-9.1B Approximate Friction Losses in Fire Hose
(psi per 100 feet)

Internal diameter of hose:	2½	3	3½	4	5	6
Flow in GPM:						
250	15	6	2	—	—	—
500	55	25	10	5	2	—
750	—	45	20	11	4	1.5
1000	—	77	36	19	6	2.5
1500	—	—	82	40	14	6
2000	—	—	—	70	25	10

Another important item to consider is hose load capability. Because of its lighter weight and construction, 4″ single-jacketed hose has a load ratio of 4 to 3 compared to 2½″ double-jacketed hose. That is, for every three feet of 2½″ double-jacketed hose the bed will carry four feet of 4″ single-jacketed supply line hose. Weight-wise, a 50-foot length of conventional 2½″ double-jacketed hose weighs approximately 47-50 lbs. while a 50 foot length of the newer type 4″ single-jacketed hose with light-weight couplings weighs approximately 37 pounds.

Thus, one engine company, laying large diameter hose instead of multiple smaller lines, is more efficient in relationship to the amount of water-moving capacity it is getting on the fire ground. The use of the large diameter hose with one engine speeds up the operation that would otherwise involve additional pumpers and men to accomplish the job.

Powered "reel trucks" with various hose load capacities are in use.

Figure B-1-9.1A. Apparatus with reel for large diameter hose.
(Photo by Swanzey, NH)

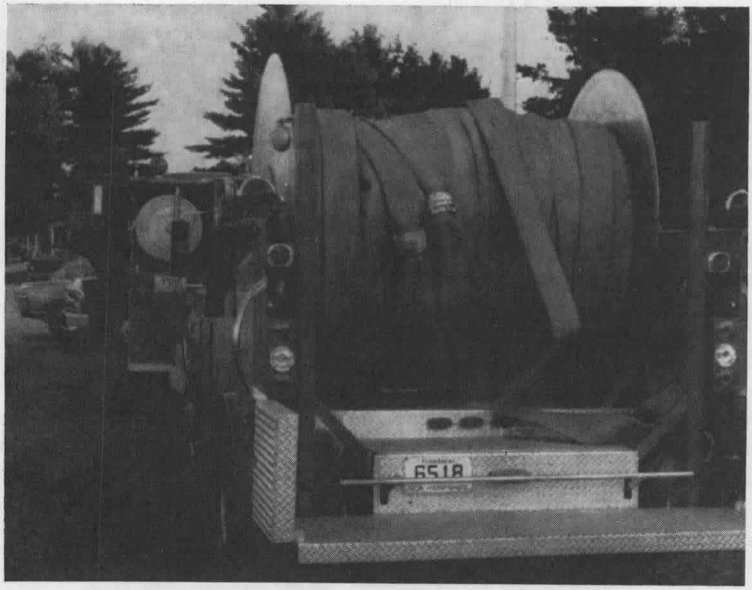


Figure B-1-9.1B. Close-up view of reel for large diameter hose.
(Photo by Swanzey, NH)

Much of the light weight, single-jacketed, large diameter hose now available is of a construction which permits field cleaning and does not require drying. The use of the "reel truck" permits rapid reloading with minimum manpower (two men) and the unit is "in service" in minutes.

Double reels, mounted in the hose bed of a pumper, can increase the 4″ hose carrying capacity up to 6,000 feet, over a mile of aboveground water main.

Large diameter hose is now available from many fire hose manufacturers in either standard threaded couplings or equipped with quick-connect type fittings that eliminate the "male-female" aspect of couplings.

Special fittings have been developed to be used with large diameter hose. These include:

- Clappered siamese with indicator: (*See Figure B-1-9.1C.*) This valve is added to the 4″ supply line one length from the hydrant or pumper at draft and allows for the addition of a second pumper without shutting down the flow of water. The indicator shows the position of the single clapper.
- Line relay valve: (*See Figure B-1-9.1D.*) Should relay pumping be required, a "line relay" valve is inserted during the hose lay. This valve has a straight-through waterway so water delivery can be started upon completion of the lay. The valve contains a gated outlet and a clappered inlet. Upon arrival of the relay pumper, a line is attached from the gated outlet to the suction of the pump, with a discharge line connected from the pump discharge into the clappered inlet. The pump pressure closes the clapper, and the full flow is relayed to the fire ground or another relay pumper. In addition, this valve also contains an automatic air bleeder and a pressure dump valve set at 150 psi. It is important to note that the relay pumper can be added to or removed from the line without shutting down the flow of water to the fire ground.
- Distributor valve: (*See Figure B-1-9.1E.*) This valve contains a 4″ opening and waterway with 2-2½″ threaded male outlets. It is placed at the end of the supply line at the fire ground allowing distribution of water to one or more attack pumpers. The valve utilizes ball shutoffs plus an adjustable dump valve.

• Incoming gated relief valve: (*See Figure B-1-9.1F.*) This valve is attached to the large suction inlet of the pumper. The supply line is connected directly to the valve. It is equipped with a fine-threaded, slow-acting gate valve, an automatic air bleeder, and adjustable dump valve. The gate valve allows connection to the supply line while utilizing the booster tank water. It is also used to control the volume of water from the supply line to the pump. The dump valve helps protect the pumper and supply line against sudden pressure surges and water hammer. The use of large diameter hose both in rural and suburban fire departments, as supply line hose from either a natural source or hydrant, is rapidly becoming an accepted practice.

The concept of large diameter hose may be viewed as an aboveground water main from a source of water to the fire scene.

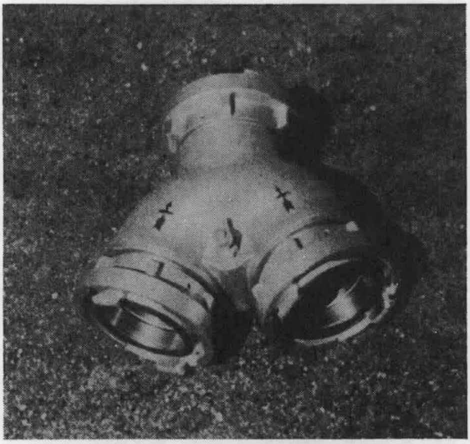


Figure B-1-9.1C. Clappered siamese with indicator.