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January 10, 2008

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Ms. Ann Cole, Director
Commission Clerk and Administrative Services
Florida Public Service Commission
2540 Shumard Oak Boulevard
Betty Easley Conference Center
Room 110
Tallahassee, FL 32399-0850

Re: Docket No. 070183-WS

Dear Ms. Cole:

Enclosed for filing on behalf of Aqua Utilities Florida, Inc. ("AUF"), are the original and fifteen copies of the Surrebuttal Testimony and Exhibit of John F. Guastella.

Please acknowledge receipt of these documents by stamping the extra copy of this letter "filed" and returning the copy to me.

Thank you for your assistance with this filing.

Sincerely,

Marsha Rule

Marsha E. Rule

MER/rl
Enclosures
cc: Rosanne Gervasi, Esq., with enclosure, via hand delivery
Stephen C. Reilly, Esq., with enclosure, via hand delivery
Martin S. Friedman, with enclosure, via U. S. Mail
Kimberly A. Joyce, Esq., with enclosure, via U. S. Mail

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BEFORE THE FLORIDA PUBLIC SERVICE COMMISSION

In re: Proposed adoption of Rule 25-30.4325, F.A.C., Water Treatment Plant Used and Useful Calculations.	))))	Docket No. 070183-WS Filed: January 10, 2008

AQUA UTILITIES FLORIDA, INC.'S NOTICE OF FILING SURREBUTTAL TESTIMONY AND EXHIBIT OF JOHN F. GUASTELLA

Aqua Utilities Florida, Inc. ("AUF"), by and through its undersigned counsel, hereby files and serves notice of filing the Surrebuttal Testimony and Exhibit of John F. Guastella on behalf of AUF in the above-referenced docket.

Respectfully submitted,

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Attorneys for Aqua Utilities Florida, Inc.

CERTIFICATE OF SERVICE

I HEREBY CERTIFY that a copy of the foregoing Notice of Filing Surrebuttal Testimony John F. Guastella was furnished by Hand Delivery(*) and U. S. Mail(**) this 10th day of January, 2008 to:

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BEFORE THE FLORIDA PUBLIC SERVICE COMMISSION

In Re: Proposed Adoption of Rule 25-30.30.4325, F.A.C., Water Treatment Plant Used & Useful	))))	Docket No. 070183-WS Filed: January 10, 2008

SURREBUTTAL TESTIMONY

OF

JOHN F. GUASTELLA

ON BEHALF OF

AQUA FLORIDA UTILITIES, INC.

Q. Have you reviewed the rebuttal testimony of Mr. Woodcock?

A. Yes.

Q. Do you have comments regarding Mr. Woodcock's testimony with respect to fire flow requirements?

A. Yes. Mr. Woodcock states that he is not aware of any design requirement that relies on the Insurance Service Organization (ISO) or the National Board of Fire Underwriters (NBFU). These organizations have established design standards for water supply systems, including fire flow requirements, and those standards are recognized and relied upon and used by engineers, water utilities and regulatory agencies in states around the country. These standards and fire flow requirements have long been recognized by the American Water Works Association (AWWA). For example, an AWWA M5 Management Manual, Copyright 1959, "A Training Course in Water Utility Management" states in the second paragraph of Chapter 4, Fire Protection, that "The most generally accepted standards for public fire protection are contained in the Standard Schedule for Grading Cities and Towns of the United States With Reference to Their Fire Defense and Physical Conditions, published by the National Board of Fire Underwriters (NBFU)." This chapter is provided as Exhibit JFG-4, and I provided a copy of the referenced Standard Schedule in Exhibit JFG-2 to my direct testimony.

A more recent publication of the AWWA M-5 manual, copyright 1999, Chapter 4 - Fire Protection (included in Exhibit JFG-4), references the NBFU's successor, the Insurance Services Office, and its published "Guide for Determination of Needed Fire Flow." See Exhibit JFG-1, filed with my direct testimony. Accordingly, it is clear that the AWWA has recognized and accepted the work of the NBFU and ISO organizations in developing fire flow standards for many years. The fire flow requirements have also been accepted in numerous cost allocation and rate design studies that I have submitted in rate cases before regulatory agencies in several states across the country. Importantly, the NBFU and ISO have also graded thousands of communities as to their fire fighting ability, including the reliability of the water systems serving those communities.

While I agree that the fire flow requirements established by local government should be met by water utilities and considered in the context of a used and useful determination, there are certainly instances where those fire flow requirements may not be the most appropriate for either design purposes or for used and useful calculations. For example, I am aware of an instance in Florida where the local government set a fire flow requirement that was exactly the same for each hydrant. Not only was the per-hydrant requirement clearly inadequate to meet the needs of large residential or commercial structures, but it did not address the overall fire flow requirement a water utility must meet on a system-wide basis or for multiple fires. These considerations thus were left to the water utility. A rule that is limited to the minimum local government requirements does not recognize that a utility must provide the most appropriate fire flow requirement, even if that is in excess of the minimum required by the local government.

The important point is that the used and useful rule would be better if it specifically recognizes the need for water systems to be designed meet the most appropriate fire flow requirements, and for a water utility's rates to include the costs to do so. My recommendation to include "an appropriate fire flow" in addition to consideration of fire flow requirements of local government simply provides for the recognition of fire flows that may be more appropriate.

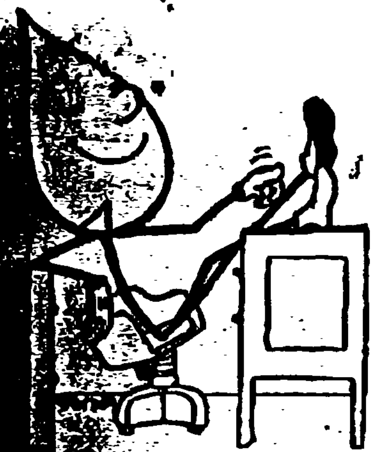
Q. Does that conclude your rebuttal testimony?

A. Yes.

Docket No. 070183-WS
Exhibit JFG-4

AMMA M-5 MANUAL (EXCERPTS)

AWWA M5
MANAGEMENT
MANUAL



A TRAINING COURSE IN

Water Utility Management

AMERICAN WATER WORKS ASSOCIATION
Incorporated
2 Park Avenue, New York, N.Y. 10016

Foreword

The preparation of training manuals for water utility personnel was undertaken by the AWWA Committee on Education in trying to ascertain the status of in-service training in the industry and to improve the quality of that training. In May 1953 at the Grand Rapids Convention, the committee reported its findings concerning the quality of "short courses" as provided in the various states at that time. That survey covered sponsorship, financing, personal expenses, course frequency, course length, attendance, education requirements, examinations, and course content. Two recommendations of the committee were that short courses with higher educational prerequisites should be developed for water works personnel, placing more emphasis on in-service training, and that conferences for management should be developed.

In following its own recommendations, the committee prepared outlines of the content of six short courses to cover the water works field. These outlines, published in the October 1955 issue of ***Willing Water,*** have since been used by several "short-course" schools to improve content. To achieve the greatest benefit from the outlines, however, the committee believed that manuals should be prepared from them. The manuals could then be used as texts or could be studied independently by the ambitious water works man. After receiving committee approval, the plan was approved by the AWWA Board of Directors in St. Louis in May 1956. Since that time, six groups of members, carefully selected for their special knowledge, were invited to prepare the original drafts of the manuals. More than 80 members participated in this project.

This manual, one of a series of four to be prepared from the original six outlines, includes one or more chapters by each of the following authors:

Ellwood H. Aldrich
E. Jerry Allen
J. J. Barr
Kenneth J. Carl
John G. Copley
J. P. Dieter
Raymond J. Faust
Burton S. Grant
Richard S. Green
C. P. Harnish
Herbert O. Hartung
Melvin P. Hatcher
James E. Hickman
Eric F. Johnson
Leo Louis
Frank E. Maloney
John W. McFarland
Robert S. Millar
Edward A. Reinke
S. Cook Shaw
W. S. Stephens
W. Victor Weir
William C. Welmon

The AWWA and the Committee on Education gratefully acknowledge the contribution of each of these men. Their only compensation will be the satisfaction derived from the knowledge that their efforts are contributing to the advancement of the water works industry.

Table of Contents

outside the corporate limits of the municipality. Some courts have held that a municipality operating a water works has a right to base its charges upon reasonable classifications determined upon such factors as the cost of service, the purpose for which the service or product is received, the quantity received, the different character of the services furnished, the time of their use, or any other matter which presents a substantial difference. The courts generally condemn only arbitrary, capricious, or unreasonable discrimination.

Fluoridation. Fluoridation has often involved considerable litigation. To date, all court tests have indicated that the practice is legal. But more to the point, water utilities that have followed the AWWA policy of leaving the decision concerning the adoption of the practice to the health and public authorities have been able to avoid the litigation.

Discontinuance of service. Responsibility to provide water normally ends when payments for the water are in arrears for an unreasonable length of time. This right to cut off water service to the premises involved has recently been extended to cover the nonpayment of sewerage service charges when the water utility has the responsibility to collect that charge. Generally, however, utilities cannot force payment by cutting off service to other premises of an owner in arrears.

These points have merely been examples of the manner in which the responsibility of a utility creates problems for management which must be foreseen and provided for. All the way from the source of supply to the customer's tap, water utility facilities and operations impinge upon the public health and wealth—and where the public is involved, there is the responsibility of a public utility.

QUESTIONS

1. What is the primary responsibility of a water utility?
2. Through what means is the water utility's discharge of its responsibilities enforced?
3. What are some of the common causes of lawsuits against water utilities?
4. What are some of the means utilities can take to protect themselves against specific types of suit?
5. What are your utility's rules on shutoffs? How are they exercised?

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CHAPTER 4

Fire Protection

PUBLIC water supply systems generally provide water for fire protection. Although this responsibility, or function, is secondary to the primary one of providing water for potable use, the fire protection requirements have a very important influence on the design and operation of most systems. Fire protection furnished by water utilities falls into two broad classifications: public protection, available directly from hydrants supplied by the public distribution system; and private protection, provided through fire service connections to sprinkler, standpipe, or other special extinguishing systems or to private yard distribution systems supplying hydrants.

Public Fire Protection

The most generally accepted standards for public fire protection are contained in the *Standard Schedule for Grading Cities and Towns of the United States With Reference to Their Fire Defenses and Physical Conditions*, published by the National Board of Fire Underwriters (NBFU). The first edition of this work appeared in 1916, the most recent in 1956. The schedule is used to determine the relative classifications of municipalities from the fire protection standpoint. [redacted]nd the [redacted] the various states. To determine these classifications, deficiency points are assigned for each feature of fire protection in which the municipality fails to meet the standards established in the schedule. The total number of deficiency points assigned establishes the class. The maximum number of points is 5,000, and there are 10 possible classes, each class covering a range of 500 points—for instance, a municipality with 1,340 points is Third Class, one with 2,760 points, Sixth Class. Seven major phases of municipal fire protection are considered in the schedule, and the 5,000 points are divided among them as shown in Table 4-1.

The 1,700 points assigned to water supply represent 34 per cent of the total, indicating the importance of water supply in relation to the overall fire protection of a municipality. There are ten possible classes for water supply, each class covering a range of 170 points—for example, a water supply with 250 points is Second Class and one with 1,100 points Seventh Class.

psi. For smaller municipalities requiring not more than 2,500 gpm and having not more than 10 buildings exceeding three stories in height, 60 psi is needed. In sparsely built residential areas or small village business districts with buildings of small area and not higher than two stories, 50 psi is required.

In the grading of municipal water supplies under the NBFU schedule, residual pressure is based on delivery to fire department pumpers throughout.

Adequacy of Supply Works

To be considered adequate under the schedule, a system should be capable of delivering the required fire flow with consumption at the maximum daily rate. [redacted]

(*) As an illustration, consider a city with a population of 40,000 and a maximum daily consumption rate of 8.50 mgd. Table 2 gives a required fire flow of 6,000 gpm or 8.64 mgd for a city of this size, so that the system would be required to deliver 8.50 + 8.64 = 17.14 mgd. This rate must be available over a 10-hr period.

All components shld be sized for MDF plus Req'd Fire Flow

The supply works [redacted], intakes, suction lines, pumps, boilers, treatment works, and supply lines, should, in connection with the storage on the distribution system, be capable of delivering the maximum daily consumption rate plus the required fire flow. As no two water systems are exactly alike, the specific methods employed to meet these requirements differ considerably, but the overall techniques generally fall into one of three categories:

1. Provide supply works capacity to meet the total requirements. This would be 17.14 mgd for the supply works of the city used for illustration.

2. Provide supply [redacted] In the illustration, a capacity of 8.50 mgd would be provided for the supply works plus storage capable of supplying 8.64 mgd for 10 hr. The storage required would be:

$$8.64 \times \frac{10}{24} = 3.60 \text{ mil gal}$$

As storage fluctuates, the actual storage capacity installed should be greater by an amount sufficient to provide 3.60 mil gal as the normal minimum storage.

3. Provide supply works capacity in excess of the maximum daily consumption rate with storage on the distribution system capable of supplying, for the specified duration, the difference between the total required rate and the capacity of the supply works. In the illustration, if a capacity of 12.50 mgd were provided for the supply works, the required normal minimum storage would be

$$(17.12 - 12.50) \times \frac{10}{24} = 1.93 \text{ mil gal.}$$

Reliability of Supply Works

To comply with NBFU standards, the supply works should be able to meet the requirements not only under normal conditions but also under emergency or unusual conditions. There are various ways in which the required reliability can be obtained, but it usually necessitates duplication of units or lines or the provision of additional storage.

To evaluate the reliability of the source of supply, consideration is given to such factors as: the frequency and duration of droughts; physical condition of intakes; danger from earthquakes, floods, forest fires, ice formations; silting; [redacted]els. [redacted] or similar [redacted] for extended periods, [redacted] or special provisions [redacted]

(*) The standards also indicate that the number and capacities of the pumps installed should be such that, with the two most important units out of service, the fire flow can be delivered for the required number of hours during a period of 5 days with consumption at the maximum daily rate. This applies to both low- and high-lift pumps. If, in the illustration previously used, the high-lift pumps consisted of a 9-, a 7-, and a 5-mgd unit, it can be seen that, with the two largest units out, the remaining pump could not even deliver the maximum daily rate. If another 5-mgd unit were provided, 10 mgd would be available with the two largest units out, and the normal minimum storage required on the distribution system would be

$$(17.12 - 10) \times \frac{10}{24} = 2.96 \text{ mil gal.}$$

If another 7-mgd unit were added instead of a 5-mgd one, the normal minimum storage required would be reduced to

$$(17.12 - 12) \times \frac{10}{24} = 2.13 \text{ mil gal.}$$

The treatment works are required to be of sufficient capacity so that, with one filter or other treatment unit out of service, the system can deliver the maximum daily consumption rate plus the fire flow. Overloads based on operating records may be considered in meeting these requirements. Storage in clear wells at the plant and on the distribution system not only improves the reliability of the plant but also enables the plant to be operated at more uniform rates.

Supply lines, including those in and around pumping stations and treatment works and those which extend into the distribution system as principal arteries, should be so arranged and valved that a break will not prevent the system from delivering the fire flow for the specified number of hours during a period of 5 days with consumption at the maximum daily rate. The locations at which a break would have the most serious effect are usually in pump suction or discharge headers. A simple arrangement of suction and discharge piping for four pumps is shown in Fig. 4-1. A

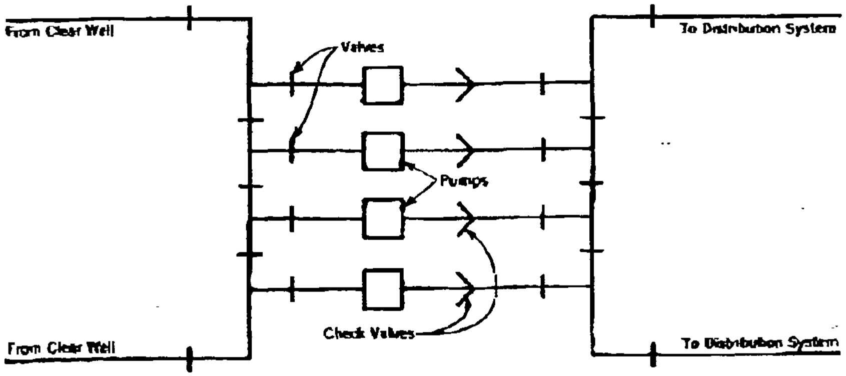

Fig. 4-1. Simple Arrangement of Suction and Discharge Piping for Four Pumps

study of this figure will indicate that not more than one pump can be put out of service by a single break.

As far as supply works piping is concerned, NBFU standards require that valves be installed in such a way that the repair of any valve will not interrupt or seriously reduce the supply. In the arrangement shown in Fig. 4-1 the repair of any valve will not put more than two pumps out of service. An arrangement of this type, with a valve between each pump connection, provides a reasonable degree of reliability.

The power used to drive the various units in the supply works must be reliable. It is required that electric power be supplied over at least two lines, preferably underground, with all equipment arranged so that a failure in any line, or the repair or replacement of a transformer, high-tension switch, control unit, or other electric-power device will not prevent the system from delivering the fire flow for the required number of hours during a period of 2 days with consumption at the maximum daily rate.

Bus bars supplying pump motors should be in duplicate or sectionalized so that the above requirement can be met. In order to offset unreliable features in electric-power supply, pumps may be provided with auxiliary internal-combustion engines, or electric generators driven by such engines may be installed; additional storage on the distribution system may also be used.

Where steam is used, it is required that, if 25 per cent of capacity (or at least one boiler) is out of service, the remaining boiler capacity must be adequate to operate the equipment and pumps necessary for the system to deliver the fire flow for the required number of hours during a period of 5 days with consumption at the maximum daily rate. Steam piping, boiler feed lines, fuel piping (gas or oil lines to boilers as well as gas, oil, or gasoline lines to internal-combustion engines), and air lines to wells should be arranged so that a failure in any line or the repair or replacement of a valve, fuel pump, boiler feed pump, injector, or other necessary device will not prevent delivery of fire flow for the required number of hours during a period of 2 days with consumption at maximum daily rate.

In providing reliable power for the various units of the supply works, due consideration should be given to wash water pumps, chemical feed machines, mixing apparatus, power-operated valves, and other appurtenances.

NBFU standards require that pumping stations and other important structures contain no combustible material in their construction. When located within the same structure, sections containing pumps, boilers, high-potential electric power equipment, filters, laboratories, shops, storage, offices, garages, and other important equipment or functions should be separated by fire-resistive partitions or fire walls. Openings in fire walls should be provided with at least one standard fire door; openings in other fire-resistive partitions should be provided with wired-glass, metal frame doors or windows as a minimum. All electrical equipment should be installed in accordance with the National Electrical Code and all hazards, including those introduced by boiler-plant operations, internal combustion engines, storage and handling of fuel and lubricating oils, and heating devices, should be properly safeguarded. Fire extinguishers of suitable type for the occupancy, inside standpipes with small hose, and outside hydrants should be provided; if the building is remote from a fire station, hose should be provided at the hydrants.

Distribution System

The standards for supply mains require that arteries and secondary feeders extend throughout the system. These should be of sufficient size, considering their length and the character of the sections served, to deliver fire flow and consumption demands to all areas. They should be properly spaced (usually about 3,000 ft apart) and looped so that no large areas are dependent upon single mains.

The gridiron of minor distribution mains should consist of mains at least 6 in. in diameter arranged so that the lengths on the long sides of blocks between intersecting mains do not exceed 600 ft. Where longer lengths of 6-in. pipe are necessary, 8-in. or larger intersecting mains are required. Where the layout of the streets and the topography are not well adapted to the above arrangement or where dead ends and poor gridironing are unavoidable, 8-in. should be the minimum main size.

In high-value districts, the minimum size should be 8-in. with intersecting mains in each street; 12-in. or larger mains should be used on the principal streets and for all lines that are not connected to other mains at intervals close enough for proper mutual support.

Valves

To isolate sections of main in the event of a break or in connection with construction or repair work, NBFU standards require that the system be equipped with an adequate number of properly located valves. Supply lines should be valved at least once a mile and interconnections between such lines should have two valves. Arterial mains require valves at not more than ¼-mi intervals; connections to the smaller mains of the distribution system should be arranged and valved so that a break or repair in any of these smaller mains will not necessitate the shutdown of an artery. Exclusive of arterial mains, valves should be installed so that shutoff lengths do not exceed 500 ft in high-value districts and 800 ft in residential districts.

If valves are to be used effectively during an emergency, they must be properly maintained. This requires a program of regular annual inspections for all valves and more frequent inspections of the large and important valves, including those at pumping stations, treatment works, and reservoirs. During these inspections the valves should be operated and any necessary repairs made. Even though the valve mechanism itself may be in good operating condition, regular inspections frequently reveal that the valve boxes have been paved over, the box has shifted so that the valve key cannot be placed on the operating nut, or the box is filled with dirt. As any of these defects could delay operation during an emergency, they have an effect on the fire rating. Inspections sometimes also reveal that valves that are supposed to be open are actually closed, thus preventing the use of the full capacity of the mains in the system. Suitable valve records should be maintained indicating inspections, operations, condition, and repairs.

Hydrants

As all water used for public fire protection must be delivered through hydrants, it is important that a sufficient number be provided on the distribution system. The number of hydrants needed in any area depends upon the fire flow required. Table 4-3 gives the hydrant distribution required for fire flows of 1,000 to 12,000 gpm; the average area served for intermediate fire flows not given in the table may be interpolated. Street intersections are the best locations for hydrants, as hose can usually be stretched in any of four directions from a pumper connected to a hydrant at an intersection. It is good practice, therefore, to place at least one hydrant at each intersection and to add intermediate hydrants, when necessary, to attain standard distribution. In high-value districts requiring large fire

TABLE 4-3

Standard Hydrant Distribution

Fire Flow Required gpm	Average Area per Hydrant sq ft
1,000	120,000
2,000	110,000
3,000	100,000
4,000	90,000
5,000	85,000
6,000	80,000
7,000	70,000
8,000	60,000
9,000	55,000
10,000	48,000
11,000	43,000
12,000	40,000

flows and numerous hydrants, two or more hydrants are generally used at intersections.

The standards require that hydrants be able to deliver 600 gpm with a loss of not more than 2.5 psi in the hydrant and a total loss of not more than 5 psi between the street main and outlet. A 4½-in. and two 2½-in. outlets should be provided, but one of the 2½-in. size may be omitted if the fire department normally uses the large outlets. Connections to the main should be at least 6 in. in diameter and gated.

If hydrants are to be properly maintained, a regular inspection program is necessary. Inspections should be made semiannually and after use. During these inspections the hydrant should be operated, checked for leaks and proper drainage, and lubricated as required. Proper records of inspections, condition, and repairs should be maintained.

Separate Zones of Service

Topography makes it necessary to provide more than one pressure zone of distribution in many municipalities. In the application of the schedule, these zones are considered individually from the standpoint of providing adequate and reliable fire protection. The various factors previously discussed, including pumping capacity, storage, power supply, construction of pumping stations, arterial mains, and minor distribution lines, are of importance, especially if these zones involve large portions of the municipality. When supply is available from one zone to another by opening normally closed valves, such emergency supplies may be of considerable value in meeting demands. In arranging service limits, the creation of dead ends by closing valves should be kept to a minimum, especially where the lines are 6 in. or smaller in size.

Private Fire Protection

Private protection is provided from the public distribution system through fire service connections supplying sprinkler, standpipe, water spray, foam, and yard hydrant systems. Standards for these special fire-extinguishing systems have been prepared by the National Fire Protection Association and have been adopted by many insurance organizations, including the NBFU. Certain portions of these standards deal with the water supplies for these systems. As the flows and pressures needed depend upon the type of system and its individual characteristics as well as the type of occupancy it is to protect, the requirements are somewhat general in nature, but the specific requirements for any installation can be obtained from the insurance rating organization in the state or from the insurance carrier.

Fire service connections are required to extend from the public distribution system directly to the fire-extinguishing system with no intermediate connections for domestic use. No connections should be made to any portion of an extinguishing system to provide domestic supply. Although practice differs, most water utilities in the United States do not require meters on fire service connections. Where meters are used, they should comply with AWWA Standard for Cold-Water Meters—Fire Service Type (C703). Detector check valves with a metered bypass are frequently used; these devices accurately measure small flows, but do not measure the large flows used during fires. They are intended for use by those water utilities that do not wish to charge for water used during fires, but do wish to control unauthorized use of water through fire service connections.

In order to supply some fire-extinguishing systems properly, it is necessary to install special fire pumps. It may also be necessary to improve the supply by the installation of ground storage as suction for the pumps or elevated storage on the private system. Standards of the National Fire Protection Association are available for such installations.

Leaders in the water utility field are strongly of the opinion that a special charge should be made by the utility for private fire protection service. Such a service places upon the water utility the responsibility to install pumps, distribution mains, and related facilities sufficient to supply the private fire hydrants and sprinkler heads although they are used only in emergencies.

In all fire-extinguishing systems that receive their supply from a public distribution system, care must be taken to prevent any contamination of the public supply. Cross connections should not be made between nonpotable sources of supply and private fire-extinguishing systems supplied through fire service connections by public water systems. All fire-extinguishing systems should be installed to comply with the requirements of the health authorities having jurisdiction.

When a private fire-extinguishing system is installed, the owner of the premises generally receives a reduction in his fire insurance rates. Such reduction will obviously depend upon the extent to which compliance has been made with the previously mentioned standards and any other special or local requirements. In order to determine if the system is satisfactory, the plans and specifications should be submitted to the insurance rating organization in the state or to the insurance carrier. Through this procedure, counsel on the installation that will make it possible for the property owner to gain maximum benefits possible from the fire service connection can be obtained.

QUESTIONS

1. a. What is the required fire flow and duration for a municipality with a population of 4,000? Of 33,000? Of 65,000?

b. What residual pressure is required for these flows if fire department pumpers are available? If fire department pumpers are not available?

2. A city of 17,000 population has a maximum daily consumption of 3.5 mil gal. If the supply works can deliver to the distribution system at a 5.0-mgd rate, how much storage is needed on the distribution system to meet the requirements for adequate fire protection?

3. A city of 27,000 population has a maximum daily consumption of 5.5 mil gal. If four pumps are provided with capacities of 6, 6, 4, and 4 mgd, how much storage is needed on the distribution system to provide reliable fire protection with respect to pump capacity?

4. a. What is the hydrant distribution required in the principal business district of a city of 40,000 population?

b. If the fire flow required in residential districts is 1,500 gpm, what hydrant distribution is required?

c. Why is it advantageous to locate hydrants at street intersections?

5. a. Name five types of private fire-extinguishing systems that can be supplied through fire service connections.

b. Why is it advantageous to have such systems installed in accordance with the requirements of the state insurance rating organization or the insurance carrier?

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Standard Schedule for Grading Cities and Towns of the United States With Reference to Their Fire Defenses and Physical Conditions. National Board of Fire Underwriters, New York (1957).

Standards of the National Fire Protection Association and National Board of Fire Underwriters for:
- Centrifugal Fire Pumps
- Foam Extinguishing Systems
- Outside Protection (Yard Piping Supplying Water for Fire Extinguishment)
- Sprinkler Systems
- Standpipe and Hose Systems
- Water Spray Systems for Fire Protection
- Water Tanks for Private Fire Protection Service

* These publications are available to AWWA members upon request from the National Board of Fire Underwriters, 85 John St., New York 38, N.Y.

CHAPTER 5

Civil I on

CIVIL defense participation is still another responsibility of the water utility. Actually, of course, the basic obligations involved are not additional ones, but the circumstances are such as to make them more difficult to fulfill at the very time that it becomes most important to fulfill them. The many new and complex problems associated with defense emergencies, therefore, demand the special attention of all water works operators and related responsible public officials. These problems are certainly the most difficult of all that water utility management must face, largely because many of the technical questions still remain unsolved and because the entire subject is constantly shifting and readjusting to fluctuations in international affairs and developments in the weapons of modern war. It is not properly within the scope of this manual to indoctrinate water utility personnel in the technical aspects of those problems, not only because this would be impossible in the space available, but because the rapidly changing nature of the situation itself precludes it.

During the past few years there has been marked intensification of effort in this field by both the water works profession and the many units of government concerned with water supply. This has been reflected in increased attention to civil defense subjects in the affairs of the AWWA and related organizations, in the greatly expanded civil defense research effort being carried on by governmental groups such as those at the Robert A. Taft Sanitary Engineering Center of the US Public Health Service, and in direct planning activities of the national and state civil defense organizations.

Special provision should be made by the water works profession to keep abreast of technical and other developments that have civil defense implications. Unless special measures to do this are taken it is unlikely that continued adequate attention will be paid to such matters by key water utility personnel who are already overloaded with the work of their daily responsibilities. Therefore, whether or not a community has an active, current civil defense program into which the water utility staff can fit, serious attention should be given, as a minimum, to making one person responsible for keeping in touch with developments. This individual should see that his utility is on mailing lists to receive all information perti-

Water Utility Management

AWWA MANUAL M5

American Water Works Association

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Foreword

In May 1953 the AWWA Committee on Education reported its findings of a survey concerning the quality of "short courses" as provided in various states at that time. A result was that the committee recommended that more emphasis be placed on in-service training for management.

In 1955 the committee published six short course outlines in *Willing Water.* To achieve the greatest benefit from the outlines, the committee prepared a manual that could be used as a text or studied independently by ambitious water works personnel.

In May 1956 the AWWA Board of Directors gave approval for the preparation of the special manual. Approximately 80 members participated in the project, each being carefully selected for his special knowledge.

In March 1979, after about six months of careful research and rewriting, the AWWA Management Division Board, acting as a committee of whole, completed the first revision and update of Manual M5, "Water Utility Management Practices."

For more detailed information on the subjects covered in each chapter, contact AWWA'S technical library staff to obtain current bibliographies on the specific subject.

ISBN 0-89867-083-2

Contents

Chapter 4

Fire Protection

Public water supply systems generally provide water for fire protection. Although this responsibility is secondary to providing water for potable use, fire protection requirements have a very important influence on the design and operation of most systems. Fire protection furnished by water utilities falls into two broad classifications: (1) public protection, available directly from hydrants supplied by the public distribution system, and (2) private protection, provided through fire service connections to sprinkler, standpipe, or other special extinguishing systems or to private yard distribution systems supplying hydrants.

Municipal fire protection surveys were initiated by the National Board of Fire Underwriters (NBFU) in 1889 to assist cities in their fire protection problems. In 1904 the survey work was stepped up after a series of disastrous conflagrations occurred in several large cities. The results of each survey were reported to the municipal officials and insurance companies that comprised the membership of the NBFU. Although the reports were of value in stating the fire protection needs of the cities, no attempt was made to determine the relative degree of fire protection existing in one city when compared to another.

In 1916 the NBFU published the "Standard Schedule for Grading Cities and Towns of the United States" with reference to fire defenses and physical conditions. Application of this schedule enabled municipalities to be placed in one of ten relative fire protection classes. These classes could be used as a guide for fire insurance underwriting and also as a factor in determining fire insurance rates. This schedule was revised in 1922, 1930, 1942, and 1956, and amendments to the 1956 edition were issued in 1963 and 1964.

Shortly after publication of the last amendment, the NBFU joined two other insurance organizations to form the American Insurance Association (AIA) on Jan. 1, 1965. The municipal fire protection survey and grading work was carried on by AIA until Oct. 1, 1971 when the Municipal Survey Division of AIA was transferred to Insurance Services Office (ISO), a new multi-line insurance rating organization.

Since that time, the local insurance rating bureaus in 44 states have also become a part of ISO. The state offices of ISO continue to survey and grade the smaller communities in their respective states. In the remaining six states the smaller municipalities continue to be handled by independent bureaus as in the past. The larger cities, nationwide, remain the responsibility of municipal survey engineers assigned to the ISO home office (New York) and the regional offices (Chicago and San Francisco).

One objective of ISO is the development of more uniform, overall fire insurance rating practices on a nationwide basis.

Public Fire Protection

The most generally accepted standards for public fire protection are contained in the "Grading Schedule for Municipal Fire Protection" (1974 edition) published by the Insurance Services Office (ISO), 160 Water St., New York, NY 10038. To determine relative class, deficiency points are assigned for each feature of fire protection in which the municipality fails to meet the established standards. The total number of deficiency points assigned establishes the class. The maximum number of points is 5000, and there are ten possible classes, each class covering a range of 500 points; for example, a municipality with 1340 points is Third Class, one with 2760 points is Sixth Class. Four major phases of municipal fire protection are considered in the schedule, and the 5000 points are divided among them as shown in Table 4.1.

The 1950 points assigned to water supply represent 39 percent of the total, indicating the importance of water supply in relation to the overall fire protection of a municipality. There are ten possible classes for water supply, each class covering a range of 170 points; for example, a water supply with 250 points is Second Class and one with 1100 points is Seventh Class.

Fire Flow Requirements

Another important change in the schedule is the method of estimating required fire flow. The formula, based on population. included in the schedule since it was first published has been eliminated. The calculation was used as a guide for estimating the fire flow required in the principal business district. There are two reasons for this. First, although the formula had previously given good results, it was found that as cities become more decentralized, population becomes a less reliable indicator of the fire protection needs of the principal business district. Second, because emphasis on the principal business district was removed, a formula that provides a means of estimating the fire flow required in that district alone was unsatisfactory. This led to the development of the "Guide for Determination of Required Fire Flow" published by ISO, which can be used for estimating fire flow requirements in any portion of a municipality. The guide was introduced at the American Water Works Association (AWWA) Annual Conference in Chicago on Jun. 4, 1972.

TABLE 4.1

Relative Values and Maximum Deficiency Points

Feature	Percent	Points
Water supply	39	1950
Fire department	39	1950
Fire service communications	9	450
Fire safety control	13	650
Total	100	5000

The period of time necessary to deliver the required fire flow is an important factor in water supply design because it often influences the size of the storage facilities needed. In the 1956 schedule a duration of 10 hr was specified for all fire flows of 2500 gpm or more. The duration required decreased progressively to 4 hr for fire flows of less than 1250 gpm with a further reduction from 4 to 2 hr for residential sections. In the new schedule the duration standards have been reduced as shown in Table 4.2 which indicates that 10 hr is now required only for fire flows of 10,000 gpm or greater and that the required duration decreases progressively to 2 hr for 2500 gpm or less.

Pressures

In most municipalities, the fire departments use pumpers to remove water from hydrants and deliver it through hose lines and nozzles to the fire. The purpose of the pumpers is to increase the pressure by a sufficient amount to overcome losses in hose lines and nozzles and to deliver a satisfactory stream on the fire. It is necessary, therefore, for the water distribution system to be able to deliver the required fire flow at a residual pressure sufficient to supply the pumpers properly. In order to have a positive pressure at the pumper suction inlet and at the same time overcome the losses in the hydrant branch, hydrant, and fire department suction hose, 20 psi is normally specified as the minimum residual pressure.

If fire department pumpers are not available or the fire department does not regularly use its pumpers, the water distribution system must be capable of delivering the required fire flow at much higher residual pressures. For large cities, the pressure required is 75 psi. For small municipalities requiring not more than 2500 gpm with more than ten buildings exceeding three stories in height, 60 psi is needed. In sparsely built residential areas or small village business districts with buildings of small area and not higher than two stories, 50 psi is required.

TABLE 4.2

Required Duration for Fire Flow

Required Fire Flow—gpm	Required Duration—h
10,000 and greater	10
9500	9
9000	9
8500	8
8000	8
7500	7
7000	7
6500	6
6000	6
5500	5
5000	5
4500	4
4000	4
3500	3
3000	3
2500 and less	2

The water supply section of the schedule includes fourteen items, each containing standards on a specific subject. Some of these items deal with the adequacy of the system, or the ability to meet the requirements under normal conditions. Other items deal with reliability, or the ability to meet the requirements under certain emergency or unusual conditions.

Adequacy of Supply Works

To be considered adequate under the schedule, a system should be capable of delivering the required fire flow with consumption at the maximum daily rate. The maximum daily consumption rate is the maximum amount of water consumed during any one day expressed as a rate over a 24-hr period.

The supply works, including sources of supply, intakes, suction lines, pumps, boilers, treatment works, and supply lines, should, in connection with the storage on the distribution system, be capable of delivering the maximum daily consumption rate plus the required fire flow. Because no two water systems are exactly alike, the specific methods employed to meet these requirements differ considerably. Overall techniques generally fall into one of three categories.

1. Provide supply works capacity to meet-the total requirements.
2. Provide supply works capacity equal to the maximum daily consumption rate with storage on the distribution system capable of meeting the required fire flow for the specified duration.
3. Provide supply works capacity in excess of the maximum daily consumption rate. Storage on the distribution system should be capable of supplying, for the specified duration, the difference between the total required rate and the capacity of the supply works.

Reliability of Supply Works

To comply with ISO standards, the supply works should be able to meet the requirements not only under normal conditions but also under emergency or unusual conditions. There are various ways in which the required reliability can be obtained, but it usually necessitates duplication of units or lines, or the provision of additional storage.

To evaluate the reliability of the source of supply, consideration is given to such factors as (1) the frequency and duration of droughts, (2) physical condition of dams and intakes, (3) danger from earthquakes, floods, forest fires, ice formations, (4) silting, and (5) clogging or increased salinity of wells. When these or similar factors interrupt or seriously reduce the supply for extended periods, then alternate supplies or special provisions are required to reduce the possibility of or effect of a change in flow.

To evaluate the reliability of pumping capacity, the standard also analyzes the ability of the supply works to deliver the maximum daily consumption rate plus the required fire flow with one and two pumps out of service. The pumps considered out of service are those that would cause the maximum reduction in delivery to the system. Because these pumps are not necessarily those having the highest rated capacities, a careful study of all pump capacities and operating characteristics is necessary.

The previous schedule in which the deficiencies on each lift were determined with one and two pumps out and then added together to obtain the total deficiency has been changed. It should be noted now that although each pumping lift is considered in the deficiency evaluation, a deficiency will only be assigned for the most serious condition with either one or two pumps out of service.

The treatment works are required to have sufficient capacity so that, with one filter or other treatment unit out of service, the system can deliver the maximum daily consumption rate plus the fire flow. Overloads based on operating records may be considered in meeting these requirements. Storage in clear wells at the plant and on the distribution system not only improves the reliability of the plant but also enables the plant to operate at more uniform rates.

Supply lines, including those in and around pumping stations, treatment works, and those which extend into the distribution system as principal arteries, should be arranged and valved so that a break will not prevent the system from delivering the fire flow for the specified number of hours during a period of five days with consumption at the maximum daily rate. The locations at which a break would have the most serious effect are usually in pump suction or discharge headers. A simple arrangement of suction and discharge piping for four pumps is shown in Fig. 4.1. A study of this figure will indicate that not more than one pump can be put out of service by a single break.

As far as supply works piping is concerned, ISO standards require that valves be installed in such a way that the repair of any valve will not interrupt or seriously reduce the supply. In the arrangement shown in Fig. 4.1 the repair of any valve will not put more than two pumps out of service. An arrangement of this type, with a valve between each pump connection, provides a reasonable degree of reliability.

The power used to drive the various units in the supply works must be reliable. It is required that electric power be supplied over at least two lines, preferably underground. Equipment must be arranged so that a failure in any line, or repair or replacement of an electric-power device will not prevent the system from delivering the fire flow for the required number of hours during a period of two days with

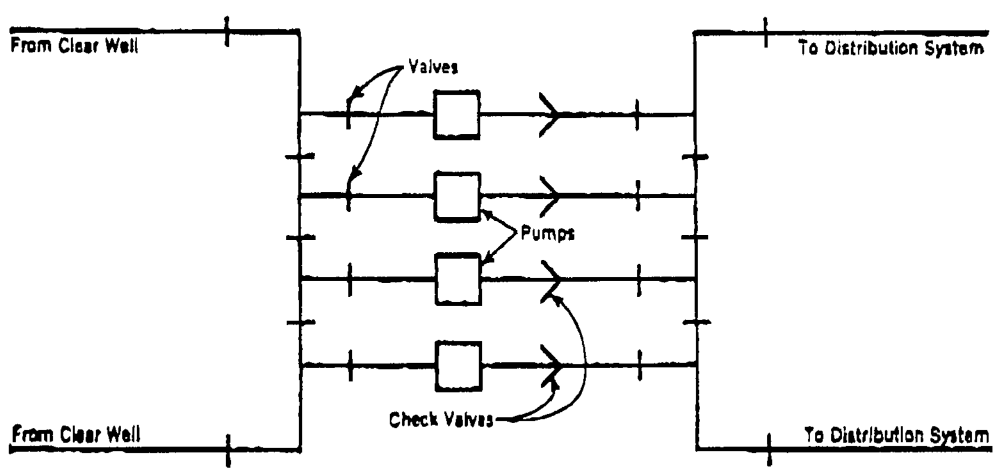

Figure 4.1 Simple Arrangement of Suction and Discharge Piping for Four Pumps

consumption at the maximum daily rate. Bus bars supplying pump motors should be duplicated or divided so that this requirement can be met. In order to offset unreliable features in electric-power supply, pumps may be provided with auxiliary internal combustion engines, or electric generators driven by such engines may be installed. Additional storage on the distribution system may also be used.

When steam is used, it is required that, if 25 percent of capacity (or at least one boiler) is out of service, the remaining boiler capacity must be adequate to operate the equipment and pumps necessary for the system to deliver the fire flow for the required number of hours during a period of five days with consumption at the maximum daily rate.

Steam piping, boiler feed lines, fuel piping (gas or oil lines to boilers as well as gas, oil, or gasoline lines to internal combustion engines), and air lines to wells should be arranged so that a failure in any line or the repair or replacement of a necessary device will not prevent delivery of fire flow for the required number of hours during a period of two days with consumption at maximum daily rate.

In providing reliable power for the various units of the supply works, due consideration should be given to wash water pumps, chemical feed machines, mixing apparatus, power-operated valves, and other appurtenances.

Pumping stations and other important structures should not contain combustible material in their construction. When located within the same structure, sections containing pumps, boilers, high-potential electric power equipment, filters, laboratories, shops, storage, offices, garages, and other important equipment or functions should be separated by fire-resistant partitions or fire walls. Openings in fire wall should be provided with at least one standard fire door; openings in other fire-resistant partitions should be provided with wired-glass, metal frame doors or windows as a minimum.

All electrical equipment should be installed in accordance with the National Electrical Code. All hazards, including those introduced by boiler-plant operations, internal combustion engines, storage and handling of fuel and lubricating oils, and heating devices, should be properly safeguarded. Suitable fire extinguishers, inside standpipes with small hose, and outside hydrants should be provided. If the building is remote from a fire station, hose should be provided at the hydrants.

Distribution System

The standards for supply mains require that arteries and secondary feeders extend throughout the system. These should be of sufficient size, considering their length and the character of the sections served, to deliver fire flow and consumption demands to all areas. They should be properly spaced (usually about 3000 ft apart) and looped so that no large areas are dependent upon single mains.

The gridiron of minor distribution mains should consist of mains at least 6 in. in diameter arranged so that the lengths on the long sides of blocks between intersecting mains do not exceed 600 ft. When longer lengths of 6-in. pipe are necessary, 8-in. or larger intersecting mains are required. If street layout and topography are not well adapted to this arrangement, or dead ends and poor gridding are unavoidable, then 8-in. pipe should be the minimum main size.

In high-value districts, the minimum size should be 8 in. with intersecting mains in each street. Mains 12 in. or larger should be used on the principal streets and for all lines that are not connected to other mains at intervals close enough for proper mutual support.

Valves

To isolate sections of main in the event of a break or in connection with construction or repair work, ISO standards require that the system be equipped with an adequate number of properly located valves. Supply lines should be valved at least once a mile and interconnections between such lines should have two valves. Arterial mains require valves at not more than ¼-mi intervals. Connections to the smaller mains of the distribution system should be arranged and valved so that a break or repair in any of the smaller mains does not necessitate the shutdown of an artery. Exclusive of arterial mains, valves should be installed so that shutoff lengths do not exceed 500 ft in high-value districts and 800 ft in residential districts.

If valves are to be used effectively during an emergency, they must be maintained properly. This requires a program of regular annual inspections for all valves and more frequent inspections of the large and important valves, including those at pumping stations, treatment works, and reservoirs. During the inspections the valves should be operated and any necessary repairs made. Even though the valve mechanism itself may be in good operating condition, regular inspections frequently reveal that (1) the valve box has been paved over, (2) the box has shifted so that the valve key cannot be placed on the operating nut, or (3) the box is filled with dirt.

Since any of these defects could delay operation during an emergency, they have an effect on the fire rating. Inspections sometimes also reveal closed valves where they should be open, thus preventing full capacity use of the mains in the system. Suitable valve records should be maintained indicating inspections, operations, condition, and repairs.

Hydrants

All water used for public fire protection must be delivered through hydrants; therefore, a sufficient number should be provided on the distribution system. The number of hydrants needed in any area depends upon the fire flow required. Table 4.3 gives the hydrant distribution required for fire flows of 1000 to 12,000 gpm; the average area served for intermediate fire flows not given in the table may be interpolated. Street intersections are the best locations for hydrants, since hose can usually be stretched in any of four directions from a pumper connected to a hydrant at an intersection. It is good practice, therefore, to place at least one hydrant at each intersection and to add intermediate hydrants, when necessary, to attain standard distribution. In high-value districts requiring large fire flows and numerous hydrants, two or more hydrants are generally used at an intersection.

The standards require that hydrants be able to deliver 600 gpm with a loss of not more than 2.5 psi in the hydrant and a total loss of not more than 5 psi between the street main and outlet. One 4½-in. and two 2½-in. outlets should be provided, but one 2½-in. outlet may be omitted if the fire department normally uses the large outlets. Connections to the main should be at least 6 in. in diameter and gated.

If hydrants are to be properly maintained, a regular inspection program is necessary. Inspections should be made semiannually and after each use. During these inspections the hydrant should be operated, checked for leaks and proper drainage, and lubricated as required. Proper records of inspections, conditions, and repairs should be maintained.

Separated Zones of Service

Topography makes it necessary to provide more than one pressure zone of distribution in many municipalities. In the application of the schedule, these zones are considered individually from the standpoint of providing adequate and reliable fire protection. The various factors previously discussed, including pumping capacity, storage, power supply, construction of pumping stations, arterial mains, and minor distribution lines are of importance, especially if these zones involve large portions of the municipality. When supply is available from one zone to another by opening normally closed valves, such emergency supplies may be of considerable value in meeting demands. In arranging service limits, the creation of dead ends by closing valves should be kept to a minimum, especially where the lines are 6 in. or smaller in size.

Private Fire Protection

Private protection is provided from the public distribution system through fire service connections supplying sprinkler, standpipe, water spray, foam, and yard hydrant systems. Standards for these special fire-extinguishing systems have been prepared by the National Fire Protection Association and have been adopted by many insurance organizations, including the ISO. Certain portions of these standards deal with the water supplies for these systems. The flows and pressures

TABLE 4.3
Standard Hydrant Distribution

Fire Flow Required—*gpm*	Average Area per Hydrant—*sq ft*
1000 or less	160,000
1500	150,000
2000	140,000
2500	130,000
3000	120,000
3500	110,000
4000	100,000
4500	95,000
5000	90,000
5500	85,000
6000	80,000
6500	75,000
7000	70,000
7500	65,000
8000	60,000
8500	57,000
9000	55,000
10,000	50,000
11,000	45,000
12,000	40,000

needed depend upon the type of system and its individual characteristics as well as the type of occupancy it is to protect. Requirements are somewhat general in nature, but the specific requirements for any installation can be obtained from the insurance rating organization in the state or from the insurance carrier.

Fire service connections are required to extend from the public distribution system directly to the fire-extinguishing system with no intermediate connections for domestic use. No connections should be made to any portion of an extinguishing system to provide domestic supply. Although practice differs, many water utilities in the US require meters on fire service connections. When meters are used, they should comply with C703, "AWWA Standard for Cold-Water Meters—Fire Service Type." Detector check valves with a metered bypass are frequently used; these devices accurately measure small flows, but do not measure the large flows used during fires. They are intended for use by those water utilities that do not wish to charge for water used during fires, but do wish to control unauthorized use of water through fire service connections.

In order to supply some fire-extinguishing systems properly, it is necessary to install special fire pumps. It may also be necessary to improve the supply by the installation of ground storage as suction for the pumps or elevated storage on the private system. Standards of the National Fire Protection Association are available for such installations.

Leaders in the water utility field feel strongly that a special charge should be made by the utility for private fire protection services. Such a service places the responsibility on the water utility to install pumps, distribution mains, and related facilities sufficient to supply the private fire hydrants and sprinkler heads although they are used only in emergencies.

In all fire-extinguishing systems that receive their supply from a public distribution system, care must be taken to prevent any contamination of the public supply. Cross connections should not be made between non-potable sources of supply and private fire-extinguishing systems supplied through fire service connections by public water systems. All fire-extinguishing systems should be installed to comply with the requirement of the health authorities having jurisdiction.

When a private fire-extinguishing system is installed, the owner of the premises generally receives a reduction in his fire insurance rates. Such reduction will obviously depend upon the extent to which compliance has been made with the previously mentioned standards and any other special or local requirements. In order to determine if the system is satisfactory, the plans and specifications should be submitted to the insurance rating organization in the state or to the insurance carrier. Through this procedure, counsel can be obtained on the installation making it possible for the property owner to gain the maximum benefits possible from the fire service connection.