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AWWA C603

Summary of Suggested Revisions

- Page 5,* 1. Eliminate the requirement for compaction of soil in 6 in. layers.
- Page 6,* 2. Add the words "to the job site" under the section covering acceptance of pipe.
- Page 7,* 3. Add the words "hoists, or other acceptable methods" in the section covering pipe handling.
- Page 14,* 4. Remove the requirement for withdrawing sheeting in 1 foot increments.
- Page 14, 16,* 5. Excavation of the trench has been rewritten to include OSHA construction standards for safeguarding the workers and general public.
- Page 18,* 6. Reference to the "unified soil classification system" is made.
- Page 20,* 7. The "unified soil classification" system is referenced to specify the types of soils required for bedding.
- Page 17,* 8. "Compacted" (as previously defined) bedding must be placed under pipe laying on earth mounds.
- Page 16,* 9. Water must be prevented "at all times" during pipe installation.
- Page 2, 24,* 10. The subject of protective clothing is adequately covered in Manual M16 which has been made part of the "Work Practices" section of this guide by reference.
- Page 37,* 11. The words "cables or other devices approved by the Engineer" have been added in the section covering thrust blocking.
- Page 41,* 12. The subject of pipe filling and air venting has been covered in great detail.
- Page 17,* 13. A recommendation has been made that pipe should be installed with the coupling hole method unless otherwise specified by the Engineer.
- Page 2, 24,* 14. Manual M16 "Work Practices for Asbestos-Cement Pipe" has been incorporated by reference.
- Page 31, 32,* 15. It is recognized that pipe spigots may be pushed or pulled into their couplings depending on the method used by the contractor.

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Page Two

- Page 37, 16. "Thrust blocking shall not block hydrant drain holes" has been added to the section discussing thrust blocking.
- Page 37, 17. Dead ends shall be provided with a blow-off assembly.
- Page 7, 18. Since pipe cannot "impact on itself," this section has been reworded. A cautionary note has been added to keep moving of pipe and materials to a minimum to prevent damage.
- Page 38, 19. The requirement for "hand placed" backfill has been deleted.
- Page 42, 20. A statement has been added to require maintaining filling pressure for 24 hours in order to expell air from pockets in couplings.
- Page 21, 21. Reference to AWWA C401 and C403 has been eliminated, and reference is made to bedding classes described in WPCF Manual of Practice No. 9.
- Page 6, 22. Recommendations for storage of rubber gaskets have been included. A further recommendation to limit pipe storage height has not been made as it was thought to be unnecessary.
- Page 2, 24, 23. AWWA Manual No. M16 "Work Practices for Asbestos-Cement Pipe" has been incorporated by reference.
- Page 33, 24. This recommended change has not been acted upon because
- a. Are poured joints still in use? If not, eliminate entire Section 7.3.3.
 - b. The material space requirement needs further discussion.
- Page 31, 25. An adequate discussion of pipe assembly is included in Section 7.3.
- Page 43, 26. Whether or not the installation requires backfilling prior or after testing depends on the Engineer's requirements.
- Page 51, 27. A section on service connections has been added.
- Page 31, 28. A cautionary note regarding the correct size and type of gasket has been added.
- Page 32, 29. Recommendation to apply lubricant to the ring and spigot has been included.
30. All dimensions and pressures have been stated in the English and metric systems.

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Page Three

- Page 41, 31. To aid in venting of air from lines being initially filled, a recommendation to fill from the low point of the line has been added.
- Page 41, 32. The reason for requiring very slow pipe line filling has been stated for the benefit of the Contractor.
- Page 42, 33. Filling rates for various pipe sizes have been included to aid the Contractor.
- Page 42, 34. Since air will not move to lower elevations, when it is necessary to fill from high elevations where air and water will move opposite of each other, line filling rates of one half of those listed in Table I are recommended.
- Page 43, 35. A recommendation to limit the length of a section under test to approximately 3,000 feet has been added.
- Page 43, 36. The importance of removing all air from the pipe line is emphasized.
- Page 44, 37. Suitable and unsuitable air vents are discussed.
- Page 45, 38. A recommendation to monitor the amount of water required to raise line pressure is made. This will give a good indication of the amount of air that may still exist in the pipe line during testing.
- Page 49, 39. The recommended method for computing the leakage rate has been added.
- Page 31, 40. Attention is drawn to the fact that "the gasket is properly installed and seated in the ring groove" (i.e. the gasket is not reversed, etc.).
- Page 25, 41. Pipe cutting methods must produce a smooth, square cut.
- Page 37, 42. All valves (in-line or other) must be tied down and anchored.
- Page 45, 43. The comment that testing at design pressure x 1.5 results in a safety factor of 1.3 is not correct. The safety factor of the pipe lines is not affected by the pipe line's test pressure. This comment was therefore not included in the revision.
- Page 41, 44. The entire section on pipe line filling has been rewritten.
- Page 5, 45. The requirement for compaction is 6 in. layers has been eliminated.
- Page 51, 46. The fact that the piping system must be disinfected and flushed has been included.

5/3/83

CAPCO JEN 0021129

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AWWA STANDARD
for
INSTALLATION OF ASBESTOS-CEMENT PRESSURE PIPE

1. Scope

- 1.1 This guide describes the methods of installing Asbestos-Cement (A/C) Pressure Pipe and Fittings to utilize the material's performance properties to the fullest advantage.
- 1.2 Included are suggestions for storing, handling, and transporting pipe, trench excavation, pipe embedment, recommended work practices, assembly and installation, backfill placement and field testing of installed pipe and fittings in pipelines.
- 1.3 This guide is not intended to supply design information nor to assume the responsibility of the Engineer in establishing procedures to attain satisfactory performance best suited to individual job conditions. A thorough review of this guide is recommended as a basis for supplementing it, as appropriate, with conditions and/or requirements of the Owner and/or Engineer.

2. Applicable Documents

2.1 Plans and Specifications - Plans and specifications for the specific project, as prepared and issued by the Engineer and/or Owner, are the primary documents that specify materials to be used, strength classifications, and all other project conditions.

2.2 AWWA Standards

AWWA C400 Standard for Asbestos-Cement Distribution Pipe, 4 Inch (100 mm) through 16 Inch (400 mm)

AWWA C401 Standard Practice for Selection of Asbestos-Cement Distribution Pipe, 4 Inch (100 mm) through 16 Inch (400 mm)

AWWA C402 Standard for Asbestos-Cement Transmission Pipe, 18 Inch (450 mm) through 42 Inch (1050 mm)

AWWA C403 Standard Practice for the Selection of Asbestos-Cement Transmission and Feeder Main Pipe, Sizes 18 Inch (450 mm) through 42 Inch (1050 mm)

AWWA C601 Standard for Disinfecting Water Mains

AWWA M16 Work Practices for Asbestos-Cement Pipe

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2.3 Other Documents

AASHTO T-99 Standard Method of Test for Moisture-Density Relationships for Soils

ANSI A21.11 Rubber Gasket Joints for Cast Iron and Ductile Iron Pressure Pipe and Fittings

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ASTM B29 Specifications for Pig Lead

OSHA Construction Standards and Regulations, U. S.

Department of Labor, Occupational Safety
and Health Administration

3. Terminology

Under this guide, the following descriptions of terms shall apply:

- 3.1 Owner - The person, firm, corporation, or government agency entering into contract with the Contractor for the installation of the asbestos-cement pipe and accessories.
- 3.2 Engineer - The person, firm, corporation, or government agency acting for the Owner as his duly authorized agent in the designing and engineering of the project.
- 3.3 Inspector - An authorized representative of the Engineer, or Owner, assigned to make any and all necessary inspections of the work performed, including materials and equipment furnished.
- 3.4 Contractor - The person, firm or corporation entering into the contract or agreement with the Owner for the installation of asbestos-cement pipe and accessories in accordance with the Owner's or Engineer's plans and specifications.
- 3.5 Plans and Specifications - Documents prepared by the Engineer and/or Owner stipulating work to be done and materials to be used, which combined with this guide and other contract documents form the basis for a comprehensive contract between the Owner and the Contractor.

- 3.6 Package Unit - Several units of asbestos-cement pipe bound together for the purpose of being transported and, when desired, unloaded at the job site.
- 3.7 Compacted Backfill - Backfill material which has been compacted to not less than 90 percent standard density as defined in AASHTO T-99.

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4. Acceptance, Storage, Handling and Transportation

4.1 Acceptance

4.1.1 At the time of delivery to the job site, all material shall be examined for defects and damage, and any defective or damaged material shall be rejected and removed from the job site. (2)

4.1.2 Replacement of Damaged or Defective Pipe - Material that is supplied by the owner and is rejected at the point of delivery due to defects or damage shall be replaced by the owner.

Material that is supplied by the contractor and is rejected at the point of delivery due to defects or damage shall be replaced by the contractor.

Material damaged subsequent to acceptance by the contractor shall be replaced by the contractor.

4.2 Storage - The interior of all pipe, couplings, rings, fittings, and other accessories shall be kept free from dirt and other foreign matter at all times. Rubber gaskets should be stored in their original container and kept away from oil and grease, direct sunlight, excessive heat, and should be stored away from electrical motors which produce ozone and away from areas where the temperature exceeds 150° F. (22)

4.3 Handling of Pipe and Accessories - At all times material should be handled with care to avoid damage. Whether moved by hand, skidways, hoists, or other acceptable method, material should not be thrown, dropped, dragged, bumped or allowed to impact on objects which may cause damage. Moving pipe and materials should be held to a minimum to reduce the possibility of damage.

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4.3.1 Unloading - The method by which the pipe is unloaded from the transporting vehicle (railroad car or truck) is the decision and responsibility of the receiver. The preferred way of unloading is in package units using mechanical equipment. However, the pipe can be unloaded individually. Before unloading the pipe and materials, it is necessary to have enough help and equipment on hand to properly handle the load. When unloading the package units using mechanical equipment, the following instructions should be carefully observed.

4.3.1.1 Position the transporting vehicle loaded with pipe in a level spot, making sure there is sufficient area for maneuvering the mechanical equipment used in unloading. The transporting vehicle should be at a complete stop with brakes engaged and the wheels securely chocked with blocks.

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4.3.1.2 Examine the load and make certain the package units are intact. Examine for any load shifts and broken braces or stops. Correct as necessary to prevent pipe from falling. If any evidence of broken or damaged material is found, it should be noted on the Bill of Lading or delivery slip.

4.3.1.3 With assurance that the transporting vehicle is secure, the unloading operation can begin by removal of chain bindings and protective pads.

4.3.1.4 Using a fork lift or front end loader equipped with forks, remove only the number of package units and length of the fork arms will accommodate or the equipment can safely handle. Begin by unloading the package units on the top and rear of the vehicle.

4.3.1.5 When a crane and slings are used to unload package units, a channel iron spreader is required to keep the pipe unit intact and prevent damage to the pipe.

No attempt should be made to transport pipes at the job site while the pipe is slung on the boom of a crane.

4.3.1.6 It is preferable that pipe package units be stored and placed on level ground. The package units should not be stacked more than one unit high. Package units on the ground must be protected by dunnage just as they were when loaded on the vehicle.

4.3.1.7 When unloading individual pieces of pipe from a truck, the following instructions should be carefully observed:

4.3.1.7.1 Bring the truck to a complete stop on level ground. Place supports of ample size on level ground so that the pipe will be resting on the supports and not the ground.

Supports should be placed about $1/5$ of the length of the pipe in from each end.

4.3.1.8 Hand-passing (without ropes and skids) should only be used on small sizes of pipes. As a general rule, 75 lbs. (34 kg) is enough weight for one man to handle safely and repeatedly. Therefore, two men, one at each end, can pass pipes weighing up to 150 lbs. (68 kg). Pipes heavier than 150 lbs. (68 kg) should be lowered with ropes and skids or with mechanical equipment.

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4.3.1.9 Ropes and skids can be used to unload single lengths of pipe from trucks and railroad cars. When unloading by this method, care must be taken to lower the pipe all the way down the skid and prevent it from rolling free in any part of its travel. Care must also be taken to keep all workmen out of the path of the pipe as it comes down the skids. Lower one pipe length at a time. Be careful not to drop or bump the pipe ends together.

4.3.1.10 When unloading individual pipe with a crane, a sling which prevents the pipe from slipping must be used. A continuous length of cable or pipe tongs fastened around the center of the pipe is

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recommended for all sizes of pipe.
Large pipe, 10 inches (250 mm) in
diameter and above, may be hoisted
with a tight sling or pipe tongs. It
is not recommended that the pipe be
unloaded or handled by pipe hooks
that are placed inside the pipe ends.

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4.4 Loading Transfer Trucks - When it is necessary to transfer pipe from one area to another after it has been unloaded from the original transporting vehicle, the following should be observed in loading the transfer truck:

- 4.4.1 Use flat, stake-bodied trucks to permit side loading and unloading. The length of the truck bed should be sufficient to support the pipe along its full length. Do not allow the pipe to project beyond the end of the truck.
- 4.4.2 When loading the package units, inspect them for any broken bands or supports. Repair as necessary before loading them, and make sure the pipe is resting on the timbers provided and not directly on the floor of the truck bed.
- 4.4.3 Prior to loading individual pieces of pipe on the floor of the transfer truck, lay two timbers for each tier of pipe with the timbers spaced in

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the same manner as on the factory delivered load.
this will prevent damage to the pipe by bolt heads
or an uneven floor on the truck bed.

4.4.3.1 The pipe should be stacked on the
transfer truck in the same manner
as it was unloaded and in the same
configuration as the original shipment
from the factory. Any chock blocks that
may have been removed during unloading
should be replaced in the reloading.

4.4.4 The load on the transfer truck must be thoroughly
secured. Two chains and load binders should be used
for each load of pipe. Padding must be placed under
the chain at points where the chain binds on the pipe.
The chains must be located within 4 inches (100 mm) 30
of the supporting timbers. DO NOT place chains in
the middle of the stack. DO NOT use a pipe or other
extension to increase the leverage on the binder.

4.5 Stringing the Pipe - It is not absolutely necessary to
distribute the pipe along the trench before the trench
is opened, although many contractors prefer to do so
since this procedure reduces future pipe-handling time
to a minimum.

- 4.5.1 When pipe is strung along the line of the work, it should be placed so that there is adequate room to perform the necessary excavating and other related functions. The pipe should be placed so as to protect it from traffic and heavy equipment. The pipe should also be safeguarded from the effect of any anticipated blasting that may be done.
- 4.5.2 If the trench is open, the pipe should be strung on the side away from the excavated earth, whenever possible, so that the pipe can be moved safely and easily to the edge of the trench for lowering into position.
- 4.5.3 If the trench is not yet open, a decision has to be made as to which side the excavated earth will be placed. Then the pipe should be strung out on the opposite side of the trench.

5. Preparation of Trench

5.1 Excavation - The trench should be excavated to the specified alignment, depth and width with any deviations approved by the Engineer. Excavation of trenches should be completed in strict conformance with OSHA Construction Standards and Regulations, Part 1926, Subpart P, on Excavations, Trenching and Shoring, or other applicable national, state or local regulations. (5)

5.1.1 Sheet piling and Shoring - Trench sheet piling and shoring should be in conformance with all national, state and local regulations for the protection of workmen.

5.1.1.1 Where sheet piling or shoring is removed, all voids resulting should be filled in a manner specified by the Engineer. This is done to insure adequate lateral support of the pipe. (4)

5.1.2 Movable Trench Boxes - Movable trench boxes should be in conformance with all national, state and local regulations for the protection of the workmen. They should be of sufficient width and length to insure the proper installation and bedding of the pipe. Care should be taken by the Contractor not to disturb the pipe or the bedding between the pipe and the walls of the trench when moving the box forward.

5.1.3 Blasting - Blasting for excavation should be undertaken only after securing all required approvals and permits. Blasting operations, including protection of persons and property, should be in strict accordance with national, state and local regulations.

5.2 Protection of Property - Trees, shrubs, fences, and all other property and surface structures should be protected during construction unless their removal is shown in the plans and specifications or approved by the Engineer.

5.2.1. Provide temporary support, adequate protection, maintenance of all underground and surface structures, water mains, drains, sewers, and other obstructions encountered in the progress of the work.

5.2.2 All properties that have been disturbed should be restored as nearly as practical to their original condition.

5.3 Traffic Safety - Appropriate traffic control devices should be provided in accordance with national, state, or local regulations to regulate, warn, and guide traffic at the work site.

- 5.4 Any structure, electrical cable, or pipeline found during excavation and ~~is~~ unaccounted for in the plans and specifications should be reported to the Engineer and indicated on the "as-built" drawings.
- 5.5 Survey Monuments - Survey monuments in the path of construction should be preserved.
- 5.6 Limitation of Advance Excavation - Trench excavation should proceed in advance of pipe installation only as far as stated in the plans and specifications or only as far as required for safe pipe installation, the shortest of the two distances governing.
- 5.7 Dewatering - The trench should be kept free of water at all times during pipe installation. Discharge from any trench dewatering apparatus should avoid damage to adjacent properties. (9)
- 5.8 Excavated Material - Excavated material should be placed in a safe location and in a manner which will not obstruct the construction work. (5)
- 5.9 Pavement Removal - Removal of pavement and road surfaces should be a part of the trench excavation. The amount removed should depend upon the width of trench required for the installation of the pipe. The dimensions of pavement removed should exceed the dimensions of the

opening required for pipe installation by 6 inches (150 mm) in all directions unless otherwise specified and approved by the Engineer. Established procedures and methods such as sawing, drilling, or chipping should be used wherever possible to ensure the breakage of pavement along straight lines.

5.10 Width of Trench - The width of the trench at the top of the pipe is critical in selection of the proper class of pipe and must conform to the details of the plans and specifications.

5.11 Preparation of Trench Bottom - The trench should be prepared for the direct and proper placement of the pipe. This includes digging coupling holes for installations where the pipe is laid on the trench bottom (the recommended method), or placing properly prepared earth mounds only when this type of installation is specified by the Engineer.

Note: Earth mounds have been used in some geographical areas with success. However, if this method is used, particularly with pipe under 12 in. diameter, caution shall be exercised to ensure that

- (1) proper clearance is maintained between the pipe or coupling and the trench bottom, and
- (2) after pipe placement, the earth is properly placed beneath the entire length of the pipe, including the coupling, and compacted to a uniform density.

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5.11.1. Pipe Foundation

5.11.1.1 All parts of the trench below grade should be backfilled to grade with thoroughly compacted granular material approved by the Engineer to a minimum of 70% Relative Density, or 90% Proctor.

5.11.1.2 When the subgrade is found to include ashes, cinders, refuse, organic material, or other unsuitable material, such material should be removed and replaced with clean, stable, thoroughly compacted suitable granular backfill material. The bedding should be consolidated and leveled in order that the pipe may be installed in accordance with the required bedding type in Section 5.11.2. (6)

5.11.1.3 When an unstable subgrade condition is encountered, a sufficient depth of unstable material should be excavated

and refilled with well compacted, suitable granular material of such size so as to stabilize the pipe foundation. It is important that this foundation be capped with granular material of such depth as to assure the pipe is not subjected to point loading conditions.

5.11.1.4 When the bottom of the trench or subgrade is found to consist of material that is unstable to such a degree that in the judgment of the Engineer it cannot be stabilized, a foundation for the pipe and/or appurtenances should be constructed using piling with timber or concrete bridging or by other methods as may be directed by the Engineer.

5.11.2 Pipe Bedding

5.11.2.1 Embedment Material - All embedment material should be free from organic material, boulders, frozen soil, or other material that in the opinion of the Engineer is unsuitable for

backfill. The embedment material should meet the requirement of Class I, II, or III as defined in the Unified Soil Classification System (USCS) of Method D2487 for Classification of Soils and as specified by the Engineer. ⑦

Special care should be exercised in selecting material for embedment, i.e., for bedding, haunching and initial backfill, because the embedment material and its placement are important considerations in assuring that the pipe will satisfactorily resist trench loading conditions during construction and after the pipeline is completely installed. The embedment material should be thoroughly compacted under, around and over the pipe.

5.11.2.2 Bedding - It should be recognized that the conditions under which the pipe is placed on the trench bottom (bedding) and the backfilling around the pipe is critical in assuring the

structural integrity of the pipe lines. It is, therefore, imperative that in the installation of the pipe, the Contractor follow the types of bedding as detailed by the Engineer in the plans and specifications, which shall be in accordance with either Class A, Class B, or Class C bedding described in WPCF Manual of Practice No. 9. (21)

Note: As shown in WPCF Manual of Practice No. 9, Class D is impermissible bedding and not recommended. This guide concurs with that position and does not recommend flat bottom Class D bedding.

5.11.2.3 Before the pipe is lowered into the trench, a coupling hole should be excavated with sufficient length, width and depth to permit pipe assembly and provide a minimum clearance of 2 inches (50 mm) below the coupling.

5.11.2.4 The pipe should be provided with continuous support between coupling holes. (Note: Use of approved granular material for bedding is recommended as a preferred method of preparing the trench bottom for pipe installation.)

5.12 Rock Conditions - When rock is encountered during excavation, all rock should be removed to provide a clearance of at least 6 inches (150 mm) below and on each side of all pipe fittings for pipe diameters 24 inches (600 mm) or smaller, and 9 inches (225 mm) for pipe diameters 27 inches (675 mm) and larger. When excavation is completed, a bed of sand, crushed stone, or earth that is free from organic material, rocks and clods larger than one inch (25 mm), or frozen earth, should be placed on the bottom of the trench to the previously mentioned depths, leveled and thoroughly compacted. IT MUST BE STRESSED THAT THOROUGH COMPACTION OF THE BEDDING MATERIAL IS ESSENTIAL TO ELIMINATE THE CONDITION OF POINT LOADING OR BEAM LOADING.

5.12.1 The above-designed clearances and bedding procedures should also be observed for pieces of concrete or masonry and other debris or subterranean structures, such as, masonry walls, piers, or foundations that may be encountered during excavation.

5.12.2 These bedding procedures should be followed when gravel formations containing loose boulders greater than 3 inches (75 mm) in diameter are encountered.

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5.12.3 In all cases, the specified clearances and bedding conditions should be maintained between the bottom of all pipe and appurtenances and any projection, point of rock, boulder, or stone of sufficient size and placement which, in the opinion of the Engineer, could endanger the integrity of the completed pipeline.

5.13 Previous Excavations - Should the trench pass over a pipeline or other previous excavation, the trench bottom should be sufficiently compacted to provide support equal to that of the native undisturbed soil, and the compaction effort should be performed in such a manner that will prevent damage to the existing installation. If necessary, material previously excavated should be spoiled and replaced with suitable material.

6. Recommended Work Practices for A/C Pipe¹

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6.1 Airborne asbestos fiber has been identified as a possible health hazard. Experience has shown that minimizing exposure to airborne asbestos dust is the only effective method of preventing asbestos-related diseases. Recommended work practices are the best assurance of controlling worker exposure and complying with national, state, and local occupational safety and health regulations governing exposure to airborne asbestos. Permissible exposure levels have been established by OSHA for an eight-hour time weighted average (TWA) exposure and for upper limit concentrations. Tests² have shown that the work practices recommended herein minimize worker exposure and do not produce asbestos levels in excess of existing OSHA regulations.

¹Work practices for asbestos-cement water pipe as described in AWWA No. M16, American Water Works Association. The content of Section 6 of this standard and AWWA M16 are consistent.

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²Reports prepared by Equitable Environmental Health, Inc., "Asbestos Exposure During the Cutting and Machining of Asbestos-Cement Pipe," March 1977, and "Dust Exposure During the Cutting and Machining of Asbestos-Cement Pipe - Additional Studies," December 1977.

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6.2 A/C pipe is shipped clean from the factory and carefully loaded using methods acceptable to the carrier. Loading, unloading, stringing out and assembling A/C pipe are essentially dust-free operations. Even in enclosed spaces, airborne asbestos fiber levels from pipe handling operations are far below existing and proposed occupational standards. All hand and mechanical unloading operations should be carried out in accordance with the manufacturer's installation manuals and as noted in Sections 4 and 7 of this standard.

6.3 Cutting - Pipe cutting methods which produce a smooth, square cut end shall be employed. (41)

6.3.1 Carbide Equipment - Blade cutters consist of a frame adjustable to the circumference of the pipe and a number of outboard, self-tracking rollers that align one or more carbide-tipped cutting blades. Blade cutters are typically hand-operated. Due to the relatively low mechanical input and clean cutting action, significant amounts of airborne asbestos dust are not produced.

6.3.2 Snap Cutting Equipment - Snap cutters or "squeeze and pop" equipment operates by means of cutting wheels mounted in a chain wrapped around the pipe barrel. Hydraulic pressure, applied by means of a remote electric or manually-operated pump, simultaneously squeezes the cutting wheels into the pipe wall until the cut is made.

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6.3.3 Abrasive Disc, Dry - Power driven saws with abrasive disc (masonry blades) should not be used for dry cutting or beveling asbestos-cement pipe. Abrasive disc cutters produce concentrations of airborne asbestos dust which exceed OSHA permissible levels. THIS WORK PRACTICE IS THEREFORE SPECIFICALLY NOT RECOMMENDED.

6.4 Machining

6.4.1 Field Lathe, Manual - Manual field lathes are designed to end-trim and re-machine rough pipe barrels to factory-machined end profiles. The lathe consists of an adjustable, self-aligning arbor inserted into the pipe bore (which acts as a mandrel upon which the turning handle operates), a screw-fed turning frame, carbide machining blade and manual (hand or ratchet) turning handles.

6.4.2 Field Lathe, Power - Power field lathes, like manual lathes, are designed to end-trim and re-machine rough pipe barrels to factory-machined end profiles. The lathe consists of an adjustable, self-aligning arbor inserted into the pipe bore (which acts as a mandrel upon which the turning handle operates), a screw-fed turning frame, carbide machining blades and electric or pneumatic power drive.

6.4.3 Rasp, Manual - Short lengths of A/C pipe (MEE's and MOA's) can be cut for pipe closures, repairs and to locate fittings exactly. Field cut ends may be rebeveled with a coarse wood rasp to form a taper approximating the same profile as the factory-beveled end.

6.5 Hole Cutting

6.5.1 Shell Cutters - For field connections into A/C pipe, clean, even entry cuts may be accomplished by means of shell cutting equipment. Shell cutters consist of a hole cutter housing mounted on the pipe, a carbide or diamond-tipped hole cutter and a manual ratchet, pneumatic, electric or gasoline drive to power the cutting head. When cutting holes in A/C pipe products, all dust and cuttings should be removed from the interior after the cutting operation. Removal may be accomplished by flushing with water, wet mopping or vacuuming prior to placing in service. DO NOT BLOW OUT WITH COMPRESSED AIR OR DRY SWEEP.

6.5.2 Drill and Rasp - Field connections may be made with a heavy duty electric drill and rasp. Using a carbide-tipped drill, a series of closely-spaced holes are first drilled around the hole outline. The disc is knocked free with a hammer and the

edges of the hole are dressed with a coarse wood rasp. When cutting holes in A/C pipe products, all dust and cuttings should be removed from the pipe or duct interior after the cutting operation. Removal may be accomplished by flushing with water, wet mopping or vacuuming prior to placing in service. DO NOT BLOW OUT WITH COMPRESSED AIR OR DRY SWEEP.

- 6.5.3 Hammer, Chisel and Rasp - Holes may be cut into A/C pipe with a hammer and chisel. The edge of a plumber's wood chisel is used to cut completely around the hole outline, about 0.25 inches (6 mm) from the prescribed line. The operation is repeated and the cut deepened until through. The edges of the hole are then dressed with a coarse wood rasp. When cutting holes in A/C pipe products, all dust and cuttings should be removed from the interior after the cutting operation. Removal may be accomplished by flushing with water, wet mopping or vacuuming prior to placing in service. DO NOT BLOW OUT WITH COMPRESSED AIR OR DRY SWEEP.

6.6 Coupling Removal

- 6.6.1 Hammer and Chisel - Replacement of damaged pipe necessitates excavation, exposure and removal. Coupling removal may be accomplished by gradually

splitting the coupling lengthwise, using a chisel and ball-peen hammer. After the top of the coupling has been split, a crowbar or similar tool is used as a lever to split the bottom of the coupling.

6.7 Housekeeping and Waste Disposal

6.7.1 Housekeeping is an important part of any safe construction operation. It is even more essential when airborne dust created by the lack of good housekeeping has the potential for harm to employees or others.

6.7.2 Equipment - All external surfaces of equipment should be maintained free of dust accumulations that might, if dispersed, create asbestos fiber concentrations above permissible exposure limits.

6.7.3 Waste Disposal

6.7.3.1 Asbestos-cement chips and cuttings from the field operations described in this section should be disposed of in a manner that will not contribute airborne asbestos dust to the atmosphere. Where cutting and machining operations are performed at the construction site, the chips should be placed in the trench and buried with the pipeline.

6.7.3.2 Where operations are performed at a central location such as a contractor's or distributor's yard on a more or less continuing basis, the chips and cuttings may be collected and mixed wet with cement and made into non-friable forms. These forms may be used in the trench as supports for cast iron fittings and valves, as appropriate. Otherwise, chips and cuttings should be collected in sealed bags or closed containers impermeable to asbestos dust. Loose material should never be dry swept. When vacuum equipment is available, it should be used. Water or other dust suppressants should be applied in those circumstances where sweeping is unavoidable. DO NOT BLOW WASTE MATERIAL WITH COMPRESSED AIR.

6.7.3.3 No visible emissions to the atmosphere may result from the collection, processing, packaging, transporting or deposition of any asbestos-containing material. Wastes should be disposed at a site operated in accordance with the requirements or applicable national, state or local laws.

7. Pipe Assembly

7.1 Inspection of Material - All pipe, couplings, fittings and accessories should be inspected for damage and other defects immediately prior to installation. Defective materials should be conspicuously marked and removed from the job site.

7.2 Lowering Pipe into Trench - All pipe, couplings and fittings should be lowered carefully into the prepared trench in such a manner as to prevent material damage. Proper implements, tools and facilities should be provided and proper procedures followed for the safe and convenient performance of the work.

7.3 Pipe Joints

7.3.1 Push-on Joints - The push-on joint is a single rubber-gasket joint. It shall be assembled by positioning a continuous rubber ring gasket in the annular groove in the fitting bell and pushing or pulling the machined pipe end into the bell. A lubricant approved by the pipe manufacturer must be used. Care should be taken to ensure obtaining the correct size and type of gasket for the fitting bell and the gasket is properly installed and seated in the ring groove. The pipe joint must not be deflected either vertically or horizontally beyond the limits recommended by the manufacturer.

7.3.1.1 Pipe Cleanliness - Foreign material should be removed from the pipe interior prior to laying. Pipe ends, coupling grooves, and gaskets should be thoroughly cleaned prior to jointing.

7.3.1.2 Lubrication of Pipe Ends, Couplings, and Gaskets - Only lubricants which have been approved by the pipe manufacturer should be used to join the pipe sections. The approved lubricant should be applied to the entire circumference of the machined end of the pipe/ and the rubber gasket in the coupling (29) Under no circumstances should the machined surface of the pipe end be left dry and unlubricated prior to jointing. Improper or inadequate lubrication may cause difficulty in properly jointing the pipe sections.

7.3.1.3 The manufacturer's installation instructions should be carefully and strictly followed. After concentric alignment of pipe and coupling, proper insertion of the gasket, and thorough lubrication, jointing is (15) completed by simply pushing or pulling the pipe end into the coupling. A bar and block or pipe puller are the preferred methods for assembling asbestos-cement pipe. When using the bar and block method, the bar is inserted into the ground at the pipe end away from the jointing, the block of wood insterted between

the bar and the pipe end to protect the pipe against damage and the pipe pushed "home" using the leverage of the bar.

7.3.1.4 For larger diameter pipes, the pipe may be suspended. The free end of the pipe should be no more than one inch above the bedding material in the trench. The bar and block method should be used for assembling the pipe.

7.3.2 Mechanical Joint - The mechanical joint is a bolted joint of the stuffing box type. In some sizes and classes, an adaptor is required between the asbestos-cement pipe and the mechanical joint. The joints shall conform to the current revision of ANSI A21.11 (AWWA C111), "Rubber-Gasket Joints for Cast-Iron and Ductile-Iron Pressure Pipe and Fittings," and shall be assembled as required in Appendix A, Notes on Installation of Mechanical Joints, of that standard.

7.3.3 Poured Joints

7.3.3.1 The yarning or packing material shall be as specified by the engineer. It shall consist of molded rubber rings. Asbestos rope or treated paper rope may be used only with the approval of the engineer

when the space between the bell and spigot will not permit the use of a rubber ring.

7.3.3.2 The yarning material shall be placed around the spigot of the pipe and shall be of proper dimensions to center the spigot in the bell. When the spigot is shoved home, the yarning material shall be driven tightly against the inside base or hub of the bell with suitable yarning tools.

7.3.3.3 When a single strand of yarning material is used, it shall have an overlap at the top of not more than 2 in. ^(50 mm) When more than a single strand is required for a joint, each strand shall be cut to sufficient length so that the ends will meet without causing overlap. The ends of the strands shall meet on opposite sides of the pipe and not on the top or at the bottom. Successive strands of yarning material shall be driven home separately.

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7.3.3.4 Lead-joint bells shall provide a jointing material space of not less than $2\frac{1}{4}$ in. ^(58 mm) for pipe of 20 in. ^(500 mm) diameter and smaller and $2\frac{1}{2}$ in. ^(63 mm) for pipe 24-42 in. ^(600-1050 mm) in diameter. (30)

7.3.3.5 Lead for caulking purposes shall meet the current requirements of ASTM B29, "Standard Specifications for Pig Lead, in the Common Desilverized Grade."

7.4 Pipe Fittings

7.4.1 Pipe fittings can be installed in the pipeline at any location designated in the plans and specifications, employing the same assembly techniques used for individual pipe lengths. The location of fittings can be facilitated by using pipe half-lengths or quarter-lengths as determined by the Contractor. Generally, exact fitting placement can be accomplished by a combination of full pipe lengths and one or more half or quarter lengths of pipe. Alternately, the length of pipe required for fitting placement can be cut and machined at the job site using work practices recommended in Section 6 of this guide.

7.4.2 Where factory fittings cannot be used, branch connections can be made by cutting a hole in the installed pipe and using factory manufactured adaptors. All work and materials should conform to the pipe manufacturer's recommendations and the work practices recommended in Section 6 of this guide.

7.4.3 Tees - Tees should be installed and supported in accordance with the plans and specifications.

7.4.4 Connections to Rigid Structures

7.4.4.1 Where the pipe barrel is connected directly to a rigid structure, the length of pipe section extending beyond the rigid structure should not exceed 3 ft. 3 in. ^(99cm) for pipe diameters of 8 in. and smaller, or 6 ft. 6 in. ^(198cm) for pipe diameters of 10 in. ^(250mm) and longer. At least one flexible joint shall be used between two adjacent rigid joints. 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.

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7.4.4.2 The precautions listed above for pipe connections to rigid structures are based on the strength characteristics of the pipe, acceptable bedding, back-filling and tamping practices.

7.5 Reaction or Thrust Blocking

A reaction or thrust block shall be provided at each hydrant, valve, bend, and tee, and at reducers or fittings where changes in pipe diameter occur. They shall be centered on the longitudinal axis and extended to solid undisturbed ground. Hydrants may be tied to the water main with rods, cables, or other devices approved by the Engineer.

The size and shape of thrust blocks or the number and size of rods or cables shall be as shown on the drawings or as specified in the supplementary specifications. Thrust blocking shall not block hydrant drain holes.

7.6 Plugging of Dead Ends

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 blow-off assembly shall be provided at all dead ends. A reaction or thrust block (see 7.5) shall be required at all dead ends.

8.3 Final Backfill

- 8.3.1 The final backfill material, usually placed by machine, need not be as carefully selected as the initial backfill material. However, care should be taken to avoid the backfilling with large stones which might damage the pipe by free fall or subsequently be forced down onto the pipe. This precaution is particularly important when the couplings are left exposed during backfilling. Trenches should be inspected to detect and remove stones which may have fallen in before backfilling. Frost penetration is a possibility whenever the backfill includes extremely stony material.
- 8.3.2 When the type of final backfill material is not indicated in the plans and specifications, clean excavated soil, free of large stones, may be used.
- 8.3.3 The final backfill should be carefully placed and spread in uniform layers so that all voids created by rocks and clods will be filled. The backfill material should be placed to the same approximate elevation over the pipe to prevent unequal loading and pipe displacement. As noted, final backfilling may be done by mechanical means in a manner approved by the Engineer.

8.4 Compaction - If the plans and specifications require that the initial and final backfill be compacted, precautions should be taken to prevent damage to the installed pipe from impact loads transmitted by the compaction equipment. Generally, 12 inches (300 mm) of earth cover over the top of the pipe will adequately protect the pipe from damage; but where there are high impact loads due to stringent compaction requirements, the initial backfill may have to be greater than 12 inches (300 mm).

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8.5 Pipe Line Flotation - When the pipe line is installed under conditions of high ground water level where the pipe may be partially or totally submerged, or if the installed pipe may be subject to flooding before the trench is completely backfilled, the Contractor should take special precautions to backfill around and over the pipe to a sufficient height to prevent flotation of the pipe and disturbance to the established line and grade.

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9. Pipe Line Filling

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9.1 Before Filling - Before the pipe line is filled with water, at least 36 hours shall elapse after the last concrete thrust or reaction backing has been cast with high early-strength cement. At least seven days shall elapse after the last concrete thrust or reaction backing has been cast with standard cement.

9.2 Filling Station - Whenever possible the pipe line shall be filled by introducing water at the lowest elevation in the pipe line.

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9.3 Air Release Vents - Provision must be made to expell air at all high points of the system and at extreme ends of the line section. Air vents shall be spaced not more than 3,000 feet (915 m) apart.

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9.4 Filling Rate - The initial filling of a pipe line is often the most critical time in the life of any pipe line. Due to the density ratio of water to air, the flow capacity of air through any oriface, such as an air release or flush valve, is approximately 29 times greater than the flow capacity of water through the same oriface. When a water column reaches such an oriface during line filling, an immediate slowdown in water column velocity occurs which creates water hammer shock waves of possibly sufficient magnitude to damage the piping system. To

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prevent damage to the pipe line, the line must be filled slowly in accordance with the maximum filling rates specified in 9.4.1 and 9.4.2.

9.4.1 When filling from the low point in the pipe line, the filling rates shall be limited to the rates shown in Table I. (33)

9.4.2 When it is necessary to fill the pipe line from the highest elevation in the system, the filling rates should be limited to 1/2 of the rates shown in Table I. (34)

TABLE I.

Diameter In. (mm)	GPM (LPM)	Diameter In. (mm)	GPM (LPM)	Diameter In. (mm)	GPM (LPM)
4 (100)	40 (151)	15 (380)	550 (2082)	27 (680)	1775 (6720)
6 (150)	90 (340)	16 (400)	625 (2366)	30 (750)	2200 (8330)
8 (200)	155 (587)	18 (450)	800 (3028)	33 (840)	2675(10125)
10 (250)	240 (908)	20 (500)	975 (3690)	36 (900)	3175(12020)
12 (300)	350 (1325)	21 (530)	1075 (4070)	39 (990)	3725(14100)
14 (350)	480 (1817)	24 (600)	1400 (5300)	42 (1050)	4325(16370)

Filling Rates for 1 FPS (.305 mps) Filling Velocity

9.5 Filling Duration - The filling operation shall continue until the entire line or line section is completely filled and a solid clear stream of water flows from all orifaces used for line flushing and venting. Prior to testing, the filling pressure should be maintained for an additional 24 hours to permit sufficient time for small air pockets at each coupling to be expelled past the rubber gaskets. (20) (42)

10. Pressure and Leakage Testing

After the trench has been properly backfilled in accordance with the Engineer's requirements and the pipe line has been initially water filled as per Section 9, the field pressure and leakage tests should be conducted on each section of the pipe line.

10.1 Length of Test Section - The length of the pipe line section to be tested should be limited to approximately 3,000 feet (915 m) wherever possible.

10.2 Air Venting - The importance of THOROUGH air venting cannot be over-emphasized. Presence of trapped air in a pipe line will cause serious flow restrictions and may cause potentially destructive water hammer surges when large pockets of air in the pipe line migrate from one location to another. Furthermore, the presence of air in the pipe lines which are being "leak tested" will tend to indicate an excessive leakage rate due to the air's ability to seep past gasketed joints which may in fact be water tight.

10.2.1 Standard water contains 2% of dissolved air by volume. Sufficient time must be allowed for this air to come out of solution, gather at the pipe line's high points, and be vented to atmosphere through appropriately located air bleed orifices. A minimum of 4 hours of continuous venting should be allowed after

the pipe line has been filled and flushed.
During this time, all air vents must remain open, and the source of water and water pressure must be maintained.

10.2.1.1 Most conventional combination air release and vacuum valves will not be suitable for continuous line venting after the initial pipe line filling.

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These valves generally close upon detecting the first presence of water during the line filling operation and will subsequently remain closed and unable to expell any additional air volumes until the pipe line pressure has been completely vented to atmosphere. Unless the pipe line contains a sufficient number of properly located continuously acting air release valves, provision must be made by the contractor to provide alternate air release orifaces such as corporation stops at each high point in the system and at least every 3,000 (915 m) feet.

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10.3 Pressure Test

10.3.1 Test Pressure - Unless otherwise specified, the test pressure for distribution pipe shall be double the operating pressure at the lowest elevation of the system, or the class designation of the pipe plus 50 psi (3.5 kg/cm^2), whichever is less. (30)
The test pressure for transmission pipe shall be the design pressure (operating pressure plus surge pressure) times $1\frac{1}{2}$.

10.3.2 Test Duration - The duration of the pressure test shall be a minimum of 1 hour. If the pressure and leakage tests are to be performed at the same time, the total time for the combined tests shall be a minimum of 2 hours.

The test shall be maintained for the specified time, during which all exposed pipe, valves, fittings, etc. shall be carefully examined.

10.3.3 The specified test pressure shall be applied by means of a pump or other device suitable to inject controlled water pressure to the pipe line in a manner that is satisfactory to the Engineer.

10.3.3.1 It is recommended that the volume of water that must be forced into the pipe line to (38)

raise the line to test pressure is carefully measured and compared to the theoretical volume required as calculated in Section 10.3.3.1.1.

If during the pressurization process the actually required water volume greatly exceeds the theoretical volume needed, the pipe line either leaks or has not been sufficiently air vented.

The cause of excessive water requirement should be determined and corrected before the test is resumed.

TABLE II

Pipe Dia.		Rate		Pipe Dia.		Rate	
Inches	(mm)	Gals/100 ft./psi	(Liters/100 m/kg/cm ²)	Inches	(mm)	Gals/100 ft./psi	(Liters/100 m/kg/cm ²)
4	(100)	.0005	(.0883)	20	(500)	.0117	2.0665
6	(150)	.0011	(.1943)	21	(530)	.0129	2.2784
8	(200)	.0019	(.3356)	24	(600)	.0169	2.9849
10	(250)	.0029	(.4416)	27	(680)	.0214	3.7797
12	(300)	.0042	(.6535)	30	(750)	.0264	4.6628
14	(350)	.0057	(1.0067)	33	(840)	.0319	5.6342
15	(380)	.0066	(1.1657)	36	(900)	.0380	6.7116
16	(400)	.0075	(1.1480)	39	(990)	.0446	7.8773
18	(450)	.0095	(1.4659)	42	(1050)	.0517	9.1313

Approximate Water Volume Required (When All Air is Expelled from Pipe Line)

Gals. to Raise Pipe Line Pressure by 1 psi for Each 100 ft. of Pipe Length

or

(Liters to Raise Pipe Line Pressure by 1 kg/cm² for Each 100 meters of Pipe Line Length)

10.3.3.1.1 To calculate approximate water volume required to raise line pressure, use the following formula and data from above Table II.

Approximate Volume = Length $\div$ 100 x Rate x (Test Pressure-Starting Pressure)

Where Volume = Gals (or Liters)

Length = Feet (or Meters)

Rate = Gals/100 ft./psi (or Liter/100 m/kg/cm²)

Pressure = psi (or kg/cm²)

EXAMPLE: A 3,000 feet long 14 in. diameter A/C pipe must be tested at 175 psi.
The initial pressure before pressurization is 50 psi.

Approximate Gallons of Water Required = 3000 $\div$ 100 x .0057 x (175-50) = 21.4

10.4 Leakage Test

10.4.1 No pipe installation will be accepted if the leakage for the section of line under test is greater than the leakage rate specified in Table III. If the leakage in any section is greater than permitted, the leak must be located, repaired, and the test repeated until the leakage rate is within the permitted allowance.

T A B L E I I I
Allowable Leakage per 100 Couplings*

Average Test Pressure at Lowest Point in Line																	
Pipe Diameter Inches mm	50 psi	75 psi	(5) ₂ kg/cm ²	100 psi	(7) ₂ kg/cm ²	125 psi	(9) ₂ kg/cm ²	150 psi	(11) ₂ kg/cm ²	175 psi	(12) ₂ kg/cm ²	200 psi	(14) ₂ kg/cm ²	225 psi	(16) ₂ kg/cm ²	250 psi	(18) ₂ kg/cm ²
	Leakage—gal/hr (Liters/hr)																
4	0.71	0.87	(3.29)	1.00	(3.79)	1.12	(4.24)	1.23	(4.66)	1.32	(5.00)	1.42	(5.37)	1.51	(5.72)	1.58	(5.98)
6	1.06	1.29	(4.88)	1.51	(5.72)	1.68	(6.36)	1.84	(6.96)	1.98	(7.49)	2.12	(8.02)	2.25	(8.52)	2.37	(8.97)
8	1.42	1.72	(6.51)	2.00	(7.57)	2.24	(8.48)	2.45	(9.27)	2.64	(9.99)	2.84	(10.75)	3.00	(11.36)	3.16	(11.96)
10	1.77	2.15	(8.14)	2.50	(9.46)	2.79	(10.56)	3.07	(11.62)	3.40	(12.87)	3.54	(13.40)	3.75	(14.19)	3.95	(14.95)
12	2.12	2.58	(9.77)	3.00	(11.36)	3.35	(12.68)	3.68	(13.93)	3.96	(14.99)	4.24	(16.05)	4.52	(17.11)	4.74	(17.94)
14	2.48	3.01	(11.39)	3.50	(13.25)	3.91	(14.80)	4.28	(16.20)	4.62	(17.49)	4.96	(18.77)	5.26	(19.91)	5.50	(20.82)
16	2.83	3.44	(13.02)	4.01	(15.18)	4.47	(16.92)	4.89	(18.51)	5.27	(19.95)	5.68	(21.50)	6.00	(22.71)	6.32	(23.92)
18	3.18	3.87	(14.65)	4.52	(17.11)	5.02	(19.00)	5.52	(20.89)	5.93	(22.45)	6.37	(24.11)	6.75	(25.55)	7.11	(26.91)
20	3.54	4.30	(16.28)	5.00	(18.93)	5.58	(21.12)	6.12	(23.16)	6.58	(24.91)	7.08	(26.80)	7.51	(28.43)	7.90	(29.90)
21	3.73	4.54	(17.18)	5.24	(19.83)	5.88	(22.26)	6.40	(24.22)	6.92	(26.19)	7.42	(28.08)	7.86	(29.75)	8.28	(31.34)
24	4.24	5.16	(19.53)	6.00	(22.71)	6.69	(25.32)	7.34	(27.78)	7.91	(29.94)	8.50	(32.17)	9.01	(34.10)	9.47	(35.84)
27	4.77	5.83	(22.07)	6.74	(25.51)	7.56	(28.61)	8.23	(31.15)	8.90	(33.69)	9.54	(36.11)	10.12	(38.80)	10.06	(40.35)
30	5.30	6.45	(24.41)	7.51	(28.43)	8.37	(31.68)	9.18	(34.75)	9.88	(37.40)	10.62	(40.20)	11.26	(42.62)	11.84	(44.81)
33	5.83	7.13	(26.99)	8.24	(31.19)	9.25	(35.01)	10.06	(38.08)	10.88	(41.18)	11.67	(44.17)	12.36	(46.78)	13.02	(49.28)
36	6.37	7.75	(29.33)	9.01	(34.10)	10.07	(38.11)	11.02	(41.71)	11.88	(44.97)	12.74	(48.22)	13.50	(51.10)	14.22	(53.82)
39	6.88	8.42	(31.87)	9.74	(36.87)	10.83	(40.99)	11.90	(45.05)	12.96	(49.05)	13.79	(52.20)	14.61	(55.30)	15.40	(58.29)
42	7.42	9.08	(34.37)	10.48	(39.67)	11.78	(44.59)	12.82	(48.52)	13.85	(52.42)	14.86	(56.25)	15.74	(59.58)	16.58	(62.76)

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10.4.2 The duration of the leakage test shall be a minimum of 4 hours.

10.4.3 The pressure of the leakage test shall be 1.5 times the maximum working pressure that will occur on that portion of the line, or shall equal the test pressure for the pressure test (see 10.3.1) whichever is less.

10.4.4 Computation of Leakage Rate

10.4.4.1 Measure and record the exact time elapsed in minutes and seconds beginning at the time of achieving initial test pressure and ending at the exact time of reestablished test pressure after a volume of water has been added to replace the leakage volume.

10.4.4.2 Measure and record the exact volume of water which must be injected to the section of pipe line under test in order to reestablish the test pressure.

10.4.4.3 Compute leakage rate in gallons/hr. by dividing volume added (10.4.4.2) by elapsed time in minutes (see 10.4.4.1).

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11. Disinfection

11.1 Before the pipe line is placed into service, all new water systems, extensions to existing systems, valved sections of extensions, replacements in the existing system, and any exposed sections of the existing system shall be disinfected and flushed in accordance with AWWA C601, "Disinfection of Water Mains."

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12. Service Connections

12.1 Maximum Recommended Sizes of Corporation Stops

For 4 in. ^(100 mm) and 6 in. ^(150 mm) diameter pipe — ^(20 mm) 3/4" diameter tap.

For 8 in. ^(200 mm) and larger diameters — ^(25 mm) 1" diameter tap.

12.2 If more than one corporation stop is used, stops must be at least 12 inches ^(300 mm) apart and not on the same center line.

12.3 Use only a clean, sharp tapping tool. Locate tap at about a 45 degree angle and tap only deep enough to allow three threads exposed when the corporation stop is inserted. (It is recommended that a test tap is made and the drilling bar is marked for proper depth of tapping.) Do not force the drill. Use a mixture of graphite and oil to lubricate the tap and stop.

12.4 When making connection, always install a bend or "gooseneck" between the corporation stop and service pipe to allow for vibration, settling of soil, etc.

12.5 For larger outlets than recommended in 12.1, tapped couplings, double strap service clamps, or tapping sleeves must be used. The maximum outlet sizes for use with service clamps are shown in Table IV.

TABLE IV

Pipe Size	Outlet Size	Pipe Size	Outlet Size
4" (100 mm)	1" (25 mm)	15" (380 mm)	2" (50 mm)
6" (150 mm)	1½" (40 mm)	16" (400 mm)	2" (50 mm)
8" (200 mm)	2" (50 mm)	18" (450 mm)	3" (75 mm)
10" (250 mm)	2" (50 mm)	20" (500 mm)	3" (75 mm)
12" (300 mm)	2" (50 mm)	21" (530 mm)	3" (75 mm)
14" (350 mm)	2" (50 mm)	24" (600 mm)	3" (75 mm)