ANSI/NFPA 1231 An American National Standard August 7, 1989

NFPA 1231
Suburban and Rural Fire Fighting
1989 Edition

NFPA

National Fire Protection Association Batterymarch Park, Quincy, MA 02269

NOTICE

All questions or other communications relating to this document should be sent only to NFPA Headquarters, addressed to the attention of the Committee responsible for the document.

For information on the procedures for requesting Technical Committees to issue Formal Interpretations, proposing Tentative Interim Amendments, proposing amendments for Committee consideration, and appeals on matters relating to the content of the document, write to the Secretary, Standards Council, National Fire Protection Association, Batterymarch Park, Quincy, MA 02269.

A statement, written or oral, that is not processed in accordance with Section 16 of the Regulations Governing Committee Projects shall not be considered the official position of NFPA or any of its Committees and shall not be considered to be, nor be relied upon as, a Formal Interpretation.

Users of this document should consult applicable Federal, State and local laws and regulations. NFPA does not, by the publication of this document, intend to urge action which is not in compliance with applicable laws and this document may not be construed as doing so.

Policy Adopted by NFPA Board of Directors on December 3, 1982

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.

Statement on NFPA Procedures

This material has been developed under the published procedures of the National Fire Protection Association, which are designed to assure the appointment of technically competent Committees having balanced representation. While these procedures assure the highest degree of care, neither the National Fire Protection Association, its members, nor those participating in its activities accepts any liability resulting from compliance or noncompliance with the provisions given herein, for any restrictions imposed on materials or processes, or for the completeness of the text.

NFPA has no power or authority to police or enforce compliance with the contents of this document and any certification of products stating compliance with requirements of this document is made at the peril of the certifier.

INSIDE,
THE PROFESSIONAL
RESEARCH,
REVIEW,
OPINION,
DISCUSSION
AND REVISION
YOU
ORDERED FROM
NFPA

NFPA®

NATIONAL FIRE PROTECTION ASSOCIATION

Errata

NFPA 1231

Standard on

Water Supplies for Suburban and Rural Fire Fighting

1989 Edition

The Committee on Forest and Rural Fire Protection notes the following errors in the 1989 edition of the *Standard on Water Supplies for Suburban and Rural Fire Fighting,* NFPA 1231:

1. *Change title on cover to read* "Water Supplies for Suburban and Rural Fire Fighting".

2. *Add Table G-1-3(e) "Factor for Exposure* (X_i)*.", as follows:*

Table G-1-3(e) Factor for Exposure (X_i)

Construction of Facing Wall of Subject Bldg.	Distance Feet to the Exposed Building	Length-Height of Facing Wall of Exposed Building	Construction of Facing Wall of Exposed Building Classes: 1,3	2, 4, 5, & 6: Unprotected Openings	2, 4, 5, & 6: Semi-Protected Openings (wired glass or outside open sprinklers)	2, 4, 5, & 6: Blank Wall
Frame, Metal or Masonry with Openings	0-10	1-100	0.22	0.21	0.16	0
		101-200	0.23	0.22	0.17	0
		201-300	0.24	0.23	0.18	0
		301-400	0.25	0.24	0.19	0
		Over 400	0.25	0.25	0.20	0
	11-30	1-100	0.17	0.15	0.11	0
		101-200	0.18	0.16	0.12	0
		201-300	0.19	0.18	0.14	0
		301-400	0.20	0.19	0.15	0
		Over 400	0.20	0.19	0.15	0
	31-60	1-100	0.12	0.10	0.07	0
		101-200	0.13	0.11	0.08	0
		201-300	0.14	0.13	0.10	0
		301-400	0.15	0.14	0.11	0
		Over 400	0.15	0.15	0.12	0
	61-100	1-100	0.08	0.06	0.04	0
		101-200	0.08	0.07	0.05	0
		201-300	0.09	0.08	0.06	0
		301-400	0.10	0.09	0.07	0
		Over 400	0.10	0.10	0.08	0
Blank Masonry Wall	Facing Wall of the Exposed Building Is Higher than Subject Building: Use the above table EXCEPT use only the Length-Height of Facing Wall of the Exposed Building ABOVE the height of the Facing Wall of the Subject Building. Buildings five stories or over in height, consider as five stories.					
	When the Height of the Facing Wall of the Exposed Building is the Same or Lower than the Height of the Facing Wall of the Subject Building, $X_i = 0$.					

3. Add Table G-1-3(f) "Factor for Communications (P_i).", as follows:

Table G-1-3(f) Factor for Communications (P_i)

Description of Protection of Passageway Openings	Fire Resistive, Non-Combustible or Slow-Burning Communications				Communications With Combustible Construction					
	Open	Enclosed			Open			Enclosed		
	Any Length	10 Ft. or Less	11 Ft. to 20 Ft.	21 Ft. to 50 Ft. +	10 Ft. or Less	11 Ft. to 20 Ft.	21 Ft. to 50 Ft. +	10 Ft. or Less	11 Ft. to 20 Ft.	21 Ft. to 50 Ft. +
Unprotected	0	+ +	0.30	0.20	0.30	0.20	0.10	+ +	+ +	0.30
Single Class A Fire Door at One End of Passageway	0	0.20	0.10	0	0.20	0.15	0	0.30	0.20	0.10
Single Class B Fire Door at One End of Passageway	0	0.30	0.20	0.10	0.25	0.20	0.10	0.35	0.25	0.15
Single Class A Fire Door at Each End or Double Class A Fire Doors at One End of Passageway	0	0	0	0	0	0	0	0	0	0
Single Class B Fire Door at Each End or Double Class B Fire Doors at One End of Passageway	0	0.10	0.05	0	0	0	0	0.15	0.10	0

\+ For over 50 feet, $P_i = 0$.
\+ + For unprotected passageways of this length, consider the 2 buildings as a single Fire Division.

4. In G-1-4, Calculation — "1. Construction Factor (C_i).", revise formula to read as follows:

$$C_i = 18F(A_i)^{0.5}$$

5. In G-1-4, Calculation — "3. Exposure (X_i) & Communication (P_i) Factors.", formula should read as follows:

$$(X + P)_i = 1.0 + \sum_{i=1}^{n} (X_i + P_i)$$

6. Table G-1-3(a). Add the coefficient related to the Class of Construction as follows: F = 1.5

7. Add a new G-1.5, "Examples of Calculating Secondary (Design) Water Supply.", as follows:

G-1-5 Examples of Calculating Secondary (Design) Water Supply.

Example 1: A 3-story, ordinary-construction building, occupied as Moderate Hazard with unused basement, has a ground floor area of 7,300 sq ft. The *effective area* is 7,300 + 1/2(7,300 + 7,300) = 14,600 sq. ft. In Table G-1-3(b), the area of 14,600 sq ft is between 13,900 sq ft and 17,400 sq ft; therefore, under Occupancy Hazard Classification 5, the Construction Factor (C_i) and Occupancy Factor (O_i) is 2,250 gpm.

Example 2: A 3-story, wood-frame building, with a GFA of 7,300 sq ft, communicates through unprotected openings with a 5-story, ordinary-construction building with a GFA of 9,700 sq ft. Both buildings are occupied as Moderate Hazard. The basements have Light-Hazard and Low-Hazard contents. The *effective area* for the *building* is 7,300 + 9,700 + 1/2 [2(7,300) + 4(9,700)] = 43,700 sq ft.

The (C_i) (O_i) for each *section* is the secondary water requirement for the section if it was separate from the other sections by one or more automatic or self-closing, labeled, Class A fire doors or by blank walls. The effective area for the wood-frame section is 7,300 + 1/2(7,300 + 7,300) = 14,600 sq ft. The effective area for the ordinary section is 9,700 + 1/2(4 × 9,700) = 29,100 sq ft.

CLASS	ACTUAL AREA	%	(C_i) (O_i) FOR EACH CLASS BASED ON EFFECTIVE BUILDING AREA	PRO-RATED (C_i) (O_i)	(C_i) (O_i) FOR EACH SECTION BASED ON ITS EFFECTIVE AREA
	(1)	(2)	(3)	(4) = (2) × (3)	(5)
Wood Frame	21,900	31.1	5,750	1,788	3,250
Ordinary	48,500	68.9	3,750	2,584	3,000
	70,400			4,372	

By proportioning, the (C_i) (O_i) is 4,250 gpm (rounded from 4,372). This is larger than the maximum by section; therefore, the (C_i) (O_i) value is 4,250 gpm.

Example 3: A 1-story, ordinary building, occupied as Moderate Hazard without basement, has an area of 210,000 sq ft. The effective total area is 210,000 sq ft. Table G-1-3(b) indicates a needed fire flow of 8,000 gpm; however, this is a 1-story building and, therefore, the value for (C_i) (O_i) = 6,000 gpm.

Example 4: A 2-story, wood-frame building, occupied as Moderate Hazard, has an area of 60,000 sq ft and communicates through unprotected openings to a 1-story, noncombustible building with an area of 45,000 sq ft. The effective area is 45,000 + 60,000 + 1/2(60,000) = 135,000 sq ft.

The effective area of the wood frame section is 60,000 + 1/2(60,000) = 90,000 sq ft. The effective area of the noncombustible section is 45,000 sq ft.

CLASS	ACTUAL AREA	%	(C_i) (O_i) FOR EACH CLASS BASED ON EFFECTIVE BUILDING AREA	PRO-RATED	(C_i) (O_i) FOR EACH SECTION BASED ON ITS EFFECTIVE AREA
	(1)	(2)	(3)	(4) = (2) × (3)	(5)
Wood Frame	120,000	72.7	8,000	5,816	8,000
Non-combustible	45,000	27.3	5,250	1,433	3,000
				7,249	

By proportioning, the C_i is 7,250 gpm (rounded from 7,249); this is less than the Section C_i for wood frame; therefore, the value for C_i = 8,000 gpm.

Example 5: The subject building, a 2-story, ordinary building of 175 ft × 100 ft is located 15 feet east of an exposed building identical in construction and area. Both buildings have unprotected openings. The length-height value of the exposed building is 2 × 175 = 350. From Table G-1-3(e), the exposure charge (X) is 0.19, or 19%.

Example 6: The subject building, a 1-story frame building of 75 ft × 100 ft, communicates on the long side, through an enclosed, frame passageway, 24 feet in length, to an ordinary building. Both buildings have unprotected window openings. The length-height value is 1 × 100 = 100. The exposure charge (X) for this side from Table G-1-3(e) is 0.15. The communication charge (P) for this side from Table G-1-3(f) is 0.30. The exposure charge and communication charge for this side ($X_i + P_i$) is the sum of 0.15 and 0.30 = 0.45.

NATIONAL FIRE PROTECTION ASSOCIATION, INC.
1 BATTERYMARCH PARK, QUINCY, MA 02269-9101

1.5M-1-90-FP

NFPA 1231

Standard on Water Supplies for

Suburban and Rural Fire Fighting

1989 Edition

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 15-18, 1989 in Washington, DC. It was issued by the Standards Council on July 14, 1989, with an effective date of August 7, 1989, and supersedes all previous editions.

The 1989 edition of this standard 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.

This 1989 edition is the fourth revision and incorporates some significant changes and additions.

Technical Committee on Forest and Rural Fire Protection

R. L. Bjornsen, *Chairman*
Fire Management Associates

Donald G. Perry, *Vice Chairman*
Santa Barbara County Fire Dept., CA

James T. Wooters, *Vice Chairman*
DeKalb County Fire Services

Mary D. Chambers, *Secretary*
Bernalillo County Fire District 10

Fred G. Allinson, Natl Volunteer Fire Council
Lynn R. Biddison, Chemonics, Fire Tral
John E. Bunting, New Boston Fire Dept., NH
George R. Cowan, Wormald CDN Inc.
Richard J. Day, California Division of Forestry and Fire Protection
Dennis Dube, Canadian Forestry Service
J. A. Foster, ISO Commercial Risk Services Inc.
Donald C. Freyer, Georgia Forestry Commission
William Goldfeder, Loudon County Dept. of Fire & Rescue
Salvatore M. Grasso, Fred S. James & Co. of NY Inc.
Edward T. Grohe, Western Fire Equipment Co.
Roy G. Hatcher, Iowa Conservation Commission
Louis G. Jekel, Rural/Metro Corp.
Ralph R. Lafferty, MacMillan Bloedel Ltd
John F. Marker, Forest Service USDA
Paul G. Mason, M&M Protection Consultants
Richard E. Montague, Incident Management Concepts
Frederick S. Richards, Office of Fire Prev. & Control, NYS Dept. of State
James C. Sorenson, USDA Forest Service
Howard L. Vandersall, Lawdon Fire Services, Inc.
David D. Walizer, State Fire Marshal's Office, CA
Louis A. Witzeman, Scottsdale Fire Dept., AZ

Alternates

Charles E. Lundfelt, North Star Serv. Area
(Alternate to W. Goldfeder)
Edward G. Mazurkiewicz, M&M Protection Consultants
(Alternate to Paul Mason)
John Vieweger, Ansul Fire Protection, Wormald US Inc.
(Alternate to George Cowan)

Bill Baden, NFPA Staff Liaison

This list represents the membership at the time the Committee was balloted on the text of this edition. Since that time, changes in the membership may have occurred.

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.

Contents

NFPA 1231

Standard on Water Supplies for

Suburban and Rural Fire Fighting

1989 Edition

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

Information on referenced publications can be found in Chapter 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 may 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 may 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 added to the appendix of this standard concerning rural water supplies, hauling of water, transporting water through large diameter hose, portable pumping equipment, and automatic sprinkler protection, any or all of which may comprise a rural "water system."

1-3 General.

1-3.1 The requirements of Chapters 5 and 6 of this standard 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 single or multiple water points, must be delivered to the fire scene. The authority having jurisdiction may determine that additional water supplies are warranted. Appendix G contains secondary water supply requirements useful when 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 Appendices C, D, and E.

Apparatus shall meet the requirements outlined in NFPA 1901, *Standard on Automotive Fire Apparatus*, and other applicable NFPA standards.

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

1-3.5 The effectiveness and reliability of fixed fire protection systems is a documented fact. Strong consideration shall be given to installation of sprinkler systems as outlined in 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*.

1-4 Definitions.

Adequate and Reliable Water Supply. A 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 0.50 through 1.50 that are mathematical factors used in a formula to determine total water supply requirements of this standard only.

Exposure Hazard. A structure within 50 ft (15.2 m) of another building and 100 sq ft (9.3 m^2) or larger in area. If a structure is of occupancy hazard classification number 3 or 4, 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 may 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.

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

Municipal-Type Water System. A system having water pipe 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 two-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 3 through 7 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 the water supply to suppress a possible fire within the property.

Secondary (Design) Water Supply. The estimated rate of flow (expressed in gpm 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., may be located to protect a cluster of buildings, such as a subdivision or an estate.

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

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 is to be utilized for prefire planning purposes as well as by the water supply officer.

2-1.2 Areas specified in 5-2.1, 5-3.1, and 5-4.1 may be surveyed as an area to determine square footage or cubic footage and square meters or cubic meters 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 Chapter 2, 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 Chapter 2.

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

3-1.4* Storage of products potentially hazardous from the standpoint of increased fire volume or of those having an explosive nature exists at many rural locations, and such products may be 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 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. (*See 5-5.1.*)

3-2.3.2 When an exposing structure is of occupany hazard classification number 3, it is considered an exposure hazard if within 50 ft (15.2 m), regardless of size.

3-2.3.3 Occupancy hazard classification number 3 examples include:

Aircraft Hangars
Cereal or Flour Mills
Chemical Works and Plants
Cotton Picker and Opening Operations
Distilleries
Explosives and Pyrotechnics Manufacturing and Storage
Feed and Grist Mills
Grain Elevators and Warehouses
Linseed Oil Mills
Lumberyards
Oil Refineries
Plastics Manufacturing and Storage
Saw Mills
Solvent Extracting
Straw or Hay in Bales
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 When an exposing structure is of occupancy hazard classification number 4, it is considered an exposure hazard if within 50 ft (15.2 m), regardless of size.

3-2.4.3 Occupancy hazard classification number 4 examples include:

Barns and Stables (commercial)
Building Materials
Department Stores
Exhibition Halls, Auditoriums, and Theaters
Feed Stores (without processing)
Freight Terminals
Mercantiles
Paper and Pulp Mills
Paper Processing Plants
Piers and Wharves
Repair Garages
Rubber Products — Manufacturing and Storage
Warehouses, such as:
  paper
  furniture
  paint
  department store
  general storage
  whiskey
Woodworking Industries

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 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 number 5 examples include:

Amusement Occupancies
Clothing Manufacturing Plants
Cold Storage Warehouses
Confectionery Product Warehouses
Farm Storage Buildings, such as:
  dairy barns
  equipment sheds
  corn cribs
Hatcheries
Laundries
Leather Goods Manufacturing Plants
Libraries (with large stock room areas)
Lithography Shops
Machine Shops
Metalworking Shops
Nurseries (plant)
Pharmaceutical Manufacturing Plants
Printing and Publishing Plants
Restaurants
Rope and Twine Manufacturing Plants
Sugar Refineries
Tanneries
Textile Manufacturing Plants
Tobacco Barns
Unoccupied Buildings

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 ft (2.44 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 number 6 examples include:

Armories
Automobile Parking Garages
Bakeries
Barber or Beauty Shops
Beverage Manufacturing Plants
Boiler Houses
Breweries
Brick, Tile, and Clay Product Manufacturing Plants
Canneries
Cement Plants
Churches
Dairy Products Manufacturing and Processing
Doctors' Offices
Electronics Plants
Foundries
Fur Processing Plants
Gasoline Service Stations
Glass and Glass Products Manufacturing Plants
Municipal Buildings
Post Offices
Slaughterhouses
Telephone Exchanges
Undertaking Establishments
Watch and Jewelry Manufacturing Plants
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
Fire Stations
Fraternity or Sorority Houses
Hospitals
Hotels and Motels
Libraries (except large stock room areas)
Museums
Nursing and Convalescent Homes
Offices (including data processing)
Police Stations
Prisons
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 When a building is located within 50 ft (15.2 m) of the surveyed building and is 100 sq ft (9.3 m^2) or greater in total area, the building is treated as an exposure with the water requirement calculated by the standard multiplied by 1.5.

4-2* Construction Classification Number.

4-2.1 The construction classifications listed in this standard have been simplified for quick use. When 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 "fireproofed") 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 0.75. 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. wood supports, floors are 3-in. tongue and grooved plank, and roof decks are 2-in. tongue and grooved plank. All wood beams and girders are 6 in. wide and 10 in. 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 1.50. Any structure in which the structural members are wholly or partly of wood or other combustible material and the construction does not qualify as ordinary construction.

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

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 in its authority. As the water supplies developed by this standard are minimum and in many cases may be suitable for exposure protection only, the authority having jurisdiction shall review the calculations to see that the 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 sq ft (9.3 m^2), the minimum 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 multiplied by the construction classification number, as determined from Chapter 4, or see Table 5-9.1(a).

$$\text{MINIMUM WATER SUPPLY} = \frac{\text{Total Cu Ft of Structure}}{\text{Occupancy Hazard Classification}} \times \text{Construction Classification No.}$$

5-2.1.1 The minimum water supply required for any structure, without exposure hazards, shall not be less than 2,000 gal (7570 L). [*See Table 5-9.1(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 5-9.1(c).

5-3 Single Structures with Exposure Hazards.

5-3.1* For all single structures with unattached structural exposure hazard closer than 50 ft (15.2 m) to any portion of the dwelling and larger than 100 sq ft (9.3 m^2), the minimum 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, multiplied by the construction classification number as determined by Chapter 4 and multiplied by 1.5. [*See Table 5-9.1(a).*]

$$\text{MINIMUM WATER SUPPLY} = \frac{\text{Total Cu Ft of Structure}}{\text{Occupancy Hazard Classification}} \times \text{Construction Classification No.} \times 1.5$$

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 3,000 gal (11 355 L). [*See Table 5-9.1(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 5-9.1(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 sq ft (9.3 m^2), the minimum 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 as determined from Chapter 4, or see Table 5-9.1(a).

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 3,000 gal (11 355 L). [*See Table 5-9.1(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 5-9.1(c).

$$\text{MINIMUM WATER SUPPLY} = \frac{\text{Total Cu Ft of Structure}}{\text{Occupancy Hazard Classification}}$$

$\times$ Construction Classification No.

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) to any portion of the structure and larger than 100 sq ft (9.3 m^2), the total water supply, in gallons, shall be determined by the cubic footage of the structure, including any attached structures, divided by the occupancy hazard classification number, as determined from Chapter 3, multiplied by the construction classification number, as determined from Chapter 4, and multiplied by 1.5, or see Table 5-9.1(a).

$$\text{MINIMUM WATER SUPPLY} = \frac{\text{Total Cu Ft of Structure}}{\text{Occupancy Hazard Classification}}$$

$\times$ 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 3,000 gal (11 355 L). [*See Table 5-9.1(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 5-9.1(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 pack 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*, and NFPA 13D, *Standard for the Installation of Sprinkler Systems in One- and Two-Family Dwellings and Mobile Homes*, the fire department having jurisdiction may 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 referred to in 5-7.1 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 referred to in 5-7.1 and 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, Section 2-7.

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*, the fire department having jurisdiction may reduce the minimum water supply required by this standard, for fire fighting purposes, in Section 5-2, 5-3, 5-4, or 5-5, whichever is applicable.

5-8 Structures with Other Automatic Fire Suppression Systems.

5-8.1* For any structure fully or partially protected by an automatic fire suppression system other than specified in 5-6.1, the fire department having jurisdiction shall determine the minimum water supply required for fire fighting purposes.

5-9 Precalculated Water Supply.

5-9.1 The following tables are included as 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 the "quick method" tables by 1.5.

An example of the use of the tables:

A farm storage building housing a dairy barn (occupancy hazard classification number 4), constructed of ordinary construction (construction classification number 1.0) with a cubic area of 160,000 cu ft (4480 m^3) will produce, by the tables, a water requirement of 40,000 gal (151 400 L).

Table 5-9.1(a) Precalculated Minimum Water Supplies by Occupancy Hazard and Construction Classification
(no exposures)

Occupancy Hazard Class.	3				4				5				6				7			
Construction Class.	.5	.75	1.0	1.5	.5	.75	1.0	1.5	.5	.75	1.0	1.5	.5	.75	1.0	1.5	.5	.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	4,500			2,400	3,600			2,000	3,000				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	4,000			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		2,143	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	5,143
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 5-9.1(a) Continued

Occupancy*	3				4				5				6				7			
Construction**	.5	.75	1.0	1.5	.5	.75	1.0	1.5	.5	.75	1.0	1.5	.5	.75	1.0	1.5	.5	.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

*Occupancy Hazard Classification

**Construction Classification

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 5-9.1(b)
Minimum Water Requirements
(Examples)

Paragraph	Type of Occupancy	Min. Gal. Water
5-2.1.1	Single Structures without Exposures	2,000 (7570 L)
5-3.1.1	Single Structures with Exposures	3,000 (11 335 L)
5-4.1.1	Multiple Structures — Single Water Point without Exposures	3,000 (11 335 L)
5-5.1.1	Multiple Structures — Single Water Point with Exposure Hazard	3,000 (11 335 L)

Table 5-9.1(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 (GPM)
up to 2,499 (up to 9459 L)	250 (946 L/min)
2,500 to 9,999 (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, may be supplied from natural bodies of water and man-made 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. Man-made sources of water include aboveground tanks, elevated gravity tanks, livestock watering tanks, cisterns, swimming pools, wells, quarries, mines, reservoirs, aqueducts, tankers, and hydrants served by a water system. (*See Appendix B.*)

The surface at the pumper 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, brush conditions, and mud slides.

Should a dry hydrant be 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. A few of these are tanker 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 Appendices 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, as part of its property survey, determine maximum safe load limits of roadways, laneways, and bridges and various climatic conditions, to determine accessibility.

6-4.1 The fire department needs to determine the maximum safe load limits of bridges in its district. 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 boundries of your city, town, county, fire district, etc. 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 cooperation of 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, in writing, the authority having jurisdiction before any structures are erected or any alterations are made to any existing structure that will increase the total cubic footage of the structure. The property owner shall provide for the authority having jurisdiction 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 Detector.

7-4.1* Each family living unit shall be provided with smoke detectors as required in NFPA 74, *Standard for the Installation, Maintenance, and Use of Household Fire Warning Equipment*.

7-5 Changes in Automatic Sprinkler Protection.

7-5.1 The property owner or occupant shall notify in writing the authority having jurisdiction whenever any alterations are made that would 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 the 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 whenever possible 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, Batterymarch Park, Quincy, MA 02269.

NFPA 13-1989, *Standard for the Installation of Sprinkler Systems*

NFPA 13D-1989, *Standard for the Installation of Sprinkler Systems In One- and Two-Family Dwellings and Mobile Homes*

NFPA 74-1989, *Standard for the Installation, Maintenance, and Use of Household Fire Warning Equipment*

NFPA 220-1985, *Standard on Types of Building Construction*

NFPA 1141-1985, *Standard for Fire Protection in Planned Building Groups*

NFPA 1901-1985, *Standard on Automotive Fire Apparatus.*

Appendix A

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 may be equipped with hydrants that may 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 may be applied in water supply matters.

A-2-1.1 Information needed to compute the minimum water supplies to 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 ridge pole.

(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 man-made sources of water.

A-3-1.4 In addition to the storage of products 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 potentially hazardous to fire fighters from the standpoint of increased fire volume, explosion, and toxicity exists at most rural fire locations. Among these are:

(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 when burning. Two compounds that are safe when independent of each other may be very hazardous to the fire fighter when mixed together in a fire situation.

(d) Localized problems also exist in corn growing areas; for instance, 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 must know the potential hazards presented by the products and the fire fighting precautions to be taken. The department membership should be forewarned of the above items through the survey of the farm by the water supply officer or other inspector, and appropriate provisions 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 grouping. The highest occupancy hazard classification number is 7 and is assigned to the lowest hazard grouping.

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, takes a construction classification number of 0.50. The fastest burning or highest hazard type of construction, wood frame, takes a construction class number of 1.50. All dwellings shall be assigned a construction classification number of 1.0 or lower when 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 may have wood trusses as a lightweight preengineered 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 may not be the case should one of the outer members be destroyed or damaged. Should this happen during a fire, the roof or floor supported by the unit may be weakened to the point where it will be unsafe to support fire fighters.

Another weak point found in the lightweight preengineered 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 may not retain their strength and integrity when 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 Examples of Calculating Minimum Water Supply. Single- and two-family dwellings — 1,200 sq ft (111.8 m²) and under (without exposure hazard).

(a) Residential:

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

50 × 24 = 1,200 (sq ft)
Heights 8 + 8 + 4* = 20 (ft)
1,200 × 20 = 24,000 (cu ft)
Occupancy Hazard Classification Number 7
Construction Classification Number 1.0 (frame dwelling)
24,000 ÷ 7 × 1.0 = 3,429 gal
Minimum Water Supply = 3,429 gal

For SI Units: 1 ft = 0.305 m; 1 sq ft = .092 m²; 1 cu ft = .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 (15.2 m), regardless of size. (*See 5-3.1.*) For a dwelling, construction classification number is no larger than 1.0.

(b) Commercial:

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

125 × 100 = 12,500 (sq ft)
Height = 14 (ft)
12,500 × 14 = 175,000 (cu ft)
Occupancy Hazard Classification Number 5
Construction Classification Number 0.75
175,000 ÷ 5 × 0.75 = 26,250
Total Water Supply = 26,250 gal

For SI Units: 1 ft = 0.305 m; 1 sq ft = .092 m²; 1 cu ft = .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 (15.2 m), regardless of size.

A-5-3.1 Single- and two-family dwellings — 1200 sq ft and under (with exposures).

(c) Residential:

Dwelling 50 ft × 24 ft; 1 story, 8 ft high; pitched roof, 8 ft from attic floor to ridge pole; 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 sq ft.

50 × 24 = 1200 (sq ft)
Heights 8 + 4* = 12 (ft)
1200 × 12 = 14,400 (cu ft)
Occupancy Hazard Classification Number 7
Construction Classification Number 1.0 (brick dwelling)
14,400 ÷ 7 × 1.0 = 2,057
As the dwelling is exposed by a frame dwelling, multiply by the exposure factor of 1.5
2,057 × 1.5 = 3,086
Minimum Water Supply = 3,086 gal

For SI Units: 1 ft = 0.305 m; 1 sq ft = .092 m²; 1 cu ft = .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 (15.2 m), regardless of size. For a dwelling, construction classification number is no larger than 1.0.

A-5-4.1 All Structures Except Dwellings (with Exposures).

(d) Assembly:

Church: 130 ft × 60 ft; height 25 ft to ridge pole (15 ft from ground to eaves with ridge pole 10 ft above the

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

eaves); brick construction with brick constructed office building within 40 ft of church.

130 × 60 = 7,800 (sq ft)
Height 15 + 5 = 20 ft
7,800 × 20 = 156,000 (cu ft)
Occupancy Hazard Classification Number 6
Construction Classification Number 1.0
156,000 ÷ 6 × 1.0 = 26,000
As church is exposed by a brick office building, multiply by the exposure factor of 1.5
26,000 × 1.5 = 39,000
Minimum Water Supply = 39,000 gal

For SI Units: 1 ft = 0.305 m; 1 sq ft = .092 m²; 1 cu ft = .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-5-5.1 Multiple Structures — Single Water Point without Exposure Hazards.

(e) A row of five dwellings, same house as example (a), except one has a brick barn measuring 80 ft by 40 ft and located 35 ft from the dwelling. The barn is larger than 100 sq ft in area and is closer than 50 ft to the dwelling. Therefore, the minimum water supply for this dwelling (3500 gal) must be multiplied by 1.5 for the exposure.

3429 × 1.5 = 5144 gal

If the dwellings 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 largest minimum water supply, which would be the barn in this case. Thus, if the barn has no hay storage and is 25 ft (7.2 m) in height to the ridge pole, and the ridge pole is 10 ft (3 m) above the eaves, the calculations would be as follows:

80 × 40 = 3200 (sq ft)
Height 15 + 5 = 20 (ft)
3200 × 20 = 64,000 (cu ft)
Occupancy Hazard Classification Number 4 (for the barn with no hay storage)
Construction Classification number is 1.0
64,000 ÷ 4 × 1.0 = 16,000
16,000 × 1.5 (for exposure hazard – the dwelling) = 24,000
Minimum Water Supply = 24,000 gal

For SI Units: 1 ft = 0.305 m; 1 sq ft = .092 m²; 1 cu ft = .028 m³; 1 gal = 3.785 L.

(f) Farm equipment shed, same as A-5-2.1(b), 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 sq ft in area and is closer than 50 ft to the equipment shed. Therefore, the minimum water supply for the equipment shed (26,250 gal) must be multiplied by 1.5.

26,250 × 1.5 = 39,375
Minimum Water Supply = 39,375 gal.
The total water supply for the dwelling is:
50 × 25 = 1,250 (sq ft)
Height 8 + 4 = 12
1,250 × 12 = 15,000 (cu ft)
Occupancy Hazard Classification Number 7
Construction Classification Number 1.0
15,000 ÷ 7 × 1.0 = 2,143 gal

For SI Units: 1 ft = 0.305 m; 1 sq ft = .092 m²; 1 cu ft = .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 the 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 (15.2 m), regardless of size. For a dwelling, 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 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 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.

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*, 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. The researchers developed a new sprinkler head for the residential system that has a uniform discharge density and quick response capabilities. The reports coming in from those areas that have adopted NFPA 13D for dwellings, apartments, mobile homes, hotels, and motels are exciting. Therefore, where a water supply is available, NFPA 13D, *Standard for the Installation of Sprinkler Systems in One- and Two-Family Dwellings*, is highly recommended for the protection of life and property.

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-5-8.1 Other automatic suppression systems could include foam, carbon dioxide, dry chemical, halon, etc., installed in part or all of the structure.

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

The state DOT, in most cases, can provide the fire department with a computer printout showing safe load limits for bridges located within the boundaries of your city, town, county, fire district, etc. This information has proved invaluable to a number of fire departments in checking bridges used to carry fire equipment. (*See Appendix B-6 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 will reveal that well over 50 percent of all persons killed by fire will die in residential fires. Therefore, it's good news that current estimates indicate that smoke detectors are in approximately 75 percent of the nation's homes. (*See NFPA 74, Standard for the Installation, Maintenance, and Use of Household Fire Warning Equipment.*) The primary concern of the standard is with life protection, and many water hauling fire departments have developed programs to promote the installation 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 toward 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 may 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 until full sprinkler protection is restored.

Appendix B Water Supply

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

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: from supplies on the fireground, which may be natural or man-made, or 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 water supply officer. The work of a properly trained and equipped water supply officer makes it possible for the officer supervising the actual fire attack to plan it on the basis of reliable water supply information, to coordinate that 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 of his 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 may maintain and even carry with him a complete set of files, which should include cards showing water points and lists of automatic and mutual aid tankers 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 water supply officer 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 water supply officer becomes the rural equivalent of the water department representative who responds to major municipal fires. The water supply officer'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 tankers, 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 a must in readily directing tankers so that time is not lost at the fill and the dump points. To obtain this level of tanker efficiency, a radio frequency separate from that used for the fire ground operations needs to be assigned to the water supply officer (WSO). The water supply officer also needs to have efficient communication with the incident commander.

B-1-2.4 Duties Before the Fire. Before the fire, the water supply officer 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 water supply officer (WSO) may survey the district and the surrounding areas for available water for fire fighting purposes. Water supplies may exist on the property to be protected or may 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 water supply officer 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 his 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-6-1) and to install dry hydrants (*see B-5-1*).

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 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 (30.4 m) north of barn,'' etc.] gallonage available [''flows minimum 250 gpm (946 L/min),'' ''10,000 gal (37 850 L/min) storage,'' etc.] and any particular problem such as weather condition or seasonal fluctuations that may make a source unusable. It is a good practice to attach a snapshot 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 water supply officer must 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 be required to build, service, and maintain the access road to the supply, including such things as snow plowing in certain areas of the country. The property owner also should have a copy of the agreement. Following is an example of such a document that has been used by several fire departments with the approval of their county or town attorney.

ANYTOWN FIRE DEPARTMENT, U.S.A.
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

Agreement provided by Guilford College Fire Department, Guilford, College, North Carolina.

B-1-2.7 Water Map. Each water supply officer 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 when such an alarm facility is available and should be carried on at least one pumper and the chief's car and by the water supply officer. Any problems that may be encountered at the supply should be recorded. (*Also see B-5-3.2.*)

B-1-2.8 Inspection of Water Supplies. It is the responsibility of the water supply officer to make inspections of all water sources available as often as conditions warrant and note any changes in the facilities. This is particularly true during adverse weather conditions, such as droughts, very wet periods, heavy freezing, and following a snowstorm.

B-1-2.9 Reliability of an Impounded Supply. For an impounded supply, cistern, tank, or storage facility, the quantity to be considered available is the minimum available [at not over 15-ft (4.5-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 this site.

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 water supply officer should see 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/or numbers should be at least 3 in. high, with a ½-in. strobe and reflective.

B-1-2.12 Water Operations. The water supply officer 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 may 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. For domestic (farm) 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. In some cases, standby power and pumps may 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 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 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 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, 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.

B-3 Natural Water Sources.

B-3-1 Streams. Streams, including rivers, bays, creeks, and irrigation canals, may represent a continuously flowing source of 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. (*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 may be necessary. In many sections of the country, streams cannot be relied upon during drought seasons. If the stream is subject to flooding or freezing, special evolutions may be necessary to make the stream usable under such conditions. Similar circumstances may exist during wet periods or when the ground is covered with snow.

(c) *Accessibility.* A river or other source of water may not be accessible to the fire department for use during a fire. Distance and terrain from the all-weather road to the source must be such as to make the water readily available. In some cases, special equipment must 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.

B-3-2 Ponds. Ponds may 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 design of ponds may 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 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 or lake, 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 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, may 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 may have very low water levels. The water under such conditions may 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. 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, may be useful for water supply subject to reasonable application of the factors listed for ponds and streams. In many cases, it may be necessary to form a temporary natural pool or form a pond with a salvage cover, for instance, to collect water for the use of the fire department when using a spring or an artesian well.

B-4 Man-Made Sources of Water.

B-4-1 General. The man-made 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, automotive sprinkler system supplies, stationary tanks, driven wells, and dry hydrants, to the occasions when fire fighters have drafted water out of the basement of a burning building into which it was pumped only minutes before to the fight the fire.

B-4-2 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 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 department 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 truck or other pumping device but should be located far enough from the hazard that one is not endangered when in use.

The water level of a cistern can be maintained by rainfall, water pumped from a well, water hauled by a tanker, or by the seasonal high water of a stream or river. The cistern can present a freezing problem in that its surface is often relatively inaccessible and the water is stagnant. One method to minimize 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 B-4-1 and Figure B-4-6(h).*]

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 hole may be adequate to break an ice formation. In fact, the weight of the suction hose itself may be sufficient provided there is no danger of damaging the strainer or the hose.

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, a bale of hay or straw, etc. on the surface of the water.

(b) Placing a barrel filled with nonflammable, nontoxic antifreeze 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 given 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 when heavy vehicles are parked adjacent.

(b) If groundwater conditions are high, it should not float when empty.

(c) Suction piping should be designed to minimize whirlpooling.

(d) Vent piping must 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 freezing problems previously discussed.

B-4-6 Cistern Specifications. Some political districts, where water systems are not available and water for water hauling fire departments is inadequate, are requiring developers to provide cisterns with all subdivisions that are constructed. As each cistern may provide fire protection for a number of buildings, the capacity is rather large and represents a substantial investment. The following are specifications for cistern design and construction that one political district is using.

Specification of Cistern Design and Construction.

1. Cisterns should be located no more than 2200 feet (671 m) truck travel distance from the nearest lot line of the furthermost lot.

2. The design of a cistern should be trouble-free and last a lifetime.

3. The cistern 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 psi (20 700 kPa). It should be placed with a minimum of 4-in. (102-mm) slump and vibrated in a workmanlike 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. × 5 in. (204 mm × 127 mm) eccentric reducer is available from suppliers.

14. The final suction connection should be 4½-in. (114-mm) National Hose male thread. It must be capped.

15. The filler pipe siamese should have 2½-in. (65-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 be a minimum 12 in. of ¾- to 1½-in. crushed, washed stone, compacted. No fill should be used under stone.

19. Filler pipe siamese should be 36 in. (914 mm) above final backfill grade.

20. Suction pipe connection should be 20–24 in. (510–610 mm) 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-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 insulated with vermin-resistant foam insulation, and 2 ft (0.6 m) of fill.

(c) All backfill should extend 10 ft (3 m) beyond the edge of the cistern, then 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 1-6 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 towards 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.

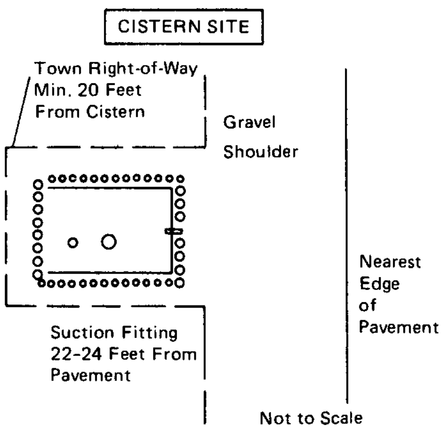


Figure B-4-6(a).

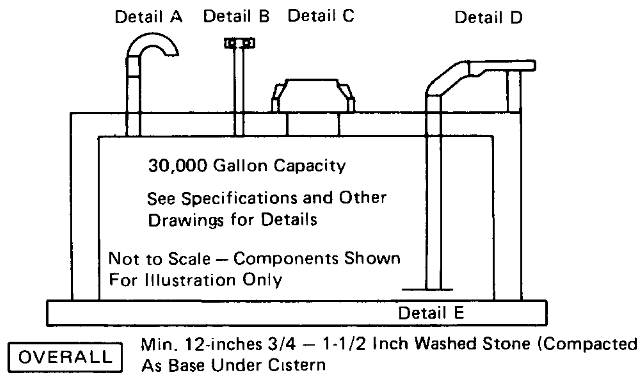


Figure B-4-6(b).

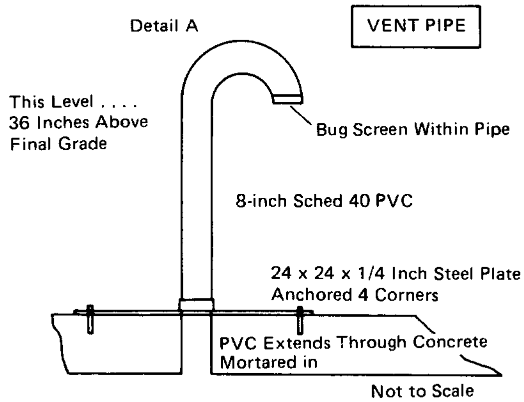


Figure B-4-6(c).

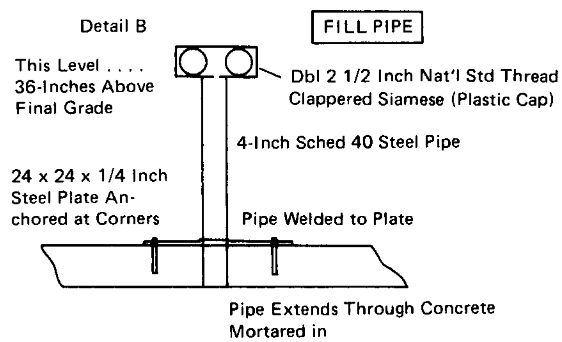


Figure B-4-6(d).

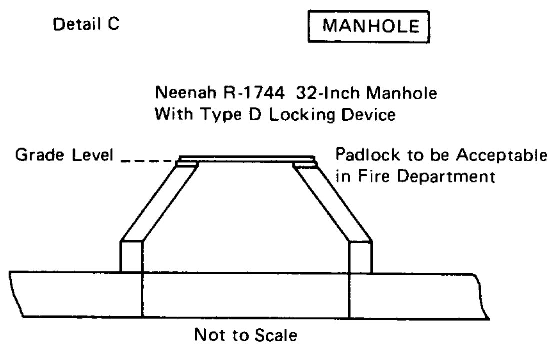


Figure B-4-6(e).

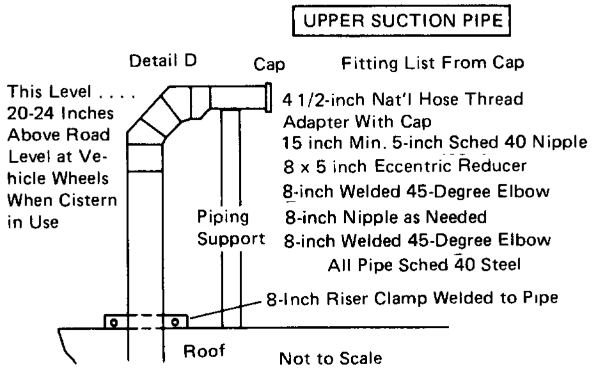


Figure B-4-6(f).

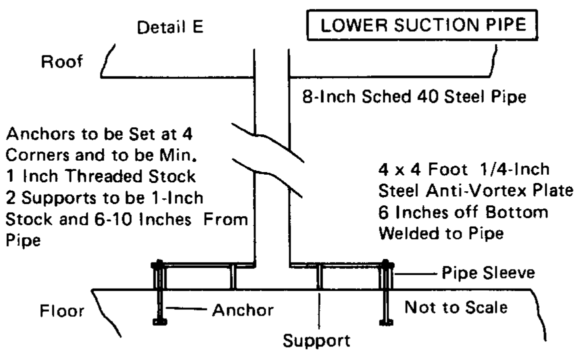


Figure B-4-6(g).

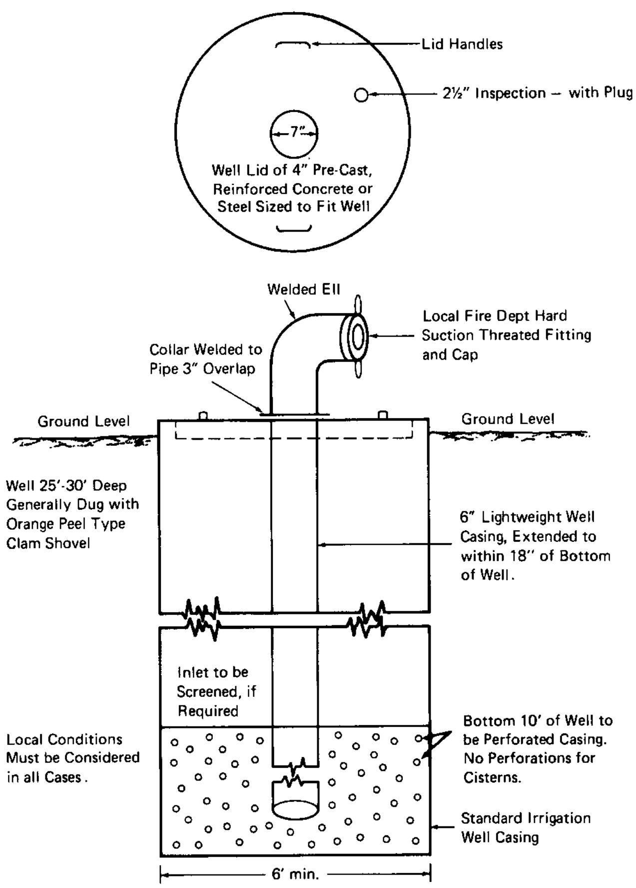


Figure B-4-6(h) Typical well (cistern) with dry hydrant installed. Same design suitable for cistern if bottom of casing is not perforated. For usable water depth, see B-4-7 warning.

B-4-7 Guide to Circular Cistern Capacity. A ready guide to the capacity of cisterns with vertical sides is given in Table B-4-7.

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)

NOTE: One cubic foot = 7.48 gallons of water.

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. (*See B-5-4.*) In a cistern, a bottom bed of gravel protecting a dry hydrant inlet, for instance, decreases the usable depth to 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 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, but have a major drawback in normally poor accessibility for large apparatus. There are some areas of the country in which swimming pool distribution is better than hydrant distribution. Should the water supply officer intend 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. It should be required that the fire department be notified in the event of drainage of such pools.

B-4-8.1 Pool Accessibility. If fire department accessibility is considered with the design of the pool, a usable water supply may be available to the fire department for supplying direct hose lines or a source of water for tanker supply. Most swimming pools are built in areas requiring security fencing or walls, and these can complicate the problem of accessibility. Fences and walls can be designed for fire department use (*see Figure B-4-8.1*) or, depending on constructon, are susceptible to forcible entry by cutters, sledgehammers, etc. In most cases, a solution to the problems of accessibility can be arrived at through preplanning and may call for long lengths of suction hose, portable pumps, dry hydrants, or properly spaced gates. Portable (or floating) pumps designed for large volume delivery at limited pressures delivering water to portable folding tanks or fire department pumpers are frequently ideal where accessibility problems exist. (*See Appendix E-1-2.6.*)

A swimming pool virtually under the eaves of a burning house may be a very poor location from which to pump if there are problems of fire exposure to the work area, etc. Pumping from a neighboring pool, if it is close enough, or setting in motion the water hauling program is frequently preferable to pumping from the pool of the burning house.

Figure B-4-8.1 Pool accessibility. Where plans are made before a fire, it may not take elaborate preparation to use a swimming pool as a water supply.

B-4-8.2 Pool Capacity. A short-form method of estimating pool capacity is:

L × W × D × 7.5 = estimated capacity (in gallons).

L = length in feet.

W = width in feet.

NOTE: These dimensions may be estimated or rounded off if pool is of stylized construction.

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

1 cu ft water = 7.5 gallons

Consideration should be given for providing more suction hose on engines responding 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 at the property is known. Lightweight or flexible-type suction hose can be advantageous for this purpose.

B-4-8.3 Care in Use of Pools. Care must be exercised to be sure structural damage will not be done to a pool and the surrounding area if the water is used for fire fighting. 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; therefore, it may be necessary to refill the pool as soon as the fire is under control and tankers can be released from fire duties.

Some pools are compacted earth covered by a plastic surfacing or light-gauge 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 these pools at all.

Another consideration is whether the ground surrounding a pool will support the weight of a fire department vehicle without collapsing. The water supply officer should study and know the various pool limitations within the area he serves by consulting with the builders and installers of these pools.

B-4-9 Livestock Watering Ponds and Tanks. Many farms have livestock water tanks and other similar facilities. If the owner is aware of the water needs for the farm's buildings for fire fighting purposes, such tanks and ponds may be so sized as to be adequate in volume for both farm and fire department use and so located as to be readily available to the fire department. Tanks may be placed on the edge of the barnyard and on a side accessible to the fire department with the pumper or pump taking suction through a connection on the tank or by suction hose. These watering tanks and ponds are often filled and maintained full by a pump operated by a windmill or by an electric pump.

When a well fitted with an electric pump is used for irrigation or industrial use, the fuses may be pulled for periods of time when the farmer or plant does not need the water supply. Therefore, the fire department should carry fuses for all of the pumps in their district, and provisions should be made for an electrician or a power company employee or someone well-versed in pumps to respond on all alarms of fire.

B-4-10 Sprinkler Systems. In some rural areas, the only large water supply may be storage provided for use of a sprinklered building. The supply may be from an underground water distribution system, a pond or suction tank with pumps, an elevated tank, or a combination of these. In many cases, preplan arrangements can be made to use the water. This is particularly true if the property owner is contacted before he installs his sprinkler protection, as it may be necessary to increase the capacity of the storage or to install a hydrant that is accessible to the fire department and connected to the private yard distribution system.

Extreme care must be exercised in the use of water supplies provided for sprinkler protection. A certain amount of water must be retained in these systems for minimum sprinkler protection. A careful study and preplan must be made to determine such use.

Some states and municipalities may have special ordinances requiring sprinkler protection for certain properties such as nursing homes. Frequently, the water supplies for these systems are minimal and may be from pressure tanks of limited capacity. Where this is the case, it is suggested that the fire department not consider such supplies in their planning, as the rural fire department must be careful that it does not disrupt the protection at such a property. (*See Appendix F for additional information on sprinkler systems.*)

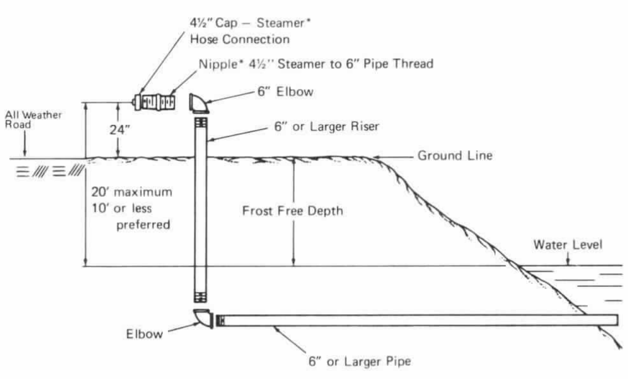
B-4-11 Driven Wells. Wells and well systems are becoming increasingly popular as water supplies for fire fighting purposes at industrial properties, shopping centers, subdivisions, and farm houses located in rural areas beyond the reach of a municipal water distribution system.

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 well hydrant. Material on this technique is available from the U.S. Forest Service. A high water table is a prerequisite to using this method. Fire fighting units in areas conducive to this technique should have the necessary equipment for such installations.

B-5 Dry Hydrants.

B-5-1 General. The use of natural water sources and man-made water sources requires an understanding of dry hydrant construction, as the dry hydrant provides a ready means of suction supply without the longer time often involved in direct drafting. Although most rural fire departments are equipped to draft water directly from farm ponds or streams, and all should be, a dry hydrant [*see Figure B-5-1(b)*] with an all-weather road access is preferable.

Figure B-5-1(a) Dry hydrant.

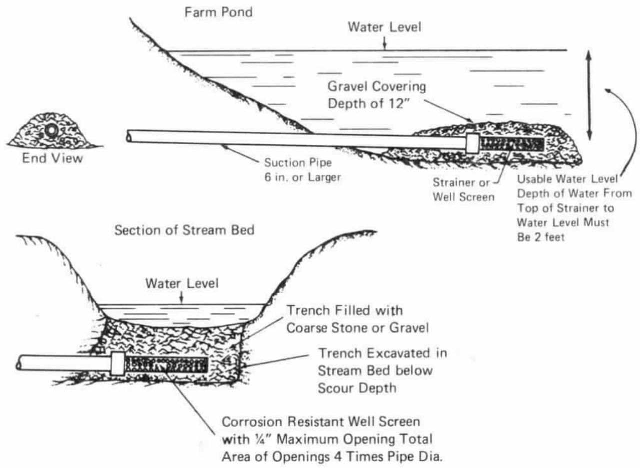


Exploded view of dry hydrant construction.

Figure B-5-1(b) Dry hydrant construction. [*See Figure B-5-2(c).*]

NOTE: Riser should be protected by post if subject to damage by auto or fire equipment.

*Steamer should be fire department's hard suction hose size and thread type.



Details of screen layout — pond and stream sites.

Figure B-5-1(c) Details of screen layout — pond and stream sites.

B-5-2 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-in. (152-mm) or larger pipe is necessary. The pipe and material should be suitable for the use and installed to manufacturer's standard. In some areas of the country, PVC pipe is being used for the construction of dry hydrants. (*See B-5-2.2.*) However, in other areas of the country, brass or bronze caps and steamer connections are being used along with iron pipe elbows and risers with asbestos cement or bituminized fiber pipe between risers and the water supply. Pipe and material used should be based on local conditions and common usage.

Table B-5-2 may be used to determine pipe size of a given hydrant line basing the flow upon 10 psi or 20 ft of head.

Table B-5-2
Gallons per Minute Flow at 20 Feet of Head on Typical 6-in. Pipe

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

For SI Units: 1 ft = 0.305 m; 1 gpm = 3.785 L/min.

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

A strainer or well screen is needed for the suction end of the pipeline to keep foreign materials out of the pipe and the pumper using the dry hydrant. A well screen as a strainer is shown in Figure B-5-1(c). However, a strainer may be constructed by boring ¼-in. (6.4-mm) or ⅜-in. (9.5-mm) holes through the pipe. The holes should be spaced on ½-in. (12.7-mm) centers, with at least 12 rows drilled. Total area of strainer holes must exceed four times the area of the diameter of the pipe. The end of the pipe should be plugged, placed in the deepest portion of the pond or other water source, and raised off the bottom about 2 ft (0.6 m) so it will 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 stream bed installations, the strainer must be buried deep enough to prevent scouring action of the stream during periods of high runoff from exposing the strainer and tearing it loose from the supply pipe. The depth at which the pipe is installed should be below the frost free depth for the area. This depth may be obtained from a hydraulic engineer, university extension service, or the U.S. Soil Conservation System. [*See Figure B-5-1(b).*]

For a dry hydrant, the pipe should be laid at a minimum slope [2 or 3 in. (50.8 or 76.2 mm) per 100 ft (30.5 m)] up to the hydrant riser. The riser on a dry hydrant should be exposed above ground approximately 24 in. (610 mm).

B-5-2.1 Pressurized Dry Hydrant Sources.

There can be two types of pressurized dry hydrants— those flowing through a dam (or dike) and those coming from an uphill water source emptying at a point downhill from the source. Although the water source uphill can be of extreme advantage when flowed to a downhill source, a major disadvantage could lie in the burying of the PVC pipe below the frost level. 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 a pond, anti-seep collars should be attached to the pipe to prevent water from seeping and channeling beside the pipe.

B-5-2.2 Design Features and Step-by-Step Procedures for Installing a Dry Hydrant Using PVC Pipe.

The design of dry hydrant installations have been carefully planned to incorporate several desirable advantages that tend to bring the installation of the PVC dry hydrant within the manpower and financial resource of a large number of rural fire departments or the property owners; however, in areas where other types of material are used, such materials may be substituted for the PVC pipe and fittings. The design features are listed here to simplify the understanding of the installation of the dry hydrant.

I. Design Features for Dry Hydrant.

A. It is recommended that dry hydrants be constructed of 6 in. (152 mm) or larger piping and fittings; however, for very short lengths of pipe, 5 in. (127 mm) may be considered.

B. No PVC piping or fittings of less than schedule 40 should be considered.

C. All piping or fittings exposed to sunlight should be primed and painted.

D. A minimum number of 90 degree elbows, preferably no more than two, are suggested to be used in the total system.

E. All connections should be cleaned and properly cemented so as to have all connections airtight.

F. The strainer may be formed in the end of the pipe by drilling 960, ⅜-in. (9.5-mm) holes along piping. A 4-in. (102-mm) strip should be reserved on the pipe to be installed on top to reduce the possibility of whirlpool during drought periods.

Figure B-5-2.2(a) A dry hydrant innovation has eliminated the top 90° or 45° elbow on each hydrant.
(*Photo by Nahunta Volunteer Fire Department, North Carolina*)

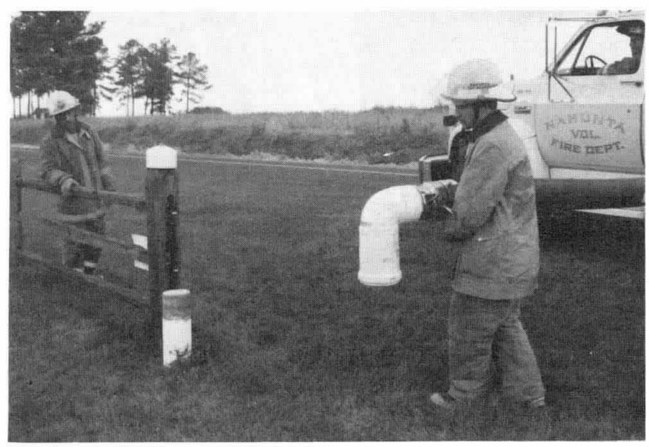


Figure B-5-2.2(b) Hard suction hose is connected to the pumper. The driver maneuvers the truck as the fire fighter walks the suction end of the hose to the dry hydrant. An "O" ring in the plastic "L" provides a tight fit and allows the operator to draft. This is a quick and simple method to connect the pumper to a dry hydrant.

II. Step-by-Step Procedures for Installing a Dry Hydrant. (Installation is made easy by some simple preplanning.)

A. Consider average water level at piping entry location.

B. Lift in excess of 15 ft (4.5 m) needs to be avoided [22 ft (6.8 m) maximum].

C. It is recommended that a backhoe or similar ditching equipment be utilized to excavate entire ditch to a horizontal elevation 3 ft (0.9 m) below water level.

D. The ditch should be excavated beginning at the most distant point from the water (riser location). Maintain a reasonable level and dig the ditch into the pond.

E. The horizontal and vertical portion (pipe and riser) should be assembled and lowered in one piece, as ditch should now have water its entire length.

F. Back-filling should begin at the riser. It is suggested that the soil around the riser be tamped so it is rigidly supported with surrounding soil.

G. The ditch water is automatically forced back to the water source as back-filling is completed. This area should be firmly packed so as not to have low areas occur at a later date due to the settling of the soil.

H. At this point is is necessary to have personnel enter the water and place cement blocks, gravel, or other permanent supports underneath pipe in the water. The support should be heavy and prevent piping from coming in contact with bottom of water source. The strainer or well screen is now to be covered with 12 in. (305 mm) of coarse gravel to secure it in place and to prevent movement and must be at least 2 ft (0.6 m) under water. The supports can also be secured to the pipe with copper wire to stabilize piping.

I. In rapidly moving streams, the pipe will need to have special protection against the rapidly flowing water and various debris and materials washing down the stream against the pipe.

B-5-3 Maintenance of Dry Hydrant. These facilities require periodic checking, testing, and maintenance at least quarterly. Checking and testing by actual drafting should be a part of fire department training and drills. Thorough surveys should reveal any deterioration in the water supply situation in ponds, streams, or cisterns.

Particular attention should be given to streams and ponds. They may need frequent removal of debris, dredging or excavation of silt, and protection from erosion. The hydrants should be tested at least annually with a pumper. Back flushing, followed by a pumper test at a maximum designed flow rate, with records kept of each test, is highly desirable. Tests of this kind will not only verify proper condition but also 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.

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

It is important to consider appearance of this water point. Grass should be kept trimmed and neat. The hydrant should be freshly painted as needed. The cap can be painted a reflective material to improve visibility during emergencies. All identification signs should be approved by the Department of Transportation prior to installation if they are to be on the right of way or come under state laws.

Location and Directions: ____________________

____

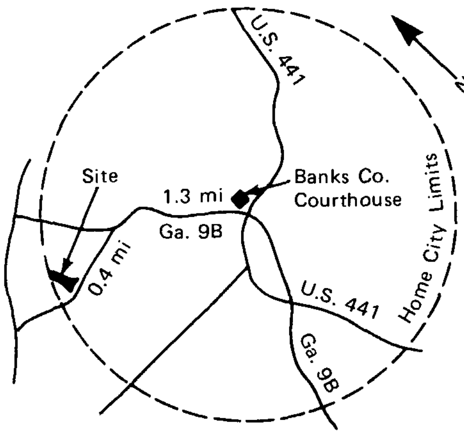
____

Depth of Water Above Intake ________

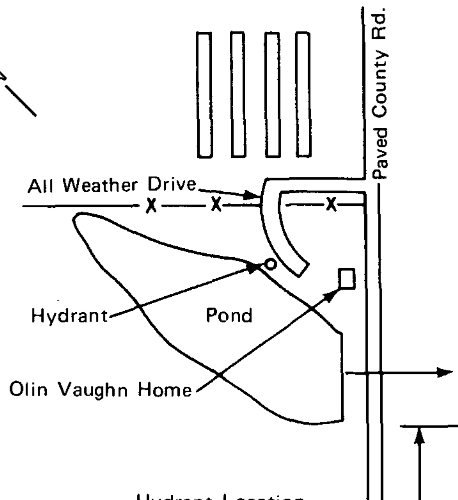
Date ________

DATE OF INSP.	BY	DEPTH OF WATER	AMOUNT OF WATER AVAILABLE	CONDITION OF WATER	EROSION	DRY HYDRANT		WEED CONTROL	ROAD CONDITION	SIGN	REMARKS
						TEST	FLOW				

Figure B-5-3.1.



General Location



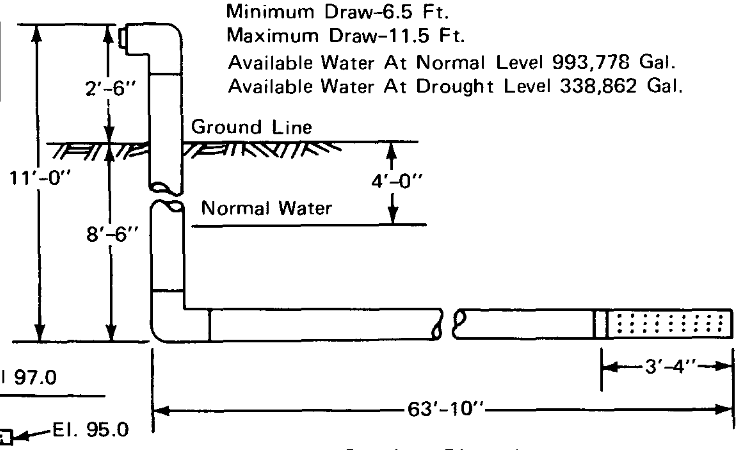
Hydrant Location

Bill of Materials

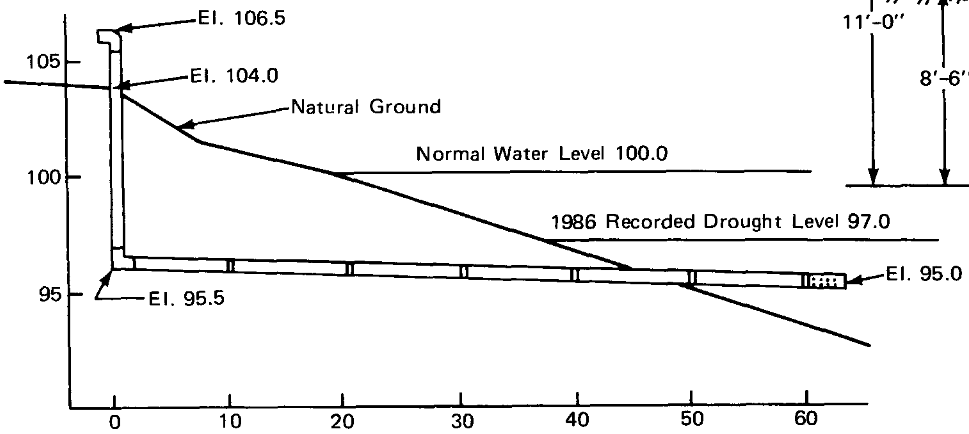
Quantity	Item
1 Ea.	Dry Hydrant Adapter-Sch 40 PVC 6" To 4½" Suction Line 90° Bend
1 Ea.	Strainer with Snap Ring
1 Ea.	Hydrant Cap
1 Ea.	6"x 3'-4" PVC Strainer
1 Ea.	6" Sch 40 PVC 90° Bend
70 L. Ft	6" Sch 40 PVC Pipe
6 Ea.	6" PVC Couplings-Sch 40
1 Ea.	Can PVC Glue

Quantities

Source of Water-Pond and Stream
Size of Normal Pool 0.84 AC.
Size of Drought Pool 0.3 8 AC.
Minimum Draw-6.5 Ft.
Maximum Draw-11.5 Ft.
Available Water At Normal Level 993,778 Gal.
Available Water At Drought Level 338,862 Gal.



Pipe Line Dimensions



Profile of Pipeline

Figure B-5-3.2(a).

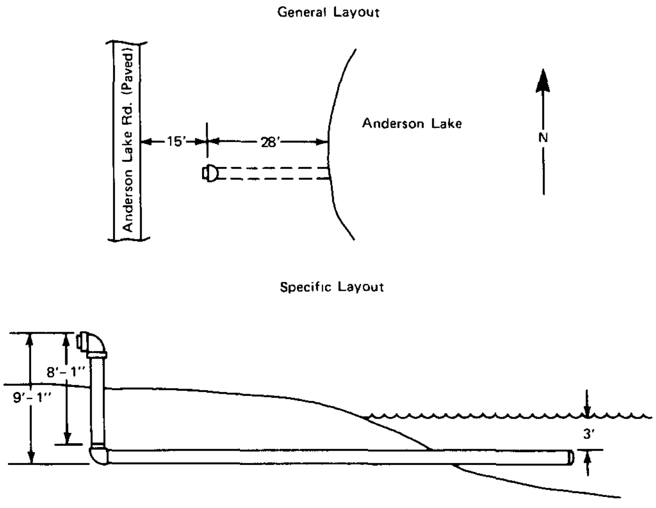


Figure B-5-3.2(b).

B-5-3.1 Maintenance Record for Dry Hydrant. It is suggested that a record of inspection be maintained with a separate card on each dry hydrant. (*See Figure B-5-3.1.*)

B-5-3.2 Map and Location/Detail Drawing. An official record should be kept of all pertinent information recommended for each dry hydrant area. An example of one type is Figure B-5-3.2(a). Additional information could be kept in format such as shown in Figure B-5-3.2(b). Both will provide invaluable information whenever the need for such is required.

B-5-4 Useful Depth of Water Sources. Careful note must be made of the fact that installation of dry hydrants, as noted in Section B-5, calls for care in measuring water storage capacities. The useful depth of a lake 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 lake, and must be not less than 2 ft (0.6 m) of water. This becomes a very important point where hydrants are installed on a body of water affected by tide or on a lake that is lowered to maintain the flow of a river during drought conditions or to generate power. A pump suction requires a submergence below the water surface of 2 ft (0.6 m) or more, depending upon the rate of pumping, to prevent the formation of a vortex or whirlpool. Baffle and anti-swirl plates may be added to minimize vortex problems and allow additional water use. The vortex allows air to enter the pump, which may cause the loss of the pump prime. Therefore, pumping rates must be adjusted as the water level is lowered. This factor should be considered by the water control officer when estimating the effective rate at which water can be drawn from all suction supplies. Floating strainers may reduce the need for a 2-ft (0.6-m) usable depth.

B-6 Access to Water Supplies.

B-6-1 General. The fact that an adequate water supply is in sight of the main road does not assure that the water can be used for fire fighting purposes. Many times, it is necessary that a suitable approach be provided to reach within 10 ft (3.05 m) of the water supply. This needs to be done and the department trained in the use and limitations of the water supply before the fire occurs. A suitable approach may call for a roadway. However, at some sites and in some areas of the country, it may not be necessary that a roadway be constructed due to soil conditions. Other sites may already have roadways provided or pavement installed with the construction of an entrance way or a gate necessary to give access to the water supply. Other sites may be reached by foot only and may necessitate that a path be constructed and maintained so that portable pumps may be carried to the site. Each site must be evaluated by the water supply officer to determine the best way, within the fire department's means, for using the water supply.

B-6-2 Roadway Access. Most man-made lakes are constructed with heavy earth-moving equipment. In order for the property owner to construct a roadway for fire department use, the water supply officer should make the property owner aware of the needs of the fire department while the heavy equipment is still on the job. Table B-6-2 details considerations that should be kept in mind when planning access.

Table B-6-2
Recommendations for Roads to Water Supplies

Width:	Roadbed — 12 ft (3.7 m) Tread — 8 ft (2.4 m) Shoulders — 2 ft (0.6 m)
Alignment:	Radius center line curvature — 50 ft (15.2 m).
Gradient:	Maximum 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:	Measures as needed to protect road ditches, cross drains, and cut and fill slopes.
Load Carrying Capacity:	Adequate to carry maximum vehicle load expected.
Condition:	Suitable for all-weather use.

B-6-2.1 While the roadway is being developed to the water supply, consideration should be given to providing an 80-ft diameter turn around for the tankers. Where conditions at the supply do not make a turn around feasible, a large underground pipe transmission line may be laid from the water supply to the highway and the tankers filled on the highway right-of-way. However, a turn around or looped facility will still need to be provided at the fill point on the right-of-way.

B-6-2.2 Bridges Used as Water Points. In some states, a fire department cannot use a bridge to park a tanker while it is being filled, thereby blocking traffic on a state road. However, the fire department may be able to use the water source by moving the fill point off of the bridge to the right-of-way. Therefore, the department needs to check with the state DOT and abide by the appropriate laws governing the situation.

B-6-3 Dry Hydrant with Suction Line. In some cases, it may be desirable to install a dry hydrant with a suction line in lieu of an access road. This may be true in marsh or swamp areas. In this case, the fire department will have access to the hydrant from the shoulder of the main road. So as not to block the road during pumper operations, a suitable parking area on the shoulder of the road should be provided. Basic recommendations in Table B-6-2 can be useful in the design of such an area so that pumpers can be used efficiently and safely.

B-7 Bridges.

B-7-1 General. It is expected that the general condition of the bridges in most of our states is poor. A large number of these bridges are very old, and many that were built for farm-to-market-type use are now in urban areas with greatly increased traffic loads.

The condition of the nation's bridges was brought to the public's attention in the late 1960s when the collapse of a large bridge received headline reporting from the news services. Furthermore, it developed that many of the states did not provide complete bridge inspection and maintenance programs.

B-7-1.1 Federal Legislation. As a result of this bridge failure, the Federal Highway Act of 1968 was passed, which required, among other things, that all states, counties, and cities receiving federal highway funding implement a program to inspect each bridge in the federally funded system every two years. Additional bridge collapses prompted ammendment of this law in 1976 to include all bridges on the public roads system.

B-7-1.2 Bridge Inspection Programs. During the last few years, a number of states have set up bridge inspection programs and the current safe tonnage is being posted. Over the entire county, a large number of bridges have been restricted to below the legal weight limit for which the road and bridge were originally designed.

One state with over 15,000 bridges reports that 50 percent of all its bridges are now posted below the original maximum load limits and 25 percent of these bridges are unsafe for use by a fully loaded school bus or normal fire department equipment.

B-7-1.3 Repair Programs. The highway departments are doing what they can with the money available to improve the situation. Priority is given to bridge upkeep on primary roads, with the bridges on the less important roads having to take what is left. Some highway departments are upgrading or raising the tonnage on their bridges as much as possible with repairs; however, many cannot be brought up to standard without complete rebuilding. Most states do not have money available for such an overhaul program.

In some states, the state highway department has consulted fire officials, explained the situation, and required that the fire department list the unsafe bridges in order of their importance to the fire service. The highway departments are then attempting to upgrade these bridges on the basis of fire department priority.

B-7-1.4 Effect on the Fire Service. The long-range nature of the bridge problem makes it a matter for serious consideration when planning purchases of apparatus. Tanker size especially must be restricted to gallonages that will not cause overloading. Any situations, such as an area isolated by an unsafe bridge, that may require particular equipment should be anticipated.

Whether or not a fire service would be held financially responsible for damage to a bridge would depend on state law; however, a good policy for every rural fire department is to check the bridge load restrictions before purchasing a new piece of apparatus. The lighter the equipment, the more bridges the department may be able to use.

B-7-1.5 Fire Department Responsibility. The fire department should check every bridge in its response districts, both primary response and mutual aid, to be sure that all bridges will safely carry the fire department load. This may not be the overwhelming task it appears. In view of the current use of computers by state highway departments to inventory their bridges, load limits may be readily available.

The fire department will need to make whatever special provision is indicated to protect an area isolated by an unsafe bridge. For example, providing a temporary station to house equipment in the isolated area, using a pumper taking suction from the river to pump water across the bridge through large hose lines, or servicing the area from another station that has a safe bridge to the area or, even better, does not have to use a bridge to respond.

B-8 Preplanning Water Supply.

B-8-1 Preplanning. Structures within the district of responsibility of the fire department should be surveyed in accordance with Chapter 2. The water requirement should be calculated, and the type and amount of equipment that should respond on first alarm should be designated. The response of fire apparatus, in conjunction with capacity of tankers, travel distance to haul water, and the volume of water supply, can then be arranged so that a constant flow to equal the water flow requirements is obtained. The procedure should be verified under training conditions prior to a fire emergency. This training exercise should include the spotting of equipment to protect the fire property and the exposures, exploration of the water sources, designation of fire lanes or routes, and review and modification of the operations to meet unusual conditions.

Aircraft and aerial photographs may be very helpful in the survey of static water availability. Such photographs are usually available from the county agriculture department or the county office of planning and zoning. Topographical maps from the U.S. Government also may be of value in this survey. However, the value may be determined by the date that the map was made or revised since an out of date map may prove to be of little value. Once sites are located, they need to be prepared for use according to the directions in this section, Appendix B.

Appendix C Water Hauling

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

C-1 Moving Water by Mobile Water Supply (Tanker).

C-1-1 General. The fire service has always experienced fire control difficulties in isolated areas. The difficulties have been many and varied, but one of the big factors is the lack of an adequate water supply. An adequate amount of water for control and extinguishment is a major consideration of most rural fire chiefs and influences the majority of their fire fighting decisions. A portion of the training of the rural fire department is taken up with engraving on the mind of the membership the need for the conservation of the meager water supply that is available in many areas.

This situation of a limited water supply at a working fire in a rural area demands the best in all phases of fire fighting. Therefore, this Appendix discusses the procedures for moving water in those areas where there are no municipal-type water distribution systems with fire hydrants.

Should the water supply be a dry hydrant, a lake, a cistern, a swimming pool, etc., some means must be provided for transporting the water from the supply to the fire. Most fire departments are using a fire department pumper (having a pump capacity of 750 gpm or more and having a minimum 500 gallon tank).

As this vehicle is always assigned to the supply, some departments provide it with little equipment beyond the pumps, the necessary hose for loading the tanker and some preconnected hand lines.

Several departments report that they have developed water supplies where the pumper is actually driven into shallow water at the water supply. Others have developed a trailer with a pump and the trailer is pulled to the water supply. Still other departments have received good service from a permanently installed pump at the supply.

Over the years, rural departments depending on hauled water have tended to utilize anything that will carry water and have exercised a great deal of ingenuity to make it work. Recently, there has been a trend in fire departments in rural areas to use "standard" pumpers and tankers with tanks in the 1000 to 1500 gal (3785 to 5678 L) range. Giant steps have been made in such tanker techniques as loading, unloading, and maintaining a continuous fire stream, based on the fire flow study, during the entire fire fighting operations. In this publication, a tanker is defined as a fire apparatus, the primary purpose of which is to move water from a source to the fire site. This is in contrast to a fire engine having a booster tank (no matter how large the tank), which will be placed at the fire to supply fire lines or placed at the water source to load the tankers.

Tankers are necessary for most rural departments and may be a big asset to a department having a weak municipal-type water system. While specially built and designed tankers are ideal, many fire chiefs are facing fires without adequate standard equipment. Since the job of putting out fires will require, on occasion, water-carrying capacity far above normal capability, a sound mutual or automatic aid program is necessary and far superior to makeshift equipment that is not designed for emergency service and is unsafe.

In building and buying nonstandard apparatus, utmost care must be exercised to consider safety and serviceability of the equipment as well as the safety of the membership of the department. A department having to depend on a mixture of tankers designed primarily for other use may need expert assistance in checking the equipment for safety before putting it in service.

If satisfactory service is going to be obtained from tankers, the size of chassis necessary to safely carry the load, the horsepower of the engine necessary to perform on the road and at the fire site, the completed vehicle's weight distribution, and the gear train combination best suited for the operation in that specific locale are items that must be carefully considered in the purchase or construction of the apparatus. The apparatus components, such as baffling of tank and center of gravity, are just as important as the engine, axles, and other drive line components and must not be overlooked.

Some fire departments, where their pumpers are equipped with large booster tanks, have retrofitted these pumps with a dump system.

C-1-2 Purchase or Construction of a Tanker. In the planning or construction of a tanker, it is necessary that careful attention be given to assure that engine, chassis, baffling, center of gravity, and brakes of adequate specifications are obtained. NFPA 1901, *Standard on Automotive Fire Apparatus*, covers tankers, and it is suggested that this standard be carefully followed. The tank should be properly constructed and baffled. Particular attention should be paid to flow rates to and from the tank. Consideration should be given to discharging the tanker to the receiving vehicle, portable tank, or other equipment as rapidly as possible to get back on the road and bring another load of water to the fireground. Some departments are installing very large dump valves with gravity flow; while other departments are providing a pump with a jet dump arrangement to reduce the time of emptying tankers.

Terrain to be traveled, weather to be encountered, and bridge and road conditions must be considered in buying or building safe tankers.

It is suggested that, for a tanker with a capacity greater than 1,500 gal (5678 L), it may be necessary to utilize a semitrailer or tandem rear axles, depending on tank size and chassis characteristics. Certain types of chassis may not provide safe carrying capabilities, and a dangerous vehicle could result from assembly. Safe, reliable equipment that at least meets the minimum standards is a must.

It is further recommended that the maximum water tank capacity for tankers should not exceed 4,800 gal (18 168 L or 20 tons of water). In some cases, it may even be found that the cost of two smaller tankers will be little more, if any, than the cost of one large tanker. The mobility, cost of upkeep, and highway bridge weight restrictions may convince many rural fire departments of the need to restrict the weight of their mobile water supply tanker.

Each load bearing tire and rim of the apparatus should carry a weight not in excess of the recommended load for truck tires of the size used, as published by the tire manufacturer's rating, when apparatus is loaded. Compliance should be determined by weighing of the loaded apparatus.

C-1-3 State Regulations.

Regardless of rear axle configuration, definite consideration should be given to the state legal weight per axle requirement. All states have single axle weight limits, which are imposed solely due to road surface conditions and longevity of highways. Although axles are designed to carry their rated weight, and vehicle and fire department planners can specify precise chassis requirements to be within the safe tolerances of total vehicle operation and weight, this still does not legally permit the fire apparatus to exceed the state's legal weight rating per axle. Since some axle weight ratings are 26,000 lbs, the consideration and attention paid to state single axle weight limits can become quite significant.

The use of dead (or dummy) axles serves only to reduce the weight per axle load (on weighing scales). In no manner does it allow the engineering parameters of motor, transmission, drive shaft, brakes, etc. designed for the GVW of the chassis to be functional. Using a nonworking axle for load carrying purposes does not make a road-safe chassis.

C-1-4 Mobile Water Supply (Tanker). In general terms, mobile water supply vehicles or "tankers" are units made for specific water hauling requirements. In some forest service areas, where fire fighting is off the road and up steep grades, a 200 gal (757 L) slip-on unit is a tanker. East of the Mississippi River, there is a trend in fire departments in rural areas to use tankers in the 1,000 to 1,500 gal (3785 to 5678 L) range. In flat areas west of the Mississippi, fire departments successfully use tankers with capacities of 3,000 to 5,000 gal (11 355 to 18 925 L) and occasionally more.

In many parts of the country, terrain and bridge and road weight restrictions limit the capacity of tankers to the 1,000 to 1,500 gal (3785 to 5678 L) range. (*See B-7-1.*) However, the department operating tankers with capacities of 1,000 gal (3785 L) or more will normally find it easy to meet minimum water requirements outlined in this publication where water supplies are readily available.

It is desirable to have tankers of similar fill and discharge capability and equal water-carrying capacities to prevent them from "stacking" at the fill and discharge points.

C-1-5 Tank Baffles. Some consider the age-old problem associated with tank baffles or swash partitions as the weakest and most dangerous area of fire engine and tanker design and construction. Considerable improvements have been made in baffles since the advent of the computer age. Poor baffling has been responsible for many accidents and each year accounts for a number of deaths throughout the country. Therefore, careful consideration must be given to baffles by the designers and builders of the tanks.

A reasonable guide is to have at least one baffled compartment for every 250 gallons (946 L) of water. This is not intended to imply that small tanks (250-300 gallons) do not need baffles.

C-1-6 Plumbing. It is important to have an outlet of adequate size to empty the tank. The reason is evident when the times to empty a 1600-gal (6056-L) mobile water supply tanker by gravity flow are considered. (*See Table C-1-6.*)

Table C-1-6 1600 Gallon Mobile Water Supply (Tanker) Gravity Flows

Outlet in Inches	Discharge Time in Minutes
2½ (65 mm)	20
4½ (114 mm)	7
6 (152 mm)	5
10 (200 mm)	1⅔
12 (305 mm)	1½

Adequate size plumbing is also important in those tankers equipped with a pump with a jet dump arrangement. Many jet dump tankers are capable of discharging at the rate of 1000 gpm (3785 L/min) or more.

Proper venting is a prerequisite to the common evolutions of filling and emptying tanks, but it is imperative to rapid filling and discharging of tanks. There must be adequate provision for air to be driven from the tank when it is being filled with water and to enter the tank when that tank is being emptied. It is recommended that as a minimum the vent opening should be four times the cross-sectional area of the inlet. Inadequate venting can result in the tank being bowed outward when it is being filled rapidly, or in impairing the discharge flow when emptying.

An 8 × 8 in. (203 × 203 mm) vent extending approximately 12 in. (305 mm) high is an adequate vent size. Also, a 3-in. (76-mm) overflow pipe is suggested in NFPA 1901, *Standard on Automotive Fire Apparatus*. This overflow pipe located in the vent pipe area has worked very well for a number of departments.

Adequate pump-to-tank plumbing size is also essential to provide for rapid discharge of water from a tanker through its pump. Many pieces of fire apparatus are in service that cannot deliver the full capacity of their pumps from their tanks because of undersized tank-to-pump plumbing. In a tanker operation in which the emphasis may be placed on rapid low pressure emptying of a tank, this can be a major limitation of efficiency.

Of major concern, in a water hauling system involving tankers, is the fact that the tanker may not be completely filled at the source of water or water supply or completely emptied at the fire. Some tankers are so designed that as little as 10 gal (38 L) of water is left in the tank while others may have 100 gal (379 L) or more.

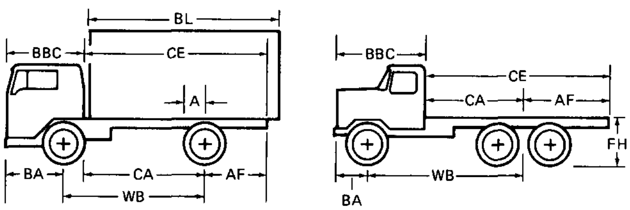
Applicable NFPA standards such as NFPA 1901, *Standard on Automotive Fire Apparatus*, contain data on adequate plumbing. Many departments are now exceeding the nominal pipe size requirements for their pumps in order to reduce friction loss and increase their capability to rapidly empty a tank by use of the pump.

C-1-6.1 Fill Line Couplings. Often, time wasted at tanker fill locations is due to difficulties in making and breaking a 2½-in. (65-mm) threaded coupling between fill pumper and the tanker. If this is the case, considerable time may be saved by using either a quarter turn coupling, or some type of flexible hose with a quick discharge, specially designed large diameter fill pipe, or a rapid fill device that drops into the tank fill opening, thus providing quick breakaway from the fill supply.

C-1-7 Weight Distribution. Weight distribution is all-important in the handling of a heavy piece of fire apparatus and should be properly designed into the unit and then verified by actual weighing of each axle. Only a slight change in the load carried or the distribution of the load may cause the design limits of the truck to be exceeded and turn a safe vehicle into an unsafe vehicle.

Figure C-1-7 provides information as to data necessary to figure accurate weight distribution and how to use this data to make the weight distribution calculation.

Data required pertains to "as is" weights of the chassis to be used, dimensions of the chassis, and weights to be placed on the chassis. "As is" weights are best determined by weighing the chassis, with separate weights obtained on front and rear axles. If the unit has dual rear axles they should be weighed together. In some cases, particularly in using a new chassis, this data may be obtained from the agency providing the chassis, but it should be noted that such items as changes in tire size, lengthening, shortening, or reinforcement may alter such standard factory-provided data, and it is consequently preferable to weigh the chassis upon starting construction planning.



BBC	=	Bumper to back of cab
BA	=	Bumper to center line of front axle
CE	=	Back of cab to end of frame
CA	=	Back of cab to center line of real axle or tandem suspension
AF	=	Center of rear axle to end of frame
FH	=	Frame height
BL	=	Body length
FA	=	Front axle weight
RA	=	Rear axle weight
B	=	Body weight — Weight of complete body to be installed on chassis
PL	=	Payload weight — Weight of commodity to be carried
A	=	Distance from center line of rear axle to center line of body or payload Center line of body (at ½ body length)
WB	=	Wheelbase distance — Distance between center line of front and rear axle or tandem suspension.

Terms:
Chassis — Basic vehicle cab, frame, and running gear
Curb Weight — Weight of chassis only
Gross Vehicle Weight (GVW) — Total of curb, body, and payload weight

The weight carried by the front and rear axle may be calculated from the following formulas:

$$\frac{(B + PL)\,A}{WB} = \text{FA (Front Axle Weight)}$$

$$(B + PL) - FA = \text{RA (Rear Axle Weight)}$$

Figure C-1-7 Weight distribution for tankers.

Dimensional data is easily obtained by use of a tape measure or carpenter's ruler. Again, it may be available from the source providing the chassis but should be verified.

Weight of the body to be added to the chassis is a combination, primarily, of the steel and other materials used in the body, the water in the tank itself, and the components added to that basic list: such items as, for example, any reels, hose, or miscellaneous equipment planned. While it is not necessary to make an individual calculation for minor items (minor in terms of weight), it is certainly important to calculate weight distribution of items of a few hundred pounds or more.

This appendix does not attempt to provide complete information on tanker construction or the weight distribution of such a tanker. The chassis manufacturer's recommended weight distribution — generally expressed as a percentage of total weight, including both chassis and the weight placed on that chassis for front and rear axle(s) — is a prudent guideline as to the final weight distribution desired. Component weights may be obtained from the manufacturers of those components. Steel weights may be obtained from the steelyard providing the material.

C-1-8 Turning Radius and Wheelbase. An important consideration in tanker shuttle operations is the area available for turning. Since the tanker may be called upon to reverse direction or to maneuver for position at the water source or the fire site, a multiple of small single axle tankers with 12-in. (305-mm) quick dump or 6-in. (152-mm) jet dumps may actually move more water to the fire location than longer wheelbase tractor trailers and dual tandem axle tankers.

C-1-9 Tanker Modification. A warning is in order that special care must be used when modifying a tanker built for one purpose to use for another purpose, such as the prevalent practice of adapting an oil tanker to fire service. The majority of oil or gasoline tankers are constructed to carry a volatile liquid whose specific gravity is less than that of water. When utilized as a water tanker, the weight may exceed the manufacturer's permissible gross vehicle weight limits. For this reason, it may be prudent to reduce the tank's size to avoid undesirable effects on weight distribution. However, in doing so, special attention should be paid to the problem of altering the center of gravity, which makes the vehicle's cornering characteristics more hazardous.

Special attention should be paid to the baffling of such tankers, and the truck should be rejected if it does not meet the demands of cornering, braking, and acceleration required by the fire service.

Other special considerations: A stainless steel milk tanker may be made out of very light gauge metal with no baffling whatever and be difficult to baffle crosswise and lengthwise.

The steel used in gasoline tankers will corrode extremely fast due to the uncoated interior of such tanks. In addition, the steel used is not of the copper-bearing or stainless type used in most fire apparatus tanks.

Aluminum fuel oil tanks have been found to be subject to corrosion from chlorinated water and corrosive rural water supplies. They may have a life expectancy less than that of steel if not properly coated and protected.

There is an inherent danger in modifying gasoline tankers — that of an explosion. All gasoline tanks should be thoroughly steam cleaned before modifications requiring welding are undertaken.

The gasoline and milk tanker are usually designed to be filled with the product each morning and to distribute that product during the day under normal traffic conditions rather than emergency conditions as is the case with fire equipment. An oil tanker or milk tanker is not required to stand in the station fully loaded day after day.

Weights of Various Fluids

Milk	— 8.5 lbs/gal
Water	— 8.3 lbs/gal
Gasoline	— 6.2 lbs/gal

C-1-10 Driver Training. An important consideration frequently missed by the rural fire department is that of driver training. There are few people trained to drive a tractor trailer combination under emergency conditions, and the fire department planning to use one must train for it. Even a two- or three-axle vehicle used as a tanker will probably have driving characteristics highly unlike other apparatus, and driver training is a must.

C-1-11 Calculating Water-Carrying Potential. Two primary factors to be considered in the development of tank water supplies are the amount of water carried on initial responding units and the amount that can be continuously delivered thereafter.

A number of fire departments have developed water hauling operations to the point where they have a maximum continuous flow capability (a sustained fire flow) of 1,000 to 2,000 gpm (3785 to 7570 L/min) at the fire scene. This, of course, requires a number of tankers to haul such large quantities of water, with a developed water source near the fire site. To improve the safety factor by reducing congestion on the highways, the departments often send the tankers to the water source by one road and use another route for the tankers to return to the fire scene. Therefore, the time for the department to travel from the fire to the water source (T_1) may be a different time than the travel time back to the fire (T_2). The reduction of congestion on the highway provides for a safer operation and may increase the actual amount of water hauled.

An appropriate formula to calculate the maximum continuous flow capability at the fire scene is:

$$Q = \frac{V}{A + (T_1 + T_2) + B} - 10\%$$

Where:

Q	=	Maximum continuous flow capability in gallons per minute;
V	=	Tanker capacity in gallons;
A	=	Time in minutes for tanker to drive 200 ft (61 m), dump water into a drop tank, and return to starting point;
T_1	=	Time in minutes for tanker to travel from fire to water source, given by formula $T_1 = 0.65 + XD_1$ [*see Table C-1-11(b)*];
T_2	=	Time in minutes for same tanker to travel from water source back to fire, given by formula $T_2 = 0.65 + XD_2$ [*see Table C-1-11(b)*];
B	=	Time in minutes for tanker to drive 200 ft (61 m), fill tanker at water source, and return to starting point;
−10%	=	Amount of water supply (tanker capacity) considered not available due to spillage, underfilling, and incomplete unloading.

The dumping time (A) and filling time (B) for the formula may be determined by drill and by close study of water sources. Equipment does not have to be operated under emergency conditions to obtain travel time (T), as this may be calculated from the following equation:

$$T = 0.65 + XD.$$

T = Time in minutes of average one-way trip travel.

D = One-way distance.

When an apparatus is equipped with an adequate engine, chassis, baffling, and brakes, a safe constant speed of 35 mph can generally be maintained on level terrain, in light traffic, and on an adequate roadway. Where conditions will not permit this speed, the average safe constant speed should be reduced.

Using an average safe constant speed of 35 mph.

$$X = \frac{60}{\text{average safe constant speed}} = \frac{60}{35 \text{ mph}} = 1.70$$

Precalculated values for "X" using various mph have been inserted into the preceding formula (T = 0.65 + XD) as follows:

Table C-1-11(a)

$T = 0.65 + 1.7\,D$	Constant Speed of 35 mph
$T = 0.65 + 2.0\,D$	Constant Speed of 30 mph
$T = 0.65 + 2.4\,D$	Constant Speed of 25 mph
$T = 0.65 + 3.0\,D$	Constant Speed of 20 mph
$T = 0.65 + 4.0\,D$	Constant Speed of 15 mph

These formulas make it possible to plan water available at any point in an area. As an example of how to calculate the water available from a supply where the water must be trucked to the fire scene, consider the following applications of the formula:

If tank capacity (V) is 1500 gallons (5678 L), time (A) to fill the tanker with water is 3.0 minutes and the time (B) to dump the tanker load of water into a portable tank is 4.0 minutes.

The distance (D_1) from the fire to the water source is 2.10 miles. As the tanker returns by a different road, the distance (D_2) from the water source is 1.80 miles.

First, solve for T_1, the time for the tanker to travel from the fire to the water source and then for T_2, the time for the tanker to travel from the water source back to the fire:

Due to good weather and road conditions, the average tanker speed going from the fire to the water source is 35 mph.

Therefore:

$T = 0.65 + XD_1$
$X = 1.7$
$D_1 = 2.10$ miles
At a contrast speed of 35 mph
$T_1 = 0.65 + 1.7\ D_1$
$T_1 = 0.65 + 17 \times 2.10$
$T_1 = 0.65 + 3.57$
$T_1 = 4.22$ minutes

[*Also see Table C-1-11(b).*]

At a constant speed of 35 mph, a tanker traveling 2.1 miles will take 4.22 minutes. Due to traffic lights, the average tanker speed between the fire and the water source is 30 mph.

Therefore:

$T_2 = 0.65 + XD_2$
At 30 mph
$X = 2.0$
$D_2 = 1.80$ miles
$T_2 = 0.65 + 2.0\ D_2$
$T_2 = 0.65 + 2.0 \times 1.8$
$T_2 = 0.65 + 3.60$
$T_2 = 4.25$ minutes

Substituting in the formulas

$$Q = \frac{V}{A + (T_1 + T_2) + B} - 10\%$$

Q = Maximum continuous flow capability in gpm with V = 1500
$A = 3.0$
$T_1 = 4.22$
$T_2 = 4.25$
$B = 4.0$

$$Q = \frac{1500}{3.0 + (4.22 + 4.25) + 4.0} - 10\%$$

$$Q = \frac{1500}{3.0 + 8.47 + 4.0} - 10\%$$

$$Q = \frac{1500}{15.47} - 10\%$$

$Q = 97 - 10\% = 87$ gpm maximum continuous flow capacity available from this 1500 gallon tanker.

To increase the maximum continuous flow capability of a tanker, any of the following changes can be made:

1 — Increase the capacity of the tanker
2 — Reduce the fill time
3 — Develop and provide additional fill points, thus reducing travel time
4 — Reduce the dump time.

With rural fire response distances normally being very long, the number and size of tankers available to the department is of paramount importance. This information will assist the department in calculating the probable tanker gallonage that will be available at various fire locations. Equally important in increasing the maximum continuous flow capacity of a tanker is to reduce the distance between the source and the building or fire. This can be accomplished by increasing the number of water supplies and/or the drafting points.

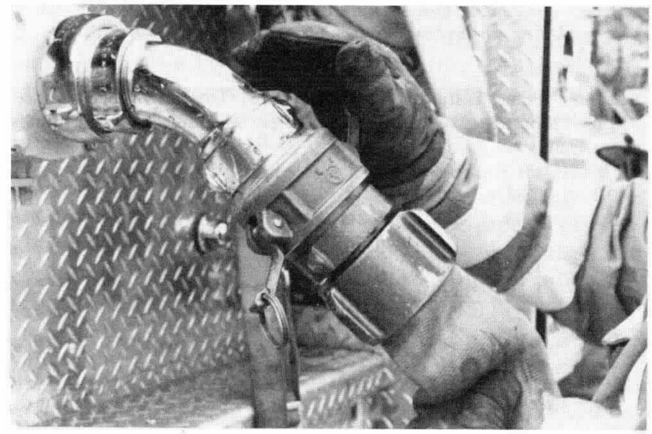


Figure C-1-11 One way to increase water hauling capacity is to reduce the fill time of the tanker. Here is one type of quick coupling that may help to reduce the fill time.

C-1-12 Discharging the Mobile Water Supply (Tanker). During water hauling operations, tanker dump/fill rates directly affect the fire flow capabilities established at the fire scene. Local needs usually determine tanker configuration and the water hauling protocols adapted. A wide variety of off-loading and filling systems are currently in use. Some departments prefer to pump off their water into portable tanks, while others utilize a nursing type of operation. An increasing number of fire departments are incorporating the use of large dump valves or jet-assisted dump arrangements. To decide which system is best requires an evaluation of effectiveness, efficiency, and overall compatibility with other segments of the water delivery.

During a comprehensive evaluation many factors must be considered. Travel distances, operating site location, and topography greatly affect water hauling turnaround time periods. Usually, the most significant time can be saved during the filling and discharge segments of the tanking operation. Normally, greater quantities of water are made available as filling/discharge rates increase. Of course, increased quantities must be logistically supported by ample water source locations and tanking vehicles.

As with other segments of fireground operations, strategic pre-planning is vital to water hauling evolutions. Preplanning and practice reduce unnecessary actions and minimize unsafe practices. For example, a properly established dump site should eliminate or substantially reduce the need to back vehicles (an act that not only requires precious time but causes 33 percent of all vehicle accidents). The use of flexible discharge tubing or side dumps in conjunction with properly set-up dump sites can often eliminate the necessity of backing.

Because two of the key periods for saving time during water hauling operations center around tanker filling and discharge, many fire departments have incorporated the use of large gravity dump valves or jet dump valve arrangements.

C-1-12.1 Mobile Water Supplies (Tanker) Equipped with Large Gravity Dumps. A number of rural fire departments have increased the size of their gravity discharge dumps to reduce the time necessary to empty other water

Table C-1-11(b) Time Distance Table
Using an Average Safe Constant Speed of 35 mph
$T = 0.65 + 1.70\ D$

Distance, Miles	Time, Minutes	Distance, Miles	Time, Minutes	Distance, Miles	Time, Minutes	Distance, Miles	Time, Minutes
0	0						
0.1	0.82	2.6	5.07	5.1	9.32	7.6	13.57
0.2	0.99	2.7	5.24	5.2	9.49	7.7	13.74
0.3	1.16	2.8	5.41	5.3	9.66	7.8	13.91
0.4	1.33	2.9	5.58	5.4	9.83	7.9	14.08
0.5	1.50	3.0	5.75	5.5	10.00	8.0	14.25
0.6	1.67	3.1	5.92	5.6	10.17	8.1	14.42
0.7	1.84	3.2	6.09	5.7	10.34	8.2	14.59
0.8	2.01	3.3	6.26	5.8	10.51	8.3	14.76
0.9	2.18	3.4	6.43	5.9	10.68	8.4	14.93
1.0	2.35	3.5	6.60	6.0	10.85	8.5	15.10
1.1	2.52	3.6	6.77	6.1	11.02	8.6	15.27
1.2	2.69	3.7	6.94	6.2	11.19	8.7	15.44
1.3	2.86	3.8	7.11	6.3	11.36	8.8	15.61
1.4	3.03	3.9	7.28	6.4	11.53	8.9	15.78
1.5	3.20	4.0	7.45	6.5	11.70	9.0	15.95
1.6	3.37	4.1	7.62	6.6	11.87	9.1	16.12
1.7	3.54	4.2	7.79	6.7	12.04	9.2	16.29
1.8	3.71	4.3	7.96	6.8	12.21	9.3	16.46
1.9	3.88	4.4	8.13	6.9	12.38	9.4	16.63
2.0	4.05	4.5	8.30	7.0	12.55	9.5	16.80
2.1	4.22	4.6	8.47	7.1	12.72	9.6	16.97
2.2	4.39	4.7	8.64	7.2	12.89	9.7	17.14
2.3	4.56	4.8	8.81	7.3	13.06	9.8	17.31
2.4	4.73	4.9	8.98	7.4	13.23	9.9	17.48
2.5	4.90	5.0	9.15	7.5	13.40	10.0	17.65

hauling tankers. Gravity dumping with discharge valves of 10 in. (254 mm), 12 in. (305 mm), or larger are often used. It must be remembered that dump valve discharge rates will vary as the depth of the water in a given tank decreases. Adequate air intakes and tank baffle cuts must be provided or inefficiency and possible tank damage can result. To check the efficiency of a dump system, actual weight tests must be conducted to determine discharge rates.

C-1-12.2 Mobile Water Supplies (Tankers) Equipped with Jet-Assisted Dumps. Basically, a jet is a pressurized water stream used to increase the velocity of a larger volume of water that is flowing by gravity through a given size dump valve. The water jet principle used to expel water from tankers has also been effectively applied to several other devices that can transfer water between portable dump tanks, fill tankers from static water sources, and reduce suction losses at draft. Water jets properly installed in the discharge piping of a tanker or tanker pumper can more than double their water hauling efficiency. Effective jet-assisted arrangements have exceeded a 1000 gpm (3785 L/min) discharge rate when using 6-in. (152-mm) discharge piping and valve. Pumps supplying such jet arrangements should be capable of delivering a minimum of 250 gpm (946 L/min) at 150 psi (1034 kPa). The size and design of the jet nozzle and the diameter and length of the dump valve piping directly affect unit efficiency.

C-1-12.3 Traditional In-line Jet-Assist Arrangement. Figure C-1-12.3(a) points out how the traditional jet is installed. A smooth tipped jet nozzle is supplied by a pump capable of delivering at least 250 gpm (946 L/m) at 150 psi (1034 kPa). Nozzle jets range in size from ¾ in. (19 mm) to 1¼ in. (32 mm). The diameter of the tip will be determined by the capacity of the pump being used and the diameter of the discharge piping and dump valve.

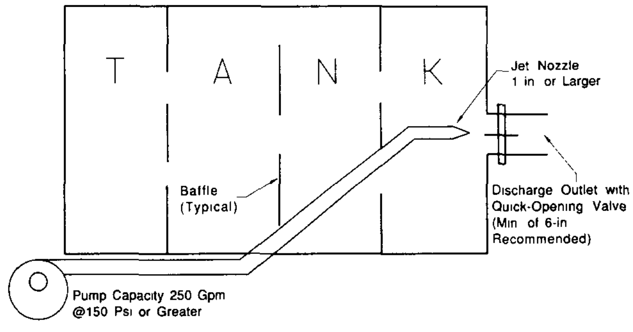


Figure C-1-12.3(a) Traditional internal jet dump.

The installation of a jet dump requires several important considerations to be made. In what location will the dump prove to be most useful, the side or the back? Will the fixed piping need to be 1½ in. (38 mm) in diameter or 2 in. (51 mm) in diameter? What is the preferable location for the jet, in-line or at the rear of the tank? The answers to these and other questions should be resolved before construction begins.

In the interests of site versatility, many departments are utilizing lightweight flexible discharge tubes equipped with quick lock or quarter-turn couplings. Such tubing arrangements allow rapid discharge of water to either side of the vehicle and reduce the need for hazardous backing at the dump site.

The rate of discharge will be governed by the size of the dump valve and piping, which can range from 4 in. (102 mm) to 12 in. (305 mm). Normally a 6-in. (152-mm) or 8-in. (203-mm) diameter dump configuration permits adequate flow capacities where water jet systems are employed. Again, it must be stressed that adequate air exchange and water flow passages must be provided for a jet-assisted dump arrangement to function properly. Tanks can collapse when air exchange is restricted. Lack of adequate gravity water flow to the jet area will also adversely effect the discharge efficiency of the water hauling unit.

Although some authorities recommend that the nozzle of the in-line jet be up to 6 in. (152 mm) from the center of the discharge opening, other effective designs have included placement of the nozzle inside the discharge piping. Figure C-1-12.3(b) details how the traditional jet ar-

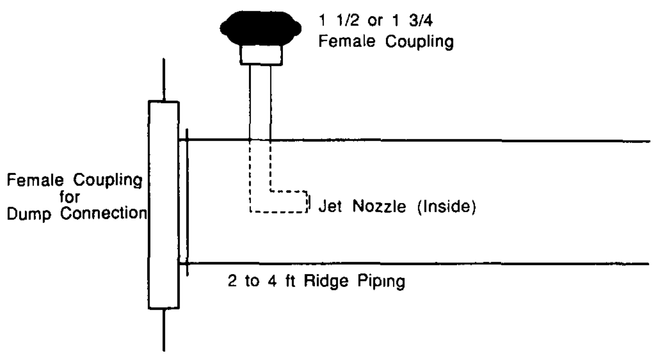


Figure C-1-12.3(b) Traditional external jet dump.

rangement can be externally added to an existing dump valve. A short length of 1½-in. (38 mm) hose is attached to the female on the jet device. The length of the added dump piping can be anywhere from 2 ft to 4 ft (0.6 m to 1.2 m) depending on whether or not a flexible tube is utilized during the dump process.

To properly operate, a jet must be able to produce between 50 psi (345 kPa) and 150 psi (1034 kPa) pressure. Higher pressures normally increase operational effectiveness. The diameter of the jet selected must be appropriate for the capacity and pressure capabilities of the pump being utilized. Also important is the size of the piping and valves that make up the jet dump system. External jets do have several advantages over internally fixed units, particularly in terms of system maintenance. Disadvantages might include the need to provide for adequate air exchange during water flow, more time for the initial setup to affix appliances, the restriction of movement around the vehicle, and the general appearance of such extensions.

C-1-12.4 Peripheral Jet Assist Arrangement. The peripheral application of jet assist nozzles has proven highly effective. This approach utilizes two or more jets installed in the sides of the discharge piping just outside the quick dump valve. In addition to the reported discharge advantages of peripheral jet streams, the externally fed system is easier to plumb and has fewer maintenance problems. The jets, installed 25 to 30 degrees from the piping wall, contact more surface area of the discharging water, thereby increasing water discharge efficiency. Because the water is drawn through the dump valve, less turbulence is created and the eddy effect often present with traditional in-line jets is overcome. Nozzles made of welding reducer pipe fittings work very effectively as jets. Two thousand gallons per minute (7570 L/min) flow rates have been obtained using a 300 gallons per minute (1136 L/min) pump to supply two ¾-in. (19-mm) nozzles in a 6-in. (152-mm) dump valve configuration. Figures C-1-12.4(a) and C-1-12.4(b) represent a typical installation.

C-1-12.5 Other Jet Assist Devices. Innovative fire organizations have put syphons and jet-related devices to good use. Some syphons use only water level differential to transfer water from one tank to another. Normally constructed of PVC pipe, such syphons are placed between portable tanks to equalize water levels. Transfer is initiated by filling the U-shaped tubing with water, placing the caps on the tubing until it is put in place, then removing the caps to allow water flow. Such an arrangement, though useful, have often proven too slow for the type of transfer operations required. A modification of the syphon transfer piping using a jet was developed and has proved useful to many departments. Although 4-in. (102-mm) PVC and aluminum piping have been used for such devices, 6-in. (152-mm) units usually are more practical. Using a ½-in. (12.7-mm) jet nozzle supplied by a 1½-in. (38-mm) hose makes possible transfer flows of 500 gpm (1900 L/min). Some departments merely add the jet to a length of suction. [*See Figures C-1-12.5(a) and C-1-12.5(b).*]

Syphons are commercially available that use the jet principle and are in some cases supplied by 2½-in. (64-mm) hose. These devices are used to remove water from basement areas or increase water supply to fire department pumpers.

In-line jets have also been developed to reduce suction losses during drafting operations. In-line and peripheral jets supplied by 1½-, 1¾-, or 2½-in. (38-, 43-, or 61-mm) hose lines can increase the output capacity of a centrifugal pump at draft up to 40 percent. The jets are placed at the intake and at every 10 ft (3 m) of suction in use. Some departments have developed a jet system for delivering water from a static source to tankers through 4-in. (102-mm) or 6-in. (152-mm) lightweight pipe. This supply piping concept is used to fill tankers through their discharge gates or via top loading or large inlets capable of filling tankers at the rate of 1000 gpm or greater.

C-1-12.6 Testing Dump Valve Capacity. Departments using large gravity dump valves or jet-assisted dump valve arrangements need to determine the flow rate at which they can dump and fill each tanker in use. Generally accepted procedures* for determining flow capacities have been suggested and should be accomplished as follows:

1. Weigh the tanker without any water on board.
2. Again weigh the tanker when it has been completely filled with water.
3. Using only gravity, off-load the tanker for one minute.
4. Reweigh the tanker and determine the gallons off-loaded by gravity.
5. Again refill the tanker and weigh it.
6. Now off-load the tanker for one minute using the jet arrangement.
7. Reweigh the tanker and determine the gallons off-loaded via the jet.
8. Make a comparison of the gallons used by gravity and those depleted using the jet.
9. Once again, fill the tanker and weigh it.
10. Now, for one minute, off-load the tanker by opening the gravity dump and pumping through a 2½-in. (61-mm) discharge.
11. After weighing the tanker, determine the number of gallons off-loaded by pumping and dumping.

An effective jet-assisted dump arrangement should produce at least twice the gpm that would be expected when off-loading by gravity. A good jet arrangement will exceed the gpm experienced during the dumping and pumping test. Whether using large dumps or jet dump arrangements, turnaround drop times and ease of operations must serve as primary considerations.

C-1-13 Portable Drop Tanks. There are, generally, three types of drop tanks: the self-supporting tank, the fold-out frame tank, and a high-sided fold-out tank for helicopter bucket-lift tanker service. The self-supporting tank is built with the sides reinforced to support the water inside the tank. The fold-out frame-type tank is similar to a child's wading pool — an open tank supported by a steel frame — and is the most common in fire service use. Tanks are available with an inlet and/or outlet built into the side of the tank. Capacities of drop tanks normally run from

*General procedure referenced from Larry Davis, *Rural Firefighting Operations Book II*, Chapter 15, page 342, IFSFI, Ashland, Mass 1986

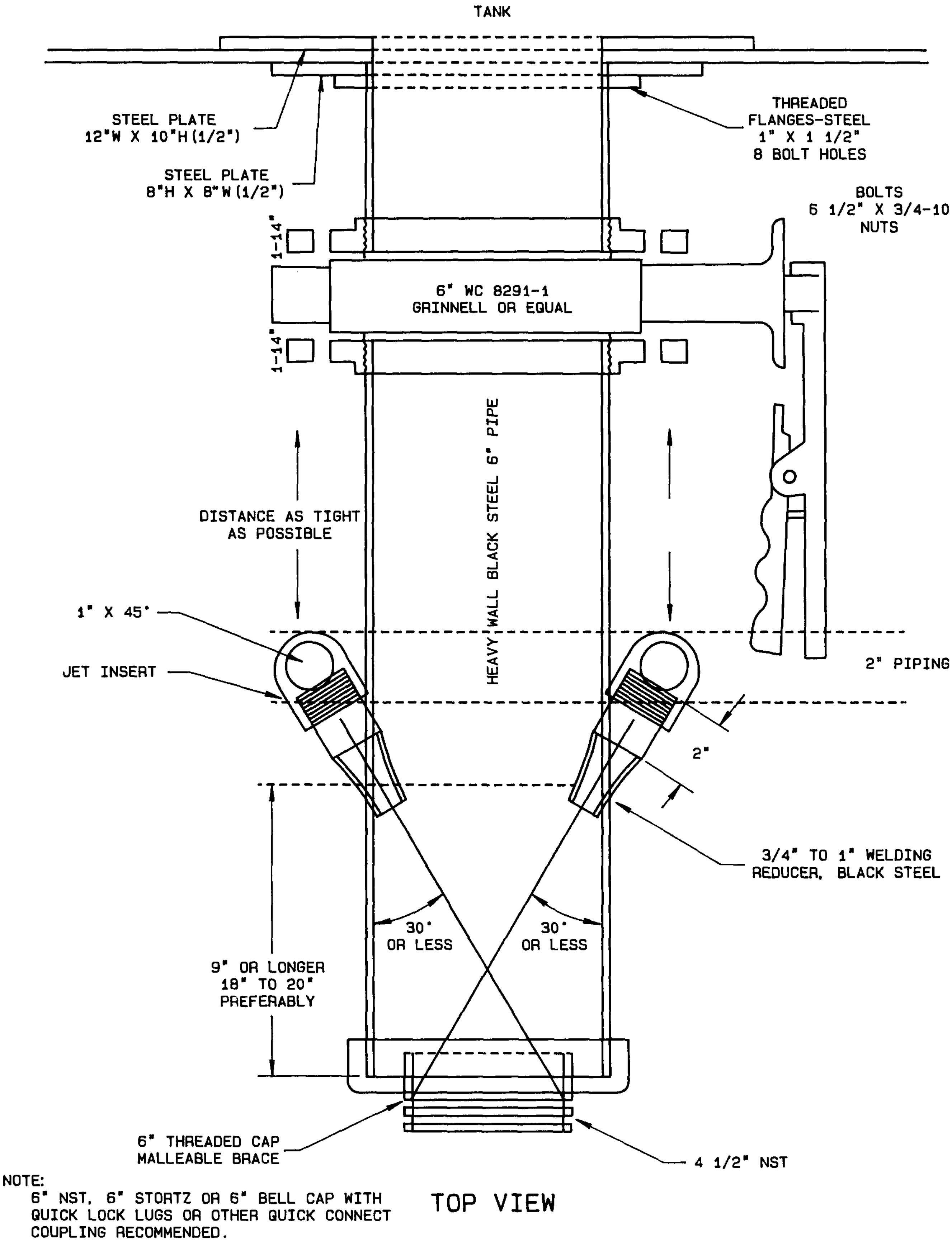
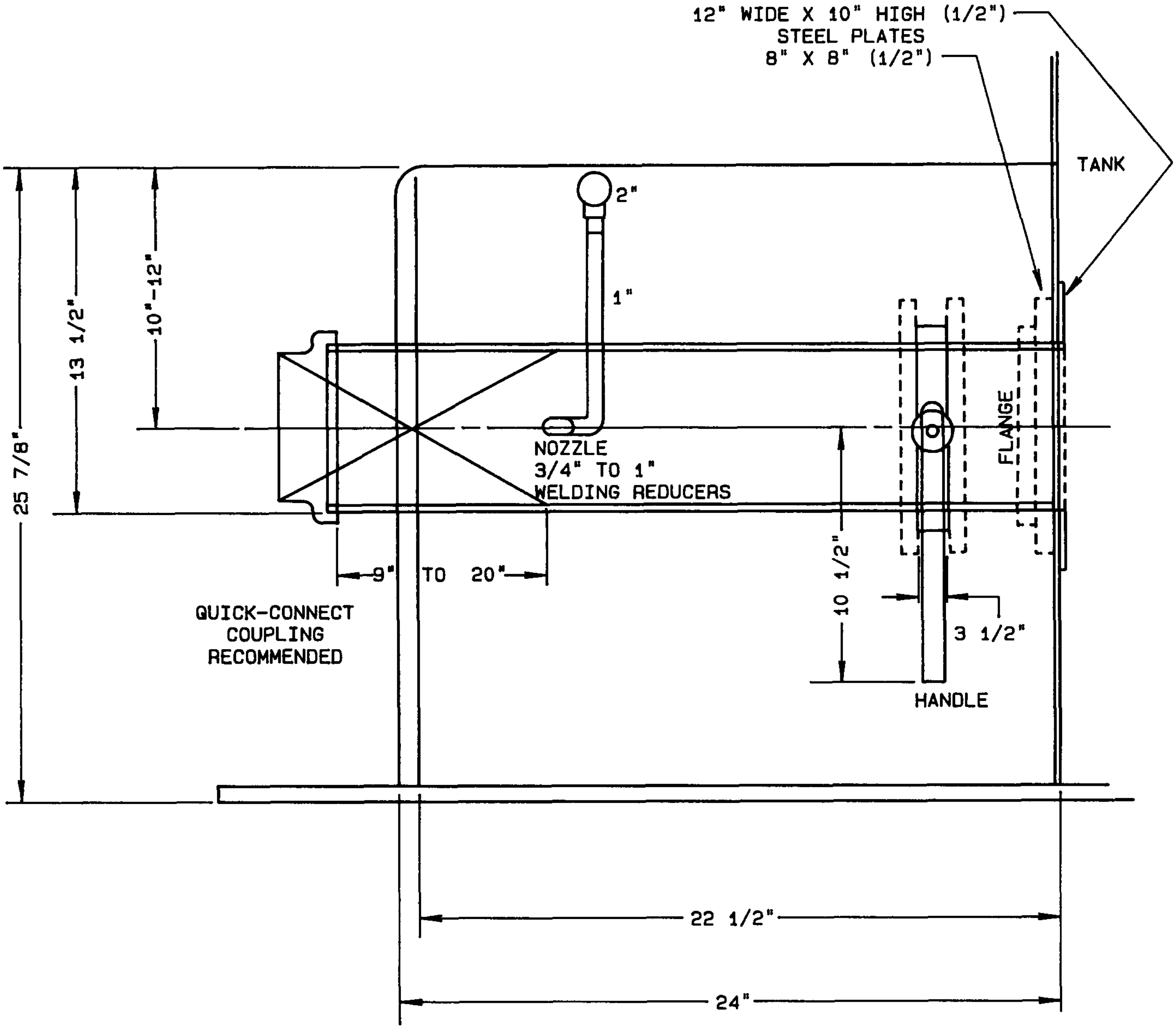


Figure C-1-12.4(a).



SIDE VIEW

Figure C-1-12.4(b).

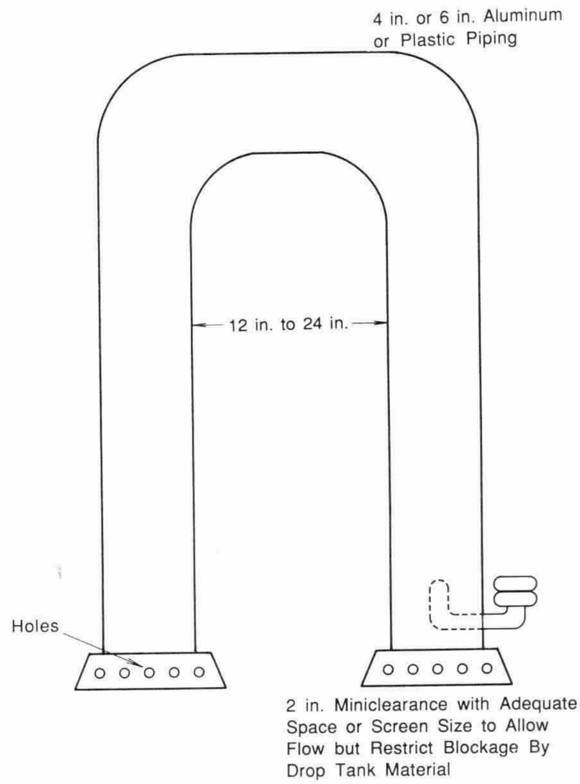


Figure C-1-12.5(a) Jet-assisted transfer syphon.

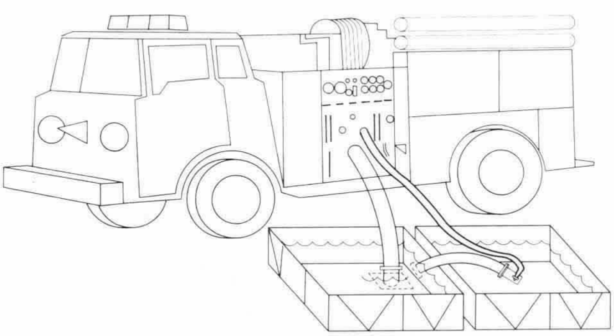


Figure C-1-12.5(b) Modified hard suction jet syphon.

Figure C-1-13(a) Portable drop tanks should be simple to set up. Note the portable tank compartment (door open) on the tanker. *(Photo by Nahunta Volunteer Fire Department, North Carolina)*

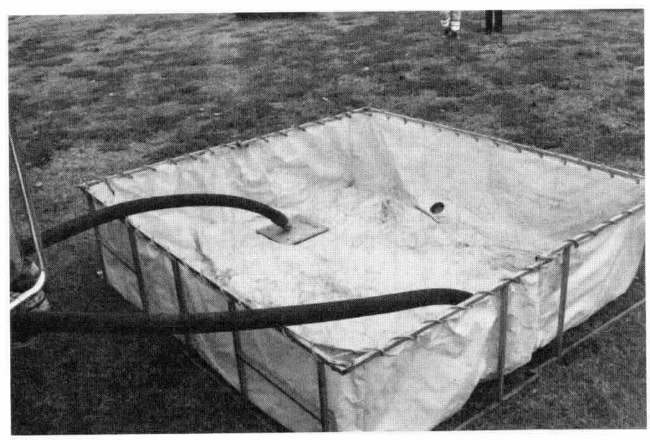


Figure C-1-13(b) Each tanker should carry a portable tank that is 40 percent greater than the capacity of the tanker. Note the strainer that minimizes whirlpooling and allows departments to draft to a depth of 1-2 in. in the portable tank.

1000 to 2500 gal (3785 to 9463 L) with 1500- to 2000-gal (5676- to 7570-L) tanks as the more popular. The addition of the drop tank for "stockpiling" water has yielded highly desirable results. This "stockpiling" allows for the continuous operation of low-volume supplies and creates a source from which a pumper may draft for supplying hose lines in a direct fire attack.

C-1-14 Use of Portable Drop Tanks and Mobile Water Supply Vehicles (Tankers). The development of the portable drop tank or portable folding tank and the jet assisted dump or large gravity dump to assist the tanker to quickly discharge its load of water has enabled many rural fire departments to utilize isolated water supplies and for the first time to obtain sufficient water for effective fire fighting. Following is a brief outline of how the system is being employed by some departments:

When an alarm of fire is received, equipment is dispatched on a preplanned basis determined by such factors as fire flow needs, hazards involved, water supply available, etc. (*See Chapter 5.*) A minimum of one tanker and one pumper respond to the fire, and the pumper begins the fire attack with water from its booster tank. The first responding tanker may act as a nurse tanker or may set up a portable drop tank and begin discharging its load of water into the drop tank. With the use of a jet-type pump, discharging through a 5- or 6-in. (127- or 152-mm) discharge pipe, or a large 12-in. (305-mm) quick dump valve, the water in the tanker can be transferred to the portable drop tank at a rate of approximately 1000 gpm (3785 L/min). A short piece of aluminum pipe with an "L" on one end gives the tanker the flexibility to discharge into the drop tank with the tanker backed up to the drop tank or with the drop tank located on either side of the tanker. As soon as the tanker has emptied its load, it immediately heads to the water supply. In the meantime, another fire department pumping unit has responded to the water supply, connected to the dry hydrant, and primed its pump. When the empty tanker arrives at the water supply, the pumper is ready to fill the tanker. The refilled tanker returns to the fire site, discharges its water, and the cycle is repeated.

It is suggested that it is more efficient to fill one tanker at a time rather than to fill two or more tankers at a slower rate. Also, if all tankers in the department have the same capacity, they will not "stack up" at the source of supply or the fire while waiting for a large tanker to be filled at the source or to discharge its water at the fire. Although preplanned, each step of this hauling operation is under the direction of the water control officer, and local conditions may dictate variations in this basic system.

As additional tankers arrive at the fire site and dump their water, they fall into the water-hauling cycle. Of course, it may be necessary for the water supply officer to open up additional water supply points with additional pumpers. Portable pumps can sometimes be used in this operation if the additional supply is not readily accessible; however, refill time may be greatly increased. The water supply officer at the fire site needs to be in radio contact with the officer in charge of each water supply or suction point. He will also advise the drivers which route to take to the fire site. Whenever possible, an alternate route should be selected for returning vehicles so that emergency vehicles will not be meeting on sharp turns or narrow country roads.

The initial alarm response to certain occupancies that require a large volume of water, based on the study producing the water flow requirements, may be beyond the ability of the local department to produce. Automatic aid pumpers and tankers may be set up to run automatically on first alarm, thereby conserving valuable time and delivering fire flows calculated in Chapter 5.

It is desirable that each tanker carry a portable drop tank with a capacity in excess of the tanker capacity.

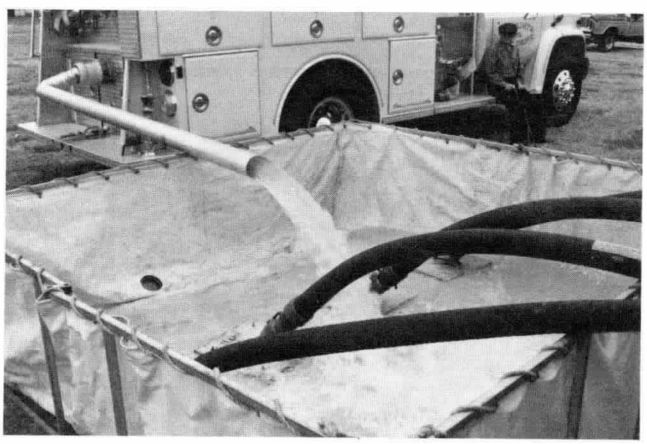


Figure C-1-14 The aluminum irrigation discharge pipe, in the shape of an "L," allows discharge from either side or rear of the tanker. Four hard suction hose lines are used to minimize any clogging of the strainers.

C-1-15 Chemical Additive and Water Supply.

C-1-15.1 General. Fire departments are using chemicals to increase their fire fighting capacity. This is important to the rural fire fighter working with a limited water supply because these chemicals can give more extinguishing capability per gallon of water. Since the chemical additives will create an additional expense, it becomes very important to be aware of the various capabilities and characteristics of chemical additives, as well as their advantages and disadvantages, relating to the types of fires encountered by each fire department.

C-1-15.2 Foam. The need for fire fighting foams occurs on surfaces when the cooling effect of water is needed and whenever continuous film-coating characteristics of a light, opaque form of water, capable of sealing vapors, are needed. The most important use of foam is in fighting fires involving flammable or combustible liquids; foam becomes the only permanent extinguishing agent used on fires of this type. Fire fighting foam is lighter than the aqueous solution from which it is formed and lighter than flammable liquids; therefore, it floats on all flammable or combustible liquids, producing an air-excluding, cooling, continuous layer of vapor-sealing, water bearing material for purposes of halting or preventing combustion. (*See NFPA 11, Standard for Low Expansion Foam and Combined Agent Systems.*)

The appropriate listings on the label should be consulted to determine proper application rates and methods. If there are no listings for application rates and methods, do not assume any. However, the word "foam" appears in the usage of wetting agent instructions as well as in the use of water expansion system (WES) units.

C-1-15.3 Other Water Additives (Wetting Agents). A wetting agent is a chemical compound that, when added to water in amounts indicated by the manufacturer, will materially reduce the water's surface tension, increase its penetrating and spreading abilities, and may also provide emulsification and foaming characteristics. Decreased surface tension disrupts the forces holding the film of water together, thereby allowing it to flow and spread uniformly over solid surfaces, also allowing it to penetrate openings and recesses that it would normally flow over. Water treated in this manner not only spreads and penetrates, but displays increased absorptive speed and superior adhesion to solid surfaces. Because of the above, leaks in plumbing and pump packing may occur that would not have occurred if the additive had not been used. Visual inspection should be made during wet water operations.

Wet water should be applied directly to the surface of the combustible. These agents do not increase the heat absorption capacity of water, but the greater spread and penetration of the wet water increase the efficiency of the extinguishing properties of water as more water surface is available for heat absorption and run-off is decreased.

Wetting agents are broadly defined as being surfactants (surface acting agents). All wetting agents are concentrated and are mixed with a liquid at varying percentages. The wetting agent can be liquid or powder. The liquid into which it is mixed for fire fighting purposes is water. However, the primary sales for some wetting agents are for use as a carrier for liquid fertilizers, fungicides, insecticides, and herbicides. Thse wetting agents can be, and are, used for fire fighting purposes. They don't have additives that will protect tanks, pumps, valves and bushings, etc., and it is recommended that unused mixtures be drained out of the tank and a flush of all parts be made with plain water. With all wetting agents, hard water usually does require a greater amount of additive to produce the same results.

Wetting agents designed for fire department use will normally contain rust inhibitors to protect the tank, pump, piping, and valves. Generally, the mixture will lose some of its rust-inhibiting characteristics if left in the tank.

Wetting agents are available in both liquid and powder form. Both forms will result in the same extinguishment characteristics.

The use of wetting agents is as a soaking or penetrating agent into forest fuels, sawdust, cotton (bales, bedding, upholstery), rags, paper, etc. These agents are used very effectively on smoldering or glowing combustibles. All of the commercially available products that fall into the above category will satisfactorily suppress Class A type fires.

Many of the wet water additive products will have instructions that make note of the production of a foam material through increasing the amount of the product.

No additional equipment is needed for the production of this foam. Caution should be exercised, as well as actual on-site testing performed, in order to determine what the resultant foam will display in terms of extinguishment and fire fighter safety.

Additionally, a few wet water additives will produce a foam through the use of a foam gun (generally a tube-type aerator and some nozzles. The instructions will indicate this is generally a Class A fire extinguishing agent. As above, local on-site testing should be performed to determine the product's capabilities.

There is commercially available a water additive that will suppress Class A and B fires. The product accomplishes the extinguishment of Class B fires by altering the water properties in such a manner that the increasing heat converts the water to a vapor, rather than steam, thereby cooling the fire.

Appendix D Large Diameter Hose

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

D-1 Transporting Water through Large Diameter Hose.

D-1-1 General. The advent of large diameter hose as an accepted tool of fire fighting has major significance in the field of rural water supplies. This hose is viewed as an aboveground water main from a water source to the fire scene, and its use is growing in the United States. Where delivery rates exceed 500 gpm (1893 L/min) and water must be moved long distances, large diameter hose provides a most efficient means of minimizing friction losses and developing the full potential of both water supplies and pumping capacities. NFPA has held that, for practical purposes, large diameter hose is that with an inside diameter of 3½ in. (89 mm) or larger.

D-1-2 Characteristics. Large diameter hose is available in either single or double jacketed construction, generally in the following sizes: 3½ in. (89 mm), 4 in. (102 mm), 4½ in. (114 mm), 5 in. (127 mm), and 6 in. (152 mm). The lower friction loss characteristics of such hose increases the usable distance between water source and fire. The department now unable to use water sources more than 1,000 ft (305 m) from a potential fire site may find that 3,000 ft (914 m) or more can become a reasonable distance when taking advantage of large diameter hose.

The basic reasons larger diameter hose moves water more efficiently are its increased size, its lower friction loss, and the relationship of these factors. They may be explained by studying the carrying capacities and friction loss factors shown in Tables D-1-3(a) and D-1-3(b).

D-1-3 Carrying Capacity of Large Diameter Hose. Tables D-1-3(a) and D-1-3(b) show, for example, that one 5-in. (127-mm) hose line delivers a volume of water approximately equivalent to six 2½-in. (65-mm) lines or four 3-in. (76-mm) lines at a given pressure and distance. [To use Table D-1-3(a) to obtain these numbers, read horizontally from the 5-in. (127-mm) hose column on the far left. Thus, the table shows one 5-in. (127-mm) length of hose to have the carrying capacity of 6.2 lengths of 2½-in. (65-mm) hose, 3.83 lengths of 3-in. (76 mm) hose, 2.56 lengths of 3½-in. (89-mm) hose, and so forth.]

Table D-1-3(a) Relative Carrying Capacity of Fire Hose in Hose Lengths

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

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

For SI Units: 1 in. = 25.4 mm.

Table D-1-3(b) Approximate Friction Losses in Fire Hose (psi per 100 feet)

Internal diameter of hose:	2½ in.	3 in.	3½ in.	4 in.	5 in.	6 in.
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

D-1-3.1 Selecting Large Hose. The size and the amount of hose to be carried by the fire department should be selected to fit the needs of the area served and the financial resources of the department. To assist in this selection of hose, Table D-1-3.1 may be helpful. The table is designed to be used primarily in relaying water with pumps discharging at 150 psi (1034 kPa) and at 20 psi (138 kPa) residual pressure at the point receiving the flow.

D-1-4 Load Capacity. Another important item to consider is hose load capacity. Most large diameter hose is of a lightweight design, which results in a coupled 100 ft (30.5 m) length of 5-in. (127-mm) hose weighing approximately 105 lb (48 kg) — little heavier than a length of 100 ft (30.5

Table D-1-3.1 Distance in Feet that a Given Size Hose Can Deliver a Quantity of Water

GPM Discharge at 150 psi Pump Pressure

GPM Discharge at 150 PSI Pump Pressure

Hose Size Inches	250 gpm	500 gpm	750 gpm	1000 gpm	1500 gpm	2000 gpm
2½	866 ft	236 ft				
3	2166 ft	520 ft	288 ft	168 ft		
3½	6500 ft	1300 ft	650 ft	361 ft	158 ft	
4		2600 ft	1181 ft	684 ft	325 ft	185 ft
5		6500 ft	3250 ft	2166 ft	928 ft	520 ft
6			8666 ft	5200 ft	2166 ft	1300 ft

Example: A 750-gpm fire flow is needed on the fire that is located 6,500 ft from the water supply. A pumper rated 750 gpm at 150 psi can relay 750 gpm at 20 psi discharge for a distance of only 650 ft if 3½-in. (89-mm) hose is used or 8,666 ft if 6-in. (152-mm) hose is used. Therefore, the department should consider using 6-in. (152-mm) hose to deliver its needed water requirements.

For SI Units: 1 in. = 25.4 mm; 1 gpm = 3.785 L/min; 1 ft = 0.305 m.

m) of conventionally constructed 2½-in. (65-mm) hose, which may weigh approximately 100 lb (45 kg).

One engine company, laying large diameter hose instead of multiple smaller lines, is much more efficient in its water-moving capacity. The use of the large diameter hose with one engine speeds up the operation that would otherwise involve multiple smaller lines with additional pumpers, men, and equipment to accomplish the same job.

D-1-5 Large Cities Using 5-in. (127-mm) Hose. Use of large diameter hose is not limited to the rural fire service. Because of its increased water-carrying capacity and efficiency, 40 percent of the 200 largest cities throughout the U.S. now employ large hose, and it may be one of the fastest growing items of technology in the fire service. It has demonstrated further utility as, literally, a portable pipeline used to bridge the gap in a water system when a main ruptures and is being repaired. It has further been used in some drought-stricken areas to bring water to the scene of a fire from a distant lake or stream, conserving

Figure D-1-6(a) Field cleaning large diameter hose.

Figure D-1-6(b) Apparatus with reels for large diameter hose.

municipal water supplies that would otherwise be used. Several communities have installed as much as two miles of 5-in. (127-mm) hose for this purpose. While the large diameter hose is being laid, the initial fire attack is made from hydrants. When the large hose carrying the water from the lake is available at the fireground, the hydrants are shut down and supplies in the municipal water system are conserved.

D-1-6 Hose Reels. A number of powered "reel trucks" with various hose load capacities are now in use.

Much of the lightweight, large diameter hose now available is of a construction that permits field cleaning and does not require drying. The use of the "reel truck" permits rapid reloading with minimum personnel (two), and the unit is in service within minutes.

Double reels mounted in the hose bed of a reel truck can produce a carrying capacity of large diameter hose of up to 6,000 ft (1829 m) over a mile of aboveground water main.

Such reel trucks generally require special power-driven systems to rewind the hose. The size of the reels is not conducive to fitting on most standard fire department pump bodies. Therefore, trucks specially designed for this operation are generally used as hose reel vehicles.

Figure D-1-6(c) Many departments have installed large diameter hose with a flat lay in the hose bed.

D-1-7 Fittings. Large diameter hose is available from many fire hose manufacturers with either standard threaded couplings or quick-connect hermaphrodite type fittings that eliminate the "male-female" aspect of couplings and, consequently, many adapters.

Special fittings (described below) have been developed to be used with large diameter hose.

Figure D-1-6(d) Fire fighters quickly reload 5-in. hose as the driver straddles the hose. Note that the hose is loaded over the bar between the stanchions.

D-1-7.1 Clappered Siamese with Indicator. (*See Figure D-1-7.1.*) This valve is added to the 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.

D-1-7.2 Line Relay Valve. (*See Figure D-1-7.2.*) 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 fireground or another relay pumper. In addition, this valve contains an automatic air bleeder and a pressure dump valve set at 150 psi (1034 kPa). 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 fireground.

D-1-7.3 Hydrassist Valve. This versatile valve can be utilized on a hydrant when water is available but pressure

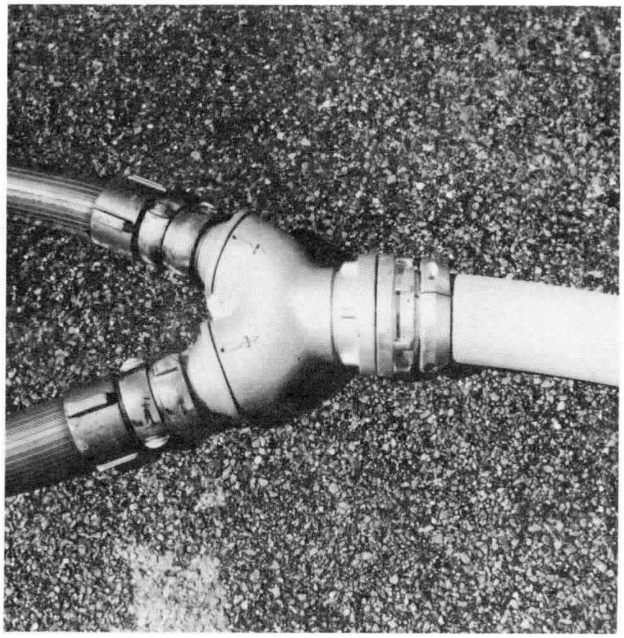


Figure D-1-7.1.

Figure D-1-7.2.

is limited. The valve is attached to the hydrant and the normal lay of supply line is initiated. When additional pressure is required, a pumper is attached to the valve and begins boosting pressure to the fire scene without interrupting the flow of water from hydrant to fire. In rural applications this valve can be equipped to lay in a line during hose lay and to allow a pumper to hook into the line and boost pressure without interrupting flow to the fire scene.

D-1-7.4 Manifold Valve. This valve contains a 4-in. (102-mm) or 5-in. (127-mm) inlet and four 2½-in. (65-mm) gated, threaded male or female outlets as well as a gated

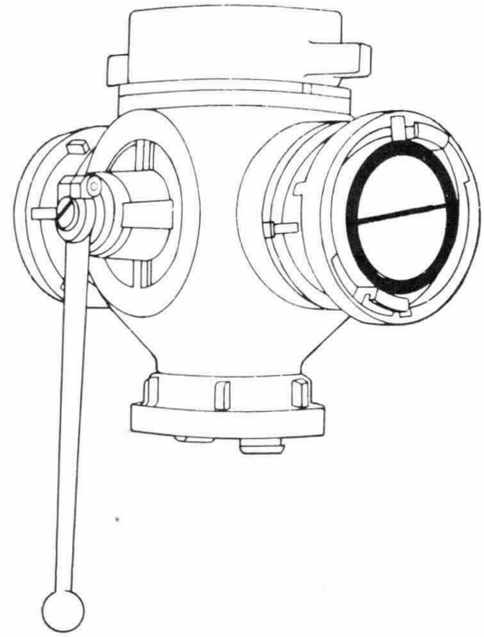


Figure D-1-7.3 Hydrassist valve.

4-in. (102-mm) or 5-in. (127-mm) outlet. The manifold is available with relief valve adjustable from 50 to 200 psi (345 to 1379 kPa). A pressure gauge is optional. The manifold is portable, allowing the fire department to establish its own portable hydrant.

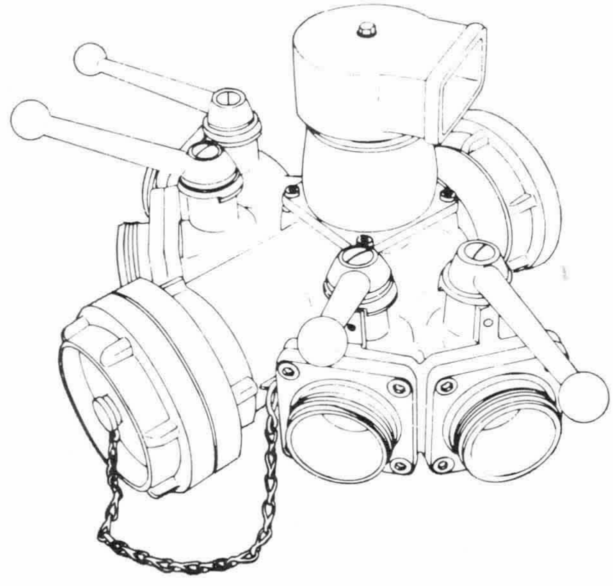


Figure D-1-7.4 Manifold valve.

D-1-7.5 Distributor Valve. (*See Figure D-1-7.5.*) This valve contains a 4-in. (102-mm) opening and waterway with two 2½-in. (65-mm) threaded male outlets. It is placed at the end of the supply line at the fireground allowing distribution of water to one or more attack pumpers. The valve utilizes ball shutoffs plus an adjustable dump valve.

Figure D-1-7.5 Distributor valve.

D-1-7.6 Incoming Gated Relief Valve. *(See Figure D-1-7.6.)* 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 an 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.

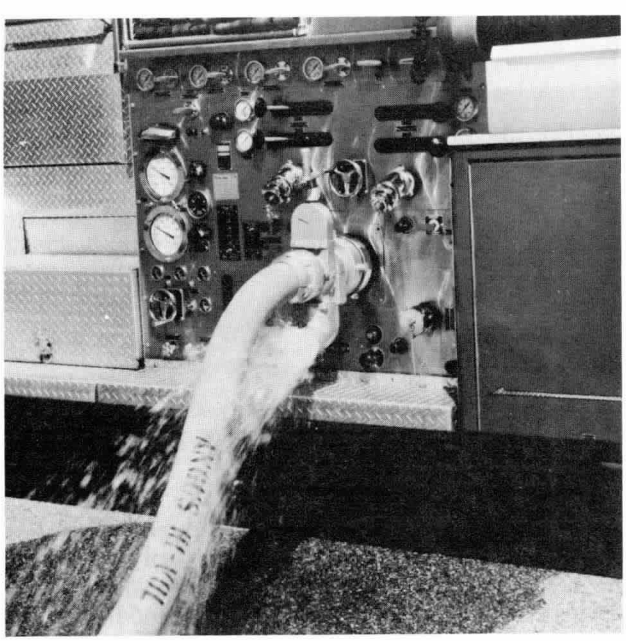


Figure D-1-7.6 Incoming gated relief valve.

D-1-7.7 Automatic Air Bleeder. *(See Figure D-1-7.7.)* Required at all points where a large diameter hose is connected to an engine inlet or at any distribution point.

Figure D-1-7.7.

D-1-8 Irrigation Piping.

D-1-8.1 General. While certainly not large diameter hose, the topic of this section of the appendix, irrigation piping, shares many of its characteristics of low friction loss and capability of transferring large volumes of water. Irrigation is increasing throughout the country, which has resulted in much lightweight aluminum pipe being available to the fire service. It may be carried on vehicles or found on the fireground in farming areas. The fire department should know which of its potential hazards may be served by such a system.

The pipe can be coupled, but usually the couplings are not a type that permits drafting. The pipe has the advantage of being a relatively permanent installation for long duration fire fighting jobs and is not susceptible to the rupture problems of fire hose. Generally, it is an excellent tool for major disaster situations but is less often used for conventional fire fighting evolutions, especially since the introduction of large diameter fire hose.

Departments working in an area in which piped irrigation systems are used should be alert to the adapters, etc., that may be necessary to turn the conventional agricultural fittings into useful fireground fittings. Adapters from the pipe coupling to fire department threads may be required and can be easily fabricated in local machine shops. They are not offered by either pipe or fire hose manufacturers. Minimum requirements are for one supply adapter; for instance, four 2½-in. (65-mm) NH (American National Fire Hose Connection Screw Thread) thread female inlets x pipe section, and one discharge adapter; or, four 2½-in. (65-mm) NH thread gated male outlets x pipe section.

Additional fittings to provide discharge gates at 100- to 300-ft (30- to 90-m) intervals [one or more 2½-in. (65-mm)

NH x pipe section] may be desirable. In areas where large diameter hose is available, adapters permitting its integration with the pipe are highly recommended.

Appendix E Portable Pumps

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

E-1 Portable Pumps.

E-1-1 General. Both diesel and gasoline driven portable pumps are available. The use of portable pumps is a common method for moving water by the rural fire department. The rural fire fighter should not be required to be a pump expert; however, the fire fighter should have the skill to place all portable pumps used by the department in operation, obtain draft, and perform each procedure in a minimum amount of time.

E-1-1.1 Evaluating Portable Pump Needs. In order to get the maximum benefit from portable pumps, the officers of the rural fire department must carefully study the needs of the department, taking into consideration the potential fire hazard, available water supplies, and the capabilities of the department to use portable pumps. The accessibility and the reliability of water supplies are determining factors in the need for and use of portable pumps. Many rural fire departments have found that both a low pressure pump and a high pressure pump are required to fill their needs.

Portable pump selection should fit the fire fighting system of which it is to be a component; if direct hose streams are to be taken from a portable pump, the nozzles and hose size determine the required pump discharge vs. pressure characteristics.

E-1-1.2 Portable Pumps. A portable pump in the fire service means a pump that can be carried to a source by fire fighters, sometimes over difficult terrain. In general, two people should be able to conveniently carry the pump. It should not weigh over 150 to 175 lb (68 to 79 kg), and should have carrying handles, be so constructed as to be easily carried in a compartment on the apparatus, and be capable of supplying at least two 1½-in. (38-mm) hand lines. Heavier pumps, perhaps trailer or truck-mounted or otherwise made mobile, are valuable but used less commonly.

Although a number of rural fire departments have used portable-type pumps that are securely mounted on their apparatus as the sole means of pumping, few fire departments consider this to be a permanent arrangement and plan to buy a fire department pumper, in addition to the portable pump(s), when finances permit.

E-1-2 Classification for Portable Pumps. Portable pumps for the fire service are covered under NFPA 1921, *Standard for Fire Department Portable Pumping Units*, which sets forth specifications to be followed when obtaining portable pumps. This standard classifies portable pumps by capacity and operating pressure.

E-1-2.1 Rating of Portable Pumps.

(a) *Small Volume — Relatively High Pressure.* This pumping unit should be capable of pumping 20 gpm (76 L/min) at 200 psi (1380 kPa) net pressure through a 1-in. (25.4-mm) discharge outlet while taking suction through a 1½-in. (38-mm) suction inlet. This class of portable pumps is especially useful to fire departments for forest fire fighting, which frequently requires long ¾-in. (19-mm) to 1½-in. (38-mm) hose lines and pumping uphill in rugged terrain. Such an arrangement will provide good nozzle reach.

(b) *Medium Volume — Medium Pressure.* This pumping unit shall be capable of discharging 60 gpm (227 L/min) at 90 psi (621 kPa) net pressure and 125 gpm (473 L/min) at 60 psi (414 kPa) net pressure through a 1½-in. (38-mm) discharge outlet while taking suction through a 2½-in. (65-mm) suction inlet. This class of portable pump has limited utility for small structural fires and may supply a 60-gpm (227-L/min) fog nozzle through 250 ft (76 m) of 1¾-in. (44-mm) hose. It can be used to fill booster tanks or be used with 2½-in. (65-mm) hose to move water a long distance.

(c) *Large Volume — Relatively Low Pressure.* This pumping unit shall be capable of supplying 125 gpm (473 L/min) at 60 psi (414 kPa) net pressure and 300 gpm (1136 L/min) at 20 psi (138 kPa) net pressure through a 2½-in. (65-mm) discharge outlet while taking suction through a 3-in. (76-mm) or 4-in. (102-mm) 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 draining cellars, manholes, and other areas where water has accumulated. It may be used to supply two 1½-in. (38-mm) or 1¾-in. (44-mm) hose lines of short length with 60-gpm (227-L/min) fog nozzles. This may result in fire streams of reduced quality and quantity that may not be suitable flows for interior fire fighting.

Among the common types of pumps used are:

E-1-2.2 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.

E-1-2.3 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 and must be equipped with a relief valve.

E-1-2.4 Low Pressure Centrifugal Pumps. The low pressure centrifugal portable pumps (high volume) generally are rated at 200 to 300 gpm (757 to 1136 L/min) and are capable of discharge at pressures of 50 to 80 psi (345 to 552 kPa). Usually these pumps will not discharge rated capacities when operating with suction lift in excess of 5 ft (1.5 m).

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

Other types 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 from 400 gpm (1514 L/min) to 600 gpm (2272 L/min) with adequate size hard suction hose at very low discharge pressures and high pump rpms. (Example: Relay from portable pump into fire pump on apparatus or portable drop tank; or relay from water source to drop tank where tanker is filled for relay to fire site.)

Operation of these pumps depends on centrifugal force to move water, and they are very effective for relay operations to pumper 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.

E-1-2.5 High Pressure Centrifugal Pumps. High pressure portable pumps (small volume) generally have a small capacity, with an average of 30 to 40 gpm (114 to 151 L/min) discharge and operating pressures in the 125 to 150 psi (862 to 1030 kPa) 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.

E-1-2.6 Floating Pumps. Pressure and volume floating pumps are available. A more recent development in portable pumps is the floating pump that primes and pumps automatically when placed in water. This type of pump is constructed to set inside a float that resists breakage and needs no maintenance. Some entire units weigh under 50 lb (23 kg), including fuel, and provide from 60 to 90 minutes of operating time from the 5-qt (4.73-L) fuel tank.

The pump serves a need for a lightweight, easy-to-operate, portable fire pump that may be placed in the water

Figure E-1-2.6 Floating 500-gpm pump in swimming pool supplying the department pumper through large diameter hose.

and does not need suction hose or strainers. However, such pumps tend to pick up leaves and other trash that may stop up nozzles and strainers of a pump being supplied by the floating pump. (*See Figure E-1-2.6.*)

E-1-2.7 High-lift Pumps. The high-lift pump is a small, portable pump that 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.

E-1-2.8 Dewatering-type Pumps. Dewatering pumps, also known as trash pumps, are pumps specifically designed to handle muddy, sandy, or otherwise contaminated water. Some are built to handle spherical solids up to 1½ in. (38 mm) in diameter. These pumps could be used in the fire service to pump water out of basements, tubs, or catchalls during salvage operations.

E-1-2.9 Diaphragm Pump. The diaphragm pump uses a piston-type action employing a diaphragm that moves water with each stroke and is capable of handling trashy water without damaging the pump.

E-1-3 Methods of Using Portable Pumps.

E-1-3.1 General. Some of 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 prefire planning, locate water sources where portable pumps are the only suitable means of using the water supply for filling tankers or for supplying fire fighting hose lines.

Departments should, when locating pumping sites for portable pumps, determine whether the site is available year-round or whether it can be used certain times of the year only. Further determination should be made as to availability under weather conditions anticipated and, if such conditions may make their use difficult, how 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. However, four-cycle engines must be used with the engine in a level position or the engine will be damaged, whereas two-cycle engines