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PART 1    GENERAL

1.1 Description

A. This section covers field pressure testing, disinfection and purity testing of potable water systems piping, fittings, and valves and field pressure testing of sewage force mains. All piping shall be flushed and hydrostatically pressure and leak tested. Defective items revealed by the testing procedures shall be removed and replaced or otherwise corrected as directed by the Engineer. All costs for labor and materials necessary to conduct the flushing, testing and disinfecting procedures specified herein, and all costs of labor and materials required to remedy defective items shall be borne by the Contractor.

B. Contractor shall provide coordination and scheduling required for SUB and Engineer to witness and provide necessary labor for operating SUB’s existing system during hydrostatic testing and disinfecting procedures. Contractor shall not operate any part of the existing water.

C. The Contractor shall perform flushing and testing of all pipelines and appurtenant piping for water and disinfection of all pipelines and appurtenant piping for potable water, complete, including conveyance of test water to point of use and all disposal thereof, all in accordance with the requirements of the Contract Documents.

1.2 Reference Specifications, Codes, and Standards

Codes and Standards: Comply with the provisions of the latest edition of the following codes, standards and specifications, except as otherwise shown and specified:

ANSI/AWWA B300 Hypochlorites

ANSI/AWWA B301 Liquid Chlorine

ANSI/AWWA C651 Disinfecting Water Mains

ANSI/AWWA C600 Installation of Ductile Iron Water Mains and Their Appurtenances

ANSI/AWWA C605 Underground Installation of PVC Pressure Pipe and Fittings for Water

ASTM F 2164 – 02 Standard Practice for Field Leak Testing of Polyethylene (PE) Pressure Piping Systems Using Hydrostatic Pressure
1.3 Contractor Submittals

A required pipeline testing and disinfection plan shall be submitted by the Contractor for review and approval by SUB Water division a minimum of one month before testing is to start. High dosage (10 ppm and above) chlorine readings, for initial disinfection, shall be able to be clearly ascertained to a tolerance of ± 5 ppm. Chlorine dosage levels under 10 ppm, for residual readings, shall be able to be clearly ascertained to a tolerance of ± 0.1 ppm. As a minimum, the Contractor’s pipeline testing and disinfection plan shall include the following:

A. Testing schedule.
B. Proposed water source for testing
C. Proposed equipment and chemicals, including chlorine dosage testing equipment.
D. Proposed plan for water conveyance including flow rates.
E. Proposed plan for water control.
F. Proposed plan for water disposal including flow rates.
G. Proposed measures to be incorporated in the project to minimize erosion while discharging water from the pipeline.
H. Proposed plan for disinfection, including dosage calculations.
I. Proposed plan for dechlorination of flushing water and superchlorinated disinfection water including discharge points and discharge rates.
J. Proposed plan for testing chlorine levels throughout the length of the pipeline including test locations.

PART 2 PRODUCTS

2.1 Equipment

A. All test equipment, chemicals for chlorination, temporary valves, bulkheads, or other water control equipment and materials shall be determined and furnished by the Contractor subject to the Engineer’s review. No materials shall be used which would be injurious to the construction or its future functions.

B. SUB shall furnish pressure gauges for testing. The Contractor shall furnish the following equipment and materials for the testing:

<table>
<thead>
<tr>
<th>Amount</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Graduated containers approved by the Engineer</td>
</tr>
<tr>
<td>1</td>
<td>Hydraulic pump approved by the Engineer with hoses, valves and fittings as needed and required for the testing and disinfection of the facilities.</td>
</tr>
</tbody>
</table>
C. Chlorine for disinfection shall be in the form of liquid chlorine or sodium hypochlorite solution.

D. Sodium hypochlorite and calcium hypochlorite shall be in accordance with the requirements of ANSI/AWWA B300. Liquid chlorine shall be in accordance with the requirements of ANSI/AWWA B301.

E. All temporary thrust restraint and equipment and facilities required for hydrostatic testing will be considered incidental.

**PART 3 EXECUTION**

3.1 Filling Mains

A. The Contractor shall make all necessary provisions for conveying water to the points of use and for the proper disposal of test water.

B. Water mains shall be filled under the direction of the Engineer in such a manner as to prevent excessive pressure reductions in the existing main and water hammer.

3.2 Hydrostatic Testing of Water Mains

General:

A. No section of the pipeline shall be hydrostatically tested until all field-placed concrete or mortar has attained full strength and all heat fusion joints are completely cooled. At the Contractor’s option, early strength concrete may be used when the full strength requirements conflict with schedule requirements. All such early applications shall be approved by the Engineer prior to each installation.

B. Hydrostatic pressure tests shall be made on any valved section of all newly laid main and service pipe in the presence of the Engineer, unless otherwise directed by the Engineer. Reference specifications, AWWA C600 Section 5.2, Hydrostatic Testing, AWWA C605 Section 10.3, and ASTM F 2164 – 02, Standard Practice for Field Leak Testing of Polyethylene (PE) Pressure Piping Systems Using Hydrostatic Pressure. All entrained air shall be expelled from the line prior to elevating the internal pressure to the specified test pressure. Flow velocities during filling should not exceed the capacities of air release devices or other openings used to release trapped air. The test pressure shall be 150 psi calculated for the point of highest elevation, but shall not exceed 200 psi at any point. The test pressure shall be applied and maintained for a two-hour duration unless otherwise specified by the Engineer. The allowable leakage shall not to exceed value as per Paragraph D below.
C. Testing shall be against closed hydrants with hydrant valves open. In addition, the test shall include the service installation(s) against the closed angle meter valve with the corporation stop open.

D. If the test reveals any defects, leakage in excess of the allowable, or failure, the Contractor shall furnish all labor, equipment, and materials required to locate and make the necessary repairs. The testing of the line (and repairing of defects, excessive leakage, and failures) shall be repeated until a test satisfactory to the Engineer has been achieved. All costs for locating, repairing, and re-testing shall be borne by the Contractor.

Ductile Iron and PVC pipe testing allowance and procedure:

E. Testing allowance shall be defined as the maximum quantity of makeup water that is added into the pipeline undergoing hydrostatic pressure testing, or any valves section thereof, in order to maintain pressure within ±5 psi of the specified test pressure (after the pipeline has been filled with water and the air has been expelled). No pipe installation will be accepted if the quantity of makeup water is greater than that determined by the following formula:

In inch-pound units,

\[ L = \frac{SD\sqrt{P}}{148,000} \]

Where:

- \( L \) = testing allowance (makeup water), in gallons per hour
- \( S \) = length of pipe tested, in feet
- \( D \) = nominal diameter of pipe, in inches
- \( P \) = average test pressure during the hydrostatic test, in pounds per square inch (gauge).

The allowable leakage at various pressures for pipe of various diameters is shown in Table 6 below from AWWA C600.
### AWWA C600

#### TABLE 6  Allowable Leakage per 1000 ft (305 m) of Pipeline* - gph

<table>
<thead>
<tr>
<th>NOMINAL PIPE DIAMETER -- (inches)</th>
<th>Avg. Test Pressure psi (bar)</th>
<th>3</th>
<th>4</th>
<th>6</th>
<th>8</th>
<th>10</th>
<th>12</th>
<th>14</th>
<th>16</th>
<th>18</th>
<th>20</th>
<th>24</th>
<th>30</th>
<th>36</th>
<th>42</th>
<th>48</th>
<th>54</th>
</tr>
</thead>
<tbody>
<tr>
<td>200 (14)</td>
<td>0.29</td>
<td>0.38</td>
<td>0.57</td>
<td>0.76</td>
<td>0.96</td>
<td>1.15</td>
<td>1.34</td>
<td>1.53</td>
<td>1.72</td>
<td>1.91</td>
<td>2.29</td>
<td>2.87</td>
<td>3.44</td>
<td>4.01</td>
<td>4.59</td>
<td>5.16</td>
<td></td>
</tr>
<tr>
<td>175 (12)</td>
<td>0.27</td>
<td>0.36</td>
<td>0.54</td>
<td>0.72</td>
<td>0.89</td>
<td>1.07</td>
<td>1.25</td>
<td>1.43</td>
<td>1.61</td>
<td>1.79</td>
<td>2.15</td>
<td>2.68</td>
<td>3.22</td>
<td>3.75</td>
<td>4.29</td>
<td>4.83</td>
<td></td>
</tr>
<tr>
<td>150 (10)</td>
<td>0.25</td>
<td>0.33</td>
<td>0.50</td>
<td>0.66</td>
<td>0.83</td>
<td>0.99</td>
<td>1.16</td>
<td>1.32</td>
<td>1.49</td>
<td>1.66</td>
<td>1.99</td>
<td>2.48</td>
<td>2.98</td>
<td>3.48</td>
<td>3.97</td>
<td>4.47</td>
<td></td>
</tr>
<tr>
<td>125 (9)</td>
<td>0.23</td>
<td>0.30</td>
<td>0.45</td>
<td>0.60</td>
<td>0.76</td>
<td>0.91</td>
<td>1.06</td>
<td>1.21</td>
<td>1.36</td>
<td>1.51</td>
<td>1.81</td>
<td>2.27</td>
<td>2.72</td>
<td>3.17</td>
<td>3.63</td>
<td>4.08</td>
<td></td>
</tr>
<tr>
<td>100 (7)</td>
<td>0.20</td>
<td>0.27</td>
<td>0.41</td>
<td>0.54</td>
<td>0.68</td>
<td>0.81</td>
<td>0.95</td>
<td>1.08</td>
<td>1.22</td>
<td>1.35</td>
<td>1.62</td>
<td>2.03</td>
<td>2.43</td>
<td>2.84</td>
<td>3.24</td>
<td>3.65</td>
<td></td>
</tr>
</tbody>
</table>

*If the pipeline under test contains sections of various diameters, the testing allowance will be the sum of the testing allowance for each size.

F. The test pressure shall be applied and maintained for a two (2) hour duration unless otherwise specified by the Engineer. The testing allowance shall be per paragraph E Above. During the test period, operate the pump as required to maintain pressure in the pipe within ±5 psi of the specified test pressure at all times. At the end of test period, operate the pump until the specified maximum test pressure is again obtained. The pump suction shall be in a graduated barrel, metered, or similar device so that the amount of makeup water required to restore the test pressure may be accurately measured.

Polyethylene pipe testing allowance and procedure:

G. **Temperature equalization:** Allow the water and pipe in the test section to equalize to a common temperature.

**Test Phase:** Add makeup water as necessary to maintain the maximum test pressure for four (4) hours. After maintaining the maximum test pressure for four (4) hours, reduce the maximum test pressure by ten (10) psi and monitor the pressure continuously for one (1) hour.

**Pass/Fail Criteria:** If the pressure during the test phase remains steady (within 5% of the maximum test pressure) for the one (1) hour test phase period, a passing test is indicated.

3.3 Flushing

A. Prior to chlorination, the main shall receive a complete flushing through all hydrants and blow-offs such that a velocity of at least 2.5 feet per second is developed in the main. If the required velocity cannot be achieved, a minimum
of three (3) pipe volumes of water shall be turned over in the lines being tested. The flushing shall be accomplished during prearranged times under direction and supervision of the Engineer. If sufficient outlets are not available, a tap shall be provided large enough to develop the required velocity in the main and to allow the removal of foam swabbing "pigs". (see Table II below)

B. All valves shall be operated through their extreme open and closed positions during flushing. Each hydrant shall be inspected after flushing to see that the entire valve operating mechanism is in good, working condition.

C. Flushing water onto the street subgrade shall not be allowed at any time. Provisions for the dechlorination and disposal of the water onto areas where no damage will be caused shall be made by the Contractor prior to any flushing operations. All flushing shall meet current regulatory requirements. Rate of operation of all valves and hydrants shall be done in a manner that avoids water hammer damage to the existing system and the improvements.

### TABLE II
REQUlRED OPENINGS FOR 2.5 fps FLUSHING VELOCITY
(40 psi Pressure)

<table>
<thead>
<tr>
<th>PIPE SIZE (inch)</th>
<th>FLOW (gpm)</th>
<th>ORIFICE SIZE (inch)</th>
<th>HYDRANT OUTLET NOZZLES</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>100</td>
<td>15/16</td>
<td>One 2-1/2</td>
</tr>
<tr>
<td>6</td>
<td>220</td>
<td>1-3/8</td>
<td>One 2-1/2</td>
</tr>
<tr>
<td>8</td>
<td>390</td>
<td>1-7/8</td>
<td>One 2-1/2</td>
</tr>
<tr>
<td>10</td>
<td>610</td>
<td>2-5/16</td>
<td>One 2-1/2</td>
</tr>
<tr>
<td>12</td>
<td>880</td>
<td>2-13/16</td>
<td>One 2-1/2</td>
</tr>
<tr>
<td>14</td>
<td>1200</td>
<td>3-1/4</td>
<td>Two 2-1/2</td>
</tr>
<tr>
<td>16</td>
<td>1565</td>
<td>3-5/8</td>
<td>Two 2-1/2</td>
</tr>
<tr>
<td>18</td>
<td>1908</td>
<td>4-3/16</td>
<td>Two 2-1/2</td>
</tr>
<tr>
<td>20</td>
<td>2450</td>
<td>4-5/8</td>
<td>Three 2-1/2</td>
</tr>
<tr>
<td>24</td>
<td>3510</td>
<td>5-9/16</td>
<td>Four 2-1/2 or One 4-1/2 and One 2-1/2</td>
</tr>
<tr>
<td>30</td>
<td>5500</td>
<td>7</td>
<td>Five 2-1/2 or One 4-1/2 and Two 2-1/2 or Two 4-1/2</td>
</tr>
</tbody>
</table>

3.4 Disinfection of Water Mains

A. After testing and repairing where necessary, all potable water systems shall be thoroughly flushed, cleaned, and disinfected by the Contractor in accordance with the latest version of AWWA C651.
B. Before sterilizing, flush all foreign matter from the pipeline. The Contractor is to provide, at no additional cost to SUB, hoses, temporary pipes, ditches, etc., as required to dispose of flushing water without damage to adjacent properties. Flushing water discharged to any public waters in the State of Oregon shall be dechlorinated in accordance with Oregon Administrative Rule Chapter 340, Division 41 – Water Quality Standards: Beneficial Uses, Policies, and Criteria for Oregon and Oregon Department of Environmental Quality memorandum entitled “Chlorinated Water Discharges”, Water Quality Division, DEQ, May 19, 1997.

C. Potable water shall be used for disinfection, hydrostatic pressure testing, and flushing. Potable water piping shall be disinfected with a solution containing an initial minimum chlorine dose of 25 parts per million (ppm) and a maximum of 50 ppm. The chlorine solution shall remain in the piping system for a period of 24 hours at which time the sterilizing mixture shall have a minimum residual strength of at least 10 ppm of chlorine. If check samples fail to produce acceptable results, the disinfection procedure shall be repeated at the expense of the Contractor until satisfactory results are obtained.

D. Disposal of any water containing chlorine shall be performed in accordance with the latest edition of AWWA C651, Section 01 10 0 Special Provisions of this specification, and any other state or local requirements. Disposal may be made into existing sanitary sewer systems providing approvals are obtained from the respective systems owner prior to disposal. Any chlorinated water discharged to open waterways must be dechlorinated prior to discharge and conform to Section 3.4 B of this specification section.

**TABLE III**

<table>
<thead>
<tr>
<th>Residual Chlorine Concentration (mg/L)</th>
<th>Vita-D-Chlor*** (Ascorbic Acid)</th>
<th>SodiumThiosulfate (Na2S2O3·5H2O)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2.2</td>
<td>1.2</td>
</tr>
<tr>
<td>2</td>
<td>4.41</td>
<td>2.4</td>
</tr>
<tr>
<td>10</td>
<td>22.03</td>
<td>12.0</td>
</tr>
<tr>
<td>50</td>
<td>110.13</td>
<td>60.0</td>
</tr>
</tbody>
</table>
* Except for residual chlorine concentration, all amounts are in pounds.

**Check with local sewer department for conditions of disposal to sanitary sewer.

***Formula for Vita-D-Chlor application: (D x D x mg/l x feet ) ÷ 1,112,300.
Where D= pipe diameter in inches, mg/l = milligrams per liter chlorine concentration, feet = number of feet of line to be treated.

****Vita-D-Chlor tablets shall only be used for dechlorination of mains containing 4 ppm or less of residual chlorine, and the Contractor must obtain the approval of the Engineer prior to use.

E. The Contractor will collect samples after the pipeline is flushed in accordance with the latest edition of AWWA C651-14 at locations directed by the Engineer. The chlorine residual must be below 1 ppm when the sample is taken.

F. Results of the bacteriological testing shall be satisfactory with SUB, the State Department of Health, and/or any other appropriate regulatory agencies having jurisdiction, or disinfection shall be repeated at the expense of the Contractor.

3.5 Bacteriological Testing

A. 16 hours after final flushing, and before the new water main connection is open to the distribution system two (2) consecutive sets of bacteriological samples shall be collected from the new main. All samples obtained from the new main shall conform to the procedures set forth in accordance with the latest edition of AWWA C651-14. Chlorine residual shall be tested before sampling and must be 1 ppm or less before the sample is collected. At least one set of samples shall be collected at intervals of 1,200 feet (366 m) from the new water main, in addition to one set from the end of the line and at least one set from each branch. All samples shall be tested for bacteriological quality in accordance with Standard Methods for the Examination of Water and Wastewater, by an Oregon State Health Division approved laboratory, and shall show the absence of coliform organisms. A standard heterotrophic plate count may be required as directed by the Engineer.

B. If trench water has entered the new main during construction or, if in the opinion of the Engineer excessive quantities of dirt or debris have entered the new main, bacteriological samples shall be taken at intervals of approximately 200 feet and shall be identified by location. Samples shall be taken of water that has remained in the new main for at least 16 hours after final flushing has been completed.
C. Samples for bacteriological analysis shall be collected in sterile bottles treated with sodium thiosulfate as required by *Standard Methods for the Examination of Water and Wastewater*. No hose or fire hydrant shall be used in the collection of samples.

D. Should the initial treatment fail to produce satisfactory bacteriological results, or if other results indicate unacceptable water quality, the main(s) may be re-flushed and shall be resampled. If the check samples fail to produce acceptable results, the original chlorination procedure or another method approved by SUB shall be repeated at the Contractor's expense until satisfactory results are obtained. No extra payment or extension of Contract time will be allowed the Contractor for the time elapsed to achieve acceptable sterilization of the pipe. Records of all bacteriologic testing shall be provided to Engineer by the Contractor prior to final acceptance of the new lines.

3.6 Disinfection of Water Main End Connections and Tie-Ins

Disinfection and pressure testing of potable water piping and appurtenances at end connections which are required to remain in service due to restrictions in allowable shutdown time shall be pressure tested and disinfected as described below:

A. Prior to connecting new potable water piping and appurtenances with existing piping and appurtenances, the interior of all new pipe, fittings, valves and appurtenances shall be swabbed or sprayed with a 1% to 5% calcium hypochlorite solution.

B. Following the disinfection procedures described above, connection of the new piping and appurtenances to the existing water system shall be made. During the system startup, the Engineer and Contractor shall visually inspect all new fittings, piping, valves and appurtenances for evidence of leakage. Any leakage observed during this period shall be promptly repaired by the Contractor, at Contractor’s expense as required by the Engineer.

3.7 Tracer Wire Conductivity Testing

A conductivity test shall be made on all tracer wire installed. Tests and visual inspection shall be made at each valve box, meter box, and listening port as applicable. Conductivity may be tested by using an electrical conductivity meter or by attaching underground locating equipment and tracing the signal to each valve box and meter box. No acceptance or payment will be made on any section or reach of pipe installed that does not have a conductive electrical locator wire installed in accordance with Standard Drawings.

END OF SECTION