SECTION 01 45 23.13

TESTING OF PIPELINES AND HYDRAULIC STRUCTURES

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes

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3.5	Test Procedures for Air Piping and Vacuum Piping
3.6	Test Procedures for Pressure Pipelines
3.7	Test Procedures for Gravity Pipe
3.8	Testing of Manholes
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B. Scope

1. Furnish all labor, materials, tools, equipment and related items required to perform exfiltration tests of gravity pipelines, perform integrity and leakage tests of pressurized pipelines and perform leakage tests of hydraulic structures.

1.2 SUBMITTALS

A. Submit shop drawings and product data to the Engineer in accordance with the requirements of the Section 01 33 23 – Shop Drawings, Product Data, and Samples of these specifications.

B. At a minimum, provide a description of the testing procedures to be employed for testing and report form to be used in the submittals.

PART 2 PRODUCTS

2.1 WATER FOR TESTING

A. Provide all equipment, necessary piping and required labor to transport the water from its source to the test location for use in testing.

B. Owner will provide the necessary water required for testing the work. Obtain a meter from the Owner to measure the amount of water used during testing. If tests fail, Contractor is responsible for cost of all water for retesting.

PART 3 EXECUTION

3.1 GENERAL

A. Field test for tightness the entire length of all pipelines using a test as described hereinafter.

B. Furnish all labor and equipment, including required pumps with regulated bypass meters and gauges, for conducting pipeline tests.

C. Furnish all equipment, necessary piping and required labor to transport water from its source to the test location for use in testing.

D. Schedule the timing and sequence of testing to the approval of the Owner and Engineer. Provide the Engineer and/or Inspector with a minimum of 24 hours' notice prior to the start of any test. All tests must be observed by the Engineer or Inspector.

E. Repair any leaks discovered during the initial filling of the pipeline and during the testing sequence. Repair all known and visible leaks whether or not the leakage rate is within allowable limits.

F. Bear complete cost of the tests, including set-up, labor, temporary piping, blocking, gauges, bulkheads, air, soap solutions, and any other materials required to conduct the tests.

3.2 NON-POROUS STRUCTURES

A. Non-porous structures, such as steel and fiberglass, shall show no leakage during the 24-hour test period.

3.3 REINFORCED CONCRETE STRUCTURES

A. General

1. Hydrostatically test concrete structures in accordance with ACI 350.1-01/350.1R-01.
2. Do not start leak testing or cleaning of surfaces until concrete is cured and joint sealants have set and cured a minimum of 14 days.
3. Consider each cell of multi-cell tanks a single tank and test individually.
4. Conduct testing before backfill is placed against walls.
5. Prior to testing, clean exposed surfaces by thorough hosing, and remove surface laitance and loose matter from walls and slabs. Remove wash water and debris by means other than washing through facility piping.
6. Prior to acceptance, no visible damp spots or seepage are allowed on the exterior surfaces of water retaining structures or interior surfaces of pits below groundwater level. Repeated tests and repairs may be required by the Engineer to obtain watertight structures. Drain all structures at the completion of the test unless otherwise directed by the Engineer. Comply with the requirements of Section 03 01 00 for repairing leaks.

B. Test Procedure

1. Fill structure to be tested to the normal operating liquid level. Filling rate shall not exceed 4 feet of water per hour, and shall be at continuous uniform rate with continuous monitoring.
2. Monitor the exterior surface of the tank for flowing leaks. Repair any flowing leaks which occur before continuing filling.
3. Maintain the water at the test level for a minimum of 72 hours prior to the actual test.
4. Measure the vertical distance to the water surface from a fixed point on the tank above the water surface. Record water levels every 24 hours.

5. The drop in water surface shall not exceed the quantitative criteria of ACI 350.1, latest edition; otherwise, the structure will be considered to have failed the leakage test.
6. The structure will also be considered to have failed the leakage test if flowing or seeping water is observed, or if moisture can be transferred to a dry hand from the exterior surface.
7. Independently measure change in water volume due to evaporation and precipitation using a 24 inch deep white, watertight container with not less than 10 square feet of surface area. Position the container to experience environmental conditions similar to the structure being tested. Correct the volume change of the structure based on the water volume change in the sample container.
8. Failing tanks which exhibit no visible signs of leaking or seepage may be permitted to be immediately retested.
9. Drain, repair, and retest failing tanks until the tanks have met the test requirements.

3.4 REPAIRS

A. If leakage exceeds the specified allowable limits, locate and remedy the point or points of leakage at no additional cost to the Owner. Make structural leaks water tight under test conditions within the limits specified.

3.5 TEST PROCEDURES FOR AIR PIPING AND VACUUM PIPING

A. Low Pressure Air Piping
   1. Subject low pressure air piping (working pressures 15 PSI and less) to a pneumatic gauge pressure test. Use a test pressure 150 percent of the maximum expected operating pressure or 20 PSI, whichever is greater. Maintain the pressure for a minimum of 2 consecutive hours. No leakage will be allowed.

B. High Pressure Air Piping and Vacuum Piping
   1. Subject high pressure air piping (working pressures greater than 15 PSI) and vacuum piping to a pneumatic gauge pressure test. Use a test pressure of 225 PSI. Maintain the pressure for a minimum of 2 consecutive hours. No leakage will be allowed.

3.6 TEST PROCEDURES FOR PRESSURE PIPELINES

A. After all piping has been placed and backfilled between the joints and restraint systems have been in place for a minimum of five days, test each run of newly laid pipe, or any valved section thereof, in the presence of the Engineer and/or Inspector. Continue tests until all leaks have been made tight to the satisfaction of the Engineer.

B. Take all precautions necessary to protect any equipment that might be damaged by pressures used in the tests. Valve off, remove, or otherwise protect delicate equipment.

C. Securely anchor and restrain all piping against movement prior to application of test pressures. Prior to the pressure test, partially backfill pipe laid in trenches to adequately secure the pipe during the test. Leave all joints, fittings, and valves open where possible. Carefully examine all exposed pipe, fittings, valves, and joints during the pressure test.

D. Before applying the specified test pressure, expel all air from the pipe. If hydrants, blow-offs, or air release valves are not available at the high places, make the necessary taps at points of highest elevation before the test is made and insert plugs after the test has been completed.

E. Segment all pipelines by capping, plugging, or closing of valves. Pump each section of piping full of water, and remove all air, to a pressure no less than two times the maximum anticipated operating head or 150 psi, whichever is greater. Provide adequate gauges on the pump to indicate the internal pipe pressure during the test. Maintain the above pressure for a minimum of two consecutive hours. Maintain the test pressure within ±5 psi of the required test pressure for the duration of the test.

F. After satisfactory completion of the pressure test, perform a leakage test. Leakage is defined as the quantity of water that must be supplied to the newly laid pipe or any valved section thereof to maintain pressure within 5 psi of the specified test pressure after the pipe has been filled with water and the air has been expelled.

G. Allowable Leakage:

1. Steel pipes – zero, except gate valves shall be permitted a maximum leakage rate of one (1) ounce per hour per inch of nominal valve size, in conformance with AWWA C500.

2. Ductile iron pipes – in conformance with AWWA C600, Section 5.2 and Table 6.

3. Concrete and PVC pipes – 11.65 gallons per inch of nominal diameter of pipe per mile over a 24-hour period.

H. Correct any leakage developed during the test at the Contractor's expense by tightening, replacing packing or gaskets, or replacing defective portions of the piping system. Caulking will not be permitted. If defective portion cannot be located, remove and reconstruct as much of the original work as necessary to obtain a facility tested without leakage, at the Contractor's expense.

I. After all tests on any section have been completed to the satisfaction of the Engineer, carefully clean, blow out, and drain the line of all water to prevent freezing of the same. Demonstrate to the satisfaction of the Engineer that any and all lines are free from obstruction and foreign material.

3.7 TEST PROCEDURES FOR GRAVITY PIPE

A. After completion of any section of sewer, ensure the grades, joints, and alignment are true to line and grade. Verify joint surfaces are smooth. Ensure there is no visual leakage and the sewer is completely free from any cracks and from protruding joint materials, deposits of sand, mortar, or other materials on the inside.

B. Correct any leakage, including active seepage, by removal and replacement of pipe joint where such leakage exists until the pipelines meet the requirements of the allowable leakage specifications.

C. Use low pressure air testing for testing of gravity pipelines. Conduct low pressure air test in accordance with the procedures and standards listed below.

1. Clean pipe to be tested by propelling snug-fitting inflated rubber ball through pipe with water.

2. Plug all pipe outlets with suitable test plugs. Brace each plug securely to prevent blowouts. As a safety precaution, include a regulator set at slightly above test pressure on pressurizing equipment to avoid over pressurizing and damaging an otherwise acceptable line. No one shall be allowed in the manhole during testing.

3. If the pipe to be tested is submerged in groundwater, insert a pipe probe by boring or jetting, into the backfill material adjacent to the center of the pipe, and determine the pressure in the probe when air passes slowly through it. This is the back pressure due to

ground water submergence over the end of the probe. All gauge pressures in the test should be increased by this amount.

4. Add air slowly to the portion of the pipe installation under test until the internal air pressure is raised to 4.0 psig.

5. After an internal pressure of 4.0 psig is obtained, allow at least two minutes for air temperature to stabilize, adding only the amount of air required to maintain pressure.

6. When pressure decreases to 3.5 psig, start stopwatch. Determine the time in seconds that is required for the internal air pressure to reach 2.5 psig. Minimum permissible holding times for runs of single pipe diameter are indicated in the table in seconds. Times for mixed pipe sizes of varying lengths should be calculated as described in ASTM C828-76T using formula t = k x d/q (q = 0.0020).

Minimum Test Time for Various Pipe Sizes			
Nominal Pipe Size (inches)	**T (time) min/100 feet**	**Nominal Pipe Size (inches)**	**T (time) min/100 feet**
3	0.2	21	3.0
4	0.3	24	3.6
6	0.7	27	4.2
8	1.2	30	4.8
10	1.5	33	5.4
12	1.8	36	6.0
15	2.1	39	6.6
18	2.4	42	7.3

D. Final Inspection Preceding Acceptance

1. Final inspection will include a visual inspection of each section of sewer by looking from manhole to manhole with the aid of reflected sunlight or an electric torch. Light used for inspection is to be plainly visible from manhole to manhole. Reflected light from manhole to manhole will not be considered as plainly visible light and shall be reason for rejection of the section of sewer as not being laid true to line and grade. Groundwater infiltration shall not exceed the rates hereinbefore stipulated and shall be distributed uniformly throughout the collecting system and not occur through a few joints. All joints shall be tight. Finished work shall be neat in appearance and of first class workmanship.

2. The Owner will conduct a CCTV inspection of the new gravity sewer piping prior to final acceptance. If video inspection indicates potential joint deflection issues a deflection measurement will be made using a laser. If any defects are found during the inspection Contractor will make repairs at no cost to the Owner until pipeline passes all inspections.

3.8 TESTING OF MANHOLES

A. After each manhole is constructed to its finished height and before backfilling, test each manhole for water tightness in one of the following manner:

1. Plug holes and fill the manhole with clean water. After eight hours, check the water level for loss of water. This loss shall not exceed 0.05 gals/hr/ft. dia./ft. head and for a 4’-0” diameter manhole, the allowable level change is shown in the following table:

Allowable Drop in Water Level of 4'-0" Diameter Manhole	
Head of Water (ft)	**Level Drop (in)**
4	.08
5	1.0
6	1.2
7	1.4
8	1.6
10	2.0
12	2.45
16	3.3
20	4.0
24	4.9

2. Plug pipe lines and perform vacuum test. Observing all recommended safety measures induce a backpressure of 5.0 PSI equivalent to 10" Hg (mercury). The manhole assembly is considered satisfactory if the vacuum loss is less than 1" Hg for the length of time listed in the following table:

	Time of Test in Seconds Manhole Diameter (Feet)		
Depth (Feet)	4	5	6
4	10	13	16
8	20	26	32
12	30	39	48
16	40	52	64
20	50	65	80
24	60	78	96
T	5	6.5	8

Note: Add "T" seconds for each additional 2'-0" of depth

3. Failure to pass one of these tests requires the contractor to correct the problems and retest. The Contractor will replace leaking gaskets and/or concrete sections and retest the completed manhole. No manhole will be accepted without successfully passing one of these tests.

3.9 FINAL ACCEPTANCE

A. No pipeline installation or hydraulic structure shall be accepted until all known and visible leaks have been repaired, whether or not the leakage is within the maximum allowable limits. Location and repair of leaks shall be performed by the Contractor at no additional expense to the Owner.

B. The Engineer must certify that all required tests have been successfully completed before the work is accepted.

END OF SECTION