MATERIAL SPECIFICATIONS APPROVED FITTINGS MANUFACTURERS

Tapping Saddles and Valves

American (DIP)
Baker Series 428 (Steel)
Clow (DIP)
Dresser (DIP)
Ford (DIP)
Hanson Concrete (Conc)
JCM Industries
Mueller (DIP)
PowerSeal (DIP)
PowerSeal Model 3417AS
Price Bros (Conc)
Rockwell 622 (Steel)
Smith-Blair (DIP)
TD Williamson (Conc)
Tyler (DIP)

Restrained Joint Systems

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

Resilient Wedged Gate Valves

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

Ball Valves

Pratt

Couplings for Out-of-Round CI Pipe

Krausz
Smith-Blair
Straub
Viking-Johnson

Check Valves

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

4-Way Fire Hydrants

American Darling
Mueller (Aquagrip allowed)

3-Way Hydrants

American Darling B84B
AVK Series 2780 Nostalgic Style Dry Barrel
Clow Medallion
East Jordan WaterMaster 5CD250
Kennedy Guardian
Mueller Centurian (Aquagrip allowed)

Valve Boxes

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

4” Reversible Rim & 23¼” Lids (Water)

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

Uniflanges

EBAA Series 2100 Megaflange

1½" & 2" Meter Setters

AY McDonald 20C615WFFF6654 (1½")
AY McDonald 20C715WGFF7766x22.75 (2")
Ford B-C10046-011 (1½"), B-C10046-013(2")
Mueller 1½" x 15" B2423, 2" x 15" B2423

Air Relief Valves (Water)

A.R.I
APCO
Crispin
ValMatic

Air Relief Valves (Sanitary Sewer)

A.R.I

Butterfly Valves

Mueller
Pratt

Butterfly Valves - Water Supply Plant Only

Av-Tek - DEX2504 (6" to 48")

Manhole Grade Adjustment Rings

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

Chimney Adjustment Rings

GNC Concrete Products (Concrete)
Ladtech (HDPE)

Fittings

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

4" Reversible Rim & 23¼" Lids (Stm)

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

4" Reversible Rim & 23¼" Lids (San)

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

8" Non-Reversible Rim & 23¼" Lid (San)

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

4" Reversible Rim & 31½" 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-Reversible Rim & 23¼" Lid (Stm)

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

4" Reversible Rim & 31½" 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)

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

Vane Grates – "Drain to River" with "COT"

East Jordan 00760033
Neenah 3076-3000

Type "D" 27⅞" Circular Grate

Deeter 1950
East Jordan 00210032

Bicycle Safe 17¾" x 29¾" Grate

East Jordan 44230231grate/FA1833032G0frame
Neenah 3076-0015

Bolted Bicycle Safe Trench Grate

East Jordan 00697033
Neenah 3076-0019

Solid Knobby Frame / 27⅞" Circular Lid

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

Vertical Standard Stormwater Grate

Neenah R5050

Cast Iron Curb Inlet – 8" Barrier

East Jordan 00760067
Neenah R-3076-8BOK

Cast Iron Curb Inlet – 6" Mountable

East Jordan 00760063
Neenah R-3076-6M

Single Inlet Frame

East Jordan 00760011
Neenah 3076-0001

Center Inlet Frame

East Jordan 00760017
Neenah 3078-0001

Left Inlet Frame

East Jordan 00760013
Neenah 3077-0001

Right Inlet Frame

East Jordan 00760015
Neenah 3077-0002

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

Carson 1520
Carson 1730
DFW Plastics DFW14800A.18.1
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 (1½")
East Jordan 36 x 36 Assembly NCR06-569B (2")
Pencell Plastics (5/8" - 3/4" and 1")
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 (1½")
Sigma 36 x 36 MB-147T2-35 (2")

Corrugated Polypropylene Stormsewer Pipe

ADS HP Storm Pipe (15" – 60")

PEX Service Line

Uponor Aqua PEX Blue 5306
Viega PureFlow PEX Blue 5306

801 Special Requirements, New Equipment Purchases

801.1 Design and Construction Features

801.1.1 Scope

The following special requirements are to be incorporated into specifications for purchase of new equipment by contractors, engineering consultants, or the City of Tulsa. In case of conflict between the "Special Requirements, New Equipment Purchases", and the purchase order, unless specifically stated by the order as an exception, the vendor shall obtain a written determination from the City of Tulsa Water or Sewer Engineer or the Plant Engineer before proceeding with the work affected.

NOTE 1: Several of the following paragraphs mention the "Engineer." This title can include any of the following applicable persons for actions: City of Tulsa Plant Engineer, City of Tulsa Water or Sewer Engineer, or a Design Engineer working at an outside engineering design firm.

NOTE 2: A portion of the following requirements apply only to Sewer Operations & Maintenance, a specific Division of the City of Tulsa Water & Sewer Department. [Comments are noted "SOM"],

801.1.2 Pumps – Horizontal, Vertical, Submersible, and Dry Pit Submersible

1. All hardware including bolts, studs, washers, nuts, nameplate / fasteners, grease caps or plugs, drain plugs or fittings, etc. shall be of plated steel minimum. Hardware for wastewater service shall be offered with an option of 316 stainless steel construction. If 316 stainless steel fasteners are specified, nickel-based anti-seize shall be applied to threaded fasteners during factory assembly.
2. Bolts and studs shall fully engage nuts, and shall have a minimum of zero to three threads visible beyond nut.
3. All through-bolt flanges shall be full-faced on back side or shall be back spot-faced.
4. Horizontal and vertical pumps in wastewater service with 8 inch and larger nozzles shall have a minimum 5 inch diameter hand hole clean-out ports with closure flange to allow access to the suction and discharge areas of the impeller. If impractical to locate the hand hole clean-out ports on the pump nozzles, the ports shall be added to the suction and discharge piping. (This requirement is referenced in "Piping" section 801.1.27.1.)
5. Horizontal and vertical pump nozzles (both suction and discharge) shall each have minimum 0.50 inch NPT (National Pipe Thread) connections for air relief, and minimum 0.75 inch NPT connections for pressure measurements. If this is not a standard for the pump manufacturer, the taps are to be incorporated into the adjacent suction and discharge piping. (This requirement is referenced in "Piping" section 801.1.27.2.)
6. An air relief valve shall be fitted at high point(s). (This requirement is referenced in "Piping" section 801.1.27.2.) The ARV shall be supplied either by the pump manufacturer or by the

engineering contractor. [SOM Submersible pumps ARV shall be installed on the discharge near the force main lift stations shut off valve & be air release only, not combo valves.]

7. Bearing housings containing oil shall be vented to the atmosphere through a desiccant breather to prevent ingestion of dirt and moisture. (N/A to submersible pumps.)
8. Equipment and accessories shall be designed and constructed for continuous operation.
9. Pumps that spare or are redundant to each other (installed or not installed) shall be identical.
10. Pumps that have stable head/capacity curves which continuously rise to shutoff are preferred for all applications and required when parallel operation is specified by the Engineer.
11. NPSHA and NPSHR (Net Positive Suction Head Available and Net Positive Suction Head Required) margin shall be a minimum of 3 feet at rated capacity and speed, or the margin recommended by Hydraulic Institute, whichever is greater.
12. Suction specific speed (NSS) greater than the Hydraulic Institute allowable of 8,500 shall require specific approval by the Engineer.
13. For sewage applications, pumps to be non-clog design, and must allow passage of spheres of the diameter specified by the Engineer.
14. For all solids-handling applications, the pump speed is not to exceed 1800 RPM per the Hydraulic Institute.
15. Impellers shall be keyed to the shaft to prevent harmful effects of any possible reverse rotation. A locking ring or threaded nut shall fix the impeller's axial position to the shaft, and withstand maximum hydraulic thrust loads.
16. All pump casings shall be unpainted when hydrostatically tested with water at 1.5 times the maximum casing design pressure. The hydrostatic tests shall be considered satisfactory when no leaks are observed for a minimum of 10 minutes.
17. Pipe strain shall be minimized during installation of piping and rotating and static equipment per vendor's IOM and Standard Maintenance Guideline AM-SMG-803, "Pipe Strain Allowed on Rotating and Static Equipment." (N/A to submersible pumps.)
18. Vibration of pumps, compressors, motors, etc. shall not exceed the values given in Tables 1 and 2 below as measured on the bearing housing(s). The maximum allowable vibration levels under any circumstance are per "ANSI/Hydraulic Institute Vibration Limits" per Tables 1 and 2 below. The "Preferred Vibration Limits" are to be aimed for with all applications. Note: ANSI/Hydraulic Institute 9.6.4-2016 specifies vibration limits in "RMS" values. The "RMS" values have been converted to "Inches / Sec. Peak" values which are 1.414 X the "Inches / Sec. RMS" values in the referenced ANSI/HI spec. A field vibration certificate shall be supplied by the installation contractor after commissioning. (N/A to submersible pumps.)
19. Overhead cranes shall be installed to provide lifts directly over the pump CG (center of gravity) and motor CG. Not applicable for supply of equipment for existing installations.

20. Peripheral piping of steel or stainless steel construction shall have wall thicknesses sized per "Piping" section 801.1.27.3 and 4. This is not a requirement for the supply of replacement pumps.
21. When specified by the Engineer, high bearing temperature sensors and alarms on pump bearings are required. (N/A to submersible pumps.)
22. When specified by the Engineer, vibration sensors and alarms on pump bearings are required.
23. Submersible and dry pit submersible pumps shall have self-contained cooling jackets and be capable of 100% duty cycle without being submerged.
24. Submersible and dry pit submersible pump impellers shall be of hardened iron.

Table 1 – Maximum Acceptable Field Vibration Levels of Rotating Equipment Not in Solids-Handling Service

Driver Size, HP	ANSI / Hydraulic Institute Vibration Limits, Inches / Sec. Peak	Preferred Vibration Limits, Inches / Sec. Peak
Less than 33 (25 kW)	0.21	0.07
Above 33 (25 kW) and below 268 (200 kW)	0.21	0.11
Greater than 268 (200 kW)	0.27	0.18

Table 2 – Maximum Acceptable Field Vibration Levels of Rotating Equipment In Solids-Handling Service

Driver Size, HP	ANSI / Hydraulic Institute Vibration Limits, Inches / Sec. Peak	Preferred Vibration Limits, Inches / Sec. Peak
Less than 33 (25 kW)	0.35	0.17
Above 33 (25 kW) and below 100 (75 kW)	0.40	0.20
100 (75 kW) and above	0.44	0.22

801.1.3 Pumps – Horizontal

1. Stainless steel shims are to be placed under the motor feet and in bearing housings. Plastic shims are not allowed.
2. Alignment positioning screws shall be provided for all horizontal motors 25 HP and larger, to facilitate longitudinal and transverse horizontal adjustments. Ends of screws that contact motor feet shall be rounded convex. The lugs holding these positioning screws shall be attached to the baseplate so that they do not interfere with the installation or removal of the motor, or the placement of shims.
3. Casing drains shall be valved and plugged on the valve outlet.
4. Pumps shall not be doweled to the baseplate, but shall be provided with dowel holes pre-drilled in the casing feet and supports only. (Drilling of the dowel holes in the baseplate

may be done in the field after alignment.) Dowel pins shall be of the pullout design and shall supplied by the manufacturer.

5. Oil-lubricated pump bearing bracket shall have an oil sample port, full-view sight glass, and desiccant breather for each oil sump.

801.1.4 Pumps – Vertical

1. Vertical pump shaft or shaft sleeve maximum runout measured immediately above the mechanical seal or stuffing box when pump is turned by hand shall be 0.002 inch TIR (Total Indicator Reading) for pumps operating above 1400 RPM, and 0.004 inch maximum TIR for pumps operating below 1400 RPM.
2. Vertical suspended can (barrel) pumps shall be furnished with a separate mounting plate for bolting and grouting to the foundation. The top of the mounting plate shall be flat within 0.002 inch of the surface plane and level to within 0.002 inch per foot of width or diameter. The foundation shall be designed so that the pump suction can (barrel) is directly attached to the separate mounting plate and is removable without damaging the grout below the mounting plate. The foundation bolts shall not be used to secure the flanged joint under pressure.
3. Vertical pumps shall operate in continuous hydraulic down-thrust over the pump's full operating range.
4. When vertical pump shafts of more than one piece are approved by the Engineer, the joints shall be secured against reverse rotation by utilizing ring and key joint connection(s).
5. All vertical pumps with mechanical seals shall have a vent connection on the stuffing box or flush piping located to ensure that fluid is present at the seal faces before start-up.
6. Vertical pumps and vertical in-line pumps shall have spacer couplings connecting the pump and motor shafts. The distance between shaft ends (DBSE) and length of spacer coupling manufactured shall allow removal of the mechanical seal without removal of the motor.
7. Vertical pumps and vertical in-line pumps shall be provided with a close-clearance register fit on the mating flanges of the motor and pump, or jacking screws provided.

801.1.5 Pumps – Submersible

1. Lifting devices (ring, chain, cable, eye, etc.) shall be of 316 stainless steel construction.
2. The power cable shall be supplied long enough to reach the furthest pump slot with 6 ft. extra.
3. For solids applications, the vertical discharge piping shall be sized to maintain at least 4 feet / second flow velocity.
4. The oil drain plug, and oil fill plug are to be positioned so they can be removed and replaced without removing the impeller or any other pump or motor component.

801.1.6 Mechanical Seals

1. Unless otherwise specified, mechanical seals shall be furnished with all pumps. The mechanical seal and seal support system shall be designed to ensure fluid film stability, to

minimize the effect of erosion of the component parts, and to ensure that process dilution is minimized.

2. For vertical, horizontal, and submersible pumps, the mechanical seal face materials are specified per Table 3. For seal flush plans refer to Table 4.
3. All mechanical seal metallic seal components shall be constructed of stainless steel. For water service, all flush and circulation tubing and/or piping shall be constructed of PEX or copper (painted on OD) tubing. For wastewater service, all flush and circulation tubing and/or piping shall be constructed of PEX or stainless steel tubing. PEX tubing deteriorates in sunlight, and shall be used for indoor applications only. All steel and stainless steel piping shall have wall thickness per "Piping" section 801.1.27.3 and 4.
4. Elastomers shall be constructed of Aflas. Elastomers are not to fret the shaft sleeve OD.
5. Seal glands shall bolt to the pump seal chamber with four equally-spaced stainless steel fasteners. The mechanical seal shall not be mounted to a standard packing cross-section stuffing box. The seal chamber shall be specially constructed to optimize the mechanical seal environment. The radial clearance of the mechanical seal ID to the sleeve OD shall have a minimum of 0.187 inch radial clearance. The cross section around the outside diameter of the mechanical seal components shall optimally be a minimum of 1.00 inch radial clearance.
6. A throttle bushing of a non-sparking material shall be provided in the mechanical seal gland to minimize leakage in case of complete seal failure.
7. For applications other than AESSEAL (or equal) double seals and API Plan 53A, each pump to be provided with a pressure switch that will send a signal to shut down the electric motor in event of no external flush water going to the mechanical seal faces.
8. For applications other than AESSEAL (or equal) double seals and API Plan 53A, to maintain flush water inside the seal constantly, a solenoid-activated flow switch shall be located downstream of the pump mechanical seal. The energizing of the electric motor activates the solenoid. A flow indicator (paddlewheel, etc.) shall be installed on this line near the solenoid-activated flow switch.
9. Water service mechanical seals shall be single or split cartridge design, and shall be equivalent to ANSI standard single cartridge seals, Chesterton 42, AESSEAL CURC, or equal.
10. Sewage service mechanical seals shall be equivalent to ANSI standard dual cartridge mechanical seals, AESSEAL CDSA, or equal. The inboard seal faces shall operate on a clean water barrier fluid, pressurized to a minimum of 15 PSI greater than the maximum process pressure in the pump seal chamber. The inboard seal face shall be pressure balanced to the barrier fluid with approximately a 30 / 70 (process / barrier) pressure balance. The mechanical seal face drive mechanism should be metal against metal for durability. The seal environment shall be protected by a close clearance between the back plate and the rotating shaft on the process side of the seal. The optimal diametrical clearance shall be 0.125 inch, and this closed frame plate configuration shall be designed for the purpose of reducing the velocity of the process slurry in the seal housing. The

double mechanical seal shall reject heat by thermosiphon flow through the seal support system and connecting piping. Alternatively, the double mechanical seal can be equipped with a pumping ring to maintain circulation through the seal and API Plan 53A system.

11. The API Plan 53A seal support system shall be AESSEAL SSE25 Water Management System or equal. Vessel capacity shall be 6.6 gallons (25 liters). The vessel shall be constructed of 304 SS and designed to ASME VIII, Div. 1. The Vessel shall be designed to 145 psig MAWP, and shall be hydro tested to 218 psig for a minimum of 10 minutes. The bottom of the vessel shall be located 1-2 feet above the centerline of the mechanical seal. The connecting tubing shall have extra-large radius, sweeping bends. The exit from the seal (BO = Barrier Out) shall enter the upper of the two vessel barrier fluid connections. The lower of the two vessel barrier fluid connections shall connect to the seal (BI = Barrier In) connection. A drain shall be fitted to the lowest portion of the vessel with a valve and a plug to allow periodic (possibly quarterly) purging of accumulated contaminates (a few ounces of water.) A stainless steel non-return valve and a stainless steel flow indicator shall be provided. A brass water supply regulator and a brass pressure gauge shall be provided. A stainless steel pressure switch shall be supplied to alarm on falling pressure. The water quality shall be filtered to 1 micron. A pre-filter of 5 microns can be, but is not required, fitted upstream of the 1 micron filter. The in-line filter shall be constructed of stainless steel, brass, or a UV-stabilized material, and be rated to 120 psig MAWP minimum. The filter is preferred, but not required, to be fitted with a flush valve. The inter-connecting tubing and tube fittings shall be stainless steel material. The barrier fluid shall be potable city water. If city water is not available, plant effluent water (PEW) can be used but with great caution as it will quickly stop up filters, greatly degrade the seal life, and should be avoided.
12. For each dual pressurized mechanical seal, the manufacturer shall provide a computerized report detailing the operating conditions for each application to include: Shaft diameter, RPM, process pressure, barrier fluid pressure, ambient temperature, designed for dry running and hard-face combinations. The report to state the heat removal capability of the system in HP and/or kW. The maximum temperature of seal water as it returns to the seal should not exceed 158°F (70°C), and the report should show the expected steady state temperature for the system. The Engineer to verify applicability considering possible cost adder and additional submittals.
13. The API Plan 53A seal support system (where applicable) shall include a unique serial number referenced to a pressure test certificate. The Engineer to verify applicability considering possible cost adders and additional submittals.
14. Each mechanical seal shall be individually serialized with a unique reference number, and that detail to be permanently electrochemically etched on the seal gland. The Engineer to verify applicability considering possible cost adder and additional submittals.
15. Each double mechanical seal to be statically air tested to API 682 pressure test parameters. The Engineer to verify applicability considering possible cost adder and additional submittals.

16. Documentation and Certifications – Vendor shall supply: Mechanical Seal GA certified drawing and Seal Support System certified drawing. Installation instructions shall be included with each seal in the shipping box. Installation instructions for system installation shall be provided separately prior to the construction phase and detail mounting position relative to the pump seal. The Engineer to verify applicability considering possible cost adder and additional submittals.

Table 3 – Mechanical Seal Face Materials

Type of Pump	Water Service	Sewage Service PH <5	Sewage Service PH >5
Horizontal	SiC vs. Carbon	SiC vs. SiC	TC vs. TC
Vertical	SiC vs. Carbon	SiC vs. SiC	TC vs. TC
Submersible	SiC vs. Carbon	TC vs. TC	TC vs. TC

Table 4 – Mechanical Seal Flush Plans per API 682

Type of Pump	Water Service	Sewage Service PH <5	Sewage Service PH >5
Horizontal	11/32	53A (32 Not Allowed)	53A (32 Not Allowed)
Vertical	13/32	53A (32 Not Allowed)	53A (32 Not Allowed)
Submersible	N/A	N/A	N/A

801.1.7 Motors – Low and Medium Voltage

1. All hardware including frame bolts, conduit box bolting, nameplate fasteners, grease caps or plugs, fan clamp and bolt, drain plugs or fittings, etc. shall be of plated steel minimum. Hardware for wastewater service shall be offered with an option of stainless steel construction. If stainless steel hardware is specified, nickel-based anti-seize to be applied to threaded fasteners during assembly.
2. Motor thrust bearings for vertical pumps shall be designed to carry the maximum thrust loads that may develop while starting, stopping, or operating at any capacity.
3. Bearing housings containing oil shall be vented to the atmosphere through a desiccant breather to prevent ingestion of dirt and moisture. (N/A to submersible pumps / motors.)
4. Equipment and accessories to be designed and constructed for continuous operation.
5. For pumps rated less than or equal to 250 BHP, motors shall be sized for end of curve BHP for rated impeller and specific gravity without including the motor service factor above 1.0. Where this leads to unnecessary oversizing of the motor, vendor shall submit an alternate quotation for the Engineer's approval.
6. Insulation Class F 155°C (311°F) is required for motors not driven by a VFD. Insulation Class H 180°C (356°F) is required for motors driven by VFDs. Windings to be epoxy impregnated by VPI.
7. Noise level shall not exceed 85 dB A sound pressure level (SPL) generated by the motor at a three foot distance from the motor in any direction.

8. Space heaters shall be 110V, 60 Hz, and supplied for 25 HP and larger motors when specified by the Engineer and required on the data sheet. Space heaters shall be arranged to provide optimum uniform heating of the stator windings.
9. When specified by the Engineer, the Premium Efficiency motor design is required. (The US Dept. of Energy recommends Premium Efficiency for motors 500 HP and under that operate more than 2,000 hours per year. Payback is approximately 3-5 years.)
10. When specified by the Engineer, high bearing temperature sensors and alarms on motor bearings are required.
11. When specified by the Engineer, vibration sensors and alarms on motor bearings are required.
12. Electric motors in variable speed applications require special engineering considerations. These motors shall be purchased as part of a packaged system including the motor and the VFD controller. When VFDs are specified the Engineer and the drive system supplier should be included in discussions regarding the application, specifications, and requirements. The electric motor shall be compatible with the variable frequency drive. The motor shall be inverter duty rated, Class H insulation, Y-connected, a grounding ring and brush (required for all motor HPs), and have insulated bearings (required for motors >100 HP). If any of these requirements are cost-prohibitive, vendor shall also submit an alternate quote.

    Note: Grounding the motor back to the VFD potential earth (PE) connection greatly reduces bearing fluting (arcing) as well as using CoolBlue on the VFD outlet leads.
13. Motors shall be designed, constructed, and rated for the NEMA area classification.
14. Oil-lubricated motors shall have an oil sample port, full-view sight glass, and desiccant breather for each oil sump.
15. No metric frame motors allowed.
16. All motors (other than submersible) shall have factory-installed over-temperature sensors that are normally closed, fail-safe contacts for motor shut-down once a critical over-temperature is reached.
17. All submersible and dry pit submersible motors shall have factory-installed over-temperature sensors that are normally closed, fail-safe contacts for motor shut-down once a critical over-temperature is reached. Seal leakage fail-safe monitoring is required.
18. All immersible motors (motors not rated for continuous submersion) shall have the option of factory-installed over-temperature sensors that are normally closed, fail-safe contacts for motor shut-down once a critical over-temperature is reached. Seal leakage fail-safe monitoring is required.

801.1.8 Gear Boxes

1. (No criteria presented.)

801.1.9 Blowers, Fans

1. (No criteria presented.)

801.1.10 Valves – Air Relief, Ball, Butterfly, Check, Plug, Gate, Sluice Gate

1. Air Relief Valves - When specified, the ARV shall be PVC or stainless steel as required by the Engineer with factory installed check plates for release of air only on header applications. And without check plates for line applications commonly called combo valves.
2. Ball valves shall be constructed of stainless steel unless otherwise specified by the Engineer.
3. Check valves shall have a visible outward arm to identify "open" and "closed" operation.
4. [SOM only - Check valves should be capable of disc and shaft replacement without removing check valve from the line. (E.G., AVK Valves)]
5. [SOM only - Unless the application doesn't allow check valves with dual arms (due to surges), check valves are required to have dual arms with weights on one arm and nothing attached to the other. Body of check valves shall be drilled tapped with SAE bolt threads to attach limit switches to the valve. The Engineer to be consulted.]
6. Sluice Gates shall have 316 SST rising stem with 90° gear reduction for most applications.
7. All valves that utilize electrical motor operators shall be fitted with mechanical stops on the stem (or other mechanical device) to prevent mechanical damage to valve while opening or closing.

801.1.11 Electrical Cable

1. Individual conductor electrical cable shall be THHN rated for 90°C (194°F.)
2. Three conductor electrical power cables shall be oil resistant Type 500.

801.1.12 Variable Frequency Drives 60-400 HP

1. VFD's shall be provided with internal bypasses, and full isolation contactors, potential earth (PE) connection, electrical input line reactors, input and output filters, internal heat sinks, internal cooling fan(s) with reusable air filters, enclosure cooling fans and filters. Electrical output cable filters preferred to be DV/DT type filters.
2. VFD's for wastewater service shall have filters impregnated with KMNO4 (potassium manganate – obtain and read the MSDS) to mitigate issues from H2S.
3. When specified by the Engineer, the VFD is to be oversized at 125% of the motor HP to extend service life. Doing so addresses temperature issues due to the possibility of the VFD operating in un-air-conditioned spaces, dirty filters on cooling fans, etc. Cooling fans to be thermostatically controlled, and on when operating a load but not on continuously because the drive is powered up.
4. Applications of 100 HP and greater to be 18 pulse design to reduce harmonics.
   Note: Grounding the motor back to the VFD PE connection greatly reduces bearing fluting (arcing) as well as using CoolBlue on the VFD outlet leads.
5. VFDs normally specified as: Voltage Sourcing – Current Regulating design, Constant Torque design, Isolating Gate Bi-Polar Transistor design.
6. When specified by the Engineer, VFD's shall be housed in humidity and climate-controlled buildings. [All SOM VFDs (regardless of HP) are required to have A/C and heat.]

801.1.13 Variable Frequency Drives 401 HP and Larger

1. VFD's shall be provided with internal bypasses, full isolation contactors, potential earth (PE) connection, electrical input line reactors, input and output filters, internal heat sinks, internal cooling fan(s) with and reusable air filters, enclosure cooling fans and filters. Electrical output cable filters preferred to be DV/DT filters.
2. VFD's for wastewater service shall have filters impregnated with KMNO4 (potassium manganate – obtain and read the MSDS) to mitigate issues from H2S.
3. When specified by the Engineer, the VFD is to be oversized at 125% of the motor HP to extend service life. Doing so addresses temperature issues due to the possibility of the VFD operating in un-air-conditioned spaces, dirty filters on cooling fans, etc.
4. Applications of 401 HP and greater to be 18 pulse design to reduce harmonics.
   Note: Grounding the motor back to the VFD PE connection greatly reduces bearing fluting (arcing) as well as using CoolBlue on the VFD outlet leads.
5. VFDs normally specified as: Voltage Sourcing – Current Regulating design, Constant Torque design, Isolating Gate Bi-Polar Transistor design.
6. When specified by the Engineer, VFD's shall be housed in humidity and climate-controlled buildings. [All SOM VFDs (regardless of HP) are required to have A/C and heat.]

801.1.14 Low Voltage Switchgear and MCCs

1. All applicable requirements of the latest edition of the National Electrical Code shall be met.
2. Integrated surge protection to be provided.
3. Color coding is per latest edition of IEEE.
4. Infrared windows and power monitoring capability are to be supplied.

801.1.15 Low Voltage Circuit Breakers

1. All applicable requirements of the latest edition of the National Electrical Code shall be met. All low voltage circuit breakers to be lockable for LOTO including spare installed units.
2. Integrated surge suppression shall be provided.

801.1.16 Motor Starters

1. All applicable requirements of the National Electrical Code shall be met.
2. NEMA design is required (over IEC design) because NEMA design allows more start/stop cycles and is more robust in design. No IEC contactors shall be used for any applications.
3. For critical assets only, a spare set of heaters to be included with the order – two sets of heaters total per motor starter. The Engineer to determine criticality.

801.1.17 Lighting

1. Unless otherwise specified, all lighting shall be designed and rated for the NEMA area classification.
2. LED lighting is required for all installations.

801.1.18 Control Systems

1. (No criteria presented.)

801.1.19 Programmable Logic Controllers

1. Rockwell Allen-Bradley ControlLogix systems using the L72 or better processor, and provided with a fully functional licensed copy of the same version of Rockwell Studio 5000 software used by the contractor to program the system using ladder logic.
2. Or, the CTI 2500-C200 based systems or CTI 2500C-C200 Compact-based systems can be provided. There is no requirement to provide programming software for the two CTI options because the City of Tulsa maintains an existing site license for all CTI PLC processors.
3. The Contractor is to select the brand of PLC to bid.
4. [SOM requires Flygt MultiSmart programable controllers, Cramer 635 E and S hour meters are required for all pumps. 120V Square D 30mm LED light indicators (red, green, & amber.) All H.O.A, push button E-Stops shall be 30mm per Lift Station standards.]

801.1.20 Control Panel Instruments

1. (No criteria presented.)

801.1.21 Level Measurement Instruments

1. [SOM requires level probes to utilize, 4-20 ma submersible transducers and internally weighted mercury float balls.]
2. All other areas of the City of Tulsa Water & Sewer Dept. utilize various designs.

801.1.22 Flow Measurement Instruments

1. Flow measurement devices shall have a local display provided, and wired for a remote display.

801.1.23 Pressure / Vacuum Measurement Instruments

1. Pressure and vacuum gauges shall be liquid-filled. When required by the Engineer, the gauges shall have isolators of the diaphragm seal design to exclude debris from the gauge function.
2. Piping of steel or stainless steel construction from the gauge-to-line or gauge-to-vessel shall have wall thickness sized per "Piping" section 801.1.27.3 and 4.
3. Pressure transducers shall have a local display provided, and wired for a remote display.

801.1.24 Uninterruptable Power Supplies (UPS)

1. The UPS shall be designed and nameplated for 20% more capacity than required.
2. [Raw Water specifies continuous duty rating for control panels for I/C engines and electric starters.]
3. Must be able to operate on generator power without failure and be able to operate at plus or minus 1Hz for nominal 60Hz systems.

801.1.25 Analytical Meters (PH, Dissolved Oxygen, etc.)

1. (No criteria presented.)

801.1.26 Gas Detectors, Wall-Mount

1. Gas detectors shall have a local display provided, and wired for a remote display.
2. A visual (red and green lights) and audible alarm (bull horn, etc.) shall be mounted outside of the area monitored.

801.1.27 Piping

1. Refer to paragraph 801.1.2.4 for hand hole clean-out ports as required. For small diameter nozzles on equipment, hand hole clean-out ports will need to be incorporated into the adjacent suction and discharge piping.
2. Refer to paragraph 801.1.2.5 and 801.1.2.6 for pipe tap connections as required. Piping adjacent to equipment nozzles may require pipe taps also.
3. Piping of steel construction shall be Schedule 160 for 1.50 inch NPS and smaller, and shall be Schedule 80 for 1.75 inch and 2.00 inch NPS (National Pipe Size). This paragraph is referenced in 801.1.2.20, 801.1.6.3, and 801.1.23.2.
4. Piping of stainless steel material shall be Schedule 40S minimum for all sizes. This paragraph is referenced in 801.1.2.20, 801.1.6.3, and 801.1.23.2.
5. P-traps are required on all installations for vault drains, washdown pads, restrooms, etc. to prevent sewer gas escape. P-traps must have accessible clean-out ports to clear clogs.

801.1.28 HVAC Units

1. Air conditioning shall be provided if the UPS is in a cabinet that could reach an internal temperature over 104°F (40°C) were A/C not provided.
2. If A/C is provided for wastewater service and Lift Stations, the condenser coils shall be coated with Blygold or equal to help prevent corrosion

801.1.29 Preparation for Shipment

1. Spare parts that are subject to corrosion (steel, cast iron, etc.) shall be individually prepared for long term storage in an unheated warehouse. Solvent washable preservative coatings shall be applied, and additional wrapping using waxed cloth, plastic shrink wrap, wood crating, or equal shall be used to protect the preservative coating. Each part shall be individually tagged external to any preservation materials.
2. Preparation of the pumps, gear boxes, fans, motors, electrical components, etc. for shipment shall be made including all exterior surfaces subject to atmospheric corrosion (with exception of machined surfaces) shall be given a coat of the manufacturer's standard paint (unless specified otherwise.) All external machined surfaces shall be coated with suitable rust preventative.
3. All threaded openings shall be plugged with pipe plugs of a material comparable to that of the casing. In no case shall nonmetallic plugs (such as plastic) be used. Exposed shafts

and shaft couplings shall be wrapped with waterproof moldable wax cloth or vapor phase inhibitor paper or equal.

4. Each piece of equipment shall be properly identified as required by the purchase order with a metal tag showing the City of Tulsa Equipment ID #.
5. One copy of the vendor's standard installation instructions shall be packed and shipped with the equipment.
6. Storage of pumps, electrical motors, electrical components, etc. shall follow the manufacturers' guidelines. Space heaters, if provided in electrical motors, are normally energized during storage at site regardless if motor is stored inside or outside.

801.1.30 Installation, O&Ms, Commissioning, Training, and Warranty

1. All contractor installed equipment must be installed per manufacturers' required installation procedures. All rotating equipment shaft alignment certificates and vibration measurement certificates shall be supplied to the Owner by the installation contractor.
2. The O&Ms shall be provided to the Owner in both electronic and hard copy formats. The O&Ms to contain as a minimum for all vendor & sub-vendor equipment including: Bills of materials, outline and sectional drawings, operating and maintenance instructions, recommended lubricants and intervals, preventive and predictive maintenance recommendations, LOTO recommendations, Maximum Allowable Working Pressure (MAWP), Maximum Allowable Working Temperature (MAWT), etc.
3. The warranty starts per the contract Terms and Conditions. It is to be noted that the equipment warranty normally starts at the time the equipment is placed into service for its intended purpose. In general, the warranty starts after the Owner receives and subsequently approves:
   A) The preliminary comprehensive O&M.
   B) The equipment start-up and a report provided including data confirming the equipment successfully passed all performance tests.
   C) The manufacturers' representatives completed the training of COT plant personnel.
   D) The final Warranty Log with Lucity information.
      NOTE: The preliminary Warranty Log provided at beginning of project.
   E) The contract is at 95% completion.

802 Preferred Manufacturers, New Equipment Purchases

802.1 Types of Equipment and Preferred Manufacturers

802.1.1 Scope

The following list of preferred manufacturers is to be incorporated into specifications for purchase of new equipment by a Contractor or an Engineering Consultant or the City of Tulsa. If there should be any conflict between this Guideline and the City of Tulsa Purchasing Ordinance #6-4 or its Revisions, the Ordinance #6-4 or its Revisions shall take precedence. This Guideline includes a list of manufacturers that is not comprehensive, and it is not required that manufacturers be chosen specifically from this list. The manufacturers listed in this Guideline are preferred due to past performance, ability, parts availability, matching of site equipment, support, total cost of ownership, etc. Full and open competition is to be encouraged on all purchases and sales.

In order to reduce any possible conflicts, and to eliminate any omissions of manufacturers during the bid request / review stages, the City of Tulsa Water or Sewer Engineer and/or the Plant Engineer shall provide all technical specs, Standard Maintenance Guidelines, a listing of any suggested potential bidders, and any supporting documents to the Contractor or Engineering Consultant or the City of Tulsa Purchaser before a purchase requisition is submitted by any of these parties. Manufacturers (or their rep's or their distributors, etc.) are invited to bid, whether they are or are not currently on this list. Therefore, all parties shall agree on the specific manufacturers selected for the new equipment before award.

NOTE 1: Some of the following paragraphs mention the "Engineer." This title can include any of the following applicable persons for actions: City of Tulsa Plant Engineer, City of Tulsa Water or Sewer Engineer, or a Design Engineer working at an outside engineering design firm.

NOTE 2: A portion of the following requirements apply only to Sewer Operations & Maintenance, a specific Division of the City of Tulsa Water & Sewer Department. [Comments are noted "SOM"],

802.1.2 Pumps – Horizontal

1. Manufacturers preferred are: Flowserve (including Ingersoll-Dresser), RuhRPumpen, Flygt, AC-Flygt, Fairbanks-Morse, Vaughan, Yeomans/Grundfos, Peerless, Patterson, Goulds, (or equal),

802.1.3 Pumps – Vertical

1. Manufacturers preferred are: Flowserve (including Ingersoll-Dresser), RuhRPumpen, Flygt, AC-Flygt, Fairbanks-Morse, Vaughan, Yeomans/Grundfos, Peerless, Patterson, Goulds, (or equal).

802.1.4 Pumps – Submersible / Dry Pit Submersible

1. Manufacturers preferred are: Vaughan, Flygt, Fairbanks-Morse, Hydromatic, Hayward Gordon, Yeomans/Grundfos, (or equal).

802.1.5 Pumps – Sump, Grinder, Chopper, Progressive Cavity, Peristaltic, Metering

1. Sump pumps; Manufacturers preferred are: Barnes, Goulds, Dayton, Zoeller, Little Giant, Homa, (or equal).
2. Grinder pumps; Manufacturers preferred are: Environment One Model 2010-74, Flygt, (or equal).
3. Chopper pumps; Manufacturers preferred are: Vaughan, Flygt, (or equal)
4. Progressive Cavity pumps; Manufacturers preferred are: Seepex, Moyno, (or equal).
5. Peristaltic pumps; Manufacturers preferred are: Watson Marlow, (or equal).
6. Metering pumps; Manufacturers preferred are: Wallace and Tiernan, Watson-Marlow, Milton Roy, Prominent Pumps, (or equal).

802.1.6 Mixers

1. Manufacturers preferred are: Mixtec, Flygt, Philadelphia, Jensen, Plenty, (or equal).

802.1.7 Mechanical Seals

1. Manufacturers preferred are: AESSEAL, Chesterton, Flowserve, John Crane, (or equal).

802.1.8 Motors – Low and Medium Voltage

1. Manufacturers preferred are: NIDEC / US Electric Motors, Baldor, GE, Siemens, (or equal).

802.1.9 Gear Boxes

1. Manufacturers preferred are: Dodge, Lufkin, (or equal).

802.1.10 Blowers, Fans

1. Manufacturers preferred are: New York Blowers, Continental Blowers and Fans, Plastec, (or equal).

802.1.11 Valves – Air Relief, Ball, Butterfly, Check, Plug, Gate, Sluice Gate

1. Air relief, ball, butterfly, check (refer to para. 802.1.11.3 below), gate valves; Manufacturers preferred are: per City of Tulsa "Division II Material Specifications Approved Fittings Manufacturers." Web site path: City of Tulsa (external web site) / Development – Business / Engineering Services / Government Departments – Engineering Services / Specifications, Checklists, and Details. [SOM requires ARVs manufactured only by Ari Valve.]
2. Plug valves are not included in Div. II spec referenced in no. 1 above; Manufacturers preferred are: per City of Tulsa Div. II spec manufacturers of gate valves, (or equal).
3. Check Valves, in addition to Div. II spec referenced in paragraph 802.1.11.1; Manufacturers preferred are: due for ease of maintenance is AVK, (or equal), unless the Engineer states otherwise per application.
4. Sluice Gate; Manufacturers preferred are: Hydro Gate, Whipps, RW Gate, (or equal).

802.1.12 Electrical Cable

1. For electrical cable; Manufacturers preferred are: Beldon, Southwire, (or equal).

802.1.13 Variable Frequency Drives

1. Manufacturers preferred for 10 Divisions of the City of Tulsa Water & Sewer Dept. are:
   A. Lakes prefers Rockwell Allen-Bradley, (or equal).
   B. Raw Water prefers Rockwell Allen-Bradley, ABB, (or equal).
   C. ABJ WTP prefers Rockwell Allen-Bradley, ABB, (or equal).
   D. Mohawk WTP prefers Rockwell Allen-Bradley, ABB, (or equal).
   E. Water Operations prefers Dan Foss (less than or equal to 300 HP), (or equal).
   F. [SOM requires Schneider Electric (Square D), Eaton, or ABB only.]
   G. NS WWTP prefers Schneider Electric (Square D), Rockwell Allen-Bradley, Eaton, (or equal).
   H. LBC WWTP prefers Schneider Electric (Square D), Rockwell Allen-Bradley, Eaton, (or equal).
   I. SS WWTP prefers Rockwell Allen-Bradley, Schneider Electric (Square D), (or equal).
   J. HC WWTP prefers Rockwell Allen-Bradley, Schneider Electric (Square D), (or equal).

802.1.14 Low Voltage Switchgear and MCC'S

1. Manufacturers preferred are: Schneider Electric (Square D), GE, Eaton, Siemens, (or equal).
2. [SOM requires Schneider Electric (Square D), or Eaton.]

802.1.15 Low Voltage Circuit Breakers

1. Manufacturers preferred are: Schneider Electric (Square D), GE, Eaton, Siemens, (or equal).
2. [SOM requires Schneider Electric (Square D), or Eaton.]

802.1.16 Motor Starters

1. Manufacturers preferred are: Schneider Electric (Square D), GE, Eaton, Siemens, (or equal). NEMA Rated only are required; No I.E.C.

802.1.17 Lighting

1. Manufacturers preferred are: Cooper, Dialight, (or equal).

802.1.18 Control Systems

1. Manufacturers preferred are: Rockwell Allen-Bradley, Control Logix, Siemens, Control Systems Inc. (CTI), (or equal).
2. [SOM requires Flygt MultiSmart only.]

802.1.19 Programmable Logic Controllers

1. Manufacturers preferred are: Rockwell Allen-Bradley Control Logix using L72 or better processor with fully functional licensed version of Rockwell RSLogix 5000 using ladder

logic, or Control Technologies Inc. CTI 2500-C200 based systems or CTI 2500C-C200 Compact based systems (The City of Tulsa already maintains CTI programming software), (or equal).

2. [SOM requires Rockwell Allen-Bradley Control Logix using L72 or better processor with fully functional licensed version of Rockwell RSLogix 5000 using ladder logic. SOM requires Flygt MultiSmart programable controllers.]

802.1.20 Control Panel Instruments

1. Manufacturers preferred are: Rockwell Allen-Bradley, APC by Schneider Electric (Square D) (or equal).

802.1.21 Level Measurement Instruments

1. Ultrasonic instruments; Manufacturers preferred are: Endress+Hauser, Siemens, Flygt, (or equal)
2. Level probes; Manufacturers preferred are: (no criteria presented), (or equal).
3. Level probes: [SOM requires Flygt.]
4. Submersible Transducers and Float Balls; Manufacturers preferred are: (no criteria presented), (or equal).
5. Submersible Transducers and Float Balls; [SOM requires Rota Float of Conery.]

802.1.22 Flow Measurement Instruments

1. Ultrasonic instruments; Manufacturers preferred are: Siemens (or equal).
3. Magnetic instruments; Manufacturers preferred are: Krone (or equal).

802.1.23 Pressure / Vacuum Measurement Instruments

1. Pressure or vacuum gauges; Manufacturers preferred are: Ashcroft (or equal).
2. Differential pressure gauges; Manufacturers preferred are: Siemens (or equal).

802.1.24 Uninterruptable Power Supplies (UPS)

1. Manufacturers preferred for units up to and including 250VA are: APC by Schneider Electric (Square D), (or equal).
2. Manufacturers preferred for units over 250VA are: Eaton Powerware, (or equal).

802.1.25 Analytical Meters (PH, Dissolved Oxygen, etc.)

1. Manufacturers preferred are: Hach (or equal).

802.1.26 Gas Detectors, Wall-Mount

1. Manufacturers preferred are: Scott Safety, Capitol Controls, Siemens, MSA, Honeywell (or equal).

802.1.27 Actuators

1. Manufacturers preferred are: Limitorque, AUMA, Rotork, (or equal).

802.1.28 Bar Screens & Compactors

1. Manufacturers preferred are: Hydro-Dyne, Parkson, Nord Gear, (or equal).

802.1.29 Sewage Grinders

1. Manufacturers preferred are: JWC, (or equal).
2. [SOM requires JWC in accordance with City of Tulsa Standards.]

802.1.30 Sewage Grinder Controllers

1. Manufacturers preferred are: JWC, (or equal).
2. [SOM requires JWC in accordance with City of Tulsa Standards.]

802.1.31 Generators

1. Manufacturers preferred are: Cummins, Generac, (or equal).
2. [SOM requires Blue Star or MTU in accordance with City of Tulsa Standards.]

802.1.32 Automatic Transfer Switches

1. Manufacturers preferred are: Cutler-Hammer, Eaton, (or equal).
2. [SOM requires Generac GTS series non-programmable with options, or ASCO 300 Series G with options.]

802.1.33 HVAC Units

1. Manufacturers preferred are: (no criteria presented), (or equal).
2. [SOM requires Bard Heat Pump with electric heat strips for back-up.]

802.1.34 Electrical Surge Protection

1. Manufacturers preferred are: (no criteria presented), (or equal).
2. [SOM requires Raycap Rayvoss (Model 277-3y-m3-03-C-H) for all installations per lift station standards.]

DIVISION II

MATERIAL SPECIFICATION APPROVED FITTINGS MANUFACTURERS

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/ASTM 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 94 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 7'. 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 3%, 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 there are not enough fines are available in the natural sands, limestone dust, or other approved fines shall be added:

Percent 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	2-1/2”	2”	1-1/2”	1”	3/4"	1/2"	3/8”	No. 4
2”	100	95 – 100	60 – 95	50 – 83	40 – 70	20 – 40		0 – 5
1-1/2”		100	95 – 100		40 – 70		10 – 30	0 – 5
3/4"				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 graduation. The maximum size aggregate to be used in structures 6” thick and under shall be 3/4"; in structures from 6” to 10” thick, the maximum size of aggregate shall be 1-1/2”. 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 28 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 six 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 100 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° F 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. Re-tempering 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 5', 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 35° F.

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 50° F, nor more than 90° F. The concrete shall be adequately protected in order to maintain this temperature for a minimum of 72 hours after it has been placed and a temperature above 32° F 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 place 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 two. 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 ensure 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 1/3 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 1/2" 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 ensure 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 24 to 48 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 24 to 48 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 1 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 = 4-1/2 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 3” 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) 3” 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 18’ or 20’. 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” 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” 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” through 48”, ANSI/AWWA C110; or the American National Standard for Ductile-Iron Compact Fittings, 3” through 48”, 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” length for 3” through 12” sleeves, 15” length for 14” through 24” sleeves, and 24” length for 30” through 48” sleeves).

203.1.6 DUCTILE IRON PIPE FOR GRAVITY SANITARY SEWER USE SHALL BE BY ENGINEERING DIRECTOR APPROVAL ONLY. Interior of all sanitary sewer 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 6” 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 B117 Salt Spray (scribed panel) – Results to equal 9.0 undercutting after two years.

2) ASTM G95 Cathodic Disbondment 1.5 volts @ 77° F. Results to equal no more than 0.5 mm undercutting after 30 days.

3) Immersion Testing rated using ASTM D714-87.

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 (.075 mm) 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 maybe left on the surface. Any area where rust reappears before lining must be re-blasted.

C) Lining

After the surface preparation and within eight 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° F. 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" 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 re-coatable with itself without roughening of the surface.**

F) Touch-Up and 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 a 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 referred hereafter as polywrap. Polywrap shall be manufactured from virgin polyethylene material conforming to the following:

203.3.2.1 Raw material requirements, per ASTM D4976:

A) Group: 2 (Linear).

B) Density: 0.910 to 0.935 g/cm^3.

C) Dielectric strength: Volume resistivity, 1015 ohm-cm, minimum.

203.3.2.2 Physical properties of finished film:

A) Tensile strength: 3,600 psi (24.8 MPa) for an 8 mil (200-µm) minimum thickness, or 28.8 lbf/in. width (50.4 N/cm width), minimum in machine and transverse direction (ASTM D882).

B) Elongation: 700%, minimum in machine and transverse direction (ASTM D882).

C) Dielectric strength: 800 V/mil (31.8 V/µm) thickness, minimum (ASTM D149).

D) Impact resistance: 600 g, minimum (ASTM D1709 Method B).

E) Propagation tear resistance: 2,550 gf (grams force), minimum in machine and transverse direction (ASTM D1922).

203.3.2.3 Thickness: Linear low-density polyethylene film shall have a minimum thickness of 0.008” (8 mil or 200 µm).

203.3.2.4 Color: Polywrap may be supplied in its natural color, white, black, or weather-resistant black containing not less than 2% carbon black with a particle diameter of 90 nm or less. A minimum 2% of a hindered amine ultraviolet inhibitor is required for all films other than the weather-resistant black film with carbon black. Where other colors are specified for purposes of identification, the pigmentation shall not contain any regulated substances.

203.3.2.5 Tape: The polywrap shall be secured as specified below with 2” wide pressure sensitive tape not less than 10 mils thick. This flexible tape shall consist of a polyethylene or polyvinyl chloride backing with a synthetic elastomeric adhesive film comprised of butyl rubber. Tape shall remain flexible over a wide range of temperatures, with tensile strength and elongation properties in conformance with ASTM D1000.

The minimum tube size for each pipe diameter shall be per Table 1.

Table 1 Polyethylene tube and sheet sizes for push-on joint pipe*

NOMINAL PIPE SIZES	PUSH-ON JOINT FLAT TUBE WIDTH	MECHANICAL JOINT FLAT TUBE WIDTH
3 in.	16 in.	16 in.
4 in.	16 in.	16 in.
6 in.	16 in.	20 in.
8 in.	20 in.	24 in.
10 in.	24 in.	27 in.
12 in.	27 in.	30 in.
14 in.	30 in.	34 in.
16 in.	34 in.	37 in.
18 in.	37 in.	41 in.
20 in.	54 in.	54 in.
24 in.	54 in.	54 in.
30 in.	67 in.	67 in.
36 in.	84 in.	84 in.
42 in.	84 in.	84 in.
48 in.	96 in.	96 in.
54 in.	108 in.	108 in.
60 in.	108 in.	108 in.
64 in.	121 in.	121 in.

*These wrap sizes should work with most push-on joint pipe and fitting bell sizes. Where bell or fitting circumferences are larger than the tube sizes shown, a larger tube to effectively cover these joints should be ordered.

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" AWWA operating nut; counterclockwise 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: one 250 psi on the valve body with rotor in the open position; and two 150 psi on the side of the valve with the opposite side open to atmosphere. Six 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 counterclockwise. 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 coats of asphalt varnish conforming to Federal Specifications TT-V-51C. For non-buried service, exterior surface shall be coated with two 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 certified copies of the manufacturers detail drawings shall be submitted for approval prior to delivery of the valve.

203.6.5 Six 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, counterclockwise 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% 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 ensure 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 THREE-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; 5-1/4” compression main valve; 6” inlet connection; standard bell or mechanical joint hub; 3’ 6” bury length, or as specified on drawings; two 2-1/2” hose nozzles with National Standard threads; one 4” 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” inlet connection; bell, flange, or mechanical joint inlet; 4’ 6” bury length; two 2-1/2” hose nozzles with National Standard threads; two 4” 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” 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’ 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 years of 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 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 ±1% 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 6” 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". 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'. Depth of cover in excess of 12' 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" 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” 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 two-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 2% of inside diameter and to maintain roundness of ±1% 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

205.1.1 Where reinforced concrete pipe (RCP) and fittings are specified or required per AWWA C301, for water, 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 of 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 a 24” flanged access manway with a 24” steel blind flange. 6” screw type hand hole fittings will not be permitted.

205.1.2 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.

205.1.3 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’ plus external live load equal to AASHTO HS 20 loading. The thickness of the mortar coating shall provide a minimum cover of 1” over the reinforcing steel.

205.1.4 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.

205.1.5 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.

205.1.6 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 are 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

205.2.1 Where reinforced concrete pipe (RCP) and fittings are specified or required per ASTM C76, for storm 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' except for shorts and specials. Pipe sections connected to a manhole or structure shall be no more than 4' 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 6%. No lifting holes will be allowed on any reinforced concrete pipes or reinforced concrete boxes.

205.2.2 Testing shall be observed and reported by an independent testing laboratory approved by the Engineer. One 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 absorption test in accordance with ASTM C497 shall be performed for each 300 tons of pipe manufactured, not less than one test per day's production. Four concrete cylinders or core samples shall be tested for compressive strength from each day’s production, two at seven 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’. The joints shall be tested for a minimum period of one 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.

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 4” in diameter through 12” 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” THROUGH 12”, 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 within arterial street right of way.

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 207A – HIGH DENSITY POLYETHYLENE (HDPE) PIPE, WATER SERVICE

207A.1 Where high density polyethylene (HDPE) pipe 4” through 63” in diameter is specified or required, it shall conform to and be tested in accordance with AWWA C906 "POLYETHYLENE (PE) PRESSURE PIPE AND FITTINGS, 4” THROUGH 63”, FOR WATER DISTRIBUTION AND TRANSMISSION" as herein modified. HDPE water pipe shall be approved by the Underwriters Laboratory Sanitation Foundation Testing Laboratory for potable water pipe. HDPE water pipe shall be restricted from use within arterial street right of way.

207A.2 Polyethylene compounds utilized in the manufacture of products furnished under this specification shall be listed in PPI TR-4, have a grade of PE47 with a minimum cell classification of PE 445574C for PE4710 materials, as defined in ASTM D3350. In conformance with AWWA C906, they shall have a PPI recommended Hydrostatic Design Basis (HDB) of 1600 psi (PE4710) at a temperature of 73.4° F (23° C). The materials shall meet the following nominal physical property requirements:

PROPERTY	TEST METHOD*	NOMINAL VALVE
Material Designation	PPI/ASTM	PE4710
Cell Classification	D3350	445574C
Density, Natural	D1505	0.947 gm/cc
Density, Black	D1505	0.956 gm/cc
Melt Index (190° C/2.16 kg)	D1238	<0.15 gm/10 min
Flow Rate (190° C/21.6 kg)	D1238	8.5 gm/10 min
Tensile Strength @ Ultimate	D638	5,000 psi
Tensile Strength @ Yield	D638	3,500 psi
Ultimate Elongation	D638	>800%
Flexural Modulus, 2% Secant	D790	110,000 – 160,000 psi
Environmental Stress Crack Resistance (ESCR)		
F_0, Condition C	D1693	>10,000 hrs.
PENT	F1473	>500 hrs.
Brittleness Temperature	D746	<-180° F
Hardness, Shore D	D2240	64
Vicat Softening Temperature	D1525	255° F
Izod Impact Strength, Notched	D256	7 ft-lb/in
Modulus of Elasticity (short term)	D638	130,000 psi
Modulus of Elasticity (long term)	D638	32,500 psi
Thermal Expansion Coefficient	D696	8.0×10^5 in/in/°F
Average Molecular Weight	GPC	330,000
PPI Hydrostatic Design Basis	D2837	1,600 psi @ 73.4° F
(As listed in PPI TR-4)		1,000 psi @ 140° F

*Test procedures are ASTM unless otherwise specified. (PPI = Plastics Pipe Institute, and GPC = Gel Permeation Chromatography.)

207A.3 HDPE pipe shall have a Diameter Ratio (DR) of 11, shall be Ductile Iron Pipe Size (DIPS) as indicated in the chart below, and shall be certified for conformance with NSF/ANSI Standard 61. A DR greater than 11 shall not be permitted.

DIP/PVC Size (in)	HDPE size (in)
6	8 DIPS
8	12 DIPS
10	12 DIPS
12	16 DIPS

207A.4 The Pressure Class of the PE pipe and PE fittings shall be specified on the basis of the Working Pressure Rating of the water system as defined in AWWA C906. Recurring positive pressure surges of up to 1/2 of the pipe's nominal pressure class and occasional pressure surges of up to 100% of the pipe's nominal pressure class may be

ignored due to the fatigue endurance of the polyethylene materials. For PE 4710, the net pressure capability shall be the working pressure rating (WPR) @ 73° F as follows:

DR	WPR (psi)	WPR + Surge (psi)	Hydrotest (psi)	Nominal 60 sec. Burst (psi)
11.0	200	300	300	800

207A.5 Polyethylene fittings, including custom fabrication, shall have the same internal pressure rating as the mating pipe. The use of derated fittings shall not be permitted. At the point of fusion, the wall thickness and outside diameter of the fitting shall be in accordance with AWWA C-906 for the same pipe size.

207A.6 All HDPE taps for water service line shall be made with a HDPE fusion tapping saddle Poly-Cam Series 415 or 575 (HDPE) or approved equal.

207A.7 Permanent identification of piping shall be provided by co-extruding multiple (minimum four) equally spaced blue color stripes into the pipe outside surface or by solid blue colored pipe shell. The identification material shall be the same material as the pipe material described herein, except for the blue color. Plain Black HDPE Pipe without color markings may not be used in the City of Tulsa Distribution System.

ASTM, AWWA, NSF and CSA standards require that markings on pipe and tubing be present at frequent intervals – generally not less than every 5’ – and that they include at least the following items of information:

A) The nominal pipe or tubing size (e.g., 1”).

B) The type of PE material from which the pipe is made (e.g., PE 4710).

C) The pipe or tubing dimension ratio or the pipe pressure rating or pressure class for 73° F water, or both.

D) The standard against which the pipe has been made and tested.

E) The manufacturer's name or trademark.

F) Production record coding the place and time of manufacture.

G) The seal or mark of the certification agency that has determined the suitability of the pipe for potable water service.

PART 208 – POLYVINYL CHLORIDE (PVC) PIPE, SEWER SERVICE

208.1 Where polyvinyl chloride (PVC) pipe 8” in diameter through 15” 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 ratio (SDR) of 26. Minimum pipe stiffness for all sizes shall be 115 psi.

208.2 Where polyvinyl chloride (PVC) pipe 18” in diameter through 48” 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 115 psi.

208.3 The PVC sewer pipe shall be supplied in 12.5’ or 20’ 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 and risers for future service connections shall be of the same material as the mainline, and manufactured and specifically designed for connection to 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 Cust 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 minute, applied on a 9” x 9” 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 ±1/16 in/ft.

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” 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 2” manhole adjusting ring where specified shall have a minimum weight of 70 pounds and the 3” 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’ 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 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 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 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:

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:

Raven Lining Systems, Inc., Tulsa, Oklahoma 800.324.2810, 918.584.2810, or Fax 918.582.4311, or equal.

211.1.15 Repair Materials:

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:

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 top coating 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 troweled 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 top coating 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 Inspecting:

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 10% clay or loam by weight. One hundred percent shall pass a 3/4" screen, and 95% 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 D75. Sieve analysis shall be performed in accordance with the method of Sieve Analysis, ANSI/ASTM CI36. 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 1/2” to 1-1/2”	1-1/2” to No. 4	1” to No. 4	3/4” to No. 4	1/2” to No. 4
4”	100	-	-	-	-
3-1/2”	50 – 100	-	-	-	-
2-1/2”	25 – 60	-	-	-	-
2”	-	10	-	-	-
1-1/2”	0 – 15	95 – 100	100	-	-
1”	-	-	95 – 100	100	-
3/4"	0 – 5	35 – 70	-	90 – 100	100
1/2"	-	-	25 – 60	-	90 – 100
3/8”	-	10 – 30	-	20 – 55	40 – 70
No. 4	-	0 – 5	0 – 10	0 – 10	0 – 15

PART 214 – RIPRAP

214.1 All riprap 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 Riprap is not allowed within the City of Tulsa unless specifically approved by the City Engineer.

PART 215 – CORRUGATED POLYPROPYLENE PIPE AND FITTINGS FOR STORMWATER

215.1 Where corrugated polypropylene (PP) pipe 15” in diameter through 60” in diameter are specified or required for storm sewer service, it shall conform to and be tested in accordance with ASTM F2881 "Standard Specification for 12” to 60” (300 to 1500 mm) Polypropylene (PP) Dual Wall Pipe and Fittings for Non-Pressure Storm Sewer Applications" and AASHTO M330. Minimum cover shall be 2’. Pipe sizes of less than 15” are not allowed in closed public or private storm sewer systems.

215.1.1 If flowable fill is to be used for backfill in lieu of ODOT Type "A" Aggregate base, a pipe anchoring system must be utilized during installation. The anchoring system must be approved by the pipe manufacturer and the Engineer prior to use.

215.2 The PP sewer pipe shall be supplied in 13’ or 20’ laying lengths as specified.

215.3 PP pipes shall be joined with a gasketed integral bell and spigot joint meeting the requirements of ASTM F2881, for the respective diameters. Joints shall be watertight according to the requirements of ASTM D3212 “Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals". Spigots shall have gaskets meeting the requirements of ASTM F477 "Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe". Gaskets shall be installed by the pipe manufacturer and covered with a removable, protective wrap to ensure the gasket is free from debris. Contractor shall use a joint lubricant, as recommended by the pipe manufacturer, on the gasket and bell during joint assembly.

215.4 Fittings shall conform to ASTM F2881 for the respective diameters.

215.5 Field testing of joints as directed by the Engineer, shall be in accordance with ASTM F2487 “Standard Practice for Infiltration and Exfiltration Acceptance Testing of Installed Corrugated High-Density Polyethylene and Polypropylene Pipelines" or ASTM F1417 "Standard Practice for Installations Acceptance of Plastic Non-pressure Sewer Lines Using Low-pressure Air".

215.6 Installation shall be in accordance with ASTM D231 “Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-flow Applications” and City of Tulsa standards.

215.7 The manufacturer shall maintain quality control through regularly scheduled testing in accordance with all referenced ASTM standards. 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 plant location, machine and date of manufacture can be identified.

SECTION END