

SECTION 33 13 00
DISINFECTION OF WATERLINES

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This specification specifies the procedure for disinfection of water systems, and in general, conforms to AWWA C651, Disinfecting Water Mains including Section 4.3.9.

1.2 MEASUREMENT AND PAYMENT

- A. Disinfection of waterlines will not be measured. Cost for work herein specified, including the furnishing of all materials, equipment, tools, labor and incidentals necessary to complete the work, shall be included in the unit price bid for waterlines in the Proposal.

PART 2 – PRODUCTS

2.1 MATERIALS

A. CHLORINE AND WATER

1. Chlorine

Calcium hypochlorite, or equal, which contains sixty-five (65%) percent chlorine by weight.

2. Water

Water for disinfection will be metered and furnished to the Contractor at no cost. Existing water lines are to remain isolated from newly laid water lines by a physical air gap until the original copy of the negative coliform test results have been received by the City Engineer from either the County Health Department or an approved TCEQ lab.

2.2 TESTING REQUIREMENTS

A. CHLORINE RESIDUAL-DROP DILUTION METHOD

The drop dilution method of approximating total residual chlorine is suitable for concentrations above 10 mg/L, such as are applied in the disinfection of water mains or tanks.

1. Apparatus

- a.) A graduated cylinder for measuring distilled water.
- b.) An automatic or safety pipet
- c.) A dropping pipet that delivers a one-milliliter (1 ml) sample in twenty (20) drops. This pipet is for measuring the water sample and should not be used for any other purpose.
- d.) A comparator kit containing a suitable range of standards.

2. Procedure

- a.) Ascertain the volume of the comparator cell and using an automatic or safety pipet, add 0.5 ml of orthotolidine for each 9.5 ml of distilled water to be added.
- b.) Using a graduated cylinder, add a measured volume of distilled water.
- c.) With the dropping pipet, add the water sample a drop at a time, allowing mixing, until a yellow color is formed that matches one of the color standards.
- d.) Record the total number of drops used and the final chlorine value obtained.
- e.) Calculate the milligrams per liter residual chlorine as follows:
 - i. Multiply by twenty the number of milliliters of distilled water used in Step 2.
 - ii. Multiply product in step a. by the final chlorine value in milligrams per liter recorded in Step 4.
 - iii. Divide the product found in step b. by the total number of drops of water sample recorded in Step 4.

PART 3 – EXECUTION

3.1 GENERAL

- A. During the construction operations, workmen shall be required to use utmost care to see that the inside of pipes, fittings, jointing materials, valves, etc., which will come into contact with potable water be maintained in a sanitary condition.
- B. Every effort must be made to keep the inside of the pipe, fittings, and valves free of all foreign matter, sticks, dirt, rocks, etc. As each joint of pipe is being laid, it must be effectively swabbed so that all foreign matter is removed. Placing dry powdered chlorine in the pipeline will be permitted in conjunction with certain methods of sterilization as specified by the Engineer. All fittings and exposed open ends of pipe must be blocked with a plug or capped until the line is completed.
- C. Sterilization of the line, or any section thereof, shall not be commenced until the Engineer has approved the method, apparatus, sterilizing agent, and the section of the line.
- D. When the entire pipeline, or certain section thereof, has been completed, tested, and made ready for use, the line or section of line shall be thoroughly sterilized according to the following procedure:
 1. The Contractor shall provide all necessary taps to complete this section of the specifications.
 2. The water main shall be flushed prior to disinfection.
 3. The flushing velocity shall be greater than 2.5 feet per second. The rate of flow required to produce this velocity in various diameters is shown in Table 1. No site for flushing should be chosen, unless it has been determined by the Engineer or Inspector that drainage is adequate at that site. Flushing is no substitute for preventive measures taken before and during pipe laying. Certain contaminants, especially in caked deposits, resist flushing at any velocity.

TABLE 1
REQUIRED OPENINGS TO FLUSH PIPELINES (40 PSI RESIDUAL PRESSURE)

Pipe Size	Flow (gpm) Required to Produce 2.5 fps Velocity	Orifice Size (in.)	Number of Hydrant Outlet Nozzles	Size (in.) of Hydrant Outlet Nozzles
4	10	15/16	1	2-1/2
6	220	1-3/8	1	2-1/2
8	390	1-7/8	1	2-1/2
10	610	2-5/16	1	2-1/2
12	880	2-13/16	1	2-1/2
14	1200	3-1/4	2	2-1/2
16	1565	3-5/8	2	2-1/2
18	1980	4-3/16	2	2-1/2

Note: A 2-1/2” hydrant outlet nozzle will discharge approximately 1,000 gpm and a 4-1/2” hydrant outlet nozzle will discharge approximately 2,500 gpm with 40 psi residual pressure.

E. METHODS OF CHLORINE APPLICATION

1. Continuous Feed Method

Note: This method is suitable for general applications.

- a. Water from the existing distribution system, or other pre-approved sources of supply, shall be made to flow at a constant, measured rate into the newly laid pipeline. The water shall receive a dose of chlorine concentration until the water in the pipe maintains a minimum of fifty milligrams per liter (50 mg/l) available chlorine. To assure that this concentration is maintained, the chlorine residual should be measured at regular intervals in accordance with the procedures described herein.

Note: In the absence of a meter, the rate may be determined either by placing a pitot gauge at the discharge, or by measuring the time to fill a container of known volume.

Table 2 gives the amount of chlorine residual required for each 100 feet of pipe of various diameters. Solutions of one percent (1%) chlorine may be prepared with approximately one pound (1 lb.) of calcium hypochlorite (65% strength) in 8.5 gallons of water.

TABLE 2
CHLORINE REQUIRED TO PRODUCE 50 MG/1
CONCENTRATION IN 100 FEET OF PIPEBY DIAMETER

Pipe Size (in.)	100% Chlorine (lb/100ft)	1% Chlorine Solution (gal/100ft)
4	0.027	0.33
6	0.061	0.73
8	0.108	1.30
10	0.170	2.04
12	0.240	2.88
16	0.427	5.12
18	0.540	6.48
24	0.960	11.50
30	1.500	18.00
36	2.160	25.90
42	2.940	35.30

- b. During the application of the chlorine, valves shall be manipulated to prevent the treatment dosage from flowing back into the line supplying the water. Chlorine application shall not cease until the entire main is filled with the chlorine solution. The chlorinated water shall be retained in the main for at least twenty-four (24) hours during which time, all valves and hydrants in the section treated shall be operated in order to disinfect the appurtenances. At the end of this twenty-four (24) hour period, the treated water shall contain no less than fifty (50) milligrams per liter and no more than one hundred (100) milligrams per liter chlorine throughout the length of the main. A dosage of more than the maximum allowable chlorine will require the Contractor to dilute the flush water with one of the TCEQ approved dilution chemicals. The chemical and description of procedure will be submitted in writing to the Engineer for approval.

2. Slug Method

This method is suitable for use with mains of large diameter for which, because of the volume of water involved, the continuous feed method is not practical.

- a.) Water from the existing distribution system shall be made to flow at a constant, measured rate (see C.1.a. Note) into the newly laid pipeline. The water shall receive a dose of chlorine, also fed at a constant, measured rate. The two (2) rates shall be proportioned so that the concentration of the water entering the pipeline is maintained at no less than 300 milligrams per liter. As the chlorinated water passes along the line, it shall expose all interior surfaces to a concentration of at least 300 mg/L for at least three (3) hours. The application shall be checked at a tap near the upstream and downstream end of the line by chlorine residual measurements made according to the procedures described herein.
- b.) As the chlorinated water flows past tees and crosses, related valves and hydrants shall be operated so as to disinfect appurtenances.

3. Dry Treatment during Installation

The dosage and application of sodium hypochlorite will be determined by the following:

- a.) Calculate weight of sodium hypochlorite required for water to be treated utilizing Table 2.
- b.) Add required amount of solution at the bell of each pipe as it is installed.

E. FINAL FLUSHING

After the applicable retention period, the heavily chlorinated water shall be flushed from the main until the chlorine concentration in the water leaving the main is less than three milligrams per liter (3 mg/l). Chlorine residual determination shall be made by the Inspector to ascertain that the heavily chlorinated water has been removed from the pipeline.

F. BACTERIOLOGIC TESTS

1. Before the water main is placed in service, a sample or samples shall be collected from points designated by the Inspector and tested for bacteriologic quality. This sample shall be collected 24 hours after final flushing. The test shall show the absence of coliform organisms before the water main may be placed in service. At least one (1) sample per one thousand (1000) feet of new line or portion thereof shall be taken. Sampling shall be supervised by the Inspector. Samples shall be submitted by the city to a TCEQ approved laboratory and/or County Health Department for analysis.
2. Samples of bacteriologic analysis shall be collected in sterile bottles obtained from the Brazos County Health Department. Samples shall be collected at points specified by the City Engineer.
3. A suggested sampling tap consists of a standard corporation cock installed in the main with a copper tube gooseneck assembly. After samples have been collected, the gooseneck assembly may be removed and retained for future use.

G. REPETITION OF PROCEDURE

1. If the initial disinfection fails to produce samples with no coliform present, the contractor shall re-disinfect the line following the procedures stated in 695.04 of this specification until samples indicating no coliform present have been obtained. When the samples indicate no coliform present and the City Engineer has received original copies of the test report, the main may be placed in service.

3.2 PROCEDURE AFTER CUTTING INTO OR REPAIRING EXISTING MAINS

- A. The procedure outlined in this section applies primarily when mains are wholly or partially dewatered. Leaks or breaks that are repaired with clamping devices while the mains remain full of water under pressure present little danger of contamination and require no disinfection.
1. Trench “Treatment”
When an old line is opened, either by accident or by design, the excavation will likely be wet and badly contaminated. Liberal quantities of hypochlorite applied to open trench areas will lessen the danger from such pollution. Tablets have the advantage in such a situation because they dissolve slowly and continue to release hypochlorite as water is pumped from the excavation.
 2. Main Disinfection
 - a.) Swabbing and Flushing. The following procedure is considered as a minimum that may be used.
 - i. Swabbing With Hypochlorite Solution: The interior of all pipe and fittings used to make the repair (particularly couplings and tapping sleeves) shall be swabbed with a 5 percent hypochlorite solution before they are installed.
 - ii. Flushing: Thorough flushing is the most practical means of removing contamination introduced during repairs. If valving and hydrant locations permit, flushing from both directions is recommended. Flushing shall be started as soon as the repairs are completed and continued until discolored water is eliminated.

3. Slug Method: In addition to the swabbing and flushing procedures of section B.1., the section of main in which the break is located can be flushed and chlorinated using the slug method where practical, as determined by the Engineer or Inspector. This method requires isolating the section of main, shutting off all service connections, flushing the main, and chlorinating the main as described in the Slug Method in C.2, except that the dose may be increased to as much as 500 mg/1, and the contact time reduced to as little as ½ hour. After chlorination, flushing shall be resumed and continued until discolored water is eliminated.
4. Sampling: Bacteriologic samples shall be taken after repairs to provide a record by which the effectiveness of the procedures used can be determined by the Inspector. If the direction of flow is unknown, samples shall be taken on each side of the main break.

END OF SECTION