

**DIVISION II  
MATERIAL SPECIFICATIONS  
APPROVED FITTINGS MANUFACTURERS**

**Tapping Saddles and Valves**

Mueller (DIP)  
Clow (DIP)  
American (DIP)  
Tyler (DIP)  
PowerSeal (DIP)  
Smith-Blair (DIP)  
Hanson Concrete (Conc)  
Price Bros (Conc)  
TD Williamson (Conc)  
Baker Series 428 (Steel)  
Rockwell 622 (Steel)  
Dresser (DIP)  
Ford (DIP)  
JCM Industries

**Restrained Joint Systems**

American Flex-Ring (DIP)  
EBAA Megalug (DIP,PVC)  
Ford Meter Box Uni-Flange (DIP,PVC)  
Star StarGrip (DIP,PVC)  
Price Snap Ring & Harness Joint (Conc)  
Hanson Snap Ring & Harness Joint (Conc)  
Northwest weld (Steel)  
Hanson weld (Steel)  
USPipe TR Flex (DIP grav sanit, water)  
Griffin SNAP-LOK (DIP grav sanit, water)  
McWane THRUST-LOCK (DIP grav sanit, water)  
Smith-Blair CAM-LOCK  
Clow TUFGRIP  
Sigma Corporation ONE-LOK Series (DIP)  
SIP Industries EZ GRIP (DIP, PVC)

**Resilient Wedged Gate Valves**

American  
Mueller (Aquagrip allowed)  
M&H  
Clow  
Kennedy  
US Pipe  
AVK

**Ball Valves**

Pratt

**Couplings for Out-of-Round CI Pipe**

Viking-Johnson  
Smith-Blair  
Straub

**Check Valves**

M&H  
American Flow Control  
Mueller  
US Pipe  
Clow  
Kennedy  
Watts  
ValMatic

**4-Way Fire Hydrants**

American Darling  
Mueller (Aquagrip allowed)

**3-Way Hydrants**

American Darling B84B  
Kennedy Guardian  
Mueller Centurian (Aquagrip allowed)  
Clow Medallion

**Valve Boxes**

(Includes Debris Cap)

Tyler 6850 Series 562-S  
East Jordan 85502737 (562-S)  
SIGMA VB 262-35  
Star VB 562SHD

**4" Reversible Rim & 23 1/4" Lids (Water)**

Neenah 1797-4R-TUL-WAT  
Deeter 1155-TUL-WAT  
East Jordan 2132R-TUL-WAT  
Sigma MH121WV-35

**Uniflanges**

EBAA Series 2100 Megaflange

### **1 ½" & 2" Meter Setters**

Ford B-C10046-011 (1 ½"), B-C10046-013(2")  
Mueller 1 ½"x15"B2423, 2"x15"B2423  
AYMcDonald 20C615WFFF6654 (1 ½")  
AYMcDonald 20C715WGFF7766x22.75 (2")

### **Air Relief Valves (Water)**

APCO  
Crispin  
ValMatic  
A.R.I

### **Air Relief Valves (Sanitary Sewer)**

A.R.I

### **Butterfly Valves**

Pratt  
Mueller

### **Manhole Grade Adjustment Rings**

East Jordan V-1901 series (CI only)  
Deeter 1856 (CI only)

### **Chimney Adjustment Rings**

GNC Concrete Products (Concrete)  
Ladtech (HDPE)

### **Fittings**

American  
Griffin  
McWane  
Clow  
Star  
Sigma  
US Pipe  
Tyler  
East Jordan  
Pipeline Components (PCI)  
SIP Industries

### **4" Reversible Rim & 23 ¼" Lids (Stm)**

(Only McGard system allowed for sealed lids)  
Neenah 1797-4R-TUL-STM  
Deeter 1155-TUL-STM  
East Jordan 2132R-TUL-STM  
Sigma MH121TW-35

### **4" Reversible Rim & 23 ¼" Lids (San)**

(Only McGard system allowed for sealed lids)  
Neenah 1797-4R-TUL-SAN  
Deeter 1155-TUL-SAN  
East Jordan 2132R-TUL-SAN  
Sigma MH121N-35

### **8" Non-Reversible Rim & 23 1/4" Lid (San)**

(Only McGard system allowed for sealed lids)  
Deeter 1265-TUL-SAN  
Neenah 1797-TUL-SAN  
East Jordan 2132-TUL-SAN  
Sigma MH122N-35

### **4" Reversible Rim & 31 ½" Lid (San)**

(Only McGard system allowed for sealed lids)  
Deeter 1296-R-TUL-SAN  
East Jordan 2230-R-TUL-SAN  
Sigma MH123N-35

### **8" Non-Rev Rim & 23 ¼" Lid (Stm)**

(Only McGard system allowed for sealed lids)  
Deeter 1265-TUL-STM  
Neenah 1797-TUL-STM  
East Jordan 2132-TUL-STM  
Sigma MH122T-35

### **4" Reversible Rim & 31 ½" Lid (Stm)**

(Only McGard system allowed for sealed lids)  
Deeter 1296-R-TUL-STM  
East Jordan 2230-R-TUL-STM  
Sigma MH123T-35

### **Cast Iron Curb Inlet – 6" Barrier**

Deeter 2445  
East Jordan 00760065  
Neenah R-3076-6BOK

### **Lampholes (with closed pickhole)**

East Jordan 3312800lid/3342800frame  
Deeter 1828  
Deeter 1828-B (Bolted Ring & Cover)

### **Vane Grates—"Drain to River" with "COT"**

Neenah 3076-3000  
East Jordan 00760033

**Type "D" 27 7/8" Circular Grate**

Deeter 1950  
East Jordan 00210032

**Bicycle Safe 17 3/4"x29 3/4" Grate**

Neenah 3076-0015  
EJ 44230231grate/FA1833032G0frame

**Bolted Bicycle Safe Trench Grate**

Neenah 3076-0019  
East Jordan 00697033

**Solid Knobby Frame/ 27 7/8" Circular Lid**

Deeter 1159 Frame /1159 Lid  
Neenah 1682-0001 Frame/R1682 Solid Lid  
East Jordan 00210002

**Vertical Standard Stormwater Grate**

Neenah R5050

**Cast Iron Curb Inlet – 8" Barrier**

Neenah R-3076-8BOK  
East Jordan 00760067

**Cast Iron Curb Inlet – 6" Mountable**

Neenah R-3076-6M  
East Jordan 00760063

**Single Inlet Frame**

Neenah 3076-0001  
East Jordan 00760011

**Center Inlet Frame**

Neenah 3078-0001  
East Jordan 00760017

**Left Inlet Frame**

Neenah 3077-0001  
East Jordan 00760013

**Right Inlet Frame**

Neenah 3077-0002  
East Jordan 00760015

**Water Meter Cans, Rims, Lids (non lockable)**

East Jordan 18 x 18 assembly 32534019  
(3/4" x 5/8")  
East Jordan 18 x 24 assembly 32535019 (1")  
East Jordan 36 x 36 Assembly 00842804 (1 1/2")  
East Jordan 36 x 36 Assembly NCR06-569B (2")  
Sigma 18 x 18 MB-161TT-35 (3/4" x 5/8")  
Sigma 18 x 24 MB-163TT-35 (1")  
Sigma 36 x 36 MB-147TT-35 (1-1/2")  
Sigma 36 x 36 MB-147T2-35 (2")

**PART 201 - CONCRETE**

201.1 CEMENT

201.1.1 All cement used in the work shall be a well-known brand of true Portland Cement and shall conform to the Standard Specifications for Portland Cement, ANSI/A.S.T.M. Designation C150. Unless otherwise permitted, the Contractor shall use only one brand of cement in the work and under no condition shall he use more than one brand of cement in the same structure. Cement, which for any reason has become partially set or contains lumps or cakes will be rejected and shall be removed from the site.

201.1.2 The acceptance or rejection of cement shall rest with the Engineer. All rejected cement shall be plainly marked for identification, shall be immediately removed from the work, and shall not be offered for inspection again. Cement kept in storage for several months may be subject to repeated tests, as directed by the Engineer.

- 201.1.3 The cement shall be delivered in strong cloth or paper bags. No cement shall be used or inspected unless delivered in the original package with the brand and name of the manufacturer plainly marked thereon. Each bag of cement shall contain approximately ninety-four pounds of cement, net weight, and four bags shall be the equivalent of one barrel. Packages received in broken or damaged condition will be rejected or accepted only as fractional packages.
- 201.1.4 The Contractor shall provide, at the site of the work, a suitable weather tight building, or buildings, having a tight floor properly blocked or raised from the ground, for the storage of cement. The building shall be large enough to permit keeping on hand a supply of cement in quantity sufficient to prevent delays or interruptions to the work, which might be due to the lack of cement. The cement shall be stored in such manner to permit easy access for the proper inspection and identification of each shipment. Cement in bags shall not be piled to a height in excess of seven feet. Suitable accurate scales shall be provided by the Contractor for weighing the cement. After it has been delivered to the job, the Contractor will not be permitted to remove or dispose of the cement in any way without the consent of the Engineer.
- 201.1.5 At the beginning of operations and at all other times while cement is required, the Contractor shall have, at the site of the work, an ample supply of acceptable cement and shall carefully guard against possible shortage on account of rejection, irregular deliveries, or any other cause.

## 201.2 WATER

- 201.2.1 All water used in mixing mortar or concrete shall be free from acid, alkali, oil, salt, vegetable, or other matter in sufficient quantity to be injurious to the finished product, and shall be from an approved source.

## 201.3 AGGREGATE

- 201.3.1 Fine aggregate for concrete shall be clean, hard, durable, uncoated grains of Arkansas River sand or other sand acceptable to the Engineer. It shall be free from injurious amounts of dust, clay balls, soft or flaky particles, shale, alkali, organic matter, loam, or other deleterious substances. It shall not contain more than three per cent, by weight, of material, which can be removed by standard decantation tests. If the color of the supernatant liquid is darker than that of the reference standard color solution when subjected to the Standard Test For Organic Impurities in Sands for Concrete ANSI/ASTM C40, the fine aggregate shall be rejected unless it passes the Standard Test for Effect of Organic Impurities in Fine Aggregate on Strength of Mortar ANSI/ASTM C87.
- 201.3.2 Fine aggregate shall be graded approximately within the limits shown in the following table. If not enough fines are available in the natural sands, limestone dust, or other approved fines shall be added:

Per Cent Passing Standard Square Mesh Screens

No. 4	No. 20	No. 50	No. 100
95-100	45-80	10-30	5-10

201.3.3 Coarse aggregate shall consist of the best available crushed limestone or other approved material. River gravel or other material with smooth surfaces shall not be used without specific written approval of the Engineer. Coarse aggregate shall be clean, tough, sound, durable rock and shall not contain harmful quantities of foreign materials and must be satisfactory to the Engineer.

201.3.4 Coarse aggregate shall be graded approximately within the limits shown in the following table:

Percent Passing Standard Square Mesh Screens

Aggregate								
Max Size	2 ½"	2"	1 ½"	1"	¾"	½"	3/8"	No. 4
2"	100	95-100	60-95	50-83	40-70	20-40		0-5
1 ½"		100	95-100		40-70		10-30	0-5
¾"				100	95-100		40-75	0-5

201.3.5 Coarse aggregate shall conform to Standard Specifications for Concrete Aggregates, ANSI/ASTM C33, except as to gradation. The maximum size aggregate to be used in structures six inches thick and under shall be three-quarters inch; in structures from six inches to ten inches thick, the maximum size of aggregate shall be one and one-half inches. If required, the Contractor shall furnish test certificates showing the aggregates meet the above requirements.

201.3.6 In case the concrete resulting from the mixture of the aggregates is not of a workable character or does not make the proper finished surface, the Engineer may require a different grading in order to secure the desired results, or they may allow the use of inert admixtures to correct deficiencies, upon proper showing that such use will not materially lower the strength or increase the permeability of the concrete.

201.4 STEEL REINFORCEMENT

201.4.1 All reinforcing steel shall be deformed bars and shall conform to the requirements of the Standard Specifications for Deformed and Plain Billet Steel Bars for Concrete Reinforcement, ANSI/ASTM A615, for grade 40 or grade 60. All steel shall be manufactured in the United States.

201.4.2 The Engineer reserves the right to require a test of three specimens of each size of bar from each carload received. These tests shall be made by a laboratory or testing firm approved by the Engineer and the cost of such testing shall be included in the price bid for steel reinforcement.

201.5 STRENGTH AND PROPORTION

- 201.5.1 The concrete shall have a compressive strength of not less than 3500 PSI, unless otherwise specified in the plans, as determined from test cylinders at twenty-eight days, made, cured, and broken, as hereinafter specified.
- 201.5.2 The concrete shall be mixed in the approximate proportion of 1:2-1/2:4-1/4 and shall contain not less than 6 sacks of cement per cubic yard of finished concrete. With the approval of the Engineer, admixtures may be added in order to increase workability.

## 201.6 TESTING OF CONCRETE

- 201.6.1 During the progress of the work, a reasonable number of compression tests shall be made when and if required by the Engineer. Each test shall consist of not less than three test cylinders. At least one test shall be made for each one hundred cubic yards of concrete placed. The test cylinders shall be made and stored in accordance with the Standard Method of Making and Curing Concrete Test Specimens in the Field, ANSI/ASTM C31, and shall be tested in accordance with the requirements relating to making compression tests on concrete test specimens as given in the Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens, ANSI/ASTM C39.
- 201.6.2 All test specimens shall be kept as near to the point of sampling as possible and yet receive the same protection from the elements as is given to the portions of the structure being built. Specimens shall be protected from injury. They shall be sent to a testing laboratory approved by the Engineer not more than seven days prior to the time of the test, and while in the laboratory shall be kept in the ordinary air at a temperature of approximately 70 degrees Fahrenheit until tested.
- 201.6.3 The Contractor shall furnish the Engineer certified reports on these tests and shall pay all the expense of making the tests and of furnishing the concrete for preparing and testing the cylinders.

## 201.7 RESPONSIBILITY OF CONTRACTOR FOR STRENGTH

- 201.7.1 It is the intent of these specifications that the Contractor shall guarantee that concrete of the specified compressive strength is incorporated in the structures and that the responsibility for producing the required grades of concrete is assumed by the Contractor.
- 201.7.2 Should the average strengths shown by test cylinders fall below the strengths required, the Engineer will require any or all of the following changes: amount of cement, grading of aggregate, or ratio of the water to the cement used. If the tests disclose that the strength of the concrete is insufficient for the structure as built, the Engineer may condemn the part of any structure in which concrete of insufficient strength has been placed and the Contractor, at his cost, shall remove and replace such concrete with concrete meeting these specifications.

## 201.8 EXPERIMENTAL CONCRETE MIXES

201.8.1 The Contractor shall make experimental mixes prior to the placing of the concrete and at any time during the progress of the work when necessary to demonstrate that the concrete will meet these specifications. Materials for making experimental mixes shall be furnished by the Contractor and these materials shall be identical with those intended for use in the work. The cost of the materials, as well as the costs of crushing test specimens made from the experimental mix, shall be borne by the Contractor and shall be included in the price bid for concrete.

## 201.9 MIXING

201.9.1 The concrete shall be mixed in an approved batch machine or mixer. The ingredients shall be accurately measured by weight, unless measurement by volume is permitted by the Engineer, before being placed in the mixer. Measuring boxes or other approved measuring apparatus shall be such that the proportions can be accurately determined. The quantity of water to be added, which will vary with the degree of dryness of the material and with the weather conditions, shall be accurately measured for each batch of concrete. Means shall be provided by which a measured quantity of water can be introduced at any stage of the process. The mixing shall be done in a thorough and satisfactory manner and shall continue until every particle of aggregate is completely covered with mortar. The mixing time for each batch shall not be less than one minute after the materials are in the mixer. The entire contents of the drum shall be discharged before recharging. Retempering of concrete, which has partly hardened, will not be permitted.

## 201.10 CONSISTENCY

201.10.1 All reinforced concrete which is required to be spaded or puddled in forms or around reinforcing steel shall be of such consistency that: all aggregate will float uniformly throughout the mass without settling or segregation; when dropped directly from the discharge chute of the mixer, it will flatten out at the center of the pile but will stand up at the edges, the pile spreading from internal expansion and not by flowing; it will flow sluggishly when tamped or spaded; it can be readily puddled into corners and angles of forms and around reinforcing steel, it can be readily spaded to the bottom of the pour or to a depth of several feet any time within thirty minutes after placing.

201.10.2 A desirable consistency is one which results in a very slight accumulation of water at the top of a layer several feet in thickness, but not with segregation or accumulation of laitance.

201.10.3 If, through accident, intention, or error in mixing, any concrete shall, in the opinion of the Engineer, vary materially from the consistency specified, such concrete shall not be incorporated in the work but shall be discharged as waste material at a location approved by the Engineer.

## 201.11 PLACING CONCRETE

- 201.11.1 Before beginning a run of concrete, surfaces of the forms, reinforcing steel, and concrete previously placed, shall be thoroughly cleaned of hardened concrete and foreign materials. Forms shall be thoroughly wetted or oiled.
- 201.11.2 Concrete shall be placed in the forms immediately after mixing. It shall be deposited so that the aggregates are not separated. Dropping the concrete any considerable distance, generally in excess of five feet, depositing large quantities at any point and running or working it along the forms, or any other practice tending to cause segregation of the ingredients, will not be allowed. It shall be compacted by vibration or continuous tamping, spading, or slicing. Care shall be taken to fill every part of the forms, to work the coarser aggregate back from the face, and to force the concrete under and around the reinforcement without displacing it. All concrete shall be thoroughly vibrated, except where specifically excepted in the specifications. The concrete shall be deposited in continuous horizontal layers and, whenever practicable, concrete in structures shall be deposited continuously for each monolithic section of the work. Chutes and tremies used for conveying concrete shall be mortar-tight.
- 201.11.3 Work shall be arranged in order that each part of the work shall be poured as a unit, if this is possible. Where necessary to stop pouring concrete, the work shall be brought up in level courses and against a vertical stop board.
- 201.11.4 The placing of concrete under water, where permitted, must be done by special approved methods.

## 201.12 PLACING IN COLD WEATHER

- 201.12.1 No concrete shall be placed without the specific permission of the Engineer when the air temperature is at or below thirty-five degrees Fahrenheit.
- 201.12.2 If concreting in freezing weather is permitted by the Engineer, care shall be taken to prevent the use of any frozen material. In addition to adequate provision for protecting the concrete against chilling or freezing, the Contractor shall be required to heat the water and aggregate in order that when deposited in the forms, the concrete will have a temperature of not less than fifty degrees Fahrenheit, nor more than ninety degrees Fahrenheit. The concrete shall be adequately protected in order to maintain this temperature for a minimum of seventy-two hours after it has been placed and a temperature above thirty-two degrees Fahrenheit for a period of two additional days. The work shall be done entirely at the Contractor's risk.
- 201.12.3 No chemicals or other foreign matter shall be added to the concrete for the purpose of preventing freezing.
- 201.12.4 When early traffic placement on a repair is required, the following guidelines are provided as a minimum to assure required strength during cold weather. The Contractor is responsible for the protection and quality of concrete placed during all weather conditions. If circumstances occur which preclude following

these guidelines, lower early strength may result in delays in opening areas to traffic as desired.

- 201.12.5 Ice, snow, and frost must be removed from the cut prior to placement of concrete. Concrete should not be placed on frozen subgrade. Removal of frozen subgrade will be paid as unclassified excavation.
- 201.12.6 Fresh concrete temperatures shall be a minimum of 50°F and a maximum of 90°F at time of placement. Hot mix water and preheated aggregate may be necessary to accomplish the minimum temperature during extremely cold weather. The minimum ambient temperature at time of placement should be at least 30°F.
- 201.12.7 Insulated blankets should be placed immediately when average daily temperatures are below 50°F or when minimum ambient temperatures are anticipated below 40°F during the curing period and left in place until opening to traffic. Insulated blankets shall be MA KA closed cell insulated blankets or approved equal. The insulated blankets shall have a minimum R-value of 2. Cost of insulated blankets shall be included in the price bid for the concrete where they are used.
- 201.12.8 Strict compliance with mix design slumps must be achieved to reach early strengths. "Drying out" of excessive slump mixes will not be allowed to reduce the slump.
- 201.12.9 All cold weather practices also apply to cementitious backfill material, except that blankets will not be required.

#### 201.13 READY-MIXED CONCRETE

201.13.1 Ready-mixed concrete may be used on the work, with the approval of the Engineer, when the Contractor can demonstrate that the concrete can be furnished in accordance with the specifications hereinabove and that delivery can be made at such rate as will insure the continuity of any pour. Standard Specifications for Ready-Mix Concrete, ANSI/ASTM C94, when not in conflict with the specifications herein, shall control the furnishing of ready-mix concrete.

201.13.2 All mixer trucks shall be equipped with water meters. Additional water shall be added at the job site only with the specific approval of the Engineer.

#### 201.14 CONSTRUCTION JOINTS

201.14.1 Construction joints shall be located as shown on the drawings and at other points as may be necessary during the construction, provided that the location and nature of additional joints shall be approved by the Engineer. In general, joints shall be located at points of minimum shear, shall be perpendicular to the principal lines of stress, and shall have suitable keys having areas of approximately one-third of the area of the joints.

201.14.2 In resuming work, the surface of the concrete previously placed shall be thoroughly cleaned of dirt, scum, laitance, or other soft material, and shall be roughened. The surface shall then be thoroughly washed with clean water and covered with at least one-half inch of cement mortar, after which concreting may proceed. Mortar shall be placed in a manner in order not to splatter forms and reinforcing steel.

## 201.15 FINISH OF CONCRETE SURFACES

201.15.1 All surfaces exposed to view shall be free from conspicuous lines, affects, or other irregularities caused by defects in the forms. If for any reason this requirement is not met, or if there are any conspicuous honeycombs, the Engineer may require the correction of the defects by rubbing with carborundum bricks and water until a satisfactory finish is obtained or removal at Contractors expense.

201.15.2 Immediately after removing the forms, all wires or other exposed metal shall be cut back of the concrete surface, and the depressions thus made and all honeycombs and other defects shall be pointed with mortar and then rubbed smooth. If the Engineer deems any honeycomb or other defect to require such treatment, the defective concrete shall be cut out to a depth sufficient to expose the reinforcement and to afford a key for the concrete replacing that cut out.

## 201.16 CURING CONCRETE

201.16.1 Exposed surfaces of concrete shall be protected by approved methods from premature drying for a period of at least seven days. Curing compounds, when approved by the Engineer, shall be applied according to the manufacturer's recommendations. The Engineer may require the frequent wetting of the concrete and/or forms and the use of means to protect it from the direct rays of the sun.

## 201.17 PLACING REINFORCEMENT

201.17.1 All reinforcement, when placed, shall be free from mill scale, loose or thick rust, dirt, paint, oil or grease, and shall present a clean surface. Bends and splices shall be accurately and neatly done and shall conform to American Concrete Institute Manual of Standard Practice for Detailing Reinforced Concrete Structures.

201.17.2 All reinforcing shall be placed in the exact position shown on the drawings and shall be held firmly in position by means of approved metal spacers and supports, by wiring to the forms, and by wiring the bars together at intersections with approved wire ties in order that the reinforcement will not be displaced during the depositing and compacting of the concrete. The placing and fastening of reinforcement in each section of the work shall be approved by the Engineer before any concrete is deposited in the section. Care shall be taken not to disturb the reinforcement after the concrete has taken its initial set.

## 201.18 FORMS

- 201.18.1 Forms shall be so designed and constructed that they may be removed without injuring the concrete. The material to be used in the form for exposed surfaces shall be sized and dressed lumber or metal in which all bolt and rivet heads are countersunk. In either case, a plain, smooth surface of the desired contour must be obtained. Undressed lumber may be used for backing or other unexposed surfaces, except inside faces of conduit.
- 201.18.2 The forms shall be built true to line and braced in a substantial and unyielding manner. They shall be mortar-tight, and if necessary to close cracks due to shrinkage, shall be thoroughly soaked in water or as shown in plans. Forms for re-entrant angles shall be filleted, and for corners shall be chamfered. Dimensions affecting the construction of subsequent portions of the work shall be carefully checked after the forms are erected and before any concrete is placed. The interior surfaces of the forms shall be adequately oiled with a non-staining mineral oil to insure the non-adhesion of mortar.
- 201.18.3 Form lumber, which is to be used a second time, shall be free from bulge or warp and shall be thoroughly cleaned. The forms shall be inspected immediately preceding the placing of concrete. Any bulging or warping shall be remedied, and all dirt, sawdust, shavings, or other debris within the forms shall be removed. No wood device of any kind used to separate forms will be permitted to remain in the finished work.
- 201.18.4 Temporary openings shall be placed at the bottom of the column and wall forms and at other points where necessary to facilitate cleaning and inspection immediately before depositing concrete.

## 201.19 REMOVAL OF FORMS

- 201.19.1 Forms shall be removed in such manner as to insure the complete safety of the structure. No forms shall be removed except with the express approval of the Engineer. In general, this approval will be based on the following:
- 201.19.2 Forms on ornamental work, railings, parapets, and vertical surfaces which do not carry loads and which will be exposed in the finished work shall be removed within twenty-four to forty-eight hours after placing, depending upon weather conditions.
- 201.19.3 Girder, beam, and joist sides only, column, pier, abutment, and wall forms may be removed within twenty-four to forty-eight hours after placing, depending upon weather conditions. No backfill shall be placed against walls, piers, or abutments, unless they are adequately supported or have reached the required strength.
- 201.19.4 Girder, beam, and joist soffit forms shall remain in place with adequate shoring underneath, and no construction load shall be supported upon, nor any shoring removed from any part of the structure under construction until that

portion of the structure has attained sufficient strength to support safely its weight and the loads placed thereon.

**PART 202 - QUICK-SETTING FLOWABLE FILL**

202.1 MATERIALS

202.1.1 Quick-setting flowable fill shall be a sand-cement slurry consisting of the following materials in a one cubic yard mixture:

Type I Cement	100 pounds
Sand	2,925 pounds
Water	585 pounds
Master Builders Pozzutec 20	80 ounces
(ASTM C494, Type C and E)	

202.1.2 NOTE: Can change somewhat due to type of sand used.

202.1.3 The combination of materials above shall be mixed in a ready-mix truck to produce the sand-cement slurry mixture.

202.1.4 Submittals shall be delivered to the City of Tulsa at a date set by the Engineer. Submittals shall include the items outlined in ODOT Specification 701.03.

202.2 CONSTRUCTION METHODS

202.2.1 For each cubic yard of quick-setting flowable fill material required, the amount of the mix components in the MATERIALS section shall be used to produce the sand-cement slurry mixture. The slurry mixture shall be mixed between 70 to 100 revolutions of the ready-mix truck.

202.2.2 To minimize segregation, all flowable fill material shall be re-mixed at the project site at mixing speed in the ready-mix truck for approximately two minutes immediately prior to discharge of the sand-cement slurry mixture. Re-mixing of the flowable fill slurry shall be done under the direction of the Engineer

202.3 TESTING

202.3.1 Special Provisions, "Flowable Fill Testing Procedures" identifies the Ohio Ready-Mixed Concrete Association (ORMCA) Standards FF1(94), and FF4(94) which shall be used in the performance of field testing.

202.3.2 The following are the testing requirements for the quick-setting flowable fill:

Flow	Minimum = 4 ½ inches
Compressive Strength (28 days)	Minimum = 25 pounds per square inch (psi)
	Maximum = 60 pounds per square inch (psi)

202.4 GENERAL

202.4.1 The time required before placing pavement over the cured quick-setting flowable fill is a minimum of six hours and/or whenever a minimum penetration value of 400 pounds per square inch (psi) is achieved. Penetrometer readings shall be taken with a Soiltest Mortar Penetrometer, Model CT-421A, or approved equal. The upper three inches of the area of the cured flowable fill mixture to be tested shall be removed prior to taking the penetrometer readings. The test value of record shall be the average of three tests.

**PART 203 - DUCTILE IRON PIPE, DUCTILE AND CAST IRON FITTINGS, AND VALVES**

203.1 PIPE AND FITTINGS

203.1.1 Where ductile iron pipe (DIP) three (3) inches in diameter and larger is specified or required, it shall conform to, and be tested in accordance with, the current American National Standard for Ductile Iron Pipe, Centrifugally Cast in Metal Molds or Sand-Lined Molds, for Water or Other Liquids, ANSI/AWWA C151/A21.51.

203.1.2 Length of joints shall be either eighteen or twenty feet. The minimum standard thickness class of each size pipe shall be as follows:

Pipe Size	Thickness Class
4" thru 8"	51
10" and larger	50

203.1.3 For 16-inch and larger Water Ductile Iron Pipe, all bell and spigot joints shall be electrically bonded, using a #4 AWG bare copper wire of adequate length to braze, using a #15 cadweld cartridge, the copper wire to the bare metal at the bell and spigot. Cost shall be included in the unit price bid per lineal foot of Ductile Iron Pipe.

203.1.4 For 16-inch and larger Water Ductile Iron Pipe, junction box test stations shall be furnished and installed, EXCEPT, no magnesium anode banks shall be furnished or installed. Junction box test stations shall be installed in accordance with the stationing shown on the Schedule of Anode Spacing. Cost shall be included in the unit price bid per lineal foot of Ductile Iron Pipe.

203.1.5 Fittings for ductile iron pipe shall be cast or ductile iron. Cast iron and ductile iron fittings shall conform to the American National Standard for Ductile-Iron and Gray-Iron Fittings, 3-inch through 48-inch, ANSI/AWWA C110; or the American National Standard for Ductile-Iron Compact Fittings, 3-inch through 48-inch, ANSI/AWWA C153. The length of all solid sleeves (both AWWA C110 and C153) shall be the longest length listed in the AWWA C110 specification (12-inch length for 3-inch through 12-inch sleeves, 15-inch length for 14-inch through 24-inch sleeves, and 24-inch length for 30-inch through 48-inch sleeves).

203.1.6 Interior of all sanitary sewer 15-in and larger ductile iron pipe shall be lined with 40 mils of ceramic epoxy ("Protecto 401", or equal).

203.1.6.1 Condition of Ductile Iron Prior to Surface Preparation.

All ductile pipe and fittings shall be delivered to the application facility without asphalt, cement lining, or any other lining on the interior surface. Because removal of old linings may not be possible, the intent of this specification is that the entire interior of the ductile iron pipe and fittings shall not have been lined with any substance prior to the application of the specified lining material and no coating shall have been applied to the first six inches of the exterior of the spigot ends.

203.1.6.2 Lining Material.

The Standard of Quality is Protecto 401 Ceramic Epoxy. The material shall be an amine cured novalac epoxy containing at least 20% by volume of ceramic quartz pigment. Any request for substitution must be accompanied by a successful history of lining pipe and fittings for sewer service, a test report verifying the following properties, and a certification of the test results.

- A. A permeability rating of 0.00 when tested according to Method A of ASTM E-96-66, Procedure A with a test duration of 30 days.
- B. The following test must be run on coupons from factory lined ductile iron pipe:
  - 1. ASTM B-117 Salt Spray (scribed panel) – Results to equal 9.0 undercutting after two years
  - 2. ASTM G-95 Cathodic Disbondment 1.5 volts @ 77°F. Results to equal no more than 0.5mm undercutting after 30 days.
  - 3. Immersion Testing rated using ASTM D-714-87.
    - a. 20% Sulfuric Acid – No effect after two years.
    - b. 140°F 25% Sodium Hydroxide – No effect after two years.
    - c. 160°F Distilled Water – No effect after two years.
    - d. 120°F Tap Water (scribed panel) 0.0 undercutting after two years with no effect.
- C. An abrasion resistance of no more than 3 mils (.075mm) loss after one million cycles using European Standard EN 598: 1994 Section 7.8 Abrasion Resistance.

### 203.1.6.3 Application

#### A. Applicator

The lining shall be applied by a competent firm with a successful history of applying linings to the interior of ductile iron pipe and fittings.

#### B. Surface Preparation

Prior to abrasive blasting, the entire area to receive the protective compound shall be inspected for oil, grease, etc. Any areas with oil, grease, or any substance which can be removed by solvent, shall be solvent cleaned to remove those substances. After the surface has been made free of grease, oil or other substances, all areas to receive the protective compounds shall be abrasive blasted using sand or grit abrasive media. The entire surface to be lined shall be struck with the blast media so that all rust, loose oxides, etc., are removed from the surface. Only slight stains and tightly adhering oxide may be left on the surface. Any area where rust reappears before lining must be reblasted.

#### C. Lining

After the surface preparation and within 8 hours of surface preparation, the interior of the pipe shall receive 40 mils nominal dry film thickness of Protecto 401. No lining shall take place when the substrate or ambient temperature is below 40 degrees Fahrenheit. The surface also must be dry and dust free. If flange pipe or fittings are included in the project, the lining shall not be used on the face of the flange.

#### D. Coating of Bell Sockets and Spigot Ends

Due to the tolerances involved, the gasket area and spigot end up to 6 inches back from the end of the spigot end must be coated with 6 mils nominal, 10 mils maximum using Protecto Joint Compound. The Joint Compound shall be applied by brush to ensure coverage. Care should be taken that the Joint Compound is smooth without excess buildup in the gasket seat or on the spigot ends. Coating of the gasket seat and spigot ends shall be done after the application of the lining.

#### E. Number of Coats

The number of coats of lining material applied shall be as recommended by the lining manufacturer. However, in no case shall this material be applied above the dry thickness per coat recommended by the lining manufacturer in printed literature. The maximum or minimum time between coats shall be that time recommended by the lining material manufacturer. **To**

**prevent delamination between coats, no material shall be used for lining which is not indefinitely recoatable with itself without roughening of the surface.**

F. Touch-Up & Repair

Protecto Joint Compound shall be used for touch-up or repair in accordance with manufacturer's recommendations.

203.1.6.4 Inspection and certification

A. Inspection

1. All ductile iron pipe and fitting linings shall be checked for thickness using a magnetic film thickness gauge. The thickness testing shall be done using the method outlined in SSPC-PA-2 Film Thickness Rating.
2. The interior lining of all pipe barrels and fittings shall be tested for pinholes with a nondestructive 2,500 volt test. Any defect found shall be repaired prior to shipment.
3. Each pipe joint and fitting shall be marked with the date of application of the lining system along with its numerical sequence of application on that date and records maintained by the applicator of his work.

B. Certification

The pipe or fitting manufacturer must supply a certificate attesting to the fact that the applicator met the requirements of this specification, and that the material used was as specified.

203.1.6.5 Handling

Protecto 401 lined pipe and fittings must be handled only from the outside of the pipe and fittings. No forks, chains, straps, hooks, etc. shall be placed inside the pipe and fittings for lifting, positioning, or laying.

203.2 JOINTS

- 203.2.1 Cast iron and ductile iron pipe and fittings shall be jointed with any of the end types as specified below, unless a particular end type is specified. Fittings shall have mechanical joints, unless otherwise specified. Flanged ends shall be used only where specifically noted on the Drawings except that the valve connection end of all tapping sleeves shall be flanged.

- 203.2.2 Mechanical joints and push-on joints shall conform to, and be tested in accordance with, the American National Standard for Rubber Gasket Joints for Ductile-Iron and Gray-Iron Pressure Pipe and Fittings, ANSI/AWWA C111/A21.11.
- 203.2.3 Flange joints shall conform to the American National Standard for Cast Iron Pipe Flanges and Flanged Fittings, ANSI B16.1.
- 203.2.4 Where ductile or cast iron pipe is to be tapped, a split case iron or a flexible stainless steel tapping sleeve may be used.
- 203.2.5 Split case iron tapping sleeves shall be of 150 psi working pressure. Sleeve body shall be cast iron conforming to ANSI/AWWA C110. Sleeve shall have mechanical joints conforming to AWWA C111 on the run and a flange branch conforming to ANSI B16.1, Class 125. End gaskets shall be natural rubber or neoprene material conforming to ANSI/AWWA C111.
- 203.2.6 Flexible stainless steel tapping sleeves shall be rated at 150 psi pressure, with flanges meeting AWWA C207. Assembly shall be NSF or UL rated. Bolts, nuts, and washers shall be stainless steel. Gaskets shall conform to ANSI/AWWA C111.
- 203.2.7 Openings of the sizes shown on the drawings shall be furnished with steel blind flanges of proper strength to withstand working pressure of the line where no other provision is made for closing the openings. Blind flanges shall be fabricated from material as specified under ANSI/AWWA C200. All bolts shall be carbon steel ANSI/ASTM A307, Grade A only, in accordance with ANSI/AWWA C207.
- 203.2.8 Where restrained joints are specified or required, they shall be of a mechanical type or push-on type assembly easily removed in field once assembled without special equipment. Assemblies shall be ANSI/AWWA rated. Set screw type retainer glands will not be permitted.
- 203.3 COATING, LINING AND POLYETHYLENE WRAP
- 203.3.1 Cast iron and ductile iron pipe and fittings shall be bituminous coated outside and cement-mortar lined inside with seal coat in accordance with American National Standard for Cement Mortar Lining for Ductile-Iron and Gray-Iron Pipe and Fittings for Water, ANSI/AWWA C104/A21.4.
- 203.3.2 All ductile iron and cast iron pipe and fittings shall be encased with polyethylene tube in accordance with AWWA C105, American National Standard for Polyethylene Encasement for Ductile Iron Piping for water and other liquids. Polyethylene film shall be manufactured of virgin polyethylene material conforming to ASTM D-1248, Type 1, Class A or C, Grade E. Thickness shall be not less than 8 mils (0.008 in.). Tensile strength shall be 1200 psi, minimum. Elongation shall be 300 percent, minimum. Tube length shall provide at least one (1) foot of overlap at each joint of pipe. Tape shall

be a 2" width, plastic backed adhesive tape, Polykan #900, Scotch #50, or equal. Tube width for each pipe diameter shall be as follows:

<b>NOMINAL PIPE SIZES</b>	<b>PUSH-ON JOINT FLAT TUBE WIDTH</b>	<b>MECHANICAL JOINT FLAT TUBE WIDTH</b>
4"	14"	16"
6"	17"	20"
8"	21"	24"
10"	25"	27"
12"	29"	30"
14"	33"	34"
16"	37"	37"
18"	41"	41"
20"	45"	45"
24"	53"	53"
30"	67"	67"
36"	81"	81"

#### 203.4 GATE VALVES

203.4.1 Where gate valves are specified, they shall be resilient-wedged.

203.4.2 Resilient-wedged gate valves shall conform to and be tested in accordance with ANSI/AWWA C509. The valve shall be bubble tight from either direction at the rated design pressure of 200 psi. The valve shall have a single disc gate with synthetic rubber seat bonded or mechanically attached to the disc; non-rising stem with 2-inch AWWA operating nut; counter clockwise opening, "O" ring stem seals, and corrosion resistant interior coating acceptable for potable water use.

203.4.3 Where specified, flanges shall be ANSI B16.1, Class 125, cast iron. Mechanical Joint, push-on, and bell and spigot joints are allowed.

#### 203.5 BALL VALVES

203.5.1 Ball valves shall conform to and be tested in accordance with the AWWA Standard for Ball Valves, ANSI/AWWA C507. Where ball valves are specified or required, they shall be: double-seated with natural or synthetic rubber located in the valve body. Ball seating surfaces shall be stainless steel; designed for 150 psi working pressure; flanged end; "O" ring rotor bearing seals; constructed of high-tensile strength cast iron; counter-clockwise opening; equipped with totally enclosed manual operators, and torque limiting control device. Valves shall be tested by, and shall withstand without leak, a hydrostatic pressure of: (1) 250 psi on the valve body with rotor in the open position; and (2) 150 psi on the side of the valve with the opposite side open to atmosphere. Six (6) copies of the test results and manufacturer's drawings shall be submitted for approval prior to delivery of the valve.

203.5.2 Valves shall be bubble tight at rated pressure with flow in either direction.

203.5.3 Where flanges are specified, they shall be ANSI B16.1, Class 125, cast iron flanges.

## 203.6 BUTTERFLY VALVES

203.6.1 Butterfly valves shall be of the tight-closing, rubber-seat type, shall have a rated pressure of 150 psig, and shall be bubble-tight at this pressure with flow in either direction. Valve opening shall be counter-clockwise. The valves shall conform to and be tested in accordance with the AWWA Standard for Rubber-Seated Butterfly Valves, ANSI/AWWA C504, Class 150B. The valve body shall be of the short-body flange type, constructed of cast iron conforming to either ASTM A126, Class B, or ANSI/ASTM A48, Class 40 or ductile iron ANSI/ASTM A536, Grade 65-45-12. Flanges shall be ANSI B 16.1, Class 125, cast iron flanges. Valve Discs shall be constructed of alloy cast iron conforming to ANSI/ASTM A436, Type 1, or cast iron conforming to ANSI/ASTM A48, Class 40, or ductile iron ANSI/ASTM A536, Grade 65-45-12. Valve shafts shall be constructed of 18-8, Type 304 or 316 stainless steel, ANSI/ASTM A296, Grade CF8, or monel. Valve seats shall be body mounted and shall be of natural or synthetic rubber compound with mating seat surfaces of 18-8, Type 304 or 316 stainless steel, or alloy cast iron conforming to ANSI/ASTM A436, Type 1, or bronze Grade A, D, or E. Valve bearings shall be corrosion resistant and self-lubricating.

203.6.2 Interior surfaces of the valve, except seating surfaces, shall be epoxy coated in accordance with AWWA Standard for Protective Interior Coatings for Valves and Hydrants, AWWA C550. Exterior surface of the valve shall be painted with two (2) coats of asphalt varnish conforming to Federal Specifications TT-V-51C. For non-buried service, exterior surface shall be coated with two (2) coats of epoxy, not zinc chromate.

203.6.3 Performance, hydrostatic and leakage tests shall be conducted in strict accordance with ANSI/AWWA C 504, except that the leakage tests as outlined in Section 5.3 are to be conducted on both faces of the disc.

203.6.4 Six (6) certified copies of the manufacturers detail drawings shall be submitted for approval prior to delivery of the valve.

203.6.5 Six (6) certified copies of the test results, signed by a registered professional engineer, are to be furnished to the Engineer.

## 203.7 MANUAL OPERATORS FOR BALL VALVES AND BUTTERFLY VALVES

203.7.1 Manual Operators for Ball and Butterfly valves shall be totally enclosed, permanently lubricated, counter-clockwise opening, and designed for buried or submerged service. Manual Operators shall be equipped with a 2" square AWWA operating nut with a removable handwheel complete with spinner and an open-closed indicator, suitable for one-man operation at 150 psi unbalanced across the valve. Manual Operators shall be either worm gear or

traveling-nut type, and shall conform to AWWA C507 for Ball Valves or AWWA C504 for Butterfly Valves.

203.7.2 Manual Operators for Ball and Butterfly Valves 16" and larger shall be equipped with a Torque Limiting Control Device. The device shall be mounted directly on the operating nut for valves in vaults and on top of the extension shaft for buried valves. The device shall be secured to the operating nut with two setscrews. The device shall declutch at 200 lb-ft of input torque in either direction of rotation. The device shall be designed for permanent buried or submerged service. Declutch and reset shall be automatic. Repeatability shall be within 5 percent of original rating for a minimum of 1000 cycles. Certified proof-of-design test reports shall be furnished for the device.

## 203.8 AIR RELIEF VALVES

203.8.1 Where air relief valves for water applications are specified or required, the valve shall be heavy-duty combination air release and vacuum type for 150 psi working pressure. Body, cover, and baffle shall be cast iron, or nylon. All internal parts to be either highest quality stainless steel, nylon or bronze. Interior and exterior surfaces of cast iron valve body and cover shall be coated with epoxy.

Air Relief Valve shall be guaranteed to operate under all surge conditions.

Acceptable Manufacturers for water ARV's: APCO, Crispin, ValMatic, ARI

203.8.2 Where air relief valves for sanitary sewer force mains, are specified or required, the valve shall be heavy-duty combination air and vacuum release type for 145 psi working pressure, tested to 230 psi, size shown on plans. Body, cover, and baffle shall be 316LC stainless steel or reinforced nylon. All internal parts shall be reinforced nylon, reinforced polypropylene or stainless steel. Valves shall have float system designed to insure separation of sewage and sealing mechanism. Valves to have back flushing attachments for routine cleaning maintenance.

## 203.9 CHECK VALVES

203.9.1 Where check valves are specified or required, they shall conform to, and be tested in accordance with the AWWA Standard for Swing-Check Valves for Ordinary Water Works Service, AWWA C508. They shall be horizontally mounted, single disc, swing type with a full diameter passage providing minimum pressure loss. Valves shall be of the non-slamming type designed for the future installation of outside lever and weight. Unless otherwise specified, all check valves installed in pump or lift stations shall be equipped with position indicator. Disk shall be coated rubber and body shall be epoxy coated. Ends shall fit the pipe or fitting to which attached (push-on, mechanical, bell and spigot, or flanged).

## 203.10 3-WAY FIRE HYDRANTS

203.10.1 Where fire hydrants are specified, they shall conform to, and be tested in accordance with the AWWA Standard for Dry-Barrel Fire Hydrants, ANSI/AWWA C502. All hydrants shall have: breakable connection features and a breakable coupling on the stem immediately above the bury line which has a lower breaking point than the rest of the unit; 5¼-inch compression main valve; 6-inch inlet connection; standard bell or mechanical joint hub; three-foot six-inch bury length, or as specified on drawings; two 2½-inch hose nozzles with National Standard threads; one 4-inch pumper nozzle with Tulsa Standard threads (refer to attached Standard Detail for Fire Hydrants); "O" ring seal; drain valve; left (counter-clockwise) opening; Federal yellow finish paint above ground line; and National Standard pentagon operating nut.

203.10.2 Where fire hydrant extensions are specified or required, they shall be of proper design to accommodate the make of fire hydrant installed.

## 203.11 FOUR-WAY FIRE HYDRANT

203.11.1 Where four-way fire hydrants are specified or required, they shall conform to, and be tested in accordance with the AWWA Standard for Dry-Barrel Fire Hydrants, ANSI/AWWA C502. All hydrants shall have: breakable connection features and a breakable coupling on the stem immediately above the bury line which has a lower breaking point than the rest of the unit; 8-inch inlet connection; bell, flange, or mechanical joint inlet; four-foot six-inch bury length; two 2½-inch hose nozzles with National Standard threads; two 4-inch pumper nozzles with Tulsa Standard threads; "O" ring seal; drain valve; left (counter-clockwise) opening; Federal yellow finish paint above ground line; and National Standard pentagon operating nut.

203.11.2 Where fire hydrant extensions are specified or required, they shall be of the proper design to accommodate the make of fire hydrant installed.

## 203.12 BLOW-OFF HYDRANT

203.12.1 Where blow off hydrants are specified or required, they shall be constructed in accordance with Construction Standard Blow-off Hydrant.

## **PART 204 - STEEL PIPE AND FITTINGS**

### 204.1 GENERAL

204.1.1 Where steel pipe is specified or required, it shall conform to the AWWA Standard for Steel Water Pipe, 6-Inches and Larger, AWWA C200. No steel less than 35,000 psi specified minimum yield strength shall be permitted. All pipe shall be hydrostatically tested in accordance with AWWA C200. Mill Test Reports shall be furnished and the hydrostatic test pressure shown on shop fabrication drawings. AWWA Designation C200 shall govern the testing. Pipe length shall be not less than 35 feet per joint, except for specials, unless

otherwise noted. There shall be no more than one longitudinal or girth seam per section. Nominal pipe diameter and steel thickness shall be as specified on the drawings. The diameter shown is the required inside diameter after cement-mortar lining. All pipe shall be manufactured by an established manufacturer who has had at least five (5) years experience in successfully building this type of pipe. Openings for air valves, main connections, and blow-off connections shall be provided with suitable reinforcements around the opening, welded to the body of the pipe in accordance with AWWA Manual M11. Openings of the sizes shown on the drawings shall be furnished with steel blind flanges of proper strength to withstand the working pressure of the line where no other provision is made for closing the openings. Blind flanges shall be fabricated from material listed above as specified under AWWA C200. All bolts shall be carbon steel ANSI/ASTM A307, Grade A only, in accordance with ANSI/AWWA C207. For corrosion monitoring of steel pipe, junction box test stations shall be furnished and installed. Magnesium anode banks shall be furnished and installed if specified in the plans. Junction box test stations and anode banks shall be installed in accordance with the stationing as shown on the Schedule of Anode Spacing in the plans.

- 204.1.2 All steel pipe shall be manufactured with ends of true circular shape, free from indentations, projections, or roll marks for a distance of eight inches (8") from the end of the pipe. This shall be done by hydraulic expansion or some other method satisfactory to the Engineer. The outside circumference shall not vary by more than + or - 1 percent or as required for jointing of pipe as described in AWWA C200.
- 204.1.3 Where steel fittings or specials are specified or required, they shall conform to all of the steel pipe specification requirements and to the AWWA Standard for Dimensions for Steel Water Pipe Fittings AWWA C208. Where fittings and specials are fabricated from mill pipe, they shall be fabricated from pipe hydrostatically tested in accordance with AWWA C200 with mitered joints dye checked for welding flaws. Changes in line and grade shall be made by steel specials or in the joints. Joint deflection shall not exceed that as recommended by the manufacturer. Inside diameter of steel specials and fittings shall be the required inside diameter of cement-mortar lining.
- 204.1.4 Where field cutting of steel pipe is permitted, pipe shall be cut by sawing. The inside lining shall be removed for a minimum of six inches each side of the cut and the pipe surface shall be cleaned and brushed to bright metal. After welding, the inside lining shall be replaced in accordance with AWWA C602.
- 204.1.5 Steel Pipe shall be designed in accordance with AWWA M11 and AWWA C200 except as noted herein. Steel Pipe shall conform to ASTM A139 Grade B or C. The design criteria for steel pipe thickness shall be based on a minimum 150 psi working pressure plus a 100-psi allowance for water hammer except the minimum thickness of steel pipe shall be 0.25 inches. The minimum thickness standard in inches for each following size pipe shall be as follows:

Minimum Thickness - Inches for Grade of Steel

Nominal Pipe Diameter	A-139 Gr. B	A-139 Gr. C
6" - 36"	0.250	0.250
42"	0.281	0.250
48"	0.313	0.281
54"	0.375	0.313
60"	0.406	0.344
66"	0.438	0.375
72"	0.500	0.406

Maximum depth of cover shall be 12 feet. Depth of cover in excess of 12 feet shall require special design.

204.1.6 Hangar and support systems shall be designed in accordance with AWWA M11.

## 204.2 JOINTS

204.2.1 Steel Pipe and fittings shall have one of the following type joints: slip joint ends for field lap welding, single beveled ends for field butt welding, double beveled ends for field butt welding, "O" ring bell and spigot joints, or plain ends for mechanically coupled field joints. Flange ends shall be used only when noted on the drawings.

204.2.2 Welded joints shall conform to, and be tested in accordance with the AWWA Standard for Field Welding of Steel Water Pipe Joints, AWWA C206. Slip joints for field lap welding shall be sized to provide tolerances per C200.

204.2.3 Mechanically coupled joints shall consist of Dresser Couplings, Style 38, or equal, or as specified on the drawings. The harness lugs, tie bolts, and nuts shall conform to AWWA M11 Steel Pipe Design and Installation, Par. 19.8.

204.2.4 Bell and spigot joints with rubber gasket shall conform to the AWWA Standard for Steel Water Pipe 6-Inches and Larger, AWWA C200 and the AWWA Steel Pipe Manual, M-11. The gasket shall be a continuous "O" ring design of natural rubber or neoprene and shall be of suitable cross-section and size to assure a watertight joint. Acceptable bell and spigot joints for all steel pipe diameters and thicknesses shall be the "O" Ring-Bar Type, or the "O" Ring-Carnegie Section, or rolled groove type joint. Bell and spigot ends shall be properly sized by forcing over a sizing die or by expanding to stretch the steel beyond its elastic limit so that the difference in diameter between outside of spigot and inside of bell at normal engagement is not less than 0.03" and not more than 0.10" as measured on circumference with a diameter tape. Shop applied interior lining on the bell end of the pipe shall be held back a minimum distance of the spigot engagement + 1-1/8" for the Bar and Carnegie Type Joints. Hold back for the rolled groove joint shall be the spigot engagement + 1/2". Interior lining for the spigot shall be continuous to the end. Field replacement of the interior joint linings shall be in accordance with Section 201.4. of these specification for cement-mortar linings. All "O" Ring joints shall

be electrically bonded using a #4 bare copper wire, 6" length #15 cadweld cartridge brazed to bare metal at the bell and spigot or equal. Shop applied exterior coatings shall be held back in accordance with manufacturer's specifications. Field replacement of exterior coatings at the joints shall be in accordance with the AWWA C216, Heat Shrinkable Cross-Linked Polyolefin Coatings for the Exterior of Specials, Connections and Fitting, AWWA C209, Cold-Applied Tape Coatings for Special Sections, Connections, and Fittings, for Steel Water Pipelines, or AWWA C205, Cement-Mortar Protective Lining and Coating for Steel Water Pipe, 4" and Larger, Shop Applied.

- 204.2.5 Where steel pipe is to be tapped in the field, a split tapping saddle of 150 psi working pressure shall be used. The saddle body shall be heavy welded ANSI/ASTM A36, or ANSI/ASTM A285, Gr. C steel with flange conforming to ANSI/AWWA C207, Class D. The gasket shall be natural rubber or neoprene design in a continuous ring of suitable cross-section, and sized to assure a watertight joint. The interior and exterior surfaces of the saddle body shall be shop coated with a fusion-bonded epoxy. The exterior coating or wrap on steel pipe shall be removed to bare metal beneath the entire area to be covered by the sleeve.
- 204.2.6 Flanged joints shall conform to the AWWA Standard for Steel Pipe flanges, AWWA C207, Class D.

### 204.3 EXTERIOR COATING

- 204.3.1 The exterior coating on steel pipe and fittings shall be in accordance with Tape Coating Systems for the Exterior of Water Pipelines, AWWA C214 or cement-mortar coatings in accordance with AWWA C205, Cement-Mortar Protective Lining and Coating For Steel Water Pipe, 4" and Larger, Shop Applied. Where tape coatings are used, the total thickness shall be no less than 80 mils. Where cement-mortar coating is used, the thickness shall be not less than 3/4" and reinforced with spiral-wire, wire-fabric, or ribbon mesh reinforcement in accordance with AWWA C205, Sec. 2.1. All above ground piping shall be cleaned, primed, and painted with enamel, as shown in the plans. The total dry film thickness shall be 6 mils.
- 204.3.2 If field welding is used, the pipe joints shall be furnished with the outside coating held back, in accordance with standard joint detailed drawings. The coating and any touch up work shall be done under the direction of the coating manufacturer, and as approved by the Engineer.

### 204.4 INTERIOR LINING

- 204.4.1 The interior lining shall be installed in the field in accordance with AWWA C602, Cement-Mortar Lining of Water Pipelines, 4-Inch and Larger, In Place; or shop applied in accordance with AWWA C205, Cement Mortar Protective Lining and Coating for Steel Water Pipe, 4" and Larger, Shop Applied. The lining shall be 3/8" thick for diameters through 36", and 1/2" thick for 42" and larger, whether shop or in place lined. Tolerances shall be in accordance with

the applicable AWWA standards. Coal-tar enamel and coal tar epoxy interior linings will not be permitted.

204.4.2 Where in place cement-mortar lining is used, the contractor shall furnish all materials, labor and equipment, prepare the interior surface, and machine place the mortar lining in the pipe. The lining at valves, specials, and bends may be hand sprayed or troweled, or hand applied as required. The lining shall be maintained in a moist condition while curing. The contractor shall be responsible for any extended curing time until acceptance by the Engineer. No additional payment shall be made for any extended curing period.

204.4.3 Where in-place mortar lining is cracked or delaminated from steel cylinder pipe, contractor shall repair broken or delaminated areas with Hilti 2-part epoxy, or approved equal.

#### 204.5 STRUTTING AND BRACING

204.5.1 Strutting and bracing shall be provided on all specials, fittings, and straight pipe, where shop lined or coated with cement mortar, so as to limit the maximum pipe deflection to two (2) percent of inside diameter and to maintain roundness of +/- one (1) percent during transportation, handling and joining the pipe. Coated pipe shall be handled with wide belt slings or padded forks. Chains, cables or other equipment likely to cause damage to the pipe or coating shall not be used. The strutting shall remain in place until all compacting and backfilling has been completed.

### **PART 205 - REINFORCED CONCRETE PIPE AND FITTINGS**

#### 205.1 REINFORCED CONCRETE PIPE AND FITTINGS FOR WATER AND SANITARY SEWER LINES

205.1.1 Where reinforced concrete pipe (RCP) and fittings are specified or required per AWWA C301, for water or sanitary sewer lines, they shall be designed, manufactured, and tested in accordance with the AWWA Standard for Prestressed Concrete Pressure Pipe, Steel Cylinder Type, for Water and Other Liquids, AWWA C301, or Reinforced Concrete Pressure Pipe, Steel Cylinder Type, Pretensioned, for Water and other Liquids, AWWA C303. All pipe shall be manufactured by an established manufacturer who has had at least three years experience in successfully building this type of pipe. All specials and fittings shall be built to the details furnished by the manufacturer and approved by the Engineer. Each special and each length of straight pipe shall be plainly marked to indicate the head for which the pipe is designed and to indicate where the pipe will be used by reference to the layout drawings. All closure fittings shall be furnished with an 18-inch flanged access manway with an 18-inch steel blind flange. 6-inch screw type hand hole fittings will not be permitted.

- 205.1.2 Sanitary Sewer Prestressed Concrete Cylinder Pipe (PCCP) or Reinforced Concrete Pipe(RCP) shall have the following interior lining systems or equal:

The lining system shall be a plural component. 100% solids, moisture tolerant, epoxy primer followed with a plural component, 100% solids, polyurethane top coat. The primer shall be a Zebron Low Temperature Epoxy (ZLTE) and the topcoat shall be Zebron #486 polyurethane as manufactured by Zebron Corporation, Anaheim, CA or approved equal. The lining system shall be suitable for application by airless spray. The primer shall be applied to a thickness of 2 to 3 mils and can be top coated when the primer becomes tacky (sticky to the touch) or can be top coated during the next 8 hours. When waiting up to 8 hours to top coat the primer, special care must be taken to assure the surfaces to be top coated are not exposed to moisture, dust, or other contaminants. The topcoat shall be applied to a 50-mil thickness and shall not exhibit running, sagging, or shrinking. The lining system shall be compatible with application to cured or green (one day old) Portland cement concrete or mortar. The applied lining shall be formed impermeable, pinhole-free. Membrane, monolithically applied with tight adherence to the concrete or mortar. The cured lining shall not peel or spall from the concrete or mortar surfaces. The lining system shall be resistant to abrasion during normal pipe handling and installation.

- 205.1.3 All concrete or mortar substrates must be sweep-abrasive grit blasted to create adequate profile then made dust free. All surfaces to be lined must be free of any oil, grease, or other deleterious materials. The surface must be dry to the touch (no standing water), but can have some surface discoloration due to moisture.
- 205.1.4 The two-component epoxy lining for PCCP shall be tested in accordance with National Association of Corrosion Engineers Standard for Discontinuity (Holiday) Testing of Protective Coatings. Results of the Discontinuity Testing shall be furnished to the City of Tulsa. Any defects shall be repaired and retested.
- 205.1.5 RCP and fittings for water lines shall be designed for the following conditions (minimum): Normal operating pressure equal to 150 psi plus 50% for surge pressure plus earth load resulting from actual backfill depth, but not less than 8 feet plus external live load equal to AASHTO HS 20 loading. The thickness of the mortar coating shall provide a minimum cover of 1 inch over the reinforcing steel.
- 205.1.6 Reinforced concrete pipe and fittings for water lines shall be jointed according to AWWA Standard for Prestressed Concrete Pressure Pipe, Steel Cylinder Type, for Water and Other Liquids, ANSI/AWWA C301, or Reinforced Concrete Pressure Pipe, Steel Cylinder Type, Pretensioned, for Water and Other Liquids, AWWA C 303.
- 205.1.7 Where concrete pressure pipe ANSI/AWWA C301, Steel Cylinder Prestressed Concrete or Pretensioned Concrete Pressure Pipe, AWWA C303 is to be tapped, the tapping saddle shall be fabricated in accordance with the

American Water Works Association Manual M-9, and as recommended by manufacturers of Concrete Pressure Pipe. Saddle shall provide grout gaskets and grout opening to enable filling the wall space between saddle and pipe wall with grout, to assure complete protection of the steel pipe wall. The saddle shall also provide gland assembly, including gasket and flange, to insure a tight seal.

205.1.8 Openings of the sizes shown on the drawings shall be furnished with steel blind flanges of proper strength to withstand the working pressure of the line where no other provisions is made for closing the openings. Blind flanges shall be fabricated from material as specified under AWWA C200. All bolts shall be carbon steel ASTM A307, Grade A only, in accordance with ANSI/AWWA C207.

## 205.2 REINFORCED CONCRETE PIPE AND FITTINGS FOR STORMWATER AND SANITARY SEWERS

205.2.1 Where reinforced concrete pipe (RCP) and fittings are specified or required per ASTM C76, for storm and sanitary sewers, except as herein modified, they shall be designed, manufactured, and tested in accordance with ASTM C76, Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe. Pipe shall be a minimum Class III. Pipe length shall be no less than 6'-0" except for shorts and specials. Pipe sections connected to a manhole or structure shall be no more than 4' - 0" in length, as measured from the inside face of the structure to the point of flexure of the joint. Elliptical reinforcement is not allowed. At least three circumferential reinforcing bars shall be provided in each pipe bell equal in area to an equivalent length of outside cage in the pipe barrel. Concrete shall have a minimum 28-day compressive strength of 6,000 psi, and absorption not to exceed six percent.

205.2.2 Testing shall be observed and reported by an independent testing laboratory approved by the Engineer. One (1) Three-Edge Bearing Test in accordance with ASTM C497 shall be performed on a representative sample of each diameter and class of pipe to be furnished. One (1) absorption test in accordance with ASTM C497 shall be performed for each 300 tons of pipe manufactured, not less than one (1) test per day's production. Four (4) concrete cylinders or core samples shall be tested for compressive strength from each days production, two at 7 days and two at 28 days. An in-plant hydrostatic test in accordance with ASTM C361 shall be performed on each section of pipe and each pipe joint at an internal hydrostatic head of 25 feet. The joints shall be tested for a minimum period of one (1) hour under constant pressure as specified. Each pipe unit that satisfactorily passes all hydrostatic testing shall bear the seal of the testing laboratory. This seal does not constitute acceptance of the pipe installation, which will be subjected to further testing and inspection in the field.

205.2.3 In lieu of the in-plant hydrostatic testing of each joint, the Contractor may substitute the following procedure: (1) Perform one in-plant hydrostatic test per days production, in accordance with the previously specified criteria; and (2) Perform an air test on each joint in the field after assembly, in accordance

with the City of Tulsa Water and Sewer Department Standard Air Test Procedure. The Contractor shall furnish all air test equipment. Testing and test conclusions shall be verified by the Engineer. The Engineer reserves the right to require additional in-plant hydrostatic testing.

- 205.2.4 Reinforced concrete pipe and fittings for storm sewer shall be jointed in accordance with ASTM C361, Standard Specification for Reinforced Concrete Low-Head Pressure Pipe. Joints shall be concrete bell and spigot, employing a rubber gasket and cement mortar formed by a diaper. Rubber gaskets shall be either a standard o-ring gasket or a Forsheda pre-lubricated gasket, or equal. For the o-ring gasket, the spigot end shall contain a groove to confine and compress the gasket on four surfaces when the joint is in final position. The Forsheda joint shall be designed and installed in accordance with the manufacturer's recommendations.
- 205.2.5 Reinforced concrete pipe and fittings for sanitary sewer shall be jointed in accordance with AWWA C302, Reinforced Concrete Pressure Pipe, Non-cylinder type. Joints shall be Steel End Ring with Spigot Groove and O-ring gasket, and include cement mortar formed by a diaper.

## **PART 206 - VITRIFIED CLAY PIPE AND FITTINGS**

### **206.1 PIPE AND FITTINGS**

- 206.1.1 Where vitrified clay pipe (VCP), fittings and in-line tees are specified or required, they shall conform to the Standard Specification for Vitrified Clay Pipe, Extra Strength, Standard Strength, and Perforated ANSI/ASTM C700. Testing shall be in accordance with methods of Testing Clay Pipe, ANSI/ASTM C301.
- 206.1.2 Where vitrified clay pipe is being installed, in-line tees for future connections to the sanitary sewer shall be manufactured specifically for vitrified clay pipe.

### **206.2 JOINTS**

- 206.2.1 Vitrified clay pipe shall be jointed with material conforming to the Standard Specification for Compression Joints for Vitrified Clay Pipe and Fittings, ANSI/ASTM C425. All jointing materials shall be used in accordance with the manufacturer's instructions and subject to the approval of the Engineer.
- 206.2.2 Where it is necessary to connect vitrified clay pipe to ductile iron pipe a rigid type adapter shall be used. Only the following adapters will be permitted: Dickey DPB- VC x DI, Dresser Style 39, and Rockwell Omni. Flexible couplings will not be permitted.

## **PART 207 - POLYVINYL CHLORIDE (PVC) PIPE, WATER SERVICE**

- 207.1 Where polyvinyl chloride (PVC) pipe four (4) inches in diameter through twelve (12) inches in diameter is specified or required, it shall conform to and be tested in accordance with AWWA C900, "AWWA STANDARD for POLYVINYL CHLORIDE (PVC) PRESSURE PIPE, 4 IN. THROUGH 12 IN., FOR WATER", as herein modified. PVC water pipe shall be approved by the Underwriters Laboratory Sanitation Foundation Testing Laboratory for potable water pipe. Polyvinyl chloride water pipe shall be restricted from use adjacent to arterial streets.
- 207.2 PVC pipe shall conform to pressure Class 200 (equivalent to Dimension Ratio 14) and shall have an outside diameter (OD) equal to the OD of equivalent size ductile iron pipe.
- 207.3 PVC pipe shall have integral wall-thickened bell ends and shall be jointed using one-piece elastomeric gaskets. Solvent cement jointing shall not be permitted.
- 207.4 Fittings for PVC pipe shall be polyethylene wrapped ductile or cast iron conforming to Part 203 of these specifications. The use of PVC fittings shall not be permitted.
- 207.5 Contractor shall submit certifications from the manufacturer that PVC pipe has been manufactured in accordance with AWWA C900, and that it meets the approval of the "NSF".
- 207.6 Where restrained joints are required, they shall be of a mechanical type assembly easily removed in field once assembled without special equipment. Assemblies shall be ANSI/AWWA approved. Setscrew type retainer glands will not be permitted.

## **PART 208 - POLYVINYL CHLORIDE (PVC) PIPE, SEWER SERVICE**

- 208.1 Where polyvinyl chloride (PVC) pipe eight (8) inches in diameter through fifteen (15) inches in diameter, fittings and inline tees are specified or required for sewer service, it shall conform to and be tested in accordance with ASTM D3034 "Type PSM Polyvinyl Chloride Sewer Pipe and Fittings" for standard dimensional ration (SDR) of 35. Minimum pipe stiffness for all sizes shall be 46 psi. Polyvinyl chloride water pipe shall be restricted from use adjacent to arterial streets.
- 208.2 Where polyvinyl chloride (PVC) pipe 18-inches in diameter through 36 inches in diameter is specified or required for sewer service it shall conform to and be tested in accordance with ASTM F679, Polyvinyl Chloride (PVC) Large Diameter Plastic Gravity Sewer Pipe and Fittings Minimum pipe stiffness shall be 46psi.

- 208.3 The PVC sewer pipe shall be supplied in 12.5 foot, or 20 foot laying lengths as specified.
- 208.4 Where it is necessary to connect PVC sewer pipe to ductile iron pipe and AWWA C110 long body solid sleeve shall be used with a special gasket for the PVC pipe. Flexible couplings will not be permitted.
- 208.5 Where PVC sewer pipe is being installed, the fittings for the service line and the in-line tees for future service connections shall be manufactured and specifically designed for Schedule 40 PVC service lines.
- 208.6 The manufacturer shall maintain quality control through regularly scheduled testing in accordance with all referenced ASTM standards. Testing for flattening and the pipe stiffness shall be performed on one test specimen for each size and class of pipe produced for the project. Certifications shall be furnished that the material was manufactured, sampled, tested, and inspected in accordance with all applicable specifications. The certifications shall indicate the manufacturer's production code from which the plant location, machine, and date of manufacture can be identified.

## **PART 209 - CASTINGS**

- 209.1 Gray iron castings shall conform to and be tested in accordance with the Standard Specification for Gray Iron Castings ASTM A48 and applicable sections of Drainage Structure Castings, AASHTO M 306, current edition. All castings, including manhole steps, lamphole covers, water meter lids, manhole frames and lids, adjustment rings and valve boxes shall be Class 35B iron.
- 209.1.1 Iron class shall be determined using only those guidelines outlined in ASTM A48. Tensile specimens shall be obtained using AASHTO M306 Para 9.1.4, Acceptance on the Basis of Test Bars Cut from Portions of Units Supplied to Purchaser. Where samples are too thin and cannot be obtained under ASTM M306 Para 9.1.4, specimens shall be obtained under ASTM M306 Para 9.1.3 Acceptance on the Basis of Cast-on Test Bars. Elapsed time during tensile test shall follow ASTM A48 para 14. Tensile test specimens shall fit the holders of the testing machine in a way such that the load will be axial.
- 209.1.2 Additionally, castings that are rated for traffic loadings within dedicated public rights-of-way or other locations subject to vehicular traffic must pass an AASHTO proof load test that can maintain a 40,000 lb proof load for one (1) minute, applied on a 9"x9" contact area in the center of the casting. The load shall be applied at a constant rate requiring a minimum of 30 seconds to reach the 40,000 lb level. Following this test the casting shall be visually inspected for cracks or permanent deformation which will be cause for rejection. Following this, the casting shall be loaded to failure.

- 209.1.3 Cost for tensile and proof load testing shall be borne by manufacturer, and testing shall be performed at a testing facility acceptable to the Engineer. All tests shall be witnessed by the Engineer.
- 209.2 Casting dimensions shall vary by not more than  $\pm 1/16$  inch per foot.
- 209.3 All bearings surfaces shall be machined to prevent rocking and rattling.
- 209.4 Where sealed manholes are specified, only McGard locking system with 5/8" – 11 thread which is keyed to City of Tulsa standard lock is allowed.
- 209.5 Only those castings which have been approved by the Department will be permitted. Approval for each casting shall consist of approved shop drawings, plus laboratory test reports of the tensile test and load test.
- 209.6 City of Tulsa Engineering Services Department, on an annual basis, reserves the right to randomly select any castings for tensile and proof load testing from the foundry's local representative's yard. Such testing shall be at manufacturer's expense.

## PART 210 - CONDUIT

- 210.1 Where conduit (also known as tunnel liner or pipe sleeve), 6 inches or larger, is specified or required, it shall be steel pipe, and be in accordance with AWWA C200, 3/8" wall thickness.

Conduit shall be sized according to the following:

Carrier Pipe		Conduit, ID
Water	Sanitary Sewer	
6"	6"	18"
8"	8"	20"
	10"	22"
12"		24"
	12"	26"
	15"	28"
16"		30"
	16"	32"
	18"	32"
24"	24"	42"
30"	30"	48"
36"	36"	54"
42"		60"
	42"	62"
	48"	68"

## **PART 211 - VAULT, PITS AND MANHOLES**

- 211.1.1 Concrete masonry units shall conform to, and be tested in accordance with the specifications for Concrete Masonry, Hollow Load Bearing Concrete Masonry Units, ANSI/ASTM C90, or Concrete Building Brick C55, Grade A.
- 211.1.2 Precast manholes shall conform to, and be tested in accordance with, the specifications for Precast Reinforced Concrete Manhole Sections, ANSI/ASTM C478, flat slab top type.
- 211.1.3 Manhole adjusting ring shall be solid cast iron that fits in the standard City of Tulsa Sanitary Sewer manhole frame and the standard manhole lid fits in the adjusting ring.
- 211.1.4 Adjusting rings shall conform to and be tested in accordance with the Standard Specification for Gray Iron Castings ASTM A48 and Drainage Structure Castings, AASHTO Designation: M306-89. Castings shall be Class 35-B iron and unpainted.
- 211.1.5 The contact surface between manhole ring and manhole frame and the contact surface between manhole ring and manhole lid shall be machined smooth to prevent rocking and rattling.
- 211.1.6 The two (2) inch manhole adjusting ring where specified shall have a minimum weight of 70 pounds and the three (3) inch manhole adjusting ring where specified shall have a minimum weight of 100 pounds.
- 211.1.7 Markings on all gray iron castings shall conform to AASHTO Designation M306-89. (AASHTO M306-89 states: Each casting shall be identified by the foundry showing): Name of Foundry, Country of manufacturer, ASTM Designation Number, Class by a number followed by a letter indicating the minimum tensile strength and size of test bar. (i.e. Class 35-B), Heat Number and Date. No other wording or marking of any kind other than those stated above or shown on the plan will be permitted on castings.
- 211.1.8 All sanitary sewer manholes and structures 5-foot I.D. or larger shall have an interior epoxy coating
- 211.1.9 **MANHOLE COATING** - This section specifies the insitu-coating of new concrete sanitary sewer manholes to provide protection against corrosion to the manhole interior. This section includes requirements for product and contractor qualifications, work, materials, and equipment required for surface preparation, repairs, and application of a monolithic solvent-free epoxy coating to specified surfaces.
- 211.1.10 **SUBMITTALS** - The following items shall be submitted to Engineer for approval:
  - A. Technical data sheet and material safety data sheet (MSDS) on each product used, including ASTM test results indicating the

product conforms to and is suitable for its intended use per these specifications.

B. Contractor Qualifications:

1. Manufacturer certification that Contractor has been trained and approved in the handling, mixing and application of the products to be used.
2. Certification that the plural component spray equipment to be used for applying the products has been manufactured or approved by the protective coating manufacturer and Contractor's personnel have been trained and certified for proper use of the equipment.
3. Three (3) recent references of Contractor projects of similar size and scope indicating successful application of a high-build solvent-free epoxy coating by plural component spray application in underground concrete structures.
4. Proof of any necessary federal, state or local permits or licenses necessary for the project.
5. Design details for any additional ancillary systems and equipment to be used in site and surface preparation, application and testing.

211.1.11 DELIVERY, STORAGE, HANDLING AND SITE CONDITIONS

- A. Protective coating materials are to be stored and handled according to their material safety data sheets.
- B. Contractor shall conform with all local, state and federal regulations including those set forth by OSHA, RCRA and the EPA and any other applicable authorities.

211.1.12 WARRANTY

Contractor shall warrant all work against defects in materials and workmanship for a period of one (1) year, unless otherwise noted, from the date of final acceptance of the project. Contractor shall, within a reasonable time after receipt of written notice thereof, repair defects in materials or workmanship which may develop during said one (1) year period, and any damage to other work caused by such defects or the repairing of same, at his own expense and without cost to the Authority.

211.1.13 EXISTING PRODUCTS

- A. Standard Portland cement or new concrete (not quick setting high strength cement) must be well cured prior to application of the protective coating. Minimum of 28 days cure time.

211.1.14 MANUFACTURER

- A. Raven Lining Systems, Inc., Tulsa, Oklahoma 800-324-2810 or 918-584-2810 or FAX 918-582-4311, or equal.

211.1.15 REPAIR MATERIALS

- A. Repair materials shall be used to fill voids, structurally reinforce and/or rebuild surfaces, etc. as determined necessary by the Authority and protective coating Contractor. Repair materials must be compatible with the specified epoxy coating and shall be applied in accordance with the manufacturer's recommendations.

211.1.16 PROTECTIVE COATING MATERIAL

- A. Raven Lining Systems' Raven 405 epoxy coating system, or equal.

Product type	Amine cured epoxy
Color	Light Blue
Solids Content (vol %)	100
Mix Ratio	3:1
Compressive Strength, psi	18,000
Tensile Strength, psi	7,600
Flexural Modulus, psi	600,000
Hardness, Type D	88
Bond Strength - Concrete	>Tensile Strength of Concrete
Chemical Resistance to:	
Sulfuric Acid, 10%	Immersion Service
Sodium Hydroxide, 20%	Immersion Service
Municipal Wastewater	Successful pass L.A. County
	Sanitation District Coating Evaluation

211.1.17 SURFACE PREPARATION

- A. Contractor shall inspect all surfaces specified to receive a protective coating prior to surface preparation. Contractor shall notify Engineer of any noticeable disparity in the surfaces which may interfere with the proper preparation or application of the repair mortar and protective coating.

- B. All contaminants including: oils, grease, incompatible existing coatings, waxes, form release, curing compounds, efflorescence, sealers, salts, or other contaminants shall be removed.
- C. All concrete or mortar that is not sound or has been damaged by chemical exposure shall be removed to a sound concrete surface or replaced.
- D. Surfaces to receive protective coating shall be cleaned and abraded to produce a sound surface with adequate profile and porosity to provide a strong bond between the protective coating and the substrate. Contractor shall utilize high pressure water cleaning equipment capable of 5,000 psi at 4 gpm.
- E. Infiltration shall be stopped by using a material which is compatible with the specified repair mortar and is suitable for topcoating with the specified epoxy protective coating.

#### 211.1.18 APPLICATION OF REPAIR MATERIALS

- A. Repair materials shall meet the specifications herein. If using approved cementitious repair materials, such shall be trowelled to provide a smooth surface with an average profile equivalent to coarse sandpaper to optimally receive the protective coating. No bugholes or honeycomb surfaces should remain after the final trowel procedure of the repair mortar. The repair materials shall be permitted to cure according to manufacturer recommendations.
- B. After leak repair is performed, all surfaces shall be inspected for remaining laitance prior to protective coating application. Any evidence of remaining contamination or laitance shall be removed. If repair materials are used, refer to these specifications for surface preparation. Areas to be coated must also be prepared in accordance with these specifications after receiving a cementitious repair mortar and prior to application of the epoxy coating.

#### 211.1.19 APPLICATION OF PROTECTIVE COATING

- A. Application procedures shall conform to the recommendations of the protective coating manufacturer, including material handling, mixing, environmental controls during application, safety, and spray equipment.
- B. The protective coating material must be spray applied with protective coating manufacturer approved heated plural component spray equipment by a Certified Contractor of the protective coating manufacturer.

- C. Specified surfaces shall be coated by spray application of a moisture tolerant, solvent-free, 100% solids, epoxy protective coating as further described herein. Spray application shall be to a minimum wet film thickness of 80 mils.
- D. If necessary, subsequent topcoating or additional coats of the protective coating should occur as soon as the basecoat becomes tack free, ideally within 12 hours but no later than the recoat window for the specified products. Additional surface preparation procedures will be required if this recoat window is exceeded.

#### 211.1.20 TESTING AND INSPECTION

- A. All manholes shall be vacuum tested after installation and prior to protective coating preparation and application.
- B. During application a wet film thickness gage, such as those available through Paul N. Gardner Company, Inc. meeting ASTM D4414 - Standard Practice for Measurement of Wet Film Thickness of Organic Coatings by Notched Gages, shall be used to ensure a monolithic coating and uniform thickness during application. A log shall be submitted to Authority by Contractor that includes wet film thickness testing and protective coating material usage per manhole structure. This log is to be kept and certified by Contractor that material usage and WFT indicates proper coverage at a minimum of 80 mils per these specifications.
- C. After the protective coating has set hard to the touch it shall be inspected by Authority with high-voltage holiday detection equipment. Surface shall first be dried, an induced holiday shall then be made on to the coated concrete surface and shall serve to determine the minimum/maximum voltage to be used to test the coating for holidays at that particular area. The spark tester shall be initially set at 8,000 volts (100 volts per 1 mil of film thickness applied) but may be adjusted as necessary to detect the induced holiday (refer to NACE RPO188-99). All detected holidays shall be marked and repaired by abrading the coating surface with grit disk paper or other hand tooling method. After abrading and cleaning, additional protective coating material can be hand applied to the repair area. Large areas may require additional surface preparation and spray application to achieve minimum thickness. All touch-up/repair procedures shall follow the protective coating manufacturer's recommendations.
- D. At the Engineer's option, select structures may be subjected to adhesion testing and destructive testing for measurement of film

thickness at no additional cost. Measurement of adhesion of the protective coating to the substrate can be made in accordance with ASTM D4541. Measurement of film thickness can be made from the dollies pulled during adhesion testing. Any areas detected to have inadequate adhesion shall be evaluated by the Engineer. Further tests may be performed to determine the extent of potentially deficient bonded area and repairs shall be made by Contractor in strict accordance with manufacturer's recommendations.

- E. A final visual inspection shall be made by the Authority and Contractor. Any deficiencies in the finished coating shall be marked and repaired by Contractor according to the procedures set forth herein.

**PART 212 - SAND FOR CUSHION OR BACKFILL**

212.1.1 Sand shall be graded from fine to coarse, free from objectionable material, and contain not more than ten percent (10%) clay or loam by weight. One hundred per cent shall pass a three-quarter inch screen, and ninety-five per cent shall pass a number four screen.

**PART 213 - CRUSHED STONE FOR SURFACING, BASE COURSE, AND STABILIZATION**

213.1 Crushed stone shall consist of clean, tough, durable fragments, free from an excess of soft or disintegrated particles. Sampling shall be in accordance with the Standard Method of Sampling Aggregates, ANSI/ASTM D 75. Sieve analysis shall be performed in accordance with the method of Sieve Analysis, ANSI/ASTM C136. Gradation to be used at each location will be specified by the Engineer. Crushed stone for aggregate base and surface course shall conform to the Oklahoma Department of Transportation Specifications for Highway Construction, and shall conform to the following gradations:

213.2 Percent Passing

Sieve Size	Type A	Type B
3"	-----	100
1-1/2"	100	40-100
3/4"	40-100	30-75
3/8"	30-75	25-60
No. 4	25-60	20-50
No. 10	20-43	15-35
No. 40	8-26	7-22

213.2.1 Crushed stone aggregate for stabilization and bedding shall conform to the following ASTM D448 and C33 gradations:

213.2.2 Percent Passing

	Size #1	Size #467	Size #57	Size #67	Size #7
Sieve Size	3 ½" to 1 ½"	1 ½" to No. 4	1" to No. 4	¾" to No. 4	½" to No. 4
4"	100	-	-	-	-
3 ½"	50-100	-	-	-	-
2 ½"	25-60	-	-	-	-
2"	-	10	-	-	-
1 ½"	0-15	95-100	100	-	-
1"	-	-	95-100	100	-
¾"	0-5	35-70	-	90-100	100
½"	-	-	25-60	-	90-100
⅜"	-	10-30	-	20-55	40-70
No. 4	-	0-5	0-10	0-10	0-15

## PART 214 - RIP RAP

214.1 All rip-rap designs and installations shall comply with the more stringent requirements of the following:

- A. The most current ODOT Standard Specifications which have also been adopted by the City of Tulsa.
- B. The most current edition of the City of Tulsa Stormwater Management Criteria Manual.

214.2 ODOT Type IV Grouted Rip-Rap is not allowed within the City of Tulsa unless specifically approved by the City Engineer.

**SECTION END**