

SECTION 01150

MEASUREMENT AND PAYMENT

PART 1 - GENERAL

1. MEASUREMENT OF QUANTITIES

The determination of quantities of work acceptably completed under the terms of the contract or as directed by the Engineer, in writing, will be made by the Engineer, based on measurements taken by him or his assistants. The measurements will be taken according to United States Standard Measurements. When materials are measured in the vehicle, the measurement will be taken at the point of delivery. When required by the Engineer, the capacity of all vehicles shall be plainly marked on each vehicle and the capacity or markings shall not be changed without permission of the Engineer.

2. SCOPE OF PAYMENT

The Contractor shall receive and accept the compensation as herein provided in full payment for furnishing all labor, materials, tools, equipment, and incidentals; for performing all work contemplated and embraced under the contract; for all loss or damage arising out of the nature of the work or from the action of the elements; for any unforeseen defects or obstructions which may arise or be encountered during the prosecution of the work, and before its final acceptance by the Engineer; for all risks of every description connected with the prosecution of the work; for all expenses incurred by or in consequence of suspension or discontinuance of such prosecution of the work as herein specified; for any infringement of patents, trademarks, or copyrights and for completing the work in an acceptable manner according to the specifications.

The payment of any current or partial estimate prior to final acceptance of the work by the Owner shall in no way constitute an acknowledgement of the acceptance of the work, nor in any way prejudice or affect the obligations of the Contractor to repair, correct, renew or replace at his expense any defects or imperfections in the construction of the work under this contract, and its appurtenances nor any damage to or attributable to such defects, which defects, imperfections, or damage shall have been discovered on or before the final inspection and acceptance of the work. The Engineer shall be the sole judge of such defects, imperfections, or damage and the Contractor shall be liable to the Owner for failure to correct the same as provided herein.

3. PAYMENT FOR EXTRA WORK

The extra work done by the Contractor, as authorized and approved by the Engineer and the Owner, will be paid for in the manner hereinafter described and the compensation thus provided shall be accepted by the Contractor as payment in full for all labor, material, tools, equipment and incidentals and all superintendent's and timekeeper's services, all insurance and all other overhead expense incurred in the prosecution of the extra work.

MEASUREMENT AND PAYMENT

Payment for extra work will be made by one or more of the following methods:

A. Unit prices agreed in writing by Engineer and Contractor and approved by the Owner before said work is commenced, subject to all other conditions of the contract.

B. A lump sum price agreed on in writing by Engineer and Contractor and approved by the Owner before said work is commenced, subject to all other conditions of the contract.

C. The actual costs, including labor, material, tools, equipment, and field supervision of such extra work plus fifteen percent (15%), which fifteen percent (15%) is hereby understood and agreed to include all overhead expense and profits, when agreed upon in writing by Engineer and Contractor and approved by the Owner before said work is commenced; subject to all other conditions of the contract. The Contractor shall, on or before the tenth (10th) day of the month succeeding that in which any extra work shall have been performed, file with the Engineer his claim and an account giving the itemized cost of such work and shall give the Engineer access to all accounts, bills, and vouchers relating thereto.

4. PARTIAL ESTIMATES

Between the 25th day and last day of each month, the Contractor will make an approximate estimate of the value of the work done and/or materials furnished during that month under these specifications and submitted to the Engineer for approval. Whenever the said estimate or estimates of work done and/or materials furnished since the last previous estimate exceed one hundred dollars (\$100.00) in amount, ninety percent (90%) of such estimated sum will be paid.

5. PAYMENTS WITHHELD

Should any defective work or materials be discovered or should a reasonable doubt arise as to the integrity of any part of the work completed prior to the final acceptance and payment, they will be deducted from the first estimate rendered after the discovery of such work an amount equal in value to defective or questioned work and this work will not be included in a subsequent estimate until the defects have been remedied or the cause for doubt removed.

6. ACCEPTANCE AND FINAL PAYMENT

Upon completion of any contract and before final acceptance, a final inspection must be made by Engineer to determine whether the work has been completed in accordance with the contract and specifications. All prior partial estimates and payments shall be subject to correction in the final estimate and payment. When the work has been so completed and certified to the Owner, the work will be considered accepted and the final estimate shall be executed and submitted.

MEASUREMENT AND PAYMENT

7. MEASUREMENT & PAYMENT

Bid Item No. 1 – Chemical Building Expansion

This item shall consist of furnishing and supplying all materials, equipment, labor, cost and incidentals necessary to construct the modifications and expansion to the existing chemical feed building and piping as indicated on the drawings and in these specifications. This item shall include but not be limited to the following:

- Excavation, bedding, vapor barrier for the chemical building expansion;
- Construction of concrete footings and foundation walls for the chemical building expansion;
- Installation of the new red iron frame for the chemical building expansion;
- Installation of the new metal wall and roof panels for the chemical building expansion;
- Installation of the new insulation for the chemical building expansion;
- Exploration of the existing metal building, footing and foundation walls for determining connections points for project improvements;
- Relocation of existing chemical feed lines as shown on the drawing;
- Construction of new bulk alum and bulk polymer chemical delivery lines, quick connects and tanker connection points;
- Installation of new bulk alum tank;
- Relocation of existing polymer tanks;
- Remove metal roof and wall panel from existing building as required for construction of the building expansion;
- Furnish new chemical feed pumps;
- Install new lights, heating and electrical improvements;
- Existing utility location and excavation prior to construction;
- Install new metal steps and handrail;
- Final grading;
- Erosion control fence during construction;
- Installation of solid slab sod upon completion of the project.

Measurement & Payment

Measurement for work under this item shall be by lump sum and shall be for furnishing and installing all equipment and materials as indicated on the plans and as described in the specifications. Payment for work under this item shall be at the lump sum price bid by the contractor and upon acceptance of the completed work for all materials, equipment, labor, power, sheeting/shoring, and incidental costs associated with construction of this item.

MEASUREMENT AND PAYMENT

SECTION 01300

SUBMITTALS

PART 1 - GENERAL

1. DESCRIPTION

This section indicates the requirements for submittal data for equipment and non-equipment items to be furnished on this project.

PART 2 - EXECUTION

1. SHOP DRAWINGS

A. The Contractor shall submit to the Engineer, with such promptness as to cause no delay in his own work or in that of any other contractor, six (6) copies of all shop drawings and schedules required for the work of various trades, and the Engineer shall pass upon them with reasonable promptness, making necessary corrections. All shop drawings submitted must bear the stamp of approval of the Contractor as evidence that the drawings have met with the approval of the Contractor prior to being transmitted to the Engineer for review. All shop drawings submitted without the stamp of approval of the Contractor will not be considered and will be returned to the Contractor for proper resubmission. If the shop drawings indicate variances from the requirements of the contract because of standard shop practice or other reason, the Contractor shall make specific mention of such variation in his letter of transmittal in order that, if acceptable, suitable action may be taken for proper adjustment; otherwise the Contractor shall not be relieved of the responsibility of executing the work in compliance with the contract even though shop drawings have been reviewed.

B. Form of Drawings:

The drawings shall be numbered consecutively and shall accurately and distinctly present the following:

- (1) All working and erection dimensions.
- (2) Arrangement and sectional views.
- (3) Connections between functional parts.
- (4) Kinds of materials and finishes.
- (5) Parts list and description thereof.

Each drawing shall be dated and shall bear the name of the project, names of equipment or materials, and the locations at which the equipment or materials are to be installed in the work. The Owner's agent may decline to consider any shop drawings that do not contain complete data on the work and full information on related matters.

SUBMITTALS

2. PROJECT DATA

A. Manufacturer's catalog sheets, brochures, diagrams, schedules, performance charts, illustrations, and other standard descriptive data shall have each copy clearly marked to identify pertinent materials, products or models. Where applicable, the data will include:

- (1) Dimensions and clearances.
- (2) Shop performance characteristics and capacities.
- (3) Wiring diagrams and controls.

B. All submittals must bear the stamp of approval of the Contractor as evidence that the data has been checked by the Contractor.

3. SUBMITTAL PROCEDURE

The procedure for review of drawings shall be as follows:

A. The Contractor shall submit six (6) prints of drawings to the Engineer for his approval. The submission of drawings shall be accompanied by a letter of transmittal (3 copies), containing the name of the project, the name of the Contractor, the number of drawings, titles, and other requirements.

B. When a drawing is satisfactory to the Engineer, three (3) prints will be stamped or marked "Approved as Noted", be dated and the required copies thereof will be returned to the Contractor by letter.

C. Should a drawing be unsatisfactory to the Engineer, he will stamp thereon "Revise and Resubmit", and will return one (1) or more copies thereof to the Contractor with the necessary corrections and changes indicated. The Contractor must make such corrections and changes and again submit at least six (6) prints of the drawings for approval. The Contractor shall revise and resubmit the working drawings as required by the Engineer, until acceptance thereof is obtained.

D. The Contractor shall allow sufficient time for preliminary review, correction and re-submission, and final review of all working (shop) drawings. The Contractor should allow not less than fourteen (14) days for each review. Drawings of items critical to job progress, when requested in writing by the Contractor, will be given priority review.

4. RECORD DRAWINGS

The Contractor shall provide the Engineer with construction record drawings reflecting items as constructed.

SUBMITTALS

SECTION 01310

CONSTRUCTION SCHEDULES

PART 1 - GENERAL

1. GENERAL WORK

A. Before any work is started on this contract, the Contractor shall submit to the Engineer six (6) copies of a detailed schedule for progression of the work. The schedule shall contain, but not be limited to, areas, dates and duration of construction. The Contractor will revise his schedule as approved and directed in writing by the Engineer at no additional increase in contract price.

B. At least every thirty (30) days, the schedule shall be revised as necessary to reflect changes in the progress of the work.

C. The Owner may require the Contractor to add to his plant, equipment, or construction forces, as well as increase the working hours, if operations fall behind the approved schedule to an extent that the completion of the work within the specified time appears doubtful.

2. SPECIFIC WORK

A. Road Closings and Crossings:

Not applicable.

B. Utility Service Interruptions:

If utility service must be discontinued in order to perform the work required, the Contractor shall provide a detailed schedule indicating locations, dates, and time frames which will be involved.

CONSTRUCTION SCHEDULES

SECTION 01410

TESTING LABORATORY SERVICES

PART 1 - GENERAL

1. SCOPE

This section covers the responsibility for obtaining testing laboratory services and field-testing.

2. EARTHWORK

The Contractor will be responsible for "all" payments for testing laboratory services, initial testing and re-testing, if required, in connection with compaction and moisture testing for fill, backfill, subgrade, sub base construction and concrete testing by the Contractor. If results of tests show failures in either compaction or moisture, the test shall be repeated. It will be the Contractor's responsibility to pay all cost incurred on retest.

The contractor shall submit to the Owner and Engineer their choice for a testing company. The Engineer shall review and approve the contractor's choice of testing company.

3. CONCRETE

The Contractor will be responsible for the selection and payment for testing laboratory services in connection with all concrete work. Field control tests, consisting of slump tests, and the servicing of compression test cylinders, shall be made under the supervision of the Engineer. The Contractor shall provide all equipment and supplies and the services as necessary for the field control testing. The contractor shall submit to the Owner and Engineer their choice for a testing company. The Engineer shall review and approve the contractor's choice of testing company.

All tests required for preliminary approval shall be made and an approved independent testing laboratory shall test all compression test cylinders for the entire project.

The frequency hereinafter specified for each field control test is a minimum. If additional field control tests are necessary, in the opinion of the Engineer, all such tests shall be made.

TESTING LABORATORY SERVICES

A. Slump:

A slump test shall be made for each 50 cubic yards of concrete. Slump shall be determined in accordance with ASTM C 143.

B. Compression Tests:

A minimum of one set of three concrete compression test cylinders shall be made each day for each 50 cubic yards of concrete placed. Two cylinders of each set shall be tested at an age of seven (7) days, another cylinder shall be tested at an age of twenty-eight (28) days, and the other cylinder reserved.

Concrete test cylinders shall be made, marked, cured, stored, and delivered to the laboratory in accordance with ASTM C 39, by the Contractor. The Contractor shall pay for all retesting required due to test failures.

4. PIPE UTILITIES

The Contractor shall be responsible for providing all equipment, labor, and supplies necessary to conduct all testing required on equipment under the contract documents. The Engineer shall supervise all testing but assumes no liability in connection with the performance of such test.

5. EQUIPMENT TESTS

The Contractor shall be responsible for providing all equipment, labor, and supplies necessary to conduct all testing required on equipment under the contract documents. The Engineer shall supervise all testing but assumes no liability in connection with the performance of such work.

6. QUALIFICATION OF LABORATORY

A. Meet "Recommended Requirements for Independent Laboratory Qualification", published by American Council of Independent Laboratories.

B. Meet basic requirements of ASTM E 329, "Standards of Recommended Practice for Inspection and Testing Agencies for Concrete and Steel as Used in Construction".

C. Authorized to operate in the state in which the project is located.

D. Submit copy of report of inspection of facilities made by Materials Reference Laboratory of National Bureau of Standards during the most recent tour of inspection, with memorandum of remedies of any deficiencies reported by the inspection.

TESTING LABORATORY SERVICES

E. Testing Equipment:

- (1) Calibrated at reasonable intervals by devices of accuracy traceable to either:
 - (a) National Bureau of Standards.
 - (b) Accepted Values of Natural Physical Constants.

7. CONTRACTOR'S GENERAL RESPONSIBILITIES

No failure of test agencies to perform adequate inspections or tests or to properly analyze or to properly analyze or report results shall relieve Contractor of responsibility for fulfillment of requirements of contract documents. It is recognized that required inspection and testing program is intended to assist the Contractor, Owner, Engineer, and governing authorities in nominal determination of probable compliances with requirements for certain elements of work. The program is not intended to limit the Contractor's regular quality control program, as needed for general assurance of compliances. The Contractor shall pay for all tests made on materials, which fail to meet specification requirements.

8. CONTRACTOR'S DUTIES

- A. Furnish copies of products test reports as required.
- B. Furnish incidental labor and facilities.
 - (1) To produce access to work to be tested.
 - (2) To facilitate inspections and tests.
 - (3) For storage and curing of test samples.
- C. Provide to the laboratory, the design mix criteria to be used for concrete, and other criteria for materials mixes that require control by the testing laboratory.

9. SPECIFIC TESTS, INSPECTIONS AND METHODS REQUIRED FOR CAST-IN-PLACE CONCRETE

A. Tests for Concrete Materials:

- (1) Test aggregates by method of sampling and testing of ASTM C 33.
- (2) For Portland cement, submit certificate of materials properties and compliance with requirements of ASTM C 150.
- (3) Submit written reports to the Owner's Representative for each material sampled and tested, prior to start of work.

TESTING LABORATORY SERVICES

- (4) Provide project identification name and number, date of report, name of Contractor, name of concrete testing service, source of concrete aggregates, material manufacturer and brand name for manufactured materials, values specified in the referenced specification for each material and test results. Indicate whether or not material is acceptable for intended use.
- (5) Certificate of material properties and compliance with specified requirements may be submitted in lieu of testing, when acceptable to the Owner's Representative. The materials producer and the Contractor must sign certificates of compliance.

B. Concrete Mix Design and Testing:

- (1) All concrete, cured and tested in accordance with applicable ASTM standards shall develop an ultimate strength at 28 days. Eighty percent (80%) of the 28-day ultimate strength shall be indicated by tests conducted at 7 days.
- (2) Prepare design mixes for each type and strength of concrete in accordance with applicable provisions of ASTM C 94.
- (3) Proportion mixes by either laboratory trial batch or field experience methods, using materials to be employed on the project for each class of concrete required, complying with ACI 211.1 for normal weight concrete and ACI 211.2 for structural light weight concrete, and report to the Owner's Representative the following data:
 - (a) Complete identification of aggregate source of supply.
 - (b) Tests of aggregates for compliance with specified requirements.
 - (c) Scale weight of each aggregate.
 - (d) Absorbed water in each aggregate.
 - (e) Brand, type and composition of cement.
 - (f) Brand, type and amount of each admixture.
 - (g) Amounts of water used in trial mixes.
 - (h) Proportions of each material per cubic yard.
 - (i) Gross weight and yield per cubic yard of the trial mixtures.
 - (j) Measured slump.
 - (k) Measured air content.
 - (l) Compressive strength developed at 7 days and 28 days from not less than 3 test cylinders cast for each 7- and 20-day test, and for each design mix.

- (4) Submit written reports to the Owner's Representative of each proposed mix for each type of concrete at least 15 days prior to start of work.
- (5) **Laboratory Trial Batches:** When laboratory trial batches are used to select concrete proportions, prepare test specimens in accordance with ASTM C 192 and conduct strength tests in accordance with ASTM C 39, as specified in ACI 301:
- (a) Establish a curve showing relationship between water-cement ratio (or cement content) and compressive strength, with at least 3 points representing batches that produce strengths above and below that required. Use not less than 3 specimens tested at 28 days, or an earlier age when acceptable to the Owner's Representative, to establish each point on the curve. The maximum allowable water-cement ratio for the concrete for the structure shall be as determined from these curves and shall correspond to an average compressive strength 15 percent greater than the specified strength.
- (6) **Field Experience Method:** When field experience methods are used to select concrete proportions, establish proportions as specified in ACI 301.
- (a) Strength data for establishing standard deviation will be considered suitable if the concrete production facility has certified records consisting of at least 30 consecutive tests in one group or the statistical average for 2 groups totaling 30 or more tests, representing similar materials and project conditions.
- (1a) **Standard Deviation:** If standard deviation exceeds 600 psi or if no suitable records are available, select proportions to produce an average strength of at least 1200 psi greater than the required compressive strength of concrete.

- (2a) After sufficient experience and test data become available from the job, using ACI 214 methods of evaluation, the standard deviation may be reduced when the probable frequency of tests more than 500 psi below required compressive strength will not exceed 1 in 100, and that the probable frequency of an average of 3 consecutive tests below required compressive strength will not exceed 1 in 100.
- (7) **Adjustment to Concrete Mixes:** Mix design adjustments may be requested by the Contractor when characteristics of materials, job conditions, weather, test results, or other circumstances warrant; at no additional cost to the Owner and as accepted by the Owner's representative. Laboratory test data for revised mix design and strength results may be submitted to and accepted by the Owner's Representative before using in the work.
- (8) **Admixtures:**
- (a) Use air-entraining admixture in all concrete, unless otherwise indicated. Add air-entraining admixture at the manufacturer's prescribed rate to result in concrete at the point of placement having air content within the following limits:
- 4% for maximum 2" aggregate.
6% for maximum ¾" aggregate.
7% for maximum ½" aggregate.
- (b) Use admixture for water reducing and set-control in strict compliance with the manufacturer's directions.
- (c) Use amounts of admixtures as recommended by the manufacturer for climatic conditions prevailing at the time of placing. Adjust quantities and types of admixtures as required to maintain quality control.
- (d) Air content should be measured using the Volumetric Method described in ASTM C 173.
- (9) **Slump Limits:**
- (a) Proportion and design mixes to result in concrete slump at the point of placement as follows:

- (1a) Ramps and Sloping Surfaces:
Not more than 3 inches.
- (2a) Reinforced Foundation Systems:
Not less than 1 inch and not more than 4 inches.
- (3a) All other Normal Weight Concrete:
Not less than 1 inch and not more than 4 inches.
- (4a) Light Weight Concrete Topping:
Not less than 1 inch and not more than 3 inches.

C. **Field Testing:**

- (1) The testing laboratory shall take samples and conduct tests to evaluate concrete. Failure to detect defective work or materials will not, in any way, prevent rejection later when such defects are discovered, nor will it be construed as obligating the Owner to make final acceptance. Sampling and testing for field quality control during the placement of concrete shall be as follows:
 - (a) **Sampling Fresh Concrete:** ASTM C 172, except modified for slump to comply with ASTM C. 94.
 - (b) **Slump:** ASTM C 143, one test for each set of compressive strength tests and whenever the indication of change requires.
 - (c) **Air Content:** ASTM C 231, pressure method; one for every strength test and whenever the indication of change requires.
 - (d) **Compression Test Specimens:** ASTM C 31; one set of 6 standard cylinders for each compressive strength test, unless otherwise directed.
 - (1a) Cast and store cylinders for laboratory cured test specimens and field-cured test specimens as specified in ASTM C 31.
 - (2a) Four cylinders shall be delivered to the laboratory about 24 hours after being molded and shall be moist-cured under laboratory conditions.

TESTING LABORATORY SERVICES

- (3a) The other two cylinders shall be kept on or near the work and shall receive the same protection from the elements and the same curing treatment as is given that portion of the work from which the sample was taken. Footing cylinders shall be treated as if taken from the super-structure.
- (e) **Concrete Temperature:** Test hourly when air temperature is 40 degrees F. and below, and when 80 degrees F. and above; and each time a set of compression test specimens is made.
- (f) **Compressive Strength Tests:** ASTM C 49; one set for each 100 cubic yards or fraction thereof, of each mix design placed in any one day or for each 5,000 square feet of surface area placed or as directed; 2 specimens tested at 7 days, 3 specimens tested at 28 days, and one specimen retained in reserve for later testing if required.
- (1a) When the total quantity of a given mix design of concrete is less than 50 cubic yards, the strength tests may be waived by the Owner's Representative if, in his judgment, adequate evidence of satisfactory strength is provided.
- (2a) When the strength of field-cured cylinders is less than 85% of companion laboratory-cured cylinders, evaluate current operations and provide corrective procedures for protecting and curing the in-place concrete.
- (g) Reports of compressive strength tests shall contain the project identification name and number, date of concrete placement, name of contractor, name of concrete supplier and truck number, name of concrete testing service, concrete type and class, location of concrete batch in the structure, design compressive strength at 28 days, concrete mix proportions and materials; compressive breaking strength and type of break for both 7-day tests, slump and air content.

D. Additional Tests:

- (1) The testing service will make additional tests of in-place concrete when test results indicate the specified concrete strengths and other characteristics have not been attained in the structure, as directed by the Owner's Representative. The testing service shall conduct tests to determine the strength and other characteristics of the in-place concrete by compression tests on cored cylinders complying with ASTM C 42, or by load testing specified in ACI 318, or other acceptable non-destructive testing methods, as directed. The Contractor shall pay for such tests conducted, and any other additional testing as may be required, when unacceptable concrete is verified to exist.

E. Evaluation of Quality Control Tests:

- (1) Do not use concrete delivered to the final point of placement that has slump or total air content outside the specified values.
- (2) Compressive strength tests for laboratory cured cylinders will be considered satisfactory, if the averages of all sets of three consecutive compressive strength tests result equal or exceed the 28-day design compressive strength of the type or class of concrete; and, no individual strength test falls below the required compressive strength by nor more than 500 psi. In all cases where the average strength of the laboratory control cylinders shown by these tests for any portion of the structure falls below the minimum ultimate compressive strengths, the Owner's Representative shall have the right to order a change in mix or in water content for the remaining portion of the structure.
- (3) Strength tests of specimens cured under field conditions shall be required by the Owner's Representative to check adequacy of curing and protecting of the concrete placed. Specimens shall be molded by the field quality control laboratory at the same time and from the same samples as the laboratory cured specimens.
 - (a) Provide improved means and procedures for protecting concrete when the 28-day compressive strength of the field-cured cylinders is less than 85% of companion laboratory-cured cylinders.
 - (b) When laboratory-cured cylinder strengths are appreciably higher than the minimum required compressive strength, field-cured cylinder strength by more than 500 psi even though the 85% criterion is not met.

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(c) If individual tests of laboratory-cured specimens produce strengths more than 500 psi below the required minimum compressive strength, or if tests of field-cured cylinders indicate deficiencies in protection and curing, provide additional measures to assure that the load-bearing capacity of the structure is not jeopardized. If the likelihood of low-strength concrete is confirmed and computations indicate the load-bearing capacity may have been significantly reduced, tests of cores drilled from the area in question may be required.

(4) If the compressive strength tests fail to meet the minimum requirements specified, the concrete represented by such tests will be considered deficient in strength and subject to additional testing as herein specified.

F. Formed Concrete Dimensional Tolerances:

(1) Formed concrete having any dimension smaller than required, and outside the specified tolerance limits, will be considered deficient in strength and subject to additional testing as herein specified.

(2) Formed concrete having any dimension greater than required will be rejected if the appearance or function of the structure is adversely affected, or if the larger dimensions interfere with other construction. Repair or remove and replace rejected concrete as required to meet the construction conditions. When permitted, accomplish the removal of excessive material in a manner to maintain the strength of the section without affecting function and appearance.

G. Strength of Concrete Structures:

(1) The strength of concrete structures in-place will be considered potentially deficient if it fails to comply with any of the requirements that control the strength of structure, including the following conditions:

(a) Failure to meet compressive strength test requirements.

(b) Concrete that differs from the required dimensions or location in such a manner as to reduce strength.

- (c) Concrete subjected to damaging mechanical disturbances, particularly load stresses, heavy shock, and excessive vibration.
- (d) Poor workmanship and quality control likely to result in deficient strength.

SECTION 01666

TESTING OF PIPING SYSTEMS AND STRUCTURES

PART 1 - GENERAL

1. SCOPE

This section covers responsibilities for the water pressure testing of piping systems. This section is general in scope and may cover areas not part of the project. Specific testing procedures for individual parts of work to be performed may be covered in with the specifications for a particular portion of the work. If this occurs, the Engineer will approve which method will be used. No air pressure testing will be allowed.

2. PRESSURE TESTING WATER LINE, PRESSURE PIPING AND FORCE MAINS

A. All testing shall be performed in accordance with AWWA C600-93 and AWWA C605-94.

B. **Time for Making Tests:** Tests shall be made only after completion of partial or complete backfill, and not until at least thirty-six (36) hours after the last cement joint to be tested has been made, and at least thirty-six (36) hours after the last cement thrust or reaction backing has been cast with high early strength cement, or at least seven (7) days after the last concrete thrust or reaction backing has been cast with standard strength cement.

C. The pipe line shall be slowly filled with water from a tap in the pipe, and the specified test pressure, measured at the point of lowest elevation, shall be supplied by means of a pump connected to the pipe in a satisfactory manner. The pump, pipe connection, and all necessary apparatus, including gauges and meters, shall be furnished by the Contractor. The Owner will provide to the Contractor water for filling lines and making tests at a rate equal to the Owner's costs.

D. Before applying the specified test pressure, all air shall be expelled from the pipe. To accomplish this, taps shall be made if necessary, at the points of highest elevation and afterwards tightly plugged. At intervals during the test, the entire route of the pipe line shall be inspected to locate any leaks or breaks. If any are found, these shall be stopped, or in the case of valves in the main lines or bulkheads, provision shall be made for measuring the leakage during the test. The test shall be repeated until satisfactory results are obtained.

E. The water pressure test shall be made at 150% of the maximum anticipated sustained operating pressure or the rated pressure (class) of the pipe, whichever is greater. The duration of the test shall be 2 hours after the line has been filled with water and brought up to test pressure and all air in the pipeline has been expelled. Leakage shall be defined as the quantity of water that must be supplied into the section being tested to maintain a pressure within 5 psi (34kPa) of the specified leakage-test pressure. No installation will be accepted if the leakage is greater than that determined by the following Tables 1 and 2. Should any test of the pipe in place disclose leakage greater than that specified, the Contractor shall at his own expense, locate and repair the defective joints or pipe until the leakage is within the specified allowance.

TABLE 1: Allowable leakage per 1,000 feet of PVC pipeline in gallons per hour.

| Average Test Pressure, psi | Nominal Pipe Diameter, Inches | | | | | | | | | | | | | | |
|----------------------------|-------------------------------|---------|--------------|---------|---------|---------|---------|---------|---------|---------|---------|--|--|--|--|
| | 4 | 6 | 8 | 12 | 14 | 16 | 18 | 20 | 24 | 30 | 36 | | | | |
| 300 | 0.46812 | 0.70218 | 0.93624 | 1.40437 | 1.63843 | 1.87249 | 2.10655 | 2.34061 | 2.80873 | 3.51091 | 4.21310 | | | | |
| 275 | 0.44819 | 0.67229 | 0.896.3 9 | 0.15736 | 1.56867 | 1.79277 | 2.01687 | 2.24096 | 2.68916 | 3.36144 | 4.03373 | | | | |
| 250 | 0.42733 | 0.64100 | 0.85467 | 0.15003 | 1.49567 | 1.70934 | 1.92301 | 2.13667 | 2.56401 | 3.20501 | 3.84601 | | | | |
| 225 | 0.40541 | 0.60811 | 0.81081 | 0.14233 | 1.41892 | 1.62162 | 1.82432 | 2.02703 | 2.43243 | 3.04054 | 3.64965 | | | | |
| 200 | 0.38222 | 0.57333 | 0.76444 | 1.14666 | 1.33777 | 1.52888 | 1.71999 | 1.91110 | 2.29332 | 2.86665 | 3.43998 | | | | |
| 175 | 0.03416 | 0.05125 | 0.71507 | 1.07260 | 1.25137 | 1.43014 | 1.60890 | 1.78767 | 2.14520 | 2.68150 | 3.21781 | | | | |
| 150 | 0.33101 | 0.49652 | 0.66202 | 0.99304 | 1.15854 | 1.32405 | 1.48955 | 1.65506 | 1.98607 | 2.48259 | 2.97911 | | | | |
| 125 | 0.30217 | 0.45326 | 0.60434 | 0.90651 | 1.05760 | 1.20869 | 1.35977 | 1.51086 | 1.81303 | 2.26629 | 2.71954 | | | | |
| 100 | 0.27027 | 0.40541 | 0.54054 | 0.81081 | 0.94595 | 1.08108 | 1.21622 | 1.35135 | 1.62162 | 2.02703 | 2.43243 | | | | |
| 75 | 0.23406 | 0.35109 | 0.46812 | 0.70218 | 0.81921 | 0.93624 | 1.05327 | 1.17030 | 1.40437 | 1.75546 | 2.10655 | | | | |
| 50 | 0.19111 | 0.28666 | 0.38222 | 0.57333 | 0.66888 | 0.76444 | 0.85999 | 0.95555 | 1.14666 | 1.43332 | 1.71999 | | | | |

TABLE 2: Allowable leakage per 1,000 feet of Ductile Iron pipeline in gallons per hour.

| Average Test Pressure, psi | Nominal Pipe Diameter, Inches | | | | | | | | | | | | | | | | | |
|----------------------------|-------------------------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|-------|
| | 3 | 4 | 6 | 8 | 10 | 12 | 14 | 16 | 18 | 20 | 24 | 30 | 36 | 42 | 48 | 54 | 60 | 64 |
| 450 | 0.48 | 0.64 | 0.95 | 1.27 | 1.59 | 1.91 | 2.23 | 2.55 | 2.87 | 3.18 | 3.82 | 4.78 | 5.73 | 6.69 | 7.64 | 8.60 | 9.56 | 10.19 |
| 400 | 0.45 | 0.60 | 0.90 | 1.20 | 1.50 | 1.80 | 2.10 | 2.40 | 2.70 | 3.00 | 3.60 | 4.50 | 5.41 | 6.31 | 7.21 | 8.11 | 9.01 | 9.61 |
| 350 | 0.42 | 0.56 | 0.84 | 1.12 | 1.40 | 1.69 | 1.97 | 2.25 | 2.53 | 2.81 | 3.37 | 4.21 | 5.06 | 5.90 | 6.74 | 7.58 | 8.43 | 8.99 |
| 300 | 0.39 | 0.52 | 0.76 | 1.04 | 1.30 | 1.56 | 1.82 | 2.08 | 2.34 | 2.60 | 3.12 | 3.90 | 4.68 | 5.46 | 6.24 | 7.02 | 7.90 | 8.32 |
| 275 | 0.37 | 0.50 | 0.75 | 1.00 | 1.24 | 1.49 | 1.74 | 1.99 | 2.24 | 2.49 | 2.99 | 3.73 | 4.48 | 5.23 | 5.98 | 6.72 | 7.47 | 7.97 |
| 250 | 0.36 | 0.47 | 0.71 | 0.95 | 1.19 | 1.42 | 1.66 | 1.90 | 2.14 | 2.37 | 2.85 | 3.56 | 4.27 | 4.99 | 5.70 | 6.41 | 7.12 | 7.60 |
| 225 | 0.34 | 0.45 | 0.68 | 0.90 | 1.13 | 1.35 | 1.58 | 1.80 | 2.03 | 2.25 | 2.70 | 3.38 | 4.05 | 4.73 | 5.41 | 6.03 | 6.76 | 7.21 |
| 200 | 0.32 | 0.43 | 0.64 | 0.85 | 1.06 | 1.28 | 1.48 | 1.70 | 1.91 | 2.12 | 2.55 | 3.19 | 3.82 | 4.46 | 5.09 | 5.73 | 6.37 | 6.80 |
| 175 | 0.30 | 0.40 | 0.59 | 0.80 | 0.99 | 1.19 | 1.39 | 1.59 | 1.79 | 1.98 | 2.38 | 2.98 | 3.58 | 4.17 | 4.77 | 5.36 | 5.96 | 6.36 |
| 150 | 0.28 | 0.37 | 0.55 | 0.74 | 0.92 | 1.10 | 1.29 | 1.47 | 1.66 | 1.84 | 2.21 | 2.76 | 3.31 | 3.86 | 4.41 | 4.97 | 5.52 | 5.88 |
| 125 | 0.25 | 0.34 | 0.50 | 0.67 | 0.84 | 1.01 | 1.18 | 1.34 | 1.51 | 1.68 | 2.01 | 2.52 | 3.02 | 3.53 | 4.03 | 4.53 | 5.04 | 5.37 |
| 100 | 0.23 | 0.30 | 0.45 | 0.60 | 0.75 | 0.90 | 1.05 | 1.20 | 1.35 | 1.50 | 1.80 | 2.25 | 2.70 | 3.15 | 3.60 | 4.05 | 4.50 | 4.80 |

TESTING OF PIPING AND SYSTEMS AND STRUCTURES

F. Valves shall not be operated in either direction at a differential pressure exceeding the rated valve working pressure. Use of a test pressure greater than the rated valve pressure can result in trapped test pressure between the gates of a double-disc gate valve. For tests at these pressures, the test setup should include a provision, independent of the valve, to reduce the line pressure to the rated valve pressure on completion of the test. The valve can then be opened enough to equalize the trapped pressure with the line pressure, or fully opened if desired. The test pressure shall not exceed the rated pressure of the valves when the pressure boundary of the test section includes closed, resilient-seated gate valves or butterfly valves.

G. Acceptance of installation shall be determined on the basis of allowable leakage. If any test of laid pipe discloses leakage greater than that specified in Section 2, repairs or replacements shall be accomplished in accordance with the specifications. All visible leaks are to be repaired regardless of the amount of leakage.

H. Prior to placing the installed water line in service, the new pipe and all exposed sections and appurtenances of existing pipelines shall be cleaned and disinfected in accordance with ANSI/AWWA C651, unless otherwise specified. Pipelines shall be flushed following completion of disinfection procedures. Ductile iron pipe should be flushed within 24 hours to prevent exposure to high concentration of chlorine which could damage the asphaltic seal coating. Provision should be made to avoid contamination of existing mains by cross-connection during testing, disinfection and flushing of new mains. Disposal of disinfection water shall comply with applicable regulations (see Appendix B of ANSI/AWWA C651).

3. GRAVITY SEWER LINES: LEAK TEST

A. All Testing Methods:

All wyes, tees and stubs shall be plugged with flexible jointed caps, or acceptable alternate, securely fastened to withstand the internal test pressure. Such plugs or caps shall be readily removable. All lines will be tested.

B. Exfiltration Method Procedures:

The section of sewer to be tested shall be sealed by inserting inflatable rubber bags in the pipes or by other means approved by the Engineer, and then water shall be introduced into a manhole until the section is completely filled. The Contractor shall fill the pipe to the test level prior to the time of exfiltration testing to permit normal absorption into the pipe walls. Duration of the test shall be two hours. No section of sewer will be accepted until the exfiltration does not exceed 200 gallons per inch diameter per mile per 24 hours, as tabulated on the following page.

| Pipe Diameter (Inches) | Allowable Leakage (Gal per 2 Hr. per 1,000 Ft. of Pipe) |
|---------------------------|---|
| 6 | 18.94 |
| 8 | 25.25 |
| 10 | 31.57 |
| 12 | 37.88 |
| 16 | 50.51 |
| 24 | 75.76 |

C. All localized or spurting leaks detected in sewers or in floors or walls of appurtenant structures shall be permanently stopped. Should any leaks, defective joints or defective construction be found, they shall be promptly corrected and should any defective pipes or specials be discovered, they shall be removed and replaced in a satisfactory manner at the Contractor's expense.

D. **Gravity Sewer Lines: Deflection Test:**

Thirty days (30) minimum after backfill is in place, PVC sewer pipe shall be measured for vertical ring deflection using a deflection testing mandrell in accordance with the Standard Details. The deflection testing shall be done by the Contractor in the presence of the Engineer or his designated representative. Maximum ring deflection of the installed pipe shall be limited to 5% of the average inside diameter as defined by ASTM Designation D2680. All pipe exceeding the allowable deflection shall be replaced by the Contractor at no additional cost to the Owner. Equipment used in making the measurements shall be subject to the approval of the Engineer. The Contractor will furnish the appropriate mandrell for the deflection test, which shall have a diameter equal to 95% of the pipe inside diameter. Mechanical devices to pull the mandrell through the pipe will not be allowed.

4. **STRUCTURES**

Structures shall be tested before backfilling by filling with water to overflowing, or other level as directed by the Engineer, and observing the water surface level twenty-four (24) hours thereafter. Exterior surfaces shall be examined for leakage. Leakage is within allowable limits for structures when there is no visible sign of leakage and where the

water surface does not drop more than one (1) inch during the twenty-four (24) hour leakage test. Dampness on the exterior wall surface during the test period will not be considered as leakage, except in the case of prestressed concrete structures. If the leakage exceeds the allowable limit, the work shall be repaired and retested.

TESTING OF PIPING AND SYSTEMS AND STRUCTURES

SECTION 01710

CLEAN UP

PART 1 - GENERAL

1. DURING CONSTRUCTION

The Contractor shall at all times keep the job site as free from all materials, debris, and rubbish, as is practicable and shall remove same from any portion of the job site, when, in the opinion of the Engineer, it becomes objectionable or interferes with the progress of the project.

2. FINAL

Upon completion of the work, the Contractor shall remove from the site, all plant, material, tools and equipment belonging to him, and leave the site with an appearance acceptable to the Engineer.

A. Clean Equipment and Materials: The Contractor shall thoroughly clean all equipment and materials installed by him and shall deliver all such materials and equipment in a bright, clean, polished and new-appearing condition.

B. Restoration of Landscape Damage: Any landscape feature scarred or damaged by the Contractor's equipment or operations shall be restored as nearly as possible to its original condition at the Contractor's expense. The Owner will decide what method of restoration shall be used.

C. Post-Construction Clean Up and Obliteration: The Contractor shall obliterate all signs of temporary construction facilities such as haul roads, work areas, structures, foundations of temporary structures, stockpiles of excess or waste materials or any other vestiges of construction, as directed by the Owner.

D. Restoration of Roads: The Contractor shall be responsible for restoring all roads to drivable condition, equal to or greater than original condition.

E. Restoration of Fence: The Contractor shall be responsible for reconstructing all fences, removed or damaged during construction, to original condition.

F. Rocks: Rocks five (5") inches and larger shall be removed from the site.

CLEAN UP