

IMPORTANT NOTE: The designation given on page 1 of this document is in error. It should read: AWWA C603-65



**AWWA C603-64**

**AWWA C603-65**

**American Water Works Association**

**AWWA STANDARD**  
*for*  
**INSTALLATION OF ASBESTOS-CEMENT  
WATER PIPE**

This "Standard for Installation of Asbestos-Cement Water Pipe" is based on a consensus of AWWA Committee 8340 D on the minimum practice consistent with good, economical service under normal conditions. It is not designed for unqualified use under all conditions, and its applicability under any circumstances must be reviewed by the responsible engineer. The standard is not intended to preclude the manufacture, marketing, purchase, or use of any product, process, or procedure.

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AWWA C603-64

AWWA Standard for

## Installation of Asbestos-Cement Water Pipe

### Sec. 1—Scope

This standard is offered as a guide to good practices in the installation of asbestos-cement water pipe and cast-iron fittings. This standard may be combined with other contract documents to form a comprehensive contract between the Owner and the Contractor. For specific projects, a thorough review of this standard is suggested for the purpose of supplementing this standard with provisions for special procedures not included herein. These provisions should be incorporated in the contract documents.

The selection of the class of pipe, bedding conditions, and depths of cover may be determined from AWWA H2—*Standard Practice for the Selection of Asbestos-Cement Water Pipe*.

The pipe selected may be manufactured in accordance with the provisions of AWWA C400—"Standard for Asbestos-Cement Water Pipe."

### Sec. 2—Definitions

Under this standard the following definitions shall apply:

2.1. *Owner*: The person, firm, corporation, or government subdivision

entering into contract with the Contractor for the installation of the asbestos-cement water pipe and accessories.

2.2. *Engineer*: The person, firm, corporation, or government agency acting for the Owner as his duly authorized agent within the scope of the duties entrusted.

2.3. *Inspector*: An authorized representative of the Engineer or Owner, assigned to make any and all necessary inspections of the work performed, materials, and equipment furnished by the Contractor.

2.4. *Contractor*: The person, firm, or corporation entering into the contract with the Owner for the installation of asbestos-cement water pipe and fittings.

2.5. *Other terms*: Whenever in the specifications or drawings the words *directed*, *required*, *permitted*, *ordered*, *designated*, *prescribed*, or words of like import are used, it shall be understood that a direction, requirement, permission, order, designation, or prescription of the Engineer is intended, and, similarly, the words *approved*, *acceptable*, *satisfactory*, or words of like import shall mean approved by, or acceptable or satisfactory to, the Engineer, unless otherwise expressly stated.

**Sec. 3—Work Included**

The Contractor shall furnish all labor, equipment, and material, not specifically provided by others, necessary to complete the pipeline as stipulated in this standard and other contract documents. The Contractor shall remove as much of the pavement as may be necessary; excavate the trenches and pits to the required dimensions; construct and maintain all bridges required for traffic control; sheet, brace, and support the adjoining ground or structures where necessary; provide for all drainage or ground water; guard the site; unload, haul, distribute, lay, test, and disinfect the pipe and accessories; rearrange the branch connections to the main sewers, or rearrange other conduits, ducts, or pipes where necessary; replace all damaged drains, sewers, or other structures; backfill the trench and pits; restore the roadway surface; remove surplus excavated material; clean the site of the work; test the completed pipeline for pressure and leakage requirements; disinfect the complete pipeline; and maintain the street or other surface over the trenches.

**Sec. 4—Inspection**

If requested in writing by the Owner, all material shall be inspected and approved by a representative of the Owner at the Manufacturer's plant before shipment. When the material has been received from the carrier and at the time of unloading, the Contractor shall inspect all pipe and accessories for loss or damage in transit. No shipment of material should be accepted by the Contractor unless proper exceptions are made at the time of delivery on the receipt obtained by the carrier as to loss or damage or

both. All laying, jointing, testing for defects and for leakage under pressure, and disinfection, shall be performed in the presence of the Engineer or his authorized inspector, and shall be subject to his approval before acceptance. All material found during the progress of the work to have cracks, flaws, or other defects shall be rejected by the Engineer or his authorized inspector, and the Contractor shall promptly remove such defective material from the site of the work.

**Sec. 5—Contractor's Responsibility for Material**

The Contractor shall be responsible for all material furnished by him. All such material that is defective in manufacture or has been damaged in transit or after delivery shall be replaced by the Contractor at his expense.

The Contractor's responsibility for material furnished by the Owner shall begin upon Contractor's acceptance at the point of delivery to him. All such material shall be examined, and material defective in manufacture or damaged (or both) shall be rejected by the Contractor at the time and place of delivery to him. All material found to be defective or damaged at this time will be replaced by the Owner. Material furnished by the Owner and accepted by the Contractor, but found to be defective prior to final acceptance of the work shall: (1) if defective in manufacture, be replaced by the Owner; (2) if damaged before or after acceptance by the Contractor, be replaced by the Contractor. Once accepted by the Contractor at the point of delivery to him, all defective or damaged material discovered prior to final acceptance of the work shall be removed by the Contractor, and he shall install, at

his own expense, the replacement material, in its stead. In that event, the Contractor shall furnish all labor, equipment, and material incidental to replacement and necessary for the completion of the work to the satisfaction of the Engineer.

The Contractor shall be responsible for the safe storage of all material furnished to or by him and accepted by him until it has been incorporated in the completed project and finally accepted by the Owner. Any material lost or stolen or that otherwise disappears from the site shall be replaced by the Contractor at his expense.

#### **Sec. 6—Handling of Pipe and Accessories**

Pipe and accessories shall, unless contrary instructions are received, be unloaded at the point of delivery, hauled to, and distributed at, the site of the project by the Contractor. They shall at all times be handled with care to avoid damage. Whether moved by hand, skidways, or hoists, material shall not be dropped or bumped. The interior and machined ends of all pipe shall be kept free from dirt and foreign matter at all times. In the distribution of material at the site of the work, each piece shall be unloaded opposite or near the place where it is to be laid in the trench.

Pipe shall be handled in such manner as to avoid damage to the machined ends. Pipe damaged at such points that cannot be repaired to the Engineer's satisfaction shall be replaced at the Contractor's expense. Valves and hydrants shall be kept drained and stored before installation in a manner protecting them from damage due to freezing of trapped water.

#### **Sec. 7—Alignment and Grade**

All pipe shall be laid and maintained to the required lines and grades. Fittings, valves, and hydrants shall be at the required locations with joints centered, spigots home, and all valve and hydrant stems plumb. No deviation shall be made from the required line or grade except with the written consent of the Engineer.

Temporary support, adequate protection, and maintenance of all underground and surface utility structures, drains, sewers, and other structures encountered in the progress of the work shall be furnished by the Contractor at his own expense. Where the grade or alignment of the pipe is obstructed by existing utility structures such as conduits, ducts, pipes, branch connections to main sewers, or main drains, the obstruction shall be permanently supported, relocated, removed, or reconstructed by the Contractor in cooperation with the owners of such utility structures. Whenever necessary to determine the location of existing underground utility structures, the Contractor, after an examination of available records, shall make all explorations and excavations for such purpose as may be directed by the Engineer. All pipe shall be laid to the depth shown on the contract drawings or as directed by the Engineer in writing. The depth shall be measured from the established street grade or the surface of the permanent improvement to the top of the pipe barrel.

#### **Sec. 8—Excavation and Preparation of Trench**

8.1. *General:* The trench shall be dug to the required alignment and depth shown on the contract drawings

or as directed by the Engineer and only so far in advance of pipelaying as the Engineer shall permit. The trench shall be braced and drained when necessary so that workmen may work therein safely and efficiently.

8.2. *Width:* The trench width at the ground surface may vary with, and depend upon, its depth and the nature of the ground encountered. The minimum clear width of un-sheeted or sheared trench measured at the horizontal diameter of the pipe shall be 18 in., or 1 ft greater than the outside diameter of the barrel of the pipe, whichever is greater. The maximum clear width of trench at the top of the pipe shall be not more than the outside diameter of the barrel of the pipe plus 2 ft. Greater width of trench at the top of the pipe shall be permitted only on written approval by the Engineer.

8.3. *Foundation:* The pipe shall be laid on stable soil. Any part of the trench excavated below grade shall be backfilled to grade with thoroughly compacted material approved by the Engineer. When an unstable subgrade condition is encountered and, in the opinion of the Engineer, it cannot support the pipe, an additional depth shall be excavated and refilled to pipe foundation grade with crushed stone or other suitable material as required by the Engineer to achieve a satisfactory trench bottom as specified in Sec. 9, below.

8.5. *Rock excavation:* Ledge rock, boulders, and large stones shall be removed to provide 6 in. of clearance to each side of and below all pipe and accessories. Excavations below subgrade in rock or in boulders shall be refilled to subgrade with material approved by the Engineer, and thoroughly compacted. Blasting for exca-

vation will be permitted only after the approval of the Engineer has been secured and only when proper precautions have been taken for the protection of persons and property. The hours of blasting shall be fixed by the Engineer. Any damage caused by blasting shall be repaired by the Contractor at his expense. The Contractor's procedures and methods of blasting shall conform to state and local laws and to municipal ordinances.

8.6. *Excavation methods:* The use of trench-digging machinery will be permitted except where its operations will cause damage to trees, buildings, or existing structures above or below the ground. At such locations hand methods shall be employed to avoid such damage. Wherever necessary to prevent caving, trench excavations in soils such as sand, gravel, and sandy soil shall be adequately sheeted and braced. Where sheeting and bracing are used, the trench width shall not be less than that specified in Sec. 8.2. As backfill is placed and if sheeting is to be withdrawn, it shall be withdrawn in increments of not more than 1 ft, and the void left by the withdrawn sheeting shall be filled and compacted. All excavated material shall be piled in a manner that will not endanger the work or obstruct sidewalks and driveways. Gutters shall be kept clear or other satisfactory provisions made for street and other drainage.

8.7. *Provision for public safety:* To protect persons from injury and to avoid property damage, adequate barricades, construction signs, torches, warning lights, and guards as required shall be placed and maintained during the progress of the construction work until the site is safe for traffic use. Whenever required, watchmen shall be provided to prevent accidents. Rules

and regulations of the local authorities regarding safety provisions shall be observed.

Excavations for pipelaying operations shall be conducted to cause the least interruption to traffic. If so directed by the Engineer, the Contractor shall provide suitable bridges at street and driveway crossings where traffic must cross open trenches. Hydrants under pressure, valve pit covers, valve boxes, curb stop boxes, fire or police call boxes, or other utility controls shall be unobstructed and accessible during the construction period. Adequate provisions shall be made for the flow of sewers, drains, and water courses encountered during construction. Structures that have been disturbed shall be satisfactorily restored by the Contractor. Trees, fences, poles, and all other property shall be protected unless their removal is authorized. Any damaged property shall be satisfactorily restored by the Contractor.

**8.8. Interruption of utility services:** No valve, switch, or other control on existing utility systems shall be operated for any purpose by the Contractor without approval of the Engineer and the utility. All consumers affected by such operations shall be notified by the Contractor as directed by the Engineer and utility before the operation and advised of the probable time when service will be restored.

#### **Sec. 9—Preparation of Trench Bottom**

As directed by the Engineer, the pipe shall be laid directly on the trench bottom or on earth mounds.

**9.1. Pipe laid on trench bottom:** Pipe shall be laid directly on a trench bottom containing coupling holes and

shaped to provide continuous contact with the pipe between coupling holes.

Before the pipe is lowered into the trench: (1) a coupling hole shall be dug with sufficient length, width, and depth to permit assembly and provide a minimum clearance of 2 in. between coupling and undisturbed trench bottom; and (2) the trench bottom between coupling holes shall be made flat and cut true and even to grade so as to provide continuous contact of the trench bottom with the pipe.

**9.2. Pipe laid on earth mounds:** Pipe shall be laid on earth mounds of a size adequate to hold the pipe in alignment and to maintain a 2-in. minimum clearance from coupling to undisturbed trench bottom. Earth mounds shall be of approved backfill material tamped in place. Each pipe shall be laid on two mounds with center of each mound placed one-fifth of the pipe length from each end. The trench shall be excavated a minimum of 2 in. below the grade of the bottom of the OD of the couplings, and high spots between couplings shall be leveled so as to maintain a minimum of 2 in. under the pipe barrel. The earth mounds shall be tamped firmly in place and raised to a height that will allow for placement of the pipe so as to maintain, before backfilling, a minimum clearance of 2 in. between the trench bottom and the pipe and coupling.

#### **Sec. 10—Lowering of Pipe and Accessories Into Trench**

Implements, tools, and facilities satisfactory to the Engineer shall be provided and used by the Contractor for the safe and efficient execution of the work. All pipe, fittings, valves, hydrants, and accessories shall be carefully lowered into the trench with suit-

able equipment in a manner that will prevent damage to pipe and fittings. Under no circumstances shall pipe or accessories be dropped or dumped into the trench. Pipe and accessories shall be inspected for defects prior to their being lowered into the trench. Any defective, damaged, or unsound material shall be repaired or replaced as directed by the Engineer. All foreign matter or dirt shall be removed from the interior and machined ends of pipe and accessories before it is lowered into position in the trench. Pipe shall be kept clean by means approved by the Engineer during and after laying.

#### **Sec. 11—Pipe Joints**

The machined ends of pipe to be jointed, the coupling grooves, and rubber rings shall be cleaned immediately before assembly, and assembly shall be made as recommended by the manufacturer. Each pipe joint shall be sealed with a coupling consisting of an asbestos-cement sleeve and two rubber rings. The location of field-assembled rings shall be checked with a suitable gage to verify that rubber rings are in the required position.

Pipe shall not be deflected either vertically or horizontally more than the limits recommended by the manufacturer.

When pipelaying is not in progress, the open ends of installed pipe shall be closed by approved means to prevent entrance of trench water into the line. Whenever water is excluded from the interior of the pipe, enough backfill shall be placed on the pipe to prevent floating. Any pipe that has floated shall be removed from the trench and relaid as directed by the Engineer. No pipe shall be laid in wet trench conditions that preclude proper bedding, or on a frozen trench bottom,

or when, in the opinion of the Engineer, the trench conditions or the weather are unsuitable for proper installation.

#### **Sec. 12—Length of Pipe at Fittings and Rigid Structures**

When rigid joints—that is, those formed by poured- or calked-joint materials, or both, or by bolts with rubber ring seals—are used at the fitting, the length of the pipe fitted into the bell of the fitting shall not be more than 3 ft 3 in. in pipe of 6-in. diameter and smaller, or 6 ft 6 in. in pipe of 8-in. diameter and larger.

When a rubber ring is used to make the seal, and flexibility is provided by a grooved design profile similar to that of the coupling used to join pipe between fittings, up to a full 13-ft length may be used.

With all the rigid joints named above, the pipe connecting any two valves or fittings shall be in two or more lengths jointed with one or more couplings to provide flexibility. If a flexible seal is used, a single 13-ft or shorter length may be used to connect the two fittings without any intermediate coupling.

A coupling shall be cast in the wall of rigid structures at the point of entry of pipelines to provide flexibility at the wall. To provide additional flexibility, the pipe at the point of entry shall have a laying length of not more than 6 ft 6 in.

#### **Sec. 13—Jointing of Pipe to Fittings**

13.1. *General:* Each cast-iron valve, hydrant, or fitting connected to asbestos-cement pipe shall either be equipped with a bell with an inside diameter large enough to receive the pipe and calking of at least  $\frac{1}{4}$ -in. thickness around the full circumference of

the pipe, or have a profile that presents a seal to be made between the machined pipe end and the bell of the fitting with a rubber ring.

Before valves, hydrants, or fittings are laid, all lumps, blisters, and excess coating shall be removed from the bell. The inside of the bell shall then be wire-brushed and both the inside of the bell and the spigot end of the pipe wiped clean and dry. When sulfur base joint compound is used, oil and grease shall be removed. All surfaces to be joined shall be kept clean until joints are made. As directed by the Engineer, bell-and-spigot joints shall be sealed with either rubber rings, lead or sulfur base compound.

13.2. *Yarning material:* For lead joints, asbestos rope, untarred braided hemp, untarred twisted jute, or other suitable material approved by the Engineer, shall be used. For sulfur compound joints, asbestos rope, untarred braided hemp or jute, or other suitable material approved by the Engineer, shall be used. Yarning material shall be sterilized and free from oil, greasy substances, or tar. Sterilization shall be accomplished by boiling in water, pressure steaming, or by suitable chemical agents. The yarning material shall be handled with reasonable care to avoid contamination and shall be dry when applied. Each strand of yarn shall be cut somewhat longer than the circumference of the pipe, so that the ends will overlap.

13.3 *Calking procedure with yarn:* The overlapped ends of successive strands shall be staggered. Strands of yarning material of proper thickness to center the spigot in the bell shall be driven home separately. Each strand shall be thoroughly packed and hammered into the joint with suitable yarning tools.

For lead joints, a minimum depth of  $2\frac{1}{4}$  in. shall be left uncalked in the bell of pipe of 20-in. diameter and smaller;  $2\frac{1}{2}$  in. for pipe 24–36 in. For sulfur compound joints, a minimum of  $2\frac{1}{2}$  in. shall be left uncalked in the bell of pipe 24-in. diameter and smaller;  $2\frac{3}{4}$  in. for pipe 30–36 in.

13.4. *Lead joints:* Lead for calking purposes shall contain no less than 99.73 per cent pure lead. Impurities shall not exceed the following percentages: arsenic, antimony, and tin (together), 0.015; copper, 0.08; zinc, 0.002; iron, 0.002; bismuth, 0.25; and silver, 0.02. The producer's name or identification mark shall be clearly cast or stamped on each bar of lead. The melting pot used to heat lead shall be kept near the joint to be poured. The lead shall be brought to the proper temperature at which a rapid change of color appears when the lead is stirred, and at which a continuous solid lead joint is insured. Before the lead is poured, all scum shall be removed. The joint runner shall fit snugly against the face of the bell, and the outside of the pipe and shall be dammed with clay at the pouring gate to provide for filling the joint even with the top of the bell. Each joint shall be made with one pour to provide a continuous solid joint with the joint space completely filled.

After the lead joints have cooled to the temperature of the pipe, they shall be calked by competent workers with pneumatic or hand tools. The calking shall be thoroughly compacted to make the joints watertight without overstraining the bells.

13.5. *Sulfur-base compound joints:* The compound for pipe joints shall be of a make approved by the Engineer. The compound shall be heated in a suitable melting furnace in ac-

cordance with the instructions of the manufacturer of the compound.

The compound shall be stirred thoroughly and continuously while it is melting and until it is used. When poured, it must be liquid, free from froth, bubbles, or any foreign matter and shall show a mirror-like surface.

After yarning, suitable funnel-shaped metal pouring gates extending not less than 8 in. above the bell shall be adequately clayed to the joint runner. The joint space and gate shall be filled with one continuous pour while the compound is at the proper temperature.

If a joint is defective, it shall be cut out and replaced entirely with new material. If compound catches fire in the melting furnace, the entire contents of the furnace shall be rejected. No pipe or fittings shall be laid in water or on a frozen trench bottom or when, in the opinion of the Engineer, the trench conditions or the weather are unsuitable for such work.

#### **Sec. 14—Setting of Bends, Tees, and Reducers**

Bends, tees, and reducers shall be lowered into the trench, inspected, cleaned as specified above, and jointed to asbestos-cement pipe, also as specified above.

Reaction or thrust backing shall be applied at bends and tees, and at points at reducers or in fittings where changes in pipe diameter occur. The design of concrete thrust backing shall be as shown on contract drawings or as directed by the Engineer. The material of reaction or thrust backing shall be concrete composed of concrete aggregates in accordance with ASTM Designation C33 and portland cement in accordance with ASTM Designation C150 for portland cement or C175 for

air-entrained portland cement. The mix shall not be leaner than 1 part cement,  $2\frac{1}{2}$  parts sand, and 5 parts stone and shall have a compressive strength of no less than 2,000 psi in 36 hr for high-early-strength cement (Types III or IIIA) and 7 days for standard cement (Types I or IA). Backing shall be placed between solid ground and the fitting to be anchored. The area of bearing on fitting and on ground shall in each instance be that required by the Engineer. Unless otherwise directed by the Engineer, the backing shall be placed so that the pipe and fitting joints will be accessible for repair. Metal harness of tie rods and pipe clamps shall be used to prevent movement as shown on the contract drawings or directed by the engineer. Steel rods and clamps shall be galvanized or otherwise rust-proofed or painted.

#### **Sec. 15—Setting of Valves and Valve Boxes**

All geared valves and any other valves designated shall be set in masonry valve pits. The wrench nuts shall be readily accessible for operation through the manhole opening. Pits shall be constructed in a manner that will permit minor valve repairs and afford protection of the pipe against impact or settlement where the pipe passes through the pit walls. Cast-iron valve boxes shall be firmly supported and shall be kept centered and plumb over the wrench nut of the gate valve; the box cover shall be flush with the surface of the finished pavement or at any other level designated by the Engineer.

#### **Sec. 16—Setting of Blowoffs**

Drainage branches or blowoffs shall be provided as shown on contract

drawings or as directed by the Engineer. Drainage branches or blowoffs shall not be connected to any sewer, submerged in any stream, or installed in any other manner that will permit back-siphonage into the distribution system.

### **Sec. 17—Setting of Hydrants**

17.1. *General:* Hydrants shall be lowered into the trench, inspected, and joined to asbestos-cement pipe as specified above, and reaction or thrust backing provided. Hydrants shall be thoroughly cleaned in the manner specified above before they are set.

17.2. *Location:* Hydrants shall be located to provide complete accessibility and to minimize the possibility of damage from vehicles or injury to pedestrians. The following provisions shall govern, unless other instructions are issued by the Engineer: the bowl of any hydrant placed behind the curb shall be set so that no portion of the hydrant or hose nozzle caps on the street side shall be less than 6 or more than 12 in. from the face of the curb; all hydrants shall stand plumb; pumper nozzles shall be at right angles to and facing the curb; hose nozzles shall parallel the curb, except that hydrants with two hose nozzles 90 deg apart shall be set so that the nozzles face the curb at an angle of 45 deg; and nozzles shall be at least 12 in. above the ground.

17.3. *Connection to main:* Each hydrant shall be connected to the main with a 6-in. asbestos-cement pipe and, if specified by the contract drawings, shall be controlled by an independent 6-in. gate valve.

17.4. *Drainage:* Hydrants shall be set with a drainage pit 2 ft in diameter and 2 ft deep below each hydrant. The pit shall be filled com-

pactly with coarse gravel or broken stone mixed with coarse sand under and around the bowl of the hydrant to a level 6 in. above the waste opening. No hydrant drainage pit shall be connected to a sewer.

17.5. *Reaction or thrust backing:* A reaction or thrust backing shall be provided at the bowl of each hydrant and shall be so placed as not to obstruct the drainage outlet of the hydrant, or, alternatively, the bowl of the hydrant shall be tied to the pipe main with rods. The size and shape of concrete thrust backing or the number and size of the tie rods shall be as shown on the contract drawings or as directed by the Engineer.

### **Sec. 18—Plugging of Dead Ends**

Standard plugs shall be inserted into the bells of all dead-end fittings. Spigot ends of fittings and plain ends of pipe shall be capped. A concrete reaction or thrust backing shall be provided at all dead ends of pipe that are capped or plugged. Capped or plugged outlets to fittings in the sizes indicated on the contract drawings or as directed by the Engineer shall be tied to the fittings with clamps and tie rods. The number and size of rods shall be as specified.

### **Sec. 19—Pressure and Leakage Test**

19.1. *General:* The following procedure is based on the assumption that the pressure and leakage tests will be performed at the same time; however, separate tests may be made, if desired. If separate tests are made, the pressure test shall be made first; the duration of the pressure test may be reduced to 1 hr, and the test pressure for the leakage test may be reduced to the maximum working pressure that

will occur on the portion of the line being tested.

After the pipeline has been laid it shall be filled with water for a minimum of 24 hr and then subjected to a hydrostatic pressure test. Unless otherwise specified, the test pressure shall be 50 per cent greater than the operating pressure gradient at the lowest elevation of the system. When, in the opinion of the Engineer, local conditions require that the trenches

test shall be 2 hr unless otherwise directed by the Engineer.

19.2. *Procedure:* Each section of pipeline shall be slowly filled with water, and the specified test pressure shall be applied by means of a pump connected to the pipe in a manner satisfactory to the Engineer. The pump, pipe connection, and all necessary apparatus except gages shall be furnished by the Contractor. The Owner will furnish gages for the test and do all

TABLE 1  
*Allowable Leakage per 100 Couplings\**

| Pipe<br>Diameter<br>in. | Test Pressure at Lowest Point in Line—psi |      |      |       |       |       |       |
|-------------------------|-------------------------------------------|------|------|-------|-------|-------|-------|
|                         | 50                                        | 75   | 100  | 125   | 150   | 200   | 225   |
|                         | Leakage—gph                               |      |      |       |       |       |       |
| 4                       | 0.71                                      | 0.87 | 1.00 | 1.02  | 1.23  | 1.42  | 1.51  |
| 6                       | 1.06                                      | 1.29 | 1.51 | 1.68  | 1.84  | 2.12  | 2.25  |
| 8                       | 1.42                                      | 1.72 | 2.00 | 2.24  | 2.45  | 2.84  | 3.00  |
| 10                      | 1.77                                      | 2.15 | 2.50 | 2.79  | 3.07  | 3.54  | 3.75  |
| 12                      | 2.12                                      | 2.58 | 3.00 | 3.35  | 3.68  | 4.24  | 4.52  |
| 14                      | 2.48                                      | 3.01 | 3.50 | 3.91  | 4.28  | 4.96  | 5.26  |
| 16                      | 2.83                                      | 3.44 | 4.01 | 4.47  | 4.89  | 5.68  | 6.00  |
| 18                      | 3.18                                      | 3.87 | 4.52 | 5.02  | 5.52  | 6.37  | 6.75  |
| 20                      | 3.54                                      | 4.30 | 5.00 | 5.58  | 6.12  | 7.08  | 7.51  |
| 24                      | 4.24                                      | 5.16 | 6.00 | 6.69  | 7.34  | 8.50  | 9.01  |
| 30                      | 5.30                                      | 6.45 | 7.51 | 8.37  | 9.18  | 10.62 | 11.26 |
| 36                      | 6.37                                      | 7.75 | 9.01 | 10.07 | 11.02 | 12.74 | 13.50 |

\*The data are based on 150 psi and represent a leakage of approximately 30 gpd per mile of pipe per inch of pipe diameter for pipe in 13-ft lengths.

be backfilled immediately after the pipe has been laid, the pressure test may be made after backfilling has been completed but before placement of permanent paving. A test shall be made only after a part or all backfilling has been completed and at least 36 hr after the last concrete thrust or reaction backing has been cast with high-early-strength cement, or at least 7 days after the last concrete thrust or reaction backing has been cast with standard cement. The duration of the

tapping, but the Contractor shall furnish all necessary assistance for conducting the tests.

During the filling of the pipe and before the application of the specified test pressure, all air shall be expelled from the pipeline—if necessary, by means of taps at points of highest elevation, and, after completion of the test, the taps shall be tightly plugged, unless otherwise specified. During the test, all exposed pipe, fittings, valves, hydrants, and asbestos-cement cou-

plings shall be carefully examined. Any joint at which the accumulated leakage exceeds the rate specified in Table 1 shall be rejected. All cracked or defective elements shall be removed and replaced by the Contractor at his expense. The test shall then be repeated until the results are satisfactory to the Engineer.

19.3. *Overall leakage:* No pipe installation will be accepted until or unless the leakage for the section of line tested is less than the rate of leakage specified in Table 1. In calculating leakage the Engineer will allow for the number of joints added to the pipeline, owing to the use of pipe lengths smaller than 13 ft, for which the data in Table 1 apply. If the test leakage in any section is greater than that permitted, the Contractor shall locate and repair the defective joints at his own expense until the leakage is within the permitted allowance.

## **Sec. 20—Backfilling, Cleaning, and Maintenance of Surfaces**

20.1. *Backfilling procedure before tests:* Backfill material approved by the Engineer—not frozen and free from rock, lumps of clay, large stones, boulders, or other unsuitable substances—shall be deposited in the trench uniformly at both sides of the pipeline for the full width of the trench up to the horizontal diameter of the pipeline. This backfill material shall be tamped in layers 4 in. thick after compaction and shall be sufficiently damp to permit thorough compaction under and on each side of the pipe to provide support free from voids.

If visual inspection during the test is not required, the pipe and joints shall be backfilled as specified above and a cushion of approved material hand placed over pipeline and joints

to an average depth of 12 in. for all sizes of pipe.

If joints are to be exposed during the test, additional approved backfill material shall be hand placed between joints in order to hold the line securely during the test. The average depth of material shall be 12 in. over the top of 8-in.-diameter and smaller pipe and 24-in. over larger pipe.

20.2. *Backfill procedure after tests:* On completion of pressure and leakage tests, exposed couplings shall be covered with approved backfill hand placed to a depth of 12 in. above the top of the pipe and couplings. The balance of backfill shall contain no stones more than 6 in. in their largest dimension, and the backfill mixture shall not contain more than 25 per cent stones. The Contractor shall not permit excavation to be used for disposal of refuse. Trenches in the right of way of a road shall be backfilled to a compaction density of 90 per cent, as determined by the American Association of State Highway Officials Method T99 for Compaction and Density of Soils. Trench not in a right of way may be backfilled without tamping. Any deficiency in the quantity of material for backfilling the trenches or filling depressions caused by settlement shall be supplied by the Contractor at his expense.

20.3. *Restoration and cleanup:* The Contractor shall restore or replace all removed or damaged paving, curbing, sidewalks, gutters, shrubbery, fences, sod, or other disturbed surfaces or structures in a condition equal to that before the work began and to the satisfaction of the Engineer and shall furnish all labor and material incidental thereto. In restoring improved surfaces, new pavement shall be laid, except that granite paving blocks, sound

brick, or sound asphalt paving blocks may be reused. No permanent surface shall be placed within 30 days after the backfilling has been completed, except by order of the Engineer.

Surplus pipeline material, tools, and temporary structures shall be removed by the Contractor. All dirt, rubbish, and excess earth from excavations shall be hauled to a dump provided by the Contractor, and the construction site shall be left clean, to the satisfaction of the Engineer.

20.4. *Maintenance of surfaces:* After the certification by the Engineer of completion of the work, the Contractor shall, unless it is otherwise stipulated by the Engineer, maintain the surface of unpaved trenches, and adjacent curbs and gutters, sidewalks, shrubbery, fences, sod, and other disturbed surfaces for a period of 3 months thereafter. The Contractor shall main-

tain for 1 year after certification of completion areas that have been repaved and curbs, gutters, and sidewalks that have been replaced. All material and labor required for the maintenance of the trench surfaces and structures shall be supplied by the Contractor, and the maintenance shall be done in a manner satisfactory to the Engineer.

#### **Sec. 21—Disinfection**

Before the pipeline is placed in service and before certification of completion by the Engineer, all new water systems, extensions to existing systems, valved sections of extensions, replacements in the existing system, and any exposed section of the existing system shall be disinfected in accordance with AWWA C601, "Disinfection of Water Mains," or to the satisfaction of the Engineer.



