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WATER TRANSMISSION, DISTRIBUTION AND SERVICE LINES

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**PART II - CONSTRUCTION MATERIALS AND METHODS
SECTION 30**

WATER TRANSMISSION, DISTRIBUTION AND SERVICE LINES

30.1 GENERAL

Piping for all newly constructed water transmission, distribution and service lines to be installed in easements or public right-of-way under the jurisdiction of the City, shall be designed, cathodically protected, fabricated and installed as hereinafter specified. The specific requirements for excavation and resurfacing over pipelines are detailed in Section 20, "Excavation, Bedding and Backfill of Pipe" and Section 11, "Hot Bituminous Pavement" of these Specifications. These Specifications shall apply to all new construction within the City of Arvada.

The Contractor performing the work shall be properly licensed with the City, obtain all permits, give twenty-four (24) hours written notice to the Public Works Department Engineering Division, setting forth the time construction is to commence or when work is to be resumed following a delay. The Contractor shall maintain a complete set of approved drawings and specifications, covering the work being performed, on the project at all times.

30.2 MATERIALS

Pipe, fittings and appurtenances to be installed in the City water system shall be equal or exceed the minimum standards as set forth by the: American Society of Testing Materials (ASTM); American Water Works Association (AWWA); American National Standards Institute (ANSI), etc. Referenced standards shall be the latest edition or revision thereof.

Standard Specifications applicable to the manufacturing of the various types of pipe and fittings to be used are listed in Table 30.1. Special requirements modifying the standard specification are referred to in Part III Section 120, and under specific items throughout this and the Design Section of these Specifications.

Manufacturers of pipe, valves and other in-line appurtenances shall furnish a certified statement that the inspection and all the specified tests have been made and the results obtained comply with the requirements of the applicable standards as herein specified. A copy of the certification shall be sent to the Project Engineer prior to installation.

**TABLE 30.1
WATER PIPE**

APPLICATION TYPE & MATERIAL	SPECIFICATION		DIAMETER	CLASS	JOINT
	ASTM	ANSI/AWWA			
SERVICE LINES					
(CU) Copper	B-251		3/4" - 2"	TYPE K	Flared or Compression (1)
(PVC) Polyvinyl Chloride (Outside vaults)		C900	3" - 8"	CL 150	Bell and spigot or MJ
(DI) Ductile Iron (Inside vaults)		C151	3" - 8"	CL 150	Flanged
DISTRIBUTION & TRANSMISSION LINES: (2)					
(PVC) Polyvinyl Chloride Cell 12454 A or B	D-1784 D-2241	C900	4" ,6",8" or 12"	CL 150-200 DR18-14	Bell and spigot ASTM F-477, D-3139 AWWA C900, C905, C909 UNI-B-1
		C905	14"-24"	CL 165 DR25	
		(PVC0) Polyvinyl Chloride Molecular Oriented	C909	6", 8" or 12"	
(DI) Ductile Iron (3) (5) grade 60-42-10		C151 Pipe C104 Lining	30" – 54"	CL 150	Bell and spigot ASTM F-477, D-3139 AWWA C111
(STL) Steel (4) (5)	A36 A139	M11 C200 Pipe C205 Cement Lining C206 Welding C214 Tape Coating	30" – 54"	225 psi plus external loads	AWWA C200 O-ring

- (1) Compression joints allowed are Mueller (110 only), Ford (Q only), AY McDonald (Q only), Cambridge (CB only), James Jones (SG only)
- (2) See Section 20 for bedding type, gradation and compaction.
- (3) Requires asphaltic protective coating, cement mortar lining, and polyethylene encasement. See Paragraph 30.2.7 of these Standards.
- (4) Requires AWWA C214 Tape Coating and AWWA C205 Cement Mortar Lining
- (5) Requires cathodic protection system.

30.2.1

Fittings for Service Lines, Meters and Mains

- A. Service Line Fittings: Service line fittings shall be of the manufacturer and types herein below specified only. Other manufacturers and model numbers must be approved by the Utilities Department prior to installation.

Corporation Stops - Ball Type Only						
Size	Brand	Mueller	Ford	AY McDonald	Cambridge	James Jones Co.
3/4"	Flare	B-25000	FB600	4701B	301-A3C3	J-1930
	Compression	B-25008	FB1000-Q	4701BQ	301-A3H3	JSG-1937
1"	Flare	B-25000	FB600	4701B	301-A4C4	J-1930
	Compression	B-25008	FB1000-Q	4701BQ	301-A4H4	JSG-1937
1 1/2"	Flare	B-25000	FB600	4701B	301-A6C6	J-1930
	Compression	B-25008	FB1000-Q	4701BQ	301-A6H6	Not allowed
2"	Flare	B-25000	FB600	4701B	301-A7C7	J-1930
	Compression	B-25008	FB1000-Q	4701BQ	301-A7H7	Not allowed
Curb Stop Valves - Ball Type Only with 1/4 Turn Check						
Size	Brand	Mueller	Ford	AY McDonald	Cambridge	James Jones Co.
3/4"	Flare	B-25204	B22-333	6100	202-C3C3	J-1902
	Compression	B-25209	B44-333-Q	6100Q	202-H3H3	JSG-1949
1"	Flare	B-25204	B22-444	6100	202-C4C4	J-1902
	Compression	B-25209	B44-444-Q	6100Q	202-H4H4	JSG-1949
1 1/2"	Flare	B-25204	B22-666	6100	202-C6C6	J-1902
	Compression	B-25209	B44-666-Q	6100Q	202-H6H6	JSG-1949
2"	Flare	B-25204	B22-777	6100	202-C7C7	J-1902
	Compression	B-25209	B44-777-Q	6100Q	202-H7H7	JSG-1949
Curb Stop Box						
	Size	Brand	Tyler			
	3/4" – 1"		6500 Series Screw Type			
	1 1/2" – 2"		6860 Series Box in asphalt			
Meter (Pit) Setter- Ball Valves Only						
Size	Brand	Mueller	Ford	AY McDonald	Cambridge	James Jones Co.
5/8"x 3/4"	Flare	B-2489	VB82W- 22-33	37-207WXCC 33	Not allowed	JO4AFCFCBVMC07
	Compression	B-2474	VB82W- 44-33-Q	31-207WXQQ 33	6040-207H3H3UO	JO4ASGSGBVMC07
3/4"	Flare	B-2489	VB83W 22-33	37-307WXCC 33	Not allowed	J04BFCFCBVMC07
	Compression	B-2474	VB83W- 44-33-Q	31-307WXQQ 33	6040-307H3H3UO	JO4BSGSGBVMC07
1"	Flare	B-2489	VB84W- 22-44	37-410WXCC 44	Not allowed	JO4CFCFCBVMC10
	Compression	B-2474	VB84W- 44-44-Q	31-410WXQQ 44	Not allowed	JO4CSGSGBVMC10
Meter (Vault) Setter - Ball Valves Only						
Size	Brand	Mueller	Ford	AY McDonald	Cambridge	James Jones Co.
1 1/2"	FIP	B-2423*	VBB76- 15B-44-66	Not Allowed	6020-615H6H6- UUB	JO2EFIPFIPBVBV -AR15
2"	FIP	B-2423*	VBB77- 15B-44-77	Not Allowed	6020-715H7H7- UUB	JO3FF1PF1PBVBV -AR15

* 15" Riser

Meter Pit			
	24" ID	Concrete	Wire reinforced concrete
	24" OD	Plastic	DFW Plastics Model Number DFW 242148 (48-1/2" Height, White Color, 3/8" wall thickness)
	24" ID	Plastic	Mid States Plastics "B" Series (48" Height, White Interior, 1 1/2" wall)

Meter Pit Cover		
Brand	Rehrig Pacific	Husky Frame Systems 12" diameter Meter Lid

Meter Pit Dome for 3/4" dia. Service					
Brand	East Jordan Iron Works	Mueller	Castings Inc.	Ford	D & L Supply
	8420	H-10818	M-70 AL	W3	L-2286

Meter Pit Dome for 1" dia. Service					
Brand	Castings				
	CI 70-16 (16" dia. lid)				

Extra Heavy Dome and Recessed Cover for 3/4" dia. Service				
(For sidewalk, parking lot or driveway installation only if there is no alternate location)				
Brand	Castings	East Jordan Iron Works	Ford	D & L Supply
	W32	8422	W3	L-2260
Extra Heavy Dome and Recessed Cover for 1" dia. Service				
Brand	Castings			
	W32-16 (16" dia. Lid)			

Service Saddles¹ – Bronze with Stainless Steel Straps (3/4" – 2" taps)							
Brand	A.Y. McDonald²	Mueller³	Ford	Romac⁵	James Jones Co.³	Powerseal⁶	Smith-Blair
PVC	3855	BR2S	202BS ⁴	202BS	J-969 Double	3409	393 ²
Ductile or Cast Iron	3825	BR2B BR2S	202B ³ 209BS ⁴	202B 202BS	J-979	3409	393 ² 323 ⁷
Asbestos Cement	3825	BR2B BR2S	202B ³ 202BS ⁴	202B 202BS	J-979	3409	393 ² 323 ⁷
¹ Saddles must be installed in accordance with manufacturer's recommended torque specifications ² Thru 12" Diameter Pipe ³ Thru 16" Diameter Pipe ⁴ Thru 30" Diameter Pipe ⁵ Thru 16" Diameter Pipe (use #305 all stainless thru 24" diameter pipe) ⁶ Thru 16" Diameter Pipe (use #3416AS all stainless thru 48" diameter pipe) ⁷ Thru 20" Diameter Pipe							

- B. Fittings for PVC and Ductile Iron Distribution and Transmission Lines: Distribution and transmission line fittings for PVC and ductile iron pipe shall be ductile iron and in accordance with ANSI/AWWA C153/A21.53 and ANSI/AWWA C110/A21.10. Fittings shall have a 350 psi pressure rating. Fittings shall be coated both internally and

externally with fusion bonded epoxy in accordance with ANSI/AWWA C116. The fittings shall be furnished with mechanical joint ends in accordance with ANSI/AWWA C111/A21.11 and, in addition, the tee-head bolts and hexagon nuts shall conform to ASTM A325, Type 3 and be fabricated from "Cor-Blue", a high strength, low alloy steel. 4" through 12" diameter fittings may also be ductile iron One-Bolt type with integral restrained joints as manufactured by One-Bolt, Inc.

- C. Steel Pipe Transmission Line Fittings: All specials and fittings shall conform to the dimensions of AWWA C208. Fittings shall be of the same material and thickness as the pipe. The minimum radius of elbows shall be 2.5 times the pipe diameter, and the maximum miter angle on each section of the elbow shall not exceed 11 1/4 degrees. If elbow radius is less than 2.5 x pipe diameter, stresses shall be checked per AWWA M11 and wall thickness or yield strength increased if necessary. Fittings shall be equal in pressure design strength and shall have the same lining and coatings as the abutting pipe. Fittings shall be made of segmentally welded sections from hydrostatically tested pipe with ends compatible with the type of joint or coupling specified for the pipe.

30.2.2 Valves

- A. Resilient Seated Gate Valves (2" - 12"): Gate valves shall be manufactured in accordance with AWWA C-509 "Resilient-Seated Gate Valves" (2" - 12") for water systems, open left (counterclockwise).

Valves shall be epoxy coated both internally and externally in accordance with ANSI/AWWA C550 and have a non-rising stem. The operating pressure for all gate valves shall be 200 psi gauge.

The stem seal shall consist of two (2) each O-rings, designed to allow replacement of the seal above the thrust collar with the valve operating under pressure in the full open position.

All valves shall have type 304 Stainless Steel Bonnet bolts and nuts.

- B. Butterfly Valves (14"-54"): Butterfly valves shall be manufactured in accordance with AWWA C-504 "Rubber Seated Butterfly Valves", open left (counterclockwise).

Valves shall be Class 150 B and be drop tight for flows in either direction at a maximum static differential pressure across the valve of 150 psi.

Valve body material shall conform to that shown in Section 5.4 of referenced specification. All flanged end valves shall have a short body laying length conforming to Table 3 of specification, AWWA C-504.

Manual valve operators shall be installed on the north or east side of the valve and sized and designed to develop output torques for Class 150 B operating service and shall be sufficient to seat, unseat and rigidly hold the disc in any intermediate position for the above conditions. The operator shall be capable of withstanding an overload input torque of 300 ft/lbs at full open or closed position without damage to the valve or valve operator. The maximum input torque required to fully open or close the valve for Class 150 B conditions shall not exceed 150 ft/lbs., when applied to the operating nut. All gearing shall be totally enclosed, full gasketed, grease packed, and sealed from ground water.

The operator shall be designed to resist a minimum pressure head of twenty-five (25) feet, when submerged in water.

External and internal valve coating shall be epoxy in accordance with ANSI/AWWA C550.

- C. Pressure Reducing Valves: Pressure reducing valves shall operate at a pressure of 150 psi gauge and be capable of reducing a high existing pressure to a pre-adjusted lower downstream pressure for varying rates of flow without causing water hammer on the system. The maximum fluid velocity through the valve shall not exceed fifteen (15) fps at maximum demand flow. The valve shall be designed to provide an access opening into the valve body for removing internal parts without removing the main valve body from the line. Valves shall be supplied and installed with stainless steel bolts, position indicator assembly, open and close speed controls, sustainer and preset pilot valves in accordance with City of Arvada specified pressures.

Pressure reducing valves approved for installation are as follows:

Singer Model 106PR or 206 PR, manufactured Singer Valve Inc., Surrey, BC or equivalent

- D. Air Release-Vacuum Valves: Combination air release vacuum valves operating to 150 psi shall be of the single body, double orifice type allowing large volumes of air to escape out of the large air vacuum orifice when filling the pipeline and to close watertight when the liquid enters the valve. During closure of the large orifice, the small air release orifice shall open to allow small pockets of air to escape automatically and independently of the large orifice. The large air vacuum orifice shall also allow large volumes of air to enter through the orifice during pipeline drainage to break the vacuum. Valves shall be manufactured in accordance with AWWA C512. Drain plugs shall be removed before installation and broiler drains installed by the Contractor before the valve is put into service.

The valve body and cover shall be high strength plastic or cast iron conforming to ASTM A-126, Class B. The body inlet must be baffled to protect the lower and upper floats from direct contact of the rushing air and water to prevent premature valve shut off. All floats shall be stainless steel conforming to ASTM A-240, be hermetically sealed and designed to withstand a minimum of 1000 psi. The upper float shall be center guided for position shut off.

The valve seat shall be Buna-N Rubber. The seat must be fastened to the valve cover, without distortion, for drop tight shut off.

The level frame shall be Delrin conforming to ASTM D-638 and the lug shall be bronze conforming to ASTM B-124-55.

ARI USA, Inc. Model D-040 or GA Industries, Inc. 945 Series are allowed.

1. Guard Valve: The guard valve to be used with two (2) inch and smaller air valves shall be a full body stainless steel ball valve with female iron pipe threads and stainless steel handle, or approved equal. Connections between the air and guard valve shall be made using brass nipples conforming to AWWA C-800, "Threads for Underground Service Line Fittings". Large guard valves may be flanged type.

A service saddle shall be used to install taps for all combination air release vacuum valves installed on water mains. Service saddles shall conform to the manufacturer and type shown in Section 30.2 of these Specifications. For air release-vacuum valves installed on transmission mains larger than 16" diameter, saddle shall be all stainless or double strap all bronze service saddle in accordance with Table 30.1.

- E Tapping Valves: Tapping valves shall conform to all the requirements set forth herein above for resilient seat gate valves and the following:

The inlet end of the valve shall be Class 125 flange and the outlet end shall be a mechanical joint. Body of the valve and seat opening shall be sized large enough to accommodate the following sizes of shell cutters:

<u>Tapping Valve Nominal Diameter</u>	<u>Shell Cutter Diameter</u>
4"	3- 7/8" ± 1/32"
6"	5-13/16" ± 1/32"
8"	7- 7/8" ± 1/32"
10"	9- 7/8" ± 1/32"
12"	11- 7/8" ± 1/32"

30.2.3 Valve Appurtenances

- A. Flanged Ends: Flanges shall be sized and drilled in accordance with ANSI-B 16.1, Class 125 specifications; flanges shall be machined to a flat face with a finish of 250 micro-inches, or machined to a flat surface with a serrated finish in accordance with AWWA C207 "Steel Pipe Flanges".
- B. Mechanical Joint: Mechanical components of this type of joint shall conform with ANSI-A21.11/AWWA C-111 "Rubber Gasketed Joints for Cast Iron and Ductile Iron Pressure Pipe and Fittings"). The tee-head bolts and hexagon nuts shall be fabricated from a high strength, low alloy steel with a ceramic filled, baked on flourocarbon resin known in the industry as "Cor-Blue" or equal.
- C. Bolting Material: Bolts and hex nuts used on the bonnet of the valve shall be manufactured from Type 304 stainless steel for corrosion resistance. The hot-dip process, in accordance with ASTM A-153, is not acceptable for the threaded portion of the bolts.
- D. Operators and Stem Extension: Operators shall be designed for buried service and to operate indefinitely in a fully buried condition. Operators shall be equipped with a standard AWWA 2" square operating nut. Valves shall open with a left (counterclockwise) rotation of the nut.

Top operating nut stem extensions shall be manufactured from cold rolled steel. Stem extensions shall be equipped with a standard AWWA two (2) inch square operating nut and shall be of sufficient length to place the stem operating nut to between two and one half (2.5) to five and one half (5.5) feet of finished grade. Stem extension shall be attached to the valve operating nut by means of 2 each 5/16" x 1/2" set screws. 1/8" deep dimples shall be drilled into operating nut for set screws to hold on to.

- E. Testing: Each valve after shop assembly shall be given the operation and hydrostatic tests in accordance with the applicable specifications.
- F. Painting: All surfaces of the valve shall be clean, dry and free from grease before painting. All ferrous surfaces, exterior and interior, except the seating surfaces of flange faces, shall be evenly coated with a fusion bonded epoxy coating.

On rubber seated valves, after above painting is complete, a lubricant compatible with the rubber seal shall be applied to the surface of the seal and the mating metal surface to prevent bonding of the two (2) surfaces during shipment and storage. Following application of the seal lubricant, the valve disc shall be placed in the fully closed position for shipment.

- G. Valve Boxes: Valve box parts shall be made of gray cast iron and the boxes shall be three (3) piece, adjustable screw type, with 5 1/4" shafts. All bases shall be No. 6 Round Base. Gray iron castings shall be manufactured in accordance with ASTM A 48, Class 35B, as noted in section 3.1 of AASHTO M306. Ductile iron castings shall conform to ASTM A536. Extension pieces shall be used where necessary. Rite height adapters are also allowed. Valve box lids shall be of the drop type having 1 1/2" skirts and marked for water usage. Slip cheater type valve box risers are unacceptable on newly constructed or newly reconstructed streets. Valve box lid shall be screw adjusted to within 1/4" of final asphalt elevation prior to final lift of asphalt being placed. Drop in valve box risers are only allowed on existing streets that are being overlaid.

Tyler Pipe Company Series 6860, East Jordan Iron Works Series 8560, Star Pipe Model VB-0006 and Castings, Inc. series 6860 or CI-500 series valve boxes meeting the above specifications are allowed.

30.2.4 Tapping Sleeves for Wet Taps (3" - 24")

All tapping sleeves for use on PVC, ductile iron or existing asbestos cement (except for size on size taps on existing asbestos cement) water mains shall be designed for an operating pressure of 150 psi and shall be fabricated using Type 304 (18-8) Stainless Steel. Sleeve shall be furnished with gridded virgin SBR compounded gasket for water service that provides full 360° pipe coverage ("full gasket"). Gasket shall be shop glued to the body section of the sleeve and the gasket shall provide adequate seal for the design pressure. Sleeve flange shall be Type 304 (18-8) Stainless Steel having the flange face machined and recessed to receive standard tapping valve in accordance with MSS Standard SP-60 for sizes 4" through 12". Flange shall conform to AWWA C207 Class D ANSI 150 lb. drilling. Bolts shall be Type 304 (18-8) Stainless Steel per ASTM A193 and A194. Fasteners shall be coated to prevent galling. Mueller H-304SS, Ford Style FTSS, JCM 432, Romac SST III and Powerseal Model 3490 or 3490MJ or equivalent are allowed. Size on size wet taps are allowed up to 12" diameter. Size on size wet taps on asbestos cement water mains shall use Mueller Catalog Number H-619 Mechanical Joint Tapping Sleeve for A-C pipe or equivalent. Tapping sleeves for wet taps on steel water mains shall be weld on tapping outlets equivalent to JCM 416 Type 1 Weld On Outlet or JCM Type 2 Three Piece Weld On Saddle. Weld on outlets shall be fusion bonded epoxy coated. A tapping saddle and valve, installed on an existing main, shall not be considered a substitute for a property line valve. The use of two (2) tapping saddles, when side by side or back to back, as a substitute for a cross will not be allowed. Edge of tapping saddle must be a minimum of 24" away from all joints as measured along the water main.

Fire Hydrants

Dry-Barrel Dry-Top Fire Hydrants: Except as modified or supplemented herein, all fire hydrants shall be designed to operate for a line pressure of 250 psi and manufactured in accordance with AWWA C-502 "Dry-Barrel Fire Hydrants". Hydrants to be 5 ft. bury.

- A. Size: Hydrants shall have a main valve opening size of 5.25 inches.
- B. Type: Hydrants shall be the 3-way type with one (1) pumper nozzle and two (2) hose nozzles all located on the same horizontal plane, between twenty (20) and twenty-six (26) inches above final grade. All extension kits are to be installed by Contractor. Proper breakaway coupling installation shall be verified by Engineering Inspector prior to reinstalling hydrant bonnet. A maximum of three (3) feet of extension will be allowed per hydrant and only 1 extension per hydrant.
- C. Base Connection: Hydrant base shall be provided with a mechanical joint to accommodate six (6) inch diameter AWWA C-900, CL-200 pipe complete with plain rubber gasket, gland, bolts and nuts, "Cor-Blue" all in accordance with ANSI A-21.11/AWWA C111.

The mechanical joint bolts and nuts shall be "Cor-Blue" or equal with a minimum yield of 50,000 psi conforming to ASTM Specification A-242.

- D. Traffic Breakaway: Hydrant shall incorporate a traffic breakaway feature of the barrel and stem.
- E. Main Valve Assembly: The main valve of the hydrant shall be 5 1/4" diameter compression type which closes with the water pressure. Seat ring shall be bronze with a machined face and external threads for threading into a bronze drain ring. Provide bronze to bronze threads for the main valve assembly and a fully bronze lined drainway.
- F. Operating Shaft and Nut: The operating nut shall be bronze or cast iron #17NS hexagonal shaped with a finish height of 1 1/4". The dimensions from point to point are 1 1/2" at the top and at the bottom.

The hydrant shall open by turning the operating nut to the right in a clockwise direction and shall have an arrow on the bonnet to designate the direction of opening.

- G. Pumper Nozzle and Cap: The pumper nozzle shall be 4 1/2" nominal diameter. Threads shall be right-hand and National Standard in accordance with NFPA #194.

Nozzle cap shall be furnished with a synthetic rubber gasket installed in a retaining groove and the dimensions and shape of the nozzle cap nut shall be the same as the operating shaft nut as described in Paragraph F above.

Nozzle caps shall be furnished with security chains with one (1) end of each securely attached to the upper barrel section of the hydrant.

- H. Hose Nozzles and Caps: The two (2) hose nozzles shall be 2 1/2" nominal diameter. Threads shall be right-hand and National Standard in accordance with NFPA #194. Each hose nozzle shall include a nozzle cap with nut and security chain the same as described in Paragraph F above.
- I. Painting and Coating: The buried portion of the hydrant shall be given a bituminous coating in accordance with AWWA C-106, Section 6-8. All ferrous metal parts shall be coated in accordance with AWWA C-500, Section 4.5 and Section 2.22. The bonnet and nozzle cap shall then be given one chrome yellow shop coat of heavy duty alkyd enamel paint conforming to Federal Specification #13538. The remaining above ground portion of the fire hydrant shall also be shop painted a safety yellow enamel.

All internal ferrous metal surfaces that are in constant contact with pressured water shall have a minimum of four (4) mils epoxy-coating as outlined in AWWA C-550 entitled "Protective Coatings for Valves and Hydrants."

- J. Hydrants allowed shall be Waterous Pacer Model WB-67-250 or AVK Modern 2700 only.

30.2.6 Restrained Joints for Steel Pipe

Restrained Joints for steel transmission lines shall conform to the requirements set forth in AWWA M11, "Steel Pipe Manual."

Joints shall be one of the following types as indicated on the construction plans:

- A. Lap welded slip joint – The standard bell shall provide for a 2½ inch lap. The minimum lap shall be 1 inch. The design maximum joint deflection or offset shall be a 1" joint pull.
- B. Double welded butt strap joint - Butt straps, where required will be a minimum of six (6) inches wide, the same thickness as the pipe wall, and will be welded to one end of each pipe section so the joint can be lapped on the outside of the pipe.

On joints where butt straps are used for realignment, adjustment, or deflection, the pipe ends will be cut straight, and fillet welds shall be made on the outside of the pipe.

- C. Flanged and bolted – Flanges shall be in accordance with AWWA C207 Class D for operating pressures to 150 psi and transient pressures to 225 psi. Flange face shall be coated with soluble rust-preventative compound. Bolts for flanges shall be type 316 stainless steel conforming to ASTM A193, Grade B8M, Class 1 and ASTM 194, Grade 8M nuts.
- D. Mechanical coupling – Mechanical couplings shall be Romac Style XR501, Viking Johnson MaxiFit or MaxiStep, Powerseal PowerMax, or equal. Insulated mechanical couplings shall be double insulated Smith Blair Style 416, Romac

Style IC400, or equal for working pressures up to 150 psi only. Mechanical couplings on steel water mains shall be harnessed for the maximum pressure in accordance with AWWA M11. Couplings shall be fusion bonded epoxy or nylon coated. Bolts shall also be coated or be stainless steel that is coated to prevent galling. Couplings shall be restrained at all locations shown on construction drawings and within the length to be restrained on all bends and fittings.

- E. Carnegie end rings restrained by means of: circumferential clamps, snap ring, bell bolts or filler rod welded to both the bell and spigot ring.

30.2.7

Exterior Coatings for Pipe and Fittings

- A. Steel Pipe Coatings: Exterior coating for steel pipe shall be a multi-layer 80 mil prefabricated Polyken YG-111 Tape System conforming to AWWA C-214 "Tape Coating Systems for the Exterior of Steel Water Pipelines", or a cement mortar coating conforming to AWWA C-205 "Cement Mortar Protective Lining and Coating for Steel Water Pipe four (4) inches and Larger - Shop Applied".
 - 1. Shop Applied Concrete Coating: Type V cement conforming to ASTM C-150 "Specification for Portland Cement" shall be used in concrete placed in the walls of concrete cylinder pipe or on metallic pipe to be coated in accordance with AWWA C-205.

Modified Type II Portland Cement, having a low tricalcium aluminate content, is considered as an equal alternate for Type V cement.

 - a. Dielectric Coating Over Concrete Coated Pressure Pipe: Prior to shipment, the exterior concrete surface shall be spray seal coated with a 100% solids cool for epoxy, applied at the rate of 61 sq. ft. per gallon and control cured. Epoxy and its application shall conform to the latest requirements of the U.S. Bureau of Reclamation.
 - 2. Shop Applied Tape Coating: Shop applied tape coating shall be a continuous four (4) layer system applied to the exterior of the metallic cylinder and extend from the end of the bell to within 4 1/4" of the spigot. It shall consist of:
 - a. Primer Layer - applied over a pipe surface prepared as specified in SSPCSP 6, "Surface Preparation Specification #6, Commercial Blast Cleaning or NACE TM-01-75, Visual standards for surfaces of New Steel Centrifugally Blast Cleaned with Steel Grit and Shot."
 - b. Corrosion Protection - wrapped twenty (20) mil tape layer.
 - c. Inner Mechanical Protection - wrapped thirty (30) mil tape layer.
 - d. Outer Mechanical Protection - wrapped thirty (30) mil tape layer.
- B. Ductile Iron Pipe coating: Ductile iron pipe shall have a bituminous seal coating in accordance with ANSI/AWWA C151/A21.51 as well as a bituminous coated cement mortar lining in accordance with ANSI/AWWA C104/A21.4.

C. Field Coating Appurtenances: Field applied coatings for in line fittings, valves, welds and appurtenances shall conform to one of the following:

1. Polyethylene Encasement: Polyethylene shall be manufactured in accordance with ANSI/AWWA C105/A21.5 "Polyethylene Encasement for Gray and Ductile Cast Iron Piping for Water and Other Liquids" with the following additional requirements or exceptions.

Materials and Physical Properties: The raw material used to manufacture polyethylene film shall be Type 1, Class A, Grade E-1, in accordance with ASTM D-1248. The film produced shall meet or exceed the following requirements:

Tensile Strength	1200 psi min.
Elongation	300% min.
Dielectric Strength	800 V/mil thickness min.
Thickness	0.008" (8 mils)
Melt Index	0.4 max.

2. Cold Applied Tape Encasement: Cold applied tape shall be Type II as described in AWWA C-209 "Standard for Cold Applied Tape Coatings for Special Sections, Connections and Fittings for Steel Water Lines". Protecto-Wrap #1170 Primer and #200 Mastic Tape or equivalent has been approved for this application.

When pipe is tape coated according to AWWA C-214, the appurtenance shall be field protected using Polyken #927 primer and Polyken #930 and/or #934 tape or equivalent.

30.2.8 Insulators - Cathodic Protection

- A. Service Line Insulators: Insulators for service lines at the corporation stop for taps on metallic mains shall be Ford Service Insulators or equal as approved by the Project Engineer.
- B. Distribution, Lateral and Transmission Line Insulators: Insulated mechanical couplings on metallic lines, six (6) inches and larger, shall be Rockwell (Smith-Blair) Style 416 or Dresser Style 39, insulating couplings, or equal. Flanged by flanged joints shall be insulated using PSI-Pacific Seal Gasket with sleeves and double insulating washers.

30.2.9 Harness Rods

- A. Lateral and Distribution Lines (6" - 12"): Harness rods shall be manufactured using Mild Steel (MS) conforming to ASTM Specification for "Structural Steel", designation A-36. Hex nuts shall be fabricated in accordance with ASTM Designation A-307, Grade A or B, hexagon heavy series.
- B. Distribution and Transmission Lines (14" - 18"): Harness rods shall be manufactured using High Strength (HS) Steel conforming to ASTM Designation A-193, Grade B7. Nuts shall conform to ASTM Standard A-194, Grade 2H.

30.2.10 Retainer Glands

Mechanical joint retainer glands may be used in lieu of harness rods on PVC and Ductile Iron pipe and shall be cast from grade 60-45-12 ductile iron conforming to ASTM A536.

Bolt circle, holes and bolts shall be dimensioned to be compatible with standard mechanical joint bells as per specification ANSI/AWWA A21.11/C111 and ANSI/AWWA A21.53/C153. These glands shall have serrations or individually actuated gripping surfaces to maximize restraint capability to hold working and test pressures. The retaining glands shall have a pressure rating equal to that of the pipe on which it is used and provide a minimum safety factor of 2:1.. Breakaway tops shall be incorporated in the design of the actuating bolts to visually ensure proper torque. Restraint shall be UL Listed and FM approved in applicable sizes. Retainer glands for PVC pipe shall be equivalent to those as manufactured by EBAA Iron, Inc. Series 2000PV (4"-36"), Uni-Flange Series 1500 (4"-24") or Star Pipe Products Stargrip Series 4000 (3"-36") or Star Pipe Products PVCgrip Series 3500 or U.S. Pipe MJ Field Lok (4"-12") or Sigma One Lok model SLCE with Corrsafe coating. Retainer glands for Ductile Iron pipe shall be equivalent to EBAA Iron, Inc. Series 1100 (30"-48"), Uni-Flange Series 1400 (30"-36") or Star Pipe Products Stargrip Series 3000 (30"-48") or Sigma One Lok series SLDE for ductile iron pipe (30" – 36"). Retainer gland bolts shall be torqued to manufacturer's recommended torque specification.

30.2.11 Bell and Spigot Joint Restraints

In lieu of harness rods, restraint devices for bell and spigot joints of PVC or Ductile Iron pipe shall consist of split restraint rings, one installed on the spigot, connected to one installed on the pipe barrel behind the bell. The restraint devices shall incorporate a series of machined serrations on the inside diameter to provide positive restraint, exact fit, 360° contact and support of the pipe wall. A split bell ring in lieu of a serrated ring may also be used behind the pipe bell. Restraint devices shall be of ductile iron, ASTM A536, Grade 65-45-12 with fusion bonded epoxy coating and connecting bolts shall be of high strength, low alloy material (Cor-Blue) in accordance with ANSI/AWWA C111/A21.11. Restraint devices for PVC pipe shall be equivalent to those manufactured by EBAA Iron, Inc. Series 1500 (4"-12") and 2800 (14"-48"), Uni-Flange Series 1390 (4"-36") or Star Pipe Products Series 1100 (4"-48") or Sigma PV-Lok series PVP. Pipe bell restraint devices for Ductile Iron pipe shall be equivalent to EBAA Iron, Inc. Series 1700 (30"-48") or Uni-Flange Series 1450 (30"-36") or Sigma One Lok SLDH Bell Joint Restraint Harness (30"– 36"). Joint restraint bolts shall be torqued to manufacturer's recommended torque specification.

30.2.12 Steel Casing for Bores

Welded steel casing pipe shall be ASTM A-53 Grade B steel and shall have an inside diameter as shown in detail W.-13, Bore Casing Details. Casing pipe installed by open cut methods shall be coal tar epoxy coated. Casing pipe that is bored shall not require epoxy coating but shall have 32 lb. anode bags with a monitoring station cad welded to each end. The minimum wall thickness of the tubing shall be:

<u>Wall Thickness</u>	<u>Casing O.D.</u>
3/8"	30" and smaller
1/2"	32"-42"

30.2.13 Casing Spacers and Insulators

APS Model SSI or SI with fusion bonded epoxy or PVC coating as manufactured by Advance Products and Systems, Inc., Lafayette, LA or equal, installed at a maximum center to center spacing of ten (10) feet along the carrier pipe invert with an additional spacer placed within 6" of each end of the casing pipe. Spacers shall be 8" width for carrier pipe 6" to 14" diameter, 12" width for carrier pipe 16" diameter or larger.

30.2.14 End Seals for Casing Pipe

1/8" thick synthetic rubber wrap around end seals with stainless steel bands shall be installed on casing pipe after carrier pipe insertion. End seals shall be APS Model AW Wrap Around End Seal as manufactured by Advance Products and Systems, Inc. Lafayette, LA or equal. End seals shall be water tight.

30.2.15 Miscellaneous Items

A. Concrete and Reinforcing Steel: Concrete and reinforcing steel shall be furnished in accordance with the requirements set forth in Part II Section 10, "Concrete", of these Specifications. Class "A" concrete shall be placed in all vaults and/or structures. Class "B" concrete may be used for kickblocks, protective pads and pipe encasement.

B. Standard Manholes: See Section 25 and Standard Drawings of these Specifications.

C. Telemetry and Electrical System for PRV Vaults: The telemetry system installed shall be capable of transmitting signals via microwave to the Ralston Water Treatment Plant at 18975 West 66th Avenue.

Telemetry equipment to be provided by Contractor and installed by City crews with interconnect to Ralston Plant recorder. Equipment shall be as specified in Special Conditions or on the construction plans for a specific project or as approved by the Water Operations Division.

The equipment shall be electrically powered, connected via microwave and fully operational. Arvada transmitter and receiver frequencies shall be verified by Contractor prior to ordering.

Electrical system to be installed in the vault shall be weather proof and include but not be limited to, 2 each 75 watt explosion proof light fixtures and bulbs; 2 each non-metallic duplex receptacles with covers; non-metallic junction boxes, breaker box, single pole switches weather head as required. Contractor shall also supply #6 copper grounding rod, 1 inch EMT Riser tubing and wire and install meter setting.

D. Vent Pipe: Vent piping for manholes and vaults shall be 6 5/8" O.D. Schedule 40 PVC pipe or steel with threaded joints. In residential areas the vent pipe above ground shall be painted brown. In parks and range land the vent pipe shall be painted caterpillar yellow. See Vent Pipe Assembly Standard Drawing W-49.

E. Pipe Detector Wire: Wire shall be AWG, Size #12, type UF or USE cable, UL Listed, and shall have a white plastic insulation jacket and single copper conductor. Airplane cable shall be used as detector wire for bored pipes.

F. Water Service Insulation: Insulation shall be, as manufactured by Insulation Materials Corporation of America or equal, one (1) inch minimum wall thickness. Side slits and bolt joints shall be duct taped.

30.2.16 Cathodic Protection and Monitoring Systems

Metallic water transmission lines (18" and larger) shall be cathodically protected by means of a National Association of Corrosion Engineers (NACE) designed sacrificial

anode system or an impressed current cathodic protection and monitoring system. Materials to be incorporated into the system shall be as hereinafter listed unless otherwise approved as equals prior to bidding by the Project Engineer.

<u>Item</u>	<u>Manufacturer or Trade Name</u>
Anode Junction Box	Cott
Test Stations, flush to grade	Cott-Fink, Gerome-Testox 500
Galvanic Anodes	Dow Galvomag
Thermite Brazing	Cadweld, Thermoweld
Brazed Coating	Koppers #50 Bitumastic
Voltmeters	D'Arsonral
Graphite Anodes	Harco-Centap-NA Treated
Cable to Anode	Duralar Halar
Calcined Fluid Petroleum Coke	Loresco, DW-2 or DW-3C.E. Equipment Co.
Rectifier, air cooled	Good-All, Universal
ES-ABS Solid Casing	Armco
Zinc Grounding Cells	Federated Metals
Reference Electrodes	Harco Permacel
Field Bonding Straps	AWG Stranded Copper Wire w/HMWPE insulation
HIRDA Anode System	Harco

30.3 PIPE INSTALLATION

Installation of pipe and appurtenances shall be performed in accordance with the acceptable practices set forth by the American Society for Testing Materials (ASTM), the American Water Works Association AWWA C600, "Installation of Ductile-Iron Water Mains and their Appurtenances"; AWWA Manuals M9, M11, AWWA C605, "Underground Installation of Polyvinyl Chloride (PVC) Pressure Pipe and Fittings for Water", approved plans and as modified herein.

At all times during construction of the pipeline, the Contractor shall use every precaution to prevent damage to protective coating on the pipe. No metal tools or heavy objects shall be permitted to come into contact unnecessarily with the finished coating. Workmen will be permitted to walk upon the coating only when necessary, in which case they shall wear shoes with rubber or composition soles and heels. Any damage to the pipe or protective coating from any cause during the storage or installation of the pipeline shall be repaired prior to laying of the pipe, as directed by the Project Engineer, by and at the expense of the Contractor.

30.3.1 Storage of Materials

The Contractor shall store and adequately protect all material prior to installation. Any damage to the materials resulting from improper storage or handling by the Contractor shall be repaired or replaced by and at the expense of the Contractor.

Stored pipe shall at all times be supported on sawdust bags, timbers, sand bags or other suitable support. Bags shall be of sufficient size to prevent contact of the pipe coating with the ground or any obstruction. Rolling pipe sections on its coating surface will not be permitted.

When pipe laying is not in progress, the ends of the pipeline, all special openings and all pipe waiting to be laid shall be kept closed with suitable bulkheads to prevent unauthorized access by persons, animals, water or any other undesirable substances.

The bulkheads shall be so designed to prevent drying out of the interior lining of the pipe. The Contractor shall introduce water into the pipe to keep the mortar lining moist where moisture has been lost due to damaged bulkheads.

It shall be the responsibility of the Contractor to prevent damage to coatings which might be caused by handling and/or embrittlement caused by storage of the completed pipe at low temperature.

PVC Pipe stored outside and to be exposed to sunlight for more than 30 days shall be covered with a solid canvas to block the light. Clear plastic is not allowed as a cover. Air circulation shall be maintained under the covering.

30.3.2

Handling Pipe

Pipes, fittings, etc., shall be carefully handled and protected against damage to lining and coating, impact shocks, and free fall. All pipe handling equipment shall be approved by the Project Engineer. Pipe shall not be placed directly on rough ground but shall be supported in an approved manner which will protect the pipe against injury whenever stored at the trench site or elsewhere. No pipe shall be installed where its coating or lining shows cracks that may be harmful. Damaged coating or lining shall be repaired to the satisfaction of the Project Engineer, or a new undamaged pipe section shall be installed, at no expense to the City.

Pipe shall be handled, hauled, and placed using wide slings and padded cradles of canvas, leather, or other suitable material so designed and constructed to prevent damage to the pipe lining or coating. The use of bare metal cables, chains, hooks, or other equipment which might injure the pipe coating will not be permitted.

- A. Pre-installation Coating Inspection: The Contractor shall permit and aid in the inspection of all coating on the underside of the pipe, at the time of the installation, and shall repair any damage before lowering the pipe into the trench. While being laid, the pipe shall not be rolled, skidded or otherwise moved when in contact with the ground at any point.

At the trench site, just prior to installing, the Contractor shall inspect the pipe coating for flaws, cracks, spalling, etc. Tape coated pipe shall be inspected for holidays with a Contractor furnished coil spring or brush type electrode, having a primary wattage no higher than twenty (20) watts and a minimum pulse, at crest voltage, of twenty (20) per second. Where holiday flaws are detected, they shall be repaired to the satisfaction of the Project Engineer before the pipe section is placed in the trench.

Cement mortar coated pipe shall be inspected for cracking or spalling while supported in belted or canvas slings, prior to lowering in the trench. Where coating imperfections are found, and providing there is no visible damage to the pipe lining, straight pipe sections shall be rotated so the damaged coating is atop the pipe after being lowered and set in the trench.

The coating shall then be cement mortar repaired and allowed to cure for a period of 24 hours before backfilling. Concrete coatings on beveled sections, bends and other special sections which cannot be rotated, as herein above described, shall be repaired to the satisfaction of the Project Engineer prior to lowering and setting in the trench.

- B. Pipe Struts: Struts in steel and pretensioned concrete cylinder pipe shall be left in place until backfilling operations have been completed. After the backfill has been placed, the struts shall be removed and will remain the property of the Contractor.

30.3.3 Excavation, Bedding and Backfill

Excavation, bedding and backfill required for the installation of pipe covered by this section of the Specifications shall be performed in accordance with Section 20 of these Specifications. See Standard Drawings for pay limits of select backfill and trench resurfacing. Valve boxes installed in streets shall be backfilled with special backfill material for the entire width of the trench. Trenches in streets shall be backfilled with special material at the discretion of the Project Engineer.

30.3.4 Alignment and Grade

When called for on approved plans or by the laying diagram, the water lines, including their appurtenance, shall be constructed to the specified line and grade. When not shown on plans, minimum pipe cover shall be four (4) feet and a maximum of six (6) feet. Gate valve and curb stop valve operators on services must not be deeper than five and one half (5-1/2) feet from finished grade.

The grade and alignment of the pipe, structures and appurtenances shall be controlled by means of laser beams or offset grade stakes, set in the field by professional survey parties. The Contractor shall be responsible to accurately transfer said grade and alignment to the trench and construct thereto.

- A. Laying Diagram: Each section of pipe shall be laid in the order and position shown on the laying diagram. In laying pipe, it shall be laid to the set line and grade, within a reasonable tolerance, approximately one (1) inch plus or minus. On grades of zero (0) slope, the intent is to lay pipe to grade. Fittings, valves and hydrants shall be installed at the specified stations and elevation. Three copies of the approved laying diagram signed by the Contractor shall be submitted prior to installation.

30.3.5 Pipe Laying

The Contractor, with the assistance of the Project Engineer and City Engineering Inspector, shall inspect each pipe and fitting to insure that there are no damaged portions of the pipe. Metallic pipe joints will inherently have small amounts of burrs, gouges, weld splatter or other small defect which the Contractor will be required to remove or smooth out. On other than transmission lines the pipe shall be cut, whenever necessary, to conform to location of fittings, line or grade. All cuts shall be straight and true, in a workmanlike manner so as to leave a smooth end without damaging the pipe. All burrs shall be removed from the ends of cut pipe, and the end lightly rasped or filed.

Cutting or beveling existing asbestos cement pipe will not be allowed. MOA-PVC pipe shall be used in place of MOA Asbestos-Cement Pipe.

Before placing pipe in the dry trench, each pipe section valve and fittings shall be thoroughly cleaned of all foreign material, kept clean at all times thereafter, and carefully examined for cracks and other defects before installation. Bell ends and spigot ends are to be examined with particular care. The openings of all pipe and fittings in the trench shall be closed to the satisfaction of the Engineering Inspector during any interruption to the work, overnight or over the weekend.

A. Frost Foundations: No pipe, fitting or appurtenance shall be installed upon a foundation into which frost has penetrated or at any time when the Project Engineer shall deem there is danger of the formation of ice or penetration of frost at the bottom of the excavation. No pipe shall be laid unless it can be established that the trench will be backfilled before the formation of ice and frost occurs.

B. Order of Laying Pipe:

1. Bell End Ahead and Uphill: Pipe shall be laid with bell ends facing in the direction of laying unless otherwise approved by the Project Engineer. In general, pipe shall be laid starting at the lower end of the line and proceeding uphill. In no case shall pipe be laid in a downhill direction where the slope is greater than ten (10) percent, unless permitted by the Project Engineer in writing.
2. Downhill: When approved, pipe that is laid on a downhill grade shall be blocked and held in place until sufficient support is furnished by the following pipe to prevent movement. All bends shall be properly installed and anchored in place before continuing laying downhill.
3. Curves: When laying pipe on curves, the intent is to lay each section to the alignment. The pipe shall be kept in alignment by placing all deflection joints or bends on the curve. Short lengths of pipe shall be used as necessary to accomplish curvature without exceeding individual deflection specified by the manufacturer. Bends shall be used whenever individual deflections exceed those specified by the manufacturer.

C. Laying Procedure:

1. Holes for Jointing and Sling Removal: Holes for jointing pipe sections and sling removal shall be excavated prior to setting the pipe in the trench. Bell holes shall have a minimum clearance of one (1) foot on each side of the pipe end and not less than eight (8) inches deep to allow room for taping or grouting the joint. For field welded joints the minimum bottom clearance shall be three (3) feet each side of the joint and one (1) foot deep.
2. Lubricating Joint: Following final cleaning of the bell and spigot a non-toxic, water-soluble joint lubricant shall be applied to the gasket, and the spigot end of the pipe. Caution shall be exercised to insure the correct type of gasket is used and the manufacturer's recommendations are followed when joining pipe sections.
3. Rotating and Jointing: When the pipe is being laid, it shall be turned and placed where possible, so that any slight damaged coating will be on top. All damaged lined or coated areas shall be repaired using materials and methods as approved by the Project Engineer.

Pipe shall be laid directly on bedding material. No blocking will be permitted, and the bedding shall be such that it forms a continuous, solid bearing for the full length of the pipe. The spigot end shall be aligned with the bell end and carefully centered so that the pipe is still supported by the slings such that the gasket will not drag as it is entered into the bell. The pipe shall be pulled together by an approved method such as bands and come-alongs or band and hydraulic jacking head as

recommended by the pipe manufacturer. In all cases, the joint shall be assembled with the axis of the pipe lengths in a straight line; and deflection, if required, shall be taken by swinging the pipe end after the joint has been completely assembled. Pipe furnished without a depth mark shall be marked before assembly to assure insertion to the full depth of the joint. The spigot end of field cut pipe lengths shall be filed, or ground to resemble the spigot end of such pipe as manufactured. Care shall be taken to assure that the gasket is not twisted or pulled when the pipe is jointed.

Where necessary to raise or lower the pipe due to unforeseen obstructions or other causes, the Project Engineer may change the alignment and/or grades. Such change shall be made by the deflection of joints, by the use of bevel adapters, or by the use of additional fittings. However, in no case shall the deflection in the joint exceed the maximum deflection recommended by the pipe manufacturer. No joints shall be out of home any amount which, in the opinion of the Project Engineer, will be detrimental to the strength and water tightness of the finished joint. In all cases the joint opening, before grouting or finishing with the protective mortar inside the pipe, will be the controlling factor.

4. **Detector Wire:** The Contractor shall furnish and install detector wire on PVC water pipe as it is installed into the system. Wire shall be white, AWG size #12, type UF or USE cable, UL listed, with single copper conductor.

During installation wire shall be taped to the top of the pipe exterior in a straight line. Splices due to breaks in wire continuity shall be made by stripping insulation from each wire end with wire stripper pliers. Wires shall be joined with a Dry Conn Direct Bury Lug solderless connector or approved equal installed in accordance with the manufacturer's instructions.

The wire shall form a continuous electrical circuit between any two contact points on the new pipeline including branch lines and fire hydrant laterals. Wire shall be stubbed out to the point where new pipe connects to existing mains unless otherwise directed by the City representative. Where the wire terminates at a point where there is not an installed wire, a 20" long x 1/2" diameter copper grounding rod shall be driven into the native soil and the tracer wire end stripped and connected to a ground rod clamp at the end of the grounding rod. Wire shall be extended to each fire hydrant installed and looped through a test station and grounded. Wire shall not be cut at the test station and shall not be connected to the test station leads. Test station shall only serve as an access point for the wire. Test station shall be a CP Test Services, Glenn Series Glenn-4 with locking lid, 2 7/8" x 4 1/2", or approved equal.

5. **Bell and Spigot Steel Joint Seating:**
 - e. **Pipe with Carnegie Joint End Rings:** As the spigot is thrust home, its advance shall be checked by two (2) steel inserts held in the seat of the bell 180 degrees apart. These inserts shall be removed and a feeler gauge entered into the recess to detect any irregularity in the position of the rubber gasket. If the gasket cannot be felt all around, the joint shall be disassembled. If the gasket is undamaged as determined by the Project Engineer, it

may be reused, but only after the bell ring and gasket have been resoaped, as previously specified. After reassembling the joint, the position of the gasket shall again be checked.

The tied joints shall be jointed as above, and then the necessary wedging or clamping shall be done as recommended by the pipe manufacturer.

- f. Pipe with Expanded Bell and Rolled Spigot Ends: After the joint has been pulled completely together as indicated by the stab marks, the gasket shall be checked using a feeler gauge. This check shall be made around the complete circumference of each joint to be sure that the gasket has not rolled out. If a gasket has rolled out, the joint shall be pulled apart, the gasket inspected, and, if damaged, shall be discarded and a new gasket installed. It should be noted that it is extremely important to obtain full engagement of the stab joint and to check each joint as it is laid.

Each steel pipe length shall be backfilled at least partially before the next length is installed to prevent pullout or movement of the pipe from expansions and contraction.

30.3.6

Jointing Specials and Fittings

- A. Mechanical and Flexible Coupled Joint: When installing mechanical and flexible steel couplings, care shall be taken that the connecting pipe ends, couplings and gaskets are clean and free of all dirt and foreign matter with special attention being given to the contact surfaces of the pipe, gaskets and couplings. These couplings shall be assembled and installed in conformity with the recommendation and instructions of the coupling manufacturer. All mechanical couplings shall be fusion bonded epoxy coated with stainless steel bolts.

Wrenches used in bolting couplings shall be of a type and size recommended by the coupling manufacturer. Coupling bolts shall be tightened so as to secure a uniform annular space between the middle ring, follower rings and the body of the pipe with all bolts tightened approximately the same amount. Diametrically opposite bolts shall be tightened progressively and evenly. Final tightening shall be done with torque wrenches set for the torque recommended by the coupling manufacturer. All clamping torque shall be applied to the nut only.

- B. Field Welded Joint: When laying pipe requiring a field welded joint, pipe deflection shall be limited to that which will produce a lap of one and one-half (1½) inches.

1. Butt Strap Joint: Butt straps, where required will be a minimum of six (6) inches wide, the same thickness as the pipe wall, and will be welded to one end of each pipe section so the joint can be lapped on the outside of the pipe.

On joints where butt straps are used for realignment, adjustment, or deflection, the pipe ends will be cut straight, and fillet welds shall be made on the outside of the pipe.

2. Lap Joints: On lap joints, exterior fillet welds shall be made as shown on the drawings. The remaining seal weld, where required, shall be 3/16" minimum. An inside weld will not be required. The clearance, before

field welding, between the outside circumference of the spigot end and the inside circumference of the bell end shall be not less than 0.09" nor more than 0.41".

3. Bell and Spigot Joints: Where welding of a bell and spigot joint is required, the all-around gap between the bell and spigot as delivered from the manufacturer shall not be less than 1/32 (0.03125) nor more than 3/32 (0.09375) of an inch.

C. Flanged Joint: Before the joint is assembled, the flange faces shall be thoroughly cleaned of all foreign material with a power wire brush. The gasket shall be centered and the connecting flanges drawn up watertight without unnecessarily stressing the flanges. All bolts shall be tightened in a progressive diametrically opposite sequence and torqued with a suitable approved and calibrated torque wrench to a torque value as recommended by the manufacturer. All clamping torque shall be applied to the nuts only.

D. Harnessed Joints: Joint harnessing by use of rods and clamps shall be installed at interference crossings; on fire hydrants, bends, offsets, domestic and fire sprinkler connections.

Rod material required to harness six (6) inch to eighteen (18) inch pipe joints is specified in paragraph 30.2.8 of this specification. After the rods are bolted in place, they shall be double wrapped with eight (8) mil thick polyethylene or other approved cold applied tape. In addition to rodding restraints, bends, fire hydrants and tees shall be kickblocked against undisturbed soil with concrete.

Harnesses, where required, on twenty (20) inch and larger transmission lines, shall be of a type as specified in AWWA Manual M-11.

E. Retainer Joints: Mechanical joint retainer glands may be used in lieu of rods and clamps for joint harnessing at interference crossings, fire hydrants, tees, bends, offsets, domestic and fire sprinkler connections. (See Paragraph 30.2.10) After the retainers are bolted in place they shall be wrapped with eight (8) mil thick polyethylene or other approved cold applied tape. In addition to the retainer gland all bends, fire hydrants and tees shall be kickblocked against undisturbed soil with concrete.

F. Insulated Joints: Extra care shall be exercised when installing insulating joints. After the insulating joint has been installed, an electrical resistance test shall be performed by an independent corrosion engineering company selected by the City. Should the resistance be found less than 10,000 ohms, the insulating joint shall be removed and any necessary repairs made. The joint shall then be reinstalled and retested. This process shall continue until the joint is successfully tested. Retesting shall be at Contractor's expense.

G. Bonding Joints: The Contractor shall provide and make two (2) each electrical bonds between the metallic cylinders of adjoining pipe sections and across all non-insulating joints. In line valves shall be made electrically continuous where called for on the drawings.

Electrical bonds shall be installed, one each side of the Pipe crown centerline, at approximately twenty (20) degrees apart, when measured from the pipe centerline. Bonding rods shall be long enough and provide sufficient slack to allow for a total joint displacement of two (2) inches.

Expanded bell and spigot steel joints shall be bonded using #4 AWG insulated copper wire, Cadweld CA-15 brazing cartridges and thermite weld caps. Carnegie end ring joints shall be bonded by welding each end of a 6" x 3/8" steel jumper rod, rolled to the mean diameter of the annular space between the rings, to the bell and spigot.

Bonding across insulated flanged joints or insulated couplings will not be allowed.

30.3.7 Joint Coating and Lining

The inside and outside of all joint recesses shall be thoroughly wiped clean to the satisfaction of the Engineering Inspector. In this cleaning operation all water, loose scale, dirt and other foreign material shall be removed from the surface of the pipe joints to be coated and lined in the field.

- A. Interior Joint Lining of Welded Steel Pipe Joints: Material used for mortar lining shall conform to AWWA Standard 205. At welded joints the Contractor shall furnish and tack weld 2" x 4" 13/13 gauge self-furred welded wire fabric to the inside of the joint recess prior to application of mortar. The mortar shall be applied with a uniform pressure producing a smooth surface and a uniform thickness of lining to match the shop applied mortar lining. At no point shall there be an indentation or projection of the mortar which exceeds 1/16 of an inch. Every precaution shall be taken to prevent damage to the lining. After the mortar lining has set sufficiently, clear seal compound "Protex" or equal, shall be applied to the joint lining to the satisfaction of the Project Engineer.

With the approval of the Project Engineer, Probond or equal may be used in place of the welded wire fabric.

- B. Exterior Tape Coated Pipe Joints: The exterior of all joints shall be thoroughly cleaned of all foreign material to the satisfaction of the Engineering Inspector and primed with Polyken #927 primer and wrapped with two (2) wraps of #930 Polyken tape. Each tape layer shall be thirty five (35) mils thick and applied so that joints lap. The primer and tape shall be manufactured by the same manufacturer as the shop applied tape coating.
- C. Exterior Cement Mortar Coated Pipe Joints: After cleaning, the outside joint recess shall be filled with grout composed of one (1) part cement and two (2) parts sand. The grout shall be poured under a polyethylene lined grout band placed around the joint recess and thoroughly rodded with a stiff wire. The joint recess at the top shall then be closed with a stiffer grout of the same mix as above. Except for piped joints, prefabricated joint protectors may be used as an alternative to mortaring the outside of the joint. If such protectors are used they shall be made from a high density polyester, polyurethane foam containing at least the equivalent of nine (9) bags per cubic yard of unhydrated Portland Cement. The protectors shall be of suitable cross section to fully protect the joint rings and shall be supplied in the form of continuous rings.

No backfilling around the outside of the joints shall be done until the grout has set, and the joint has been inspected and approved.

- D. Interior Cement Mortar Lined Pipe Joints on Steel Pipe: After cleaning, the inside pipe joint recess shall be dry packed filled with a grout composed of one (1) part cement and one (1) part sand. This grout shall be troweled flush with the interior surface, and all excess shall be removed. At no point shall there be an indentation or projection of the mortar exceeding 1/16".

30.3.8

Coating of Flexible Joints, Valves and Fittings for Steel Pipe

After assembly and cleaning; the exposed metal surface shall then be primed by brush or spraying and then wrapped with two (2) layers of Type II elastomeric tape, all in accordance with AWWA C-209 "Standard for Cold-Applied Tape Coatings for Special Section Connections and Fittings for Steel Water Pipelines".

NOTE: When line pipe, coated in conformance with AWWA C-214 is installed, the appurtenances shall be primed and tape coated using Polyken Primer and Tape.

The two (2) layers of tape, each thirty five (35) mil thick, shall overlap the adjoining pipe sections a minimum of three (3) inches. A final six (6) inch wide tape wrap shall be placed over the above two tape wraps to seal all seams, folds or overlaps.

- A. Coating Non-Metallic Pipe Line Appurtenances: Metallic fittings, valves and inline appurtenances installed in nonmetallic water lines, (existing asbestos cement and polyvinyl chloride) may be wrapped in two (2) layers of polyethylene in lieu of the Type II tape as specified above.

The polyethylene shall have a minimum thickness of eight (8) mils and shall be in accordance with AWWA Standard C-105. A two (2) inch wide, ten (10) mil thick polyethylene sensitive tape shall be used to close seams and hold folds over overlaps. Damage to polyethylene wrapped fittings and appurtenances in the trench prior to and during backfill shall be repaired to the satisfaction of the City. All polyethylene wrapping shall be repaired and in a state of readiness prior to tapping a line.

30.3.9

Field Welding Procedures

Field welding shall be performed in accordance with AWWA C-206 "Field Welding of Steel Water Pipe".

All welding shall be done by skilled welders who have had adequate experience in the method and materials to be used. All welding operators shall be qualified under the provisions of Section 4.4 of referenced specification. Welders shall be qualified by a local approved testing agency not more than six (6) months prior to commencing work on the pipeline. Machines and electrodes similar to those used in the work shall be used in qualification test. The test will include welding an actual field section to the top of the pipe.

The Contractor shall furnish all materials and bear the expense of qualifying welders and submit to the City, proof of their certification.

- A. Pipe Coating Protection During Welding: An eighteen (18) inch wide strip of heat resistant material shall be draped over the top half of the pipe on each side of the coating holdback during welding to avoid damage to the coating by hot weld splatter. No welding ground shall be made on the coated part of the pipe.
- B. Stress Relief: Where more than one (1) welding pass is required, the welding procedures set forth in AWWA C-206 shall be strictly adhered to; all dirt, slag and flux shall be removed before the succeeding bead is applied.

30.3.10 Valves and Valve Boxes

Valves shall be handled in such a manner so as to prevent any injury or damage to any part of the valve. Joints shall be thoroughly cleaned and prepared prior to installation. If so ordered by the Engineer, valves shall be operated prior to installation to insure proper operation ability.

A line or outlet valve that is to be buried in soil shall be thoroughly cleaned and then wrapped as specified under exterior coating of flexible joint, valves, etc. above.

All valves shall be installed such that the valve stems are plumb and in the location shown on the drawings with disk seat bolts facing nearest access manhole.

A valve box shall be provided with three (3) inch and larger tapping valves and on the curb stops of 1½" and 2" service lines. The valve box shall not transmit shock or stress to the valve and shall be centered and plumb over the valve wrench nut, with the box cover screw adjusted within ¼" below finish grade. It is the responsibility of the Contractor to insure that valve boxes are centered over the valve operating nut, plumb and raised to the proper elevation prior to the final lift of asphalt being placed.

Operating nuts for butterfly valves shall be placed to the north and east of the water main.

Valve box and stem extensions shall be furnished and installed on all valves that the operator nut is greater than five and one half (5-1/2) feet below finish grade. The top elevation of the operating nut on the valve or valve stem extension shall be no greater than four and one half (4-1/2) feet, nor less than two and one half (2-1/2) feet below finish grade. This also applies to curb stop valves on service lines.

30.3.11 Marker Posts

When valves, manholes (or bends on mains larger than 12") are installed outside of a paved surface, a marker post shall be installed adjacent to the valve or manhole. Marker post shall be a 5 foot long 3" diameter steel post set in concrete to a depth of 2 feet. Post shall be filled with soil and capped with 6" of concrete. Post shall be painted fire hydrant yellow.

30.3.12 Service Taps

Wet taps two (2) inch and smaller shall be made by the City of Arvada Water Utility Division crews. Service saddles and corporation stops meeting the standards shown in Section 30.2 shall be supplied and installed by the Contractor. Taps will be made by City crews only after release of mains by the Engineering Division following their installation, submittal of health release certifications, payment of appropriate fees and completion of the tap application papers. Service installations shall be performed by a Contractor licensed and bonded with the City of Arvada.

Notification and requests for tapping on mains shall be made in writing to the Water Utility Division twenty four (24) hours prior to the time the tap is to be made. Any excavation and dewatering necessary for tapping shall be completed prior to the arrival of the Water Utility Division Tap Crew. The Contractor shall excavate, expose the main at least twenty-four (24) inches on all sides, and provide a safe dry trench for the City tapping operation. A safe dry trench perpendicular to the main is considered as being:

- A. Three (3) foot wide by five (5) feet long and excavated to a depth of one (1) foot below the main.

- B. When unstable ground conditions exist or the trench is deeper than five (5) feet, the trench must be shored, sheeted or sloped and dewatered before City crews will make the tap.

PVC pipe shall not be tapped when the ambient temperature or the temperature of the PVC is less than 32 degrees Fahrenheit. If taps are desired when the temperature is less than 32 degrees Fahrenheit, reasonable precautions will be taken by City crews but any pipe failures will be the responsibility of the Contractor and/or developer.

Under no circumstances will the City tap a main within twenty four (24) inches of the ends of a pipe or pipe collar, within eighteen (18) inches of an existing tap or on an existing machined-overall (MOA) asbestos pipe section.

Dry tapping of a distribution or lateral main is strictly prohibited unless approved by the Utilities Department. A tapping saddle and valve, installed on an existing main, shall not be considered a substitute for a property line valve. The use of two (2) tapping saddles, when side by side or back to back, as a substitute for a cross will not be allowed.

- C. 3/4" through 1" Service Tap - Connection of a 3/4" or 1" diameter service line to four (4) inch through twelve (12) inch laterals or mains main shall be made by wet tapping the line by means of a corporation stop installed by the Contractor into an approved service saddle installed by the Contractor. Direct tapping into the line is not allowed. In all instances the corporation stop, when in place on the service saddle, shall be at an angle of forty-five (45) degrees above springline and perpendicular to the centerline of the lateral or main being tapped.
- D. 1 1/2" through 2" Service Tap – 1 1/2" through 2" diameter service line connections to four (4) inch through twelve (12) inch laterals or mains shall also be made by wet tapping the line by means of a corporation stop installed by the Contractor into an approved service saddle. The service saddle shall be mounted on the line such that the corporation stop installed then is perpendicular to the centerline and at the springline of the lateral or main being tapped.
- E. 3" and Larger Service Tap - Three (3) inch and larger service lines shall be connected to the lateral or main by means of an approved stainless steel tapping saddle and resilient seat tapping valve installed perpendicular thereto. Valve boxes and cover shall be installed directly over the valve operating nut on all valves three (3) inches and larger.

30.3.13

Fire Hydrant Laterals

Piping for fire hydrant lateral shall be rodded and/or mechanically retained and clamped between the mechanical joint end of the valve at the main and the fire hydrant.

Pipe for the fire hydrant lateral shall be Class 200 PVC (Polyvinyl Chloride) conforming to AWWA C900 or Class 150 PVC conforming to AWWA C909 and extend perpendicular from the main. The hydrant shall be set plumb at the end of the lateral, face the main and be adjusted to finish grade. The use of horizontal bends, vertical bends and offsets to install the lateral or tapping into the lateral line is strictly prohibited unless approved by the Project Engineer.

30.3.14

Fire Sprinkler Lines

Piping for 4" and larger buried fire sprinkler lines from existing water mains to buildings or structures with internal sprinkler systems shall be Class 200 PVC (Polyvinyl Chloride) conforming to AWWA C900 or Class 200 PVCO (Polyvinyl Chloride Oriented) conforming to AWWA C909 only and shall extend perpendicular from the water main. All joints shall be restrained from the mechanical joint end of the gate valve at the water main through the vertical 90° bend installed under the building wall inside the building or structure. Only gate valves are allowed on fire lines regardless of fire line diameter. Piping for 2" buried fire sprinkler lines from existing water mains to buildings or structures with internal sprinkler systems shall be Type K soft copper (with quick joint compression or flared brass fittings) to within 5 feet of the building or structure where it shall transition to Type L rigid copper with silver soldered joints through the vertical 90 degree elbow installed under the building wall inside the building or structure.

30.3.15

Water Service Lines

Water service line pipe (3/4" - 2") from the main to the curb stop and box or to the meter yoke in the pit shall be one continuous length of seamless copper tube of the type designated as Type "K" (soft) in the industry. Three (3) inch service lines shall utilize 4" PVC pipe outside of the meter vault and shall be reduced to 3" ductile iron pipe just outside of each side of the vault. The size of the service line shall be the same size as the meter except for a 5/8" x 3/4" meter the service line shall be 3/4" and for 3" meters where the size of the service shall be 4". A 4" tapping sleeve and valve shall be used on a 3" service. The service line through and on both sides of the meter pit must be copper and/or brass only for services 2" or less. Leaded joints and galvanized piping shall not be allowed inside meter vaults or on service lines. Installation of reducers at or between the corporation stop and the meter yoke will not be allowed and no branch connections will be allowed inside the meter vault. Sprinkler system connections must be made a minimum of 5 feet outside of the downstream side of the meter vault.

A bypass is to be installed on all 1½" and larger meters for domestic use. Irrigation only services do not require a bypass. See Standard Drawings.

Service piping between the meter and the building for ¾" – 2" services shall be Type K copper only. Transition fittings for copper shall be Mueller or Ford (or equal) flared fittings or Mueller #110 or Ford Quick Joint (or equal) compression fittings with integral metal insert. Piping for 3" and larger services shall be PVC outside of the meter vault and flanged Ductile Iron inside the meter vault.

Connection of copper to all metallic water mains shall be electrically insulated by means of an approved insulator fitting installed on the corporation stop. After installation, the fitting shall be cleaned and wrapped with a double layer of eight (8) mil polyethylene before backfilling. An insulator fitting shall also be installed on the outlet side of the meter setter.

- A. Curb Stop Valve, Valve Boxes and Meters: Single family service line installations shall terminate at a meter yoke in the meter pit or curb stop (under approved conditions only) at a point near the property line. See Standard Drawings. Service lines 1 1/2" and larger shall terminate at a curb stop valve and box at or near property or easement line. Curb stop valves shall be of the same size as the service pipe. A curb stop valve shall be installed on each service line leaving a manifold.

Locations of meter pits shall be established by the Project Engineer. Installation of curb stop valve and box or meter pit in roadways, driveways, parking areas or

sidewalks is strongly discouraged. With special approval, heavy duty frames with recessed covers shall be installed in instances where it is impossible to meet the above requirements. See Section 30.2. If the street or ground is not to final grade at the time of meter pit installation, the property owner must raise or lower the meter pit to coincide with final grade when established. Meter pit lids must be placed 1" above the grade at the back of the adjacent curb. Ramneck shall be placed between the dome or set ring and top riser ring and also between all subsequent riser rings. All service line installations including meter settings must be inspected by a representative of the Engineering Division before backfill.

B. Separation of Water Service and Sanitary Sewer Service or Drains: Except as permitted below, the underground water service pipe and the building drain or building sanitary sewer shall be not less than ten (10) feet apart horizontally and shall be separated by undisturbed or compacted earth. Under extenuating circumstances, the water service pipe may be placed in the same trench with the building drain or building sanitary sewer provided prior written approval is given by the City and the following conditions are met:

1. The bottom of the water service pipe at all points shall be at least twelve (12) inches above the top of the sewer line at its highest point.
2. The water service pipe shall be placed on a solid shelf excavated at one side of the common trench.
3. The water service line is one (1) continuous section of Type "K" copper tubing, joint free.
4. The material and joints of the sewer service pipe shall be installed in such manner and shall possess the necessary strength and durability to prevent the escape of solids, liquids and gases therefrom under all known adverse conditions such as corrosion, strains due to temperature changes, settlement, vibrations and superimposed loads.

C. Service Line Crossing Curb, Gutter and Sidewalks: The point where the service line crosses under an existing or proposed curb, gutter or sidewalk, the curb shall be marked. The point shall be indicated by chiseling a symbol "V" on the curb directly over the service line.

Service lines shall be pushed, bored or jacked through the soil under existing curb, gutters and sidewalks. Tunneling or open trench cutting beneath existing curbs, gutters and sidewalks is discouraged.

For pipe with an internal diameter of twelve (12) inches or less, the depth of backfill over the pipe, measured from official street grade or finish grade to the top of the pipe, shall be four (4) feet and shall be known as the pipe cover. If difficulties arise when crossing interferences and where specifically approved by the Project Engineer, deviations of the four (4) foot pipe cover may be permitted at a point in the line. A maximum of six (6) feet of cover shall be maintained in these instances. When approved by the Project Engineer and where the pipe cover is less than four (4) feet, the carrier pipe shall be insulated against frost with an approved insulating material sufficient in thickness to prevent frost penetration and freezing.

D. Service Line Crossing a Foreign Line: A water service line crossing over a foreign line (storm sewers, water transmission lines, etc.) shall be insulated through areas and at points where its bury is less than 4.5 feet. Imcoflex or equal insulation shall be of sufficient thickness dependent on bury, to prevent

frost penetration and freezing of the service line. Butt joints between sections and side slits in insulation shall be duct or mole taped upon placement around service line.

- E. Backfill of Service Lines in Streets: Service line trenches cut through surfaced streets or adjacent to existing curbs, gutters, and sidewalks in public ROW shall be bedded using squeegee and backfilled using Flash Fill or Flow Fill Material.

Granular bedding material shall be compacted to seventy (70) percent relative density for sand materials as determined by the relative density of cohesionless soils test, ASTM D-2049. The trench shall be filled with Flow Fill or Flash Fill material to within six (6) inches of the finished street grade and the trench then topped out to finish grade with four (4) inches of CDOT Grading S asphaltic concrete and a 2" top lift of CDOT Grading SX asphaltic concrete. Asphaltic concrete shall be placed and compacted in accordance with these Specifications and shall be minimum six (6) inch thickness or match existing asphalt, whichever is greater.

30.3.16 Interruption of Water Service

The Contractor must, in writing, advise affected users twenty four (24) hours prior to performing work on a service, distribution or transmission line which will interrupt a customer's supply of water. Contractor prepared notices shall be hand delivered to each customer or occupant. If the occupant cannot be contacted, the written notice shall be left attached to the door knob or screen.

In addition, the Contractor must contact Arvada's Engineering Inspection Section (720-898-7640) and schedule the closing of valves necessary to isolate the line or lines on which work is to be performed. Only City personnel are to operate existing system valves or new valves if they are connected to the City system. Also, it is the Contractor's responsibility to advise Arvada Fire Protection District (303-421-3012) as to time and interval the system will be down and also the location of all fire hydrants that will be out of service.

A normal outage shall be a maximum of four (4) hours and between the hours of 8:30 a.m. and 3:00 p.m. If the outage will be greater than four (4) hours, the work shall be done in a manner to minimize the inconvenience to users, such as working at night in a continuous operation until service is restored. A connection which will require an outage longer than four (4) hours shall be subject to review by the City as to the appropriate time for the connection. If in the process of installing a connection there exists a customer, industry or building in the area that cannot be out of water such as a hospital, school, etc., the Contractor shall take appropriate means to provide and convey potable water to them at all times during the performance of the work.

30.3.17 Sanitary and Storm Sewer Crossings

It shall be the Contractor's responsibility to protect all utility, sanitary and storm sewers which either parallel or cross the line being installed.

Contractor cost for protecting parallel or crossing utility sanitary and storm sewers shall be included in the unit price bid in the proposal for furnishing and installing pipe.

- A. Crossing Over Sanitary Sewer: When a water line crosses over a sanitary sewer with less than a two (2) foot clearance between the sewer and water line, the Contractor will encase the sanitary sewer with concrete, to a distance of two (2) feet each side of the outside edge of the water line.

- B. Crossing Under Sanitary Sewer: When a water line crosses under a sanitary sewer, any VCP sanitary sewer pipe must be replaced with PVC pipe and all joints on the sewer line within ten (10) feet of the water line shall be concrete encased, unless otherwise approved by the Project Engineer.

All drains that previously existed under the sanitary or storm sewer shall be restored in a manner that will not allow any flow in the drain to enter and flow down the trench in which the water conduit is laid. When a water line crosses under a storm or sanitary sewer, compacted bedding must be installed to one (1) foot over the storm or sanitary sewer.

- C. Paralleling Foreign Conduits: The City reserves the right to require concrete encasement of pipe joints or the entire pipe of sanitary or storm sewer which are within ten (10) feet and/or less than two (2) feet below the flowline of a water line being installed.

30.3.18 Boring of Casing Pipe and Threading of Carrier Pipe

Boring of casing pipe and threading of carrier pipe shall be completed in accordance with section 25.5 of these Specifications. Carrier pipe for water mains shall be installed in the casing pipe using approved centering, restraining casing spacers and insulators only. Steel banded skids and chocks are not allowed. Sand filler is also not allowed for water main carrier pipes. End seals of casing pipes shall be rubber boots as described in Section 30.2.14.

30.3.19 Special Items

- A. Vent Piping: Vent piping from manholes and vaults shall be trenched with a minimum cover of eighteen (18) inches and carried to a location as designated by the Project Engineer in the field, at which point the vents shall be projected to a height of four (4) feet above the ground, or flush with the ground, to permit installation of the six (6) inch vent pipe box assembly. The steel and PVC pipe to be supplied shall be Schedule 40.

- B. Painting: All metal exposed to atmosphere or buried in the ground, except aluminum, brass, bronze, or copper, shall be painted.

All exposed metal and that portion of the black steel vent pipes that is to be buried shall be given two (2) coats of CA-1180 mastic cold coating or equal as manufactured by Protecto Wrap Company, Denver, CO, except for metal with shop applied coating approved by the Project Engineer. All metal exposed to the atmosphere shall be painted with one (1) coat of red-lead priming paint and two (2) coats of aluminum paint, unless otherwise directed by the Project Engineer.

All surfaces to be painted shall be cleaned of oil, grease, weld spatters, burrs, grit, dust, or other objectionable surface irregularities. Cleaning solvent used shall be mineral spirits or equivalent.

Paint shall not be applied, except under shelter, during wet, damp, or foggy weather, or when windblown dust, dirt, debris, or insects will collect on freshly applied paint. Paint shall not be applied at an air temperature below fifty (50) degrees Fahrenheit, or to surfaces of metals, such as the surface of a valve or pipe containing cold water, with a temperature below fifty (50) degrees Fahrenheit regardless of the air temperature, or when metal temperature and atmospheric conditions cause condensation on the surface of the metal.

Painted surfaces which have become damaged prior to acceptance shall be repainted with the same or equivalent paint used in the original application to the satisfaction of the Project Engineer.

- C. Trench Support: The trench shall be adequately supported and the safety of workers provided for as required by the Occupational Safety and Health Administration (OSHA). Sheeting and shoring shall be utilized where required to prevent any excessive widening or sloughing of the trench which may be detrimental to human safety, to the pipe or appurtenances being installed, to existing utilities, to existing structures or to any other existing facility or item. Where excavations are made under severe water conditions, the Project Engineer may require the Contractor to use an approved sheet piling, instead of sheeting and shoring.

Excavated material shall not be placed closer than two (2) feet from the top edge of the trench. Heavy equipment should not be used or parked near the sides of the trench unless the trench is adequately braced.

- D. Test Site and Anodes: The test site and anode installations shall be as called for on the project drawing. If not specified thereon they shall be as shown on City of Arvada Standard Drawing W-62 and W-63.
- E. Manholes and Vaults: The Contractor shall furnish materials for and construct all manholes and vaults as shown on the drawings. All manholes and vaults shall be so constructed that they are as watertight as practicable throughout the full depth, including the areas where valve operators or blowoffs extend through the barrel or wall sections.
- F. Concrete and Reinforcing Steel: Concrete and reinforcing steel to be incorporated in the project shall be furnished and installed in accordance with Section 10 - "Concrete", of these Specifications.
- G. Thrust Anchor Blocks: Thrust anchor blocks shall be placed behind outlets, bulkheads, bends, branches, tees, fire hydrants and fittings which require support due to unbalanced thrust. These anchor blocks shall be Class "B" concrete and of the size and shape indicated in the standard drawings or on the project drawings. Care shall be taken not to block outlets or to cover bolts, nuts, clamps, or other fittings with concrete, making them inaccessible. A polyethylene bond breaker shall be placed between the pipe and the thrust block to aid in future removal. Anchor blocks larger than one (1) cubic yard shall have a minimum of two lifting hooks placed into the top.

The Contractor's attention is particularly called to the requirements that the entire face of the excavation against which the anchor block will bear shall be undisturbed earth and shall be flat and at the proper angle with the pipe unless otherwise specified by the Project Engineer.

All forming for concrete thrust blocks and anchors will be done by bulkheading around the shape of the thrust blocks and anchor with bracing or burlap sacks filled with sand or earth. Sacks shall be left in place in the trench. No horizontal struts or braces required for trench shoring shall remain in the concrete kickblocks. Before any concrete is placed, the excavation for concrete shall be inspected and approved by the Project Engineer and/or City Inspector.

Backfill may be placed over thrust blocks once the surface has set sufficiently to resist the weight of the backfill. However, no tamping or compacting of the

backfill shall be allowed above the thrust block for a minimum of twenty four hours (24) after placement of the concrete.

- H. Progress of Work - The maximum amount of open trench allowed shall be that amount which, in the opinion of the Project Engineer, is reasonable and prudent for conditions existing at any particular location. That amount may be as little as sixty (60) feet at some locations. It is not the intention of this specification to impede the Contractor's progress; however, the Project Engineer will be the judge of the amount of open trench allowed.

In streets, the complete backfilling operation to the finished grade and cleanup operation shall proceed on a continuous basis and shall follow within 150 feet of the installation of the pipe. However, at the end of each working day, pipe backfill shall cover the installed pipe sufficiently to protect the coating and/or lining of the installed pipe. Any deviation from the above requirements shall be made only with the written approval of the Project Engineer.

30.4 TESTING AND CLEAN UP

30.4.1 Testing Cathodic Protection System

The Contractor shall furnish all material and properly construct and connect in place a cathodic protection system where called for in strict accordance with contract documents. The Contractor shall locate, expose and repair all points along the pipeline, where by testing; there is a lack of electrical continuity or improper isolation. Test stations shall be free of debris or dirt and test leads left with sufficient slack for easy testing and repair. Test stations shall be tagged with the words "City of Arvada" and the diameter of the water main in inches that they are connected to.

The City and/or Contractor will employ a corrosion engineering firm to conduct tests and report results obtained during and after completion of the installation or the work may be conducted by City Personnel as determined by the City Engineer or designee. Testing will be performed in accordance with accepted practices as recommended by NACE - "National Association of Corrosion Engineers".

All insulated fittings shall be tested for proper isolation. Electrical continuity tests of the bonded and tied portion of the pipeline shall also be performed. Structure for soil potential measurements, shall be recorded on all protected structures along with DC current outputs of the components. Testing shall be repeated and repairs made, at Contractor's expense, until the system is functional and operating to the standard it was designed for.

30.4.2 Testing Pipe Detector Wire

Electrical continuity in the wire must be restored and maintained. City personnel will test for electrical continuity and alignment after trench backfill is complete and after permanent asphalt surfacing is installed, as a condition of warranty acceptance.

30.4.3 Hydrostatic Testing and Disinfecting Lines

Potable water lines shall be hydrostatic tested, disinfected and flushed prior to being placed into service. Line disinfection performed simultaneously with hydrostatic testing must satisfy the requirements of the Jefferson County and Colorado Health Departments.

Hydrostatic testing shall only be performed after the line has been cleaned of debris, concrete anchor blocks have cured and all backfill is in place. Water Operations Division

personnel shall be the sole operators of existing valves through which water for testing, disinfecting and flushing is obtained.

- A. Disinfection of Water Lines: Disinfection of potable water lines shall be performed in accordance with AWWA C651 "Disinfecting Water Mains" and to the satisfaction of the Jefferson County and Colorado Health Departments. Following twenty-four (24) hour soak and absorption time the residual chlorine content of the water shall be no less than twenty-five (25) parts per million (milligrams per liter), when tested at any one or all fire hydrants, blow-offs, corporation stops, stub ends, etc., on the line.

Suggested methods of chlorination and their limitations are:

1. Tablet Method: Five (5) gram calcium hypochlorite tablets, each containing 3.75 grams available chlorine, shall only be used when the line cannot be flushed prior to chlorination. The tablet method shall not be used when trench water or foreign materials have entered the water line during installation or the ambient temperature is below forty-one (41) degrees Fahrenheit. The tablets shall be secured to the crown of each pipe section, as it is installed in the trench, with "red" PERMATEX or other approved adhesive. Under normal conditions to obtain the 25 MG/L residual chlorine concentration, after twenty-four (24) hour solution time, will require the use of the number of tablets called for under pipe diameter and opposite pipe joint length as listed below.

Pipe Diameter Inches	Tablets Required for 20 ft.	Cl Residual in 20 ft. Pipe mg/L
3	1	116.97
4	2	131.59
6	3	87.73
8	6	98.69
12	12	87.73
14	17	91.31
16	22	90.47
18	28	90.98
24	49	89.56
27	62	89.53
30	77	90.07
36	111	90.17
42	151	90.12
48	197	90.01
54	249	89.89
60	308	90.07

2. Continuous Feed Method: This method shall be used when it is necessary to flush the line prior to chlorination or for rechlorination.

Water from an existing distribution source shall be made to flow at a constant rate through the line to be disinfected. Chlorine is then pumped into the line from the water supply source at a rate which will result in a chlorine concentration of no less than 50 parts per million (MG/L), when tested at any or all accessible discharge locations. The amount of chlorine to be inserted per 100 feet of pipe, to produce 25 parts per million (MG/L) residual concentration after a twenty-four (24) hour solution time, will normally be as shown below.

Pipe Dia. In.	100% Cl. lbs./100 ft.	1% of Cl. Solution gal/100 ft.
6	0.061	0.73
8	0.108	1.30
10	0.170	2.04
12	0.240	2.88
14	0.333	3.98
16	0.435	5.20

- 3. Slug Method: The slug method shall be used for 18" and larger transmission mains or where use of the tablet or continuous feed method are impractical.

Chlorine in gaseous or super chlorinated liquid form shall be introduced at the water supply source, after the line has been filled. The chlorine slug shall be caused to traverse the entire length of the line, at a velocity, length and concentration, such that the entire interior surface of the pipe is exposed to the equivalent of 300 MG/L of chlorine for at least three (3) hours.

- 4. Cut and Repair Method: When a water line breaks or is cut into and it is impossible or impractical to rechlorinate using the continuous feed or slug methods, the following procedure shall be used.

All fittings, valves, couplings and make up pipe sections shall be swabbed with a 5% sodium hypochlorite solution (Clorox) or a 350 parts per million (MG/L) available chlorine solution made from calcium hypochlorite, just prior to being installed. (One 5 g. tablet as specified under the tablet method, dissolved in 10 liters of water is equal to 325 parts per million (MG/L)).

- B. Bacteriological Analysis of New Water Mains: Prior to pressure testing or placing any new water main in service a bacteriological analysis of the water in the new main shall be performed by City forces. A minimum of 16 hours after the new main is flushed of the high chlorine residual a bacteriological sample will be obtained by City forces. Results of the bacteriological analysis shall be available 24 hours after the sample was obtained. If the bacteriological analysis turns up positive a second test shall be taken. If the second test turns up positive the main shall be re-flushed and the process started over until a negative bacteriological analysis is obtained. Only after a negative bacteriological analysis is obtained can a new water main be placed in service and water services transferred to the new main.

- C. Pressure Testing Lines: Once the line has been cleaned of debris and backfilled, the pipe shall be filled with potable water. Filling for pressure and/or chlorination testing shall be done at a velocity rate at which air can be released to atmosphere through fire hydrants, air valves, blow-offs, etc., on the line, without causing surges or damage to the line and its appurtenances. All air within the pipe shall be purged therefrom, and twenty-four (24) hours lapsed time allowed for water absorption into the pipe lining, before pressure testing.

The hydrostatic test pressure shall be 150 psig at the lowest point in the line or section under test. Fire lines shall be tested at 200 psig. Test pressure shall be maintained continuously for a minimum period of two (2) hours. Pressure shall be applied in a manner satisfactory to the Project Engineer with all testing apparatus furnished by the Contractor.

Leakage shall be defined as the quantity of water that must be supplied into the newly laid pipe, or any valved section thereof, to maintain the specified leakage test pressure after the air in the pipe line has been expelled and/or displaced with water. No pipe installation will be accepted if the leakage in U.S. gallons per hour is greater than that set forth herein below in accordance with AWWA C600, C605 and M11:

Allowable leakage for steel pipe is for O-ring rubber gasket joints only. The allowance shall be zero on all-welded or mechanically coupled steel pipe and for all fire lines.

ALLOWABLE LEAKAGE – ELASTOMERIC JOINT PIPE			
U.S. GALLONS PER HOUR			
Pipe Diameter Inches	Nominal Allowable Leakage Per 1,000 ft.		
Pipe Type	DIP	PVC	Steel
4	0.37	0.33	
6	0.55	0.50	
8	0.74	0.66	
12	1.10	0.99	
14	1.29	1.16	
16	1.47	1.32	
18	1.66	1.49	
20	1.84	1.66	
24	2.21	1.99	
30	2.76	2.48	5.91
36	3.31	2.98	7.09
42	3.85		8.27
48	4.41		9.45
54	4.97		10.63

The City reserves the right to substitute its own calibrated meter and/or pump for the Contractor's meter or pump for testing.

- D. Flushing Super Chlorinated Water Lines: Prior to connecting super chlorinated lines to the City system, the lines shall be flushed with potable water until the residual chlorine is consistent with normal potable water chlorine. Care in flushing must be taken to prevent erosion and/or killing desirable vegetation. The Contractor is responsible in providing any special materials or supplies to meet this requirement.

Super chlorinated water in the line must be fully dechlorinated prior to release to streets or into storm sewers, ditches, streams and/or their tributaries. Contractors proposed method of dechlorination must be approved by the City Engineer or designee and be performed within the limits set forth in the NPDES permit, as issued to the City by the Colorado Department of Health. Sodium Thiosulfate Pentahydrate XTL can be used as a dechlorinator, available from Van Waters & Rogers, Inc. If the super chlorinated water is released to a dirt area that will not run to a receiving water then the requirement to dechlorinate may be waived by a representative of the City's Water Quality Section.

20 Foot Pipe Sections		
Pipe Diameter Inches	5 gram Chlorine Tablets Required for Each 20 ft. Section	lbs. Thiosulfate Needed for 100 ft. of 20 ft. Sections
3	1	0.07
4	2	0.14
6	3	0.20
8	6	0.41
12	12	0.81
14	17	1.15
16	22	1.49
18	28	1.89
24	49	3.31
27	62	4.19
30	77	5.21
36	111	7.51
42	151	10.21
48	197	13.32
54	249	16.84
60	308	20.82

A City representative shall be present and operate all valves during flushing and dechlorination of lines.

30.4.4 Connecting to City System

Connection to the City system shall be in a neat and workmanlike manner. An Engineering Inspector shall be present at all times during the construction of the connection. Under no circumstances shall a non-disinfected main, which cannot be

isolated, be connected to an existing disinfected main. Disinfection of the line shall meet the requirements of the Jefferson County and Colorado Health Departments.

The City is not responsible for water tightness of its valves and existing facilities. If existing valves leak, the City will assist in reducing the influx of water, but the Contractor must use methods at his own disposal to work with the resulting leakage.

When connecting lines to the City water system, it may be necessary to operate new and existing valves. Valves on or connected to the City system must be operated by City personnel only. The Contractor shall give the Engineering Inspector forty-eight (48) hours notice to arrange for operating the valves. Both the Contractor and the Engineering Inspector shall be present when the valves are being operated.

- A. Placing Line in Service: A line will only be accepted for tapping and/or placing in service after all of the following conditions have been met:
1. The main has been installed to the satisfaction of the Engineering Inspector and all pertinent notes and measurements have been made.
 2. The main has been successfully filled, chlorinated, de-chlorinated and pressure tested to the requirements of the City of Arvada.
 3. A bacteriological sample has been collected and results indicate that no E. Coli or total coliform bacteria are present.

30.4.5 Housekeeping, Restoration and Cleanup
See Section 5 of these Specifications.