

DIVISION 200 - MATERIALS

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SECTION 201 - GENERAL

All materials incorporated into the system shall be furnished by the Contractor in accordance with the Water System Standards unless otherwise specified or approved by the Manager.

Materials are usually specified in terms of the latest applicable standard specifications of the American Society of Testing Materials (ASTM), American National Standards Institute (ANSI), American Water Works Association (AWWA), and General Services Administration Federal Specifications. Should the standard specifications noted in these Standards be in conflict with later revisions or amendments thereof, the Manager shall be consulted for the applicable standard specifications.

In some instances, materials are specified as acceptable items by means of the manufacturer's catalog designations or reference numbers rather than by detailed specifications. It should be clearly understood that such references are frequently changed by the manufacturer. For any modifications to the material and the identification number, the manufacturer shall resubmit the material for review and approval by the Manager prior to incorporation to the Water System Standards. For any changes to catalog designations, reference numbers and manufacturer's name, a formal letter indicating such changes shall be submitted to the Manager. If any reference number is found to be obsolete, the Manager should be consulted for the latest designation.

Acceptable materials are listed in DIVISION 400 - APPROVED MATERIAL LIST AND STANDARD DETAILS.

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SECTION 202 - DUCTILE IRON PIPE, FITTINGS, AND APPURTENANCES

202.01 GENERAL.

Unless otherwise noted ductile iron pipe shall conform to ANSI A-21.51, and AWWA C151.

All ductile iron pipes shall be of the class called for in the Proposal, plans, or the specifications. Pipes shall be furnished in lengths not shorter than 18 feet nor longer than 20 feet and shall conform to Table 200-1 and Table 200-2.

Table 200-1 - STANDARD DIMENSIONS OF MECHANICAL JOINT AND PUSH-ON JOINT DUCTILE IRON PIPE			
Pipe Size (Inches)	Thickness (Class)	Thickness (Inches)	Outside Diameter (Inches)
3	52	0.28	3.96
4	52	0.29	4.80
6	52	0.31	6.90
8	52	0.33	9.05
10	52	0.35	11.10
12	52	0.37	13.20
16	52	0.40	17.40
18	52	0.41	19.50
20	52	0.42	21.60
24	52	0.44	25.80
30	52	0.47	32.00
36	52	0.53	38.30
42	52	0.59	44.50

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Table 200-2 - STANDARD DIMENSIONS OF DUCTILE IRON PIPE FOR USE WITH THREADED FLANGES			
Pipe Size (Inches)	Thickness (Class)	Thickness (Inches)	Outside Diameter (Inches)
3	53	0.31	3.96
4	53	0.32	4.80
6	53	0.34	6.90
8	53	0.36	9.05
10	53	0.38	11.10
12	53	0.40	13.20
16	53	0.43	17.40
18	53	0.44	19.50
20	53	0.45	21.60
24	53	0.47	25.80
30	53	0.51	32.00
36	53	0.58	38.30
42	53	0.65	44.50

Whenever ductile iron pipe is to be furnished with a thickness other than those shown in Tables 200-1 and 200-2, the design thickness shall be submitted in writing to the Department for approval at least ten (10) calendar days prior to the date of opening of bids.

Ductile iron pipe shall be either mechanical joint, push-on joint, or flanged joint unless otherwise specified.

A. Fittings. Ductile iron and cast iron fittings and special castings shall comply with ANSI A-21.10 and AWWA C110 and have mechanical joints, push-on joints or flanged joints and shall be all bell (without spigot or plain ends) unless otherwise specified.

For Oahu Only:

The class of mechanical joint, ductile iron fittings shall be:

1. *Class 350 for 4-inch to 24-inch fittings*
2. *Class 250 for 30-inch to 42-inch fittings*

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The class of flanged, ductile iron fittings shall be:

- 1. Class 350 for 4-inch to 12-inch fittings*
- 2. Class 250 for 16-inch to 42-inch fittings*

If fittings and special castings called for on the plans are not covered by ANSI A-21.10 and by AWWA C110, the Contractor shall submit shop drawings and manufacturer's specifications to the Manager for approval prior to casting. Six copies of the approved drawings and specifications shall be forwarded to the Manager.

For Hawaii and Maui Only: Fittings shall be either mechanical joints or flanged joints only.

B. Polyethylene Encasement. Unless otherwise specified, all ductile iron pipes, valves, and fittings shall be encased in 8 mil minimum thickness polyethylene material in accordance with ANSI A-21.5 and AWWA C105. *(For Hawaii Only: Ductile iron mains, valves, and fittings located at invert elevation of 5 feet or lower shall be polyethylene encased.)* Polyethylene material shall have permanent markings per AWWA C105.

For Oahu Only: All ductile iron pipes, valves and fittings shall be encased in 2 layers of polyethylene material. Copper service laterals shall be encased with polyethylene wrap (3 feet minimum) from the connection to ductile iron pipes as shown on the Standard Details.

C. Corrosion Protection. See Division 500 for required coating types and other corrosion control requirements as applicable to the project.

D. Interior Lining. All pipes, fittings, and special castings, except sleeves and plugs, shall be cement mortar lined in accordance with ANSI A-21.4 and AWWA C104.

Interior linings shall have tapered ends and shall be sealed with a bituminous seal coat.

E. Exterior Coating. All ductile iron pipes, fittings, and special castings shall be coated on the exterior surfaces with a bituminous coating approximately 1 mil thick. The finished coating shall be continuous, smooth, neither brittle when cold nor sticky when exposed to the sun and shall be strongly adherent to the pipe. Surfaces shall be clean and dry, free from all grease, oil, sand, and other foreign materials when painted.

F. Bolts And Nuts. All bolts and nuts shall be either silicon bronze (ASTM F467 and F468) or stainless steel (ASTM F593 and F594, type 316). All bolts and nuts shall be silicon bronze only if submerged in water. Bolts and nuts installed shall be compatible in strength and material characteristics. Bolts shall protrude beyond the nuts and protrusion shall be a minimum of 1/8-inch but shall not exceed 1/2-inch. All stainless steel bolt and nut threads shall be pre-coated with anti-seizing graphite compound before installation.

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202.02 MECHANICAL JOINT.

A. General. Mechanical joints shall conform with all provisions of ANSI A-21.11 and AWWA C111, "Rubber-Gasket Joints for Ductile Iron Pressure Pipe and Fittings".

Mechanical joint pipes and fittings shall be furnished complete with gaskets, glands, bolts, and nuts.

Ductile iron MJ glands shall be straight-sided polygon in shape. Ductile iron thickness shall be the same as gray (cast) iron dimensions in AWWA C111. Glands shall be full-bodied from and between bolt holes. Scalloped or reduced metal gland section glands are not permitted.

Silicon bronze (ASTM F467 and F468) or stainless steel (ASTM F593 and F594, type 316) bolts and nuts shall be used for all mechanical joints. All bolts and nuts shall be silicon bronze only if submerged in water. All stainless steel bolt and nut threads shall be pre-coated with anti-seizing graphite compound before installation.

Gaskets shall be vulcanized natural or vulcanized synthetic rubber, free of porous areas, foreign materials, and visible defects. No reclaimed rubber shall be used.

Bolt holes shall straddle the vertical centerline.

B. Fittings. Mechanical joint fittings shall be manufactured in accordance with ANSI A-21.10 and AWWA C110. The mechanical joint fittings shall be Class 250 or 350 as called for in the proposal or designated on the plans equal to or exceeding the class of the ductile iron pipe to be installed.

For Oahu and Kauai only: Compact fittings are not permitted.

For Maui Only: Except for top vertical with anchor blocks, mechanical joint fittings may be manufactured in accordance with AWWA C153, compact fittings. Glands shall comply with AWWA C111.

For Hawaii only: Mechanical joint fittings may be manufactured in accordance with AWWA C153, compact fittings.

202.03 PUSH-ON JOINT.

A. General. Push-on joint shall conform with all applicable provisions of ANSI A-21.11 and AWWA C111, "Rubber-Gasket Joints for Ductile Iron Pressure Pipe and Fittings". The plain end of the pipe shall have a slight taper to ease its sliding-fit with the gasket when the joint is made.

Push-on joint pipe shall be furnished complete with gaskets and lubricant.

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B. Fittings. Fittings for push-on joint pipe shall be mechanical joint or push-on joint fittings unless otherwise specified. The push-on joint fittings shall be manufactured in accordance with ANSI A-21.10 and AWWA C110.

For Hawaii and Maui Only: Joints for fittings shall be mechanical joint.

202.04 FLANGED JOINT.

A. General. Flanged pipes and fittings shall be furnished complete with gaskets, bolts, and nuts. Threaded flanged pipes shall conform to AWWA C115.

Flanges shall be faced and drilled in accordance with ANSI B-16.1, Class 125, rated for 150 to 200 psi or Class 250, rated for 250 psi. Bolt holes shall straddle the vertical center line.

Gaskets shall be "full face" 1/16-inch thick, duck-inserted rubber packing, Garlock No. 19, "half-face" 1/8-inch thick "FLANGE-TYTE" gasket, or approved equal.

The bolts used for all flanged joints shall protrude beyond the nuts a minimum of 1/8-inch but shall not exceed 1/2-inch. All stainless steel bolt and nut threads shall be pre-coated with anti-seizing graphite compound before installation. Should the bolts protrude more than 1/2-inch, the bolt ends shall be machine cut before installation. Bolts shall be with cut threads and American Standard heavy hexagon heads. Nuts shall be compatible with the bolts in strength and material characteristics. Nuts shall be hexagon. Bolts and nuts for flanges shall conform to one of the following:

1. Silicon bronze bolts and nuts shall conform to ASTM F467 and F468.
2. Stainless Steel bolts and nuts shall conform to ASTM F593 and F594, type 316.

B. Fittings. Flanged fittings shall be Class 250 or 350 as called for in the Proposal or designated on the plans. Fittings shall conform with ANSI A-21.10 and AWWA C110.

All flanged fittings and special castings shall have integral flanges and shall be sand cast.

202.05 SPECIAL FITTINGS. *(For Maui only)*

A. Pipeline Couplings. *Pipeline coupling shall be supplied in the "long body" style, 12-inches minimum length.*

SECTION 203 - CONCRETE CYLINDER PIPE AND FITTINGS

203.01 GENERAL.

Concrete cylinder pipe shall be either pretensioned concrete cylinder pipe (bar wrapped concrete pressure pipe) or cement mortar lined and coated cylinder pipe.

Concrete cylinder pipe shall be in sections having nominal lengths of 16 to 32 feet, except where shorter lengths are required for fittings, curves, closures, or special sections. The pipe shall consist of the following component parts:

1. A welded sheet-steel cylinder with bell and spigot steel joints.
2. A centrifugally cast concrete or mortar lining.
3. Reinforcement consisting of steel reinforcement.
4. Mortar or concrete enveloping the steel cylinder and reinforcement.
5. A self-centering joint with a preformed rubber gasket so designed that the joint will be water tight under all conditions of service.

Pipe shall be of the class designated on the plans or called for in the Proposal. *(For Oahu only: All straight pipes shall be class 250.)*

The diameter of the pipe and fitting called for in the Proposal or designated on the plans shall be the clear inside diameter.

Pipes, fittings, and specials shall be water cured for a period of not less than 7 days in accordance with Federal Specifications SS-P-1540 for cement mortar lined and coated pipe or AWWA C303 for pretensioned concrete cylinder pipe.

A. Steel Cylinder. Steel for cylinder shall be hot-rolled, low carbon open hearth or electric furnace steel sheets conforming to the requirements of ASTM A415 or steel plates conforming to ASTM A283, either Grade "B", "C", or "D" and ASTM A570 Grade "C". Steel cylinder shall be fabricated in accordance with AWWA C200 for fabricated electrically welded pipe and C-303 for pretensioned type pipe. Steel cylinder thickness shall be as specified in Section 203.02 - **PRETENSIONED CONCRETE CYLINDER PIPE** and Section 203.03 - **CEMENT MORTAR LINED AND COATED CYLINDER PIPE** of these standards.

B. Interior Lining. The cement mortar lining shall be applied within the cylinder by the centrifugal method to the thickness specified in Table 200-3 and Table 200-4 of these specifications.

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Two or more external stiffener rings shall be in place around each cylinder during centrifugation of the lining. The end gauge rings and stiffener rings shall limit the deviation from the mean diameter of the cylinder, at any section, to a maximum of 1/2 percent. End gauge rings shall remain in place until the end of the primary cure. Stiffener rings shall also remain in place during primary cure unless equivalent support is provided by other means.

C. Exterior Coating. The coating thickness shall be as specified in Table 200-3 and Table 200-4 of these specifications.

D. Flanged Joints. All flanges for the joint shall be as specified under AWWA C207.

E. Water. Water used for concrete, mortar, and for curing shall be clean, salt-free, potable water.

F. Guarantee. All materials furnished and workmanship performed in accordance with these specifications shall be guaranteed for a period of one year.

G. Rejection. Pipes and fittings delivered at the job site showing cracks and checks in the lining or coating shall be rejected.

H. Corrosion Protection. See Division 500 for additional corrosion control requirements as applicable to the project.

203.02 PRETENSIONED CONCRETE CYLINDER PIPE. (Bar Wrapped Concrete Pressure Pipe)

A. General. Pretensioned concrete cylinder pipe shall be designed and manufactured as specified in AWWA C303, "Concrete Pressure Pipe, Bar Wrapped Steel Cylinder Type" with the following additions and modifications.

1. The manufacturer shall submit detailed design calculations and drawings prior to manufacture of any pipe.

Values for nominal lining thickness and nominal coating thickness shall be as shown in Table 200-3.

Each steel cylinder shall be subjected to hydrostatic test which will stress the steel to a unit stress of 0.75 times the specified minimum yield point of the steel used.

Minimum cylinder gauge thickness shall be 14 gauge USG.

Minimum bar center to center rod spacing shall be 1 inch and maximum spacing shall be 1.96 inch, but under no circumstance shall rod area be less than 1% of the diameter of the pipe nor 0.23 square inches per foot, whichever is greater.

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Class 150 and Class 250 pipes shall be designed in accordance with Equation 7-1, AWWA Manual M9 - "Concrete Pressure Pipe". For Equation 7-1, P_w shall be the test pressure of the main.

Table 200-3 - PRETENSIONED CONCRETE CYLINDER PIPE LINING AND COATING THICKNESS						
Nominal I.D. of Pipe (Inches)	16	20	24	30	36	42
Nominal Lining Thickness (Inches)	1/2	3/4	3/4	3/4	3/4	3/4
Nominal Coating Thickness (Inches)	1	1	1	1	1	1

2. As the circumferential rod reinforcement is wound, a Portland cement slurry composed of one sack of cement to not more than five gallons of water shall be applied to the reinforcement and cylinder. A retarder may be used in the mix. A sulfate-resistant cement and/or high build epoxy coating may be required in certain areas. See Division 500 for corrosion control requirements as applicable to the project.
3. Sized bell and spigot joint rings shall be welded to the steel cylinder prior to hydrostatic testing. The bell shall have a minimum thickness equal to the thickness of the steel cylinder but not less than 10 gauge for 16-inch and smaller and 3/16 inch for 20-inch and larger.

The spigot end shall be formed from hot-rolled steel section having Carnegie Shape M-3516. The ring shall be attached to the cylinder by electric arc welding. The root dimension of the joint band fillet weld shall be equal to the thickness of the cylinder or the bell or spigot rings, whichever is less. The spigot ring shall have a minimum thickness equal to the thickness of the steel cylinder.

4. Electrical continuity plates or straps are required. See Division 500 for corrosion control requirements as applicable to the project.

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203.03 CEMENT MORTAR LINED AND COATED CYLINDER PIPE.

A. General. Cement mortar lined and coated cylinder pipe shall be manufactured in accordance with Federal Specification SS-P-1540 with the following modifications:

1. Minimum values for lining and coating thickness shall be as shown in Table 200-4.

Each cylinder shall be subjected to a hydrostatic test which will stress the steel to a unit stress of 0.75 times the specified minimum yield point of the steel used.

The manufacturer shall submit detailed design calculations and drawings prior to the manufacture of any pipe.

Minimum cylinder gauge thickness shall be 12 gauge USG.

Nominal I.D. of Pipe (Inches)	16	20	24	30	36	42
Nominal Lining Thickness (Inches)	1/2	3/4	3/4	3/4	3/4	3/4
Nominal Coating Thickness (Inches)	1	1	1	1	1	1

2. The bell and spigot ends of the pipe shall be formed by welding to the steel cylinder.

The bell and spigot ends formed by welding the joint rings to the steel cylinder shall meet the following requirements:

- a. The sized bell and spigot joint rings shall be welded to the steel cylinder prior to hydrostatic testing.
- b. The bell shall have a minimum thickness equal to the thickness of the steel cylinder but not less than 10 gauge for 16-inch and smaller pipes and 1/4-inch for 20-inch and larger pipe.
- c. The spigot end shall be formed from hot-rolled steel section having Carnegie Shape M-3516.

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- d. The bell and spigot joint rings shall be attached to the cylinder by electric arc welding. The root dimension of the joint band fillet weld shall be equal to the thickness of the cylinder or the bell or spigot rings, whichever is less.
 - e. Electrical continuity plates or straps are required. See Division 500 for corrosion control requirements as applicable to the project.
3. Exterior Coating. Prior to the application of the coating, a cement slurry composed of one sack of Portland cement to not more than five gallons of water shall be applied in such a manner as to coat the exposed surface of the steel assembly evenly and uniformly.
 4. A sulfate-resistant cement and/or high build epoxy coating may be required in certain areas. See Division 500 for corrosion control requirements as applicable to the project.

203.04 CONCRETE CYLINDER FITTINGS.

A. General. Fittings shall be fabricated from welded steel sheet or plate, lined and encased with cement mortar. Steel sheet or plate for the fittings and specials shall be cut, shaped, and welded to the required shape and dimensions shown on the drawings. Butt welding shall be used.

B. Fittings. Fittings shall be suitably reinforced and designed equal in strength to the abutting pipe sections.

Fittings may be fabricated to be integral with a straight section of pipe with the understanding that any field adjustments required will be done at no cost to the Department.

At connections, all fittings requiring "strut-type" design for thrust blocks shall be reinforced externally with a ½-inch steel plate as shown on the Standard Details. Joint shall conform with the type of joint fabricated for the pipe.

C. Reinforcement. Crimped 2-inch by 4-inch, No. 13 gauge welded wire mesh shall be applied to the exterior steel surface which is to be cement mortar cased. Plain 2-inch by 4-inch, No. 13 gauge welded wire mesh shall be applied to the interior steel surface of fittings and specials 30-inch in diameter and larger which are to be cement mortar lined. Where the lining is placed centrifugally, no wire mesh reinforcement is required. The wires at 2-inch spacing shall extend circumferentially around the fitting. The ends of the reinforcement shall be lapped 4 inches and tied together.

Outlets built into the pipe for blowoffs, branches, air relief valves and access manhole shall be of suitable design. The cylinder shall be reinforced with collars or wrappers as required for the opening before the lining and coating are applied.

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Wyes, tees, crosses, and reducers 16-inch in diameter and larger shall be reinforced with steel ribs or crotch plates welded continuously to the cylinder or by other methods to withstand the longitudinal crushing effect produced by the design pressure.

D. Factory Testing of Steel Cylinder. Fittings shall be subjected to a hydrostatic test equal to 150 percent of the designed working pressure. Any defect revealed by the test shall be repaired. Testing shall continue until all defects are eliminated.

203.05 CORROSION PROTECTION.

See Division 500 for corrosion control requirements as applicable to the project.

SECTION 204 - PLASTIC PIPE

204.01 POLYVINYL CHLORIDE (PVC) C-900 & C-905 PIPE.

A. General. PVC C-900 and C-905 pipe shall be cast-iron-pipe-equivalent O.D. type as called for in the Bid, Plans and Specifications.

Only elastomeric-gasket type joints shall be allowed. Pipe shall be furnished complete with integral bells or couplings of the same type and composition as the pipe, with gaskets conforming to ASTM F477, and with lubricant. All gaskets and lubricants shall be made from materials that are compatible with the plastic material and with each other when used together. The material shall not support the growth of bacteria nor adversely affect the potable quality of the water that is to be transported.

Conducting cable (*copper toning wire for Oahu only*) shall be installed over the PVC pipe for its entire length. See Division 500 for corrosion protection requirements as applicable to the project.

The installation of PVC pipes according to the plans and specifications may require additional fittings, special couplings, and items of work not specified due to the limited ability of PVC pipe to deflect at the joints. Bending of PVC pipes will not be allowed.

All PVC pipe deflections shall be accomplished only by the use of Special PVC deflection couplings. Deflection around curves shall be accomplished only by the use of PVC deflection couplings.

B. AWWA C900 PVC PIPE. PVC C900 pipe shall be in compliance with Table 200-5 and AWWA C900, "AWWA Standard For Polyvinyl Chloride (PVC) Pressure Pipe, 4-inch Through 12-inch For Water Distribution".

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Table 200-5 - PVC C900 PIPE STANDARD DIMENSIONS				
Pipe Size (In.)	Class (psi)	DR	Thickness (In.)	Outside Diameter (In.)
4	150	18	0.267	4.800
4	200	14	0.343	4.800
6	150	18	0.383	6.900
6	200	14	0.493	6.900
8	150	18	0.503	9.050
8	200	14	0.646	9.050
12	150	18	0.733	13.200
12	200	14	0.943	13.200

C. AWWA C905 PVC Pipe. PVC C905 pipe shall be in compliance with Table 200-6 and AWWA C905, "AWWA Standard for Polyvinyl Chloride (PVC) Transmission Pipe, Nominal Diameters 14-inches Through 36-inches".

Table 200-6 - PVC C905 PIPE STANDARD DIMENSIONS				
Pipe Size (In.)	Class (psi)	DR	Thickness (In.)	Outside Diameter (In.)
16	150	18	0.967	17.400
18	150	18	1.083	19.500
20	150	18	1.200	21.600
24	150	18	1.433	25.800
30	150	18	1.778	32.000

D. Fittings.

1. Ductile Iron Fittings. Ductile iron fittings used with PVC C900 and C905 pipes shall conform to ANSI A-21.10. Fittings shall have mechanical or push-on joints. The class of fittings shall be at least equal to the class of the PVC pipe to be installed. Joints for the fittings shall meet all applicable requirements of ANSI A-21.11.

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2. PVC Fittings. PVC fittings shall be used only with PVC C900, Class 150 pipes and shall conform to AWWA C907, "AWWA Standard For Polyvinyl Chloride (PVC) Pressure Fittings For Water - 4 In. Through 8 In." Only the types of fittings specified in AWWA C907 are approved for use. Ductile iron fittings shall be used for all types of fittings not specified in AWWA C-907. The reaction block requirements for PVC fittings shall be the same as for ductile iron fittings. Hub clamps and set screws shall not be used on PVC fittings. Prior to the installation of all PVC fittings, the Contractor shall submit a manufacturer's certification that all PVC fittings conform in all respects to AWWA C907. PVC fittings shall bear permanent identification markings conforming to AWWA C907.

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SECTION 205 - VALVES AND APPURTENANCES

205.01 GENERAL.

Unless otherwise noted, each type of valve shall conform to the appropriate ASTM or AWWA standards specified. All valves shall be of the type and class as called for in the proposal, plans or specifications.

See Division 500 for required corrosion protection requirements as applicable to the project and as shown on the plans and specifications.

205.02 GATE VALVES.

A. General. All gate valves shall be approved by the Manager. Valves shall have non-rising stems, unless otherwise specified, with inside screw and shall open to the left or counter-clockwise. Valves shall have the manufacturer's name, size, catalog number, and working pressure molded or stamped thereon in places where the name and number may be easily seen when the valves are installed. External surfaces of valves shall be shop coated with fusion-bonded epoxy coating or with two coats of an asphalt coating conforming to Federal Specifications TT-C-494B. Valves shall be furnished complete with all accessories.

Mechanical joint, push-on joint, and flanged joint for gate valves shall be in accordance with all applicable requirements specified for joints.

For Maui Only: Mainline valves shall be mechanical joint or flange joint.

All valves shall be for buried service unless otherwise specified.

Stuffing box bolts and nuts, bonnet bolts and nuts, and gland or flange bolts and nuts shall be Silicon Bronze in accordance with ASTM F467 and F468 or may be ASTM F593 and F594, type 316 stainless steel bolts and nuts. All stainless steel bolt and nut threads shall be pre-coated with anti-seizing graphite compound before installation.

All valves shall be full body and not thin-walled or reduced walled-type.

For working pressures of 200 psi or less, all gate valves 4-inches to 12-inches (*16-inch for Maui*) shall be resilient seat type of gate valve. For working pressures greater than 200 psi or when the gate valve size is larger than 12-inches (*16-inch for Maui*), the gate valve shall be the metal-seated type.

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B. Valves Three (3)-inch and Smaller. Valves shall be of the wedge-disc type with non-rising stem, screw ends, and brass or bronze body. Metal composition of the body, centerpiece, and other cast parts shall be bronze, meeting the requirements of ASTM B62. All packing shall be Johns-Manville "Duro" packing style No. S-171 or approved equal, and shall have each ring cut to fit with staggered joints. Continuous (spiraled) packing shall not be used. Valves shall be provided with brass handwheels and stuffing box glands. Unless otherwise specified, valves shall be for 200-pound water service.

C. Metal-Seated Valves Four (4)-Inch and Larger. All metal-seated gate valves four (4)-inch and larger shall conform to AWWA C500 with cast iron body, bronze (not brass) mounted, double disc, and parallel seat and shall be furnished with 2-inch square operating nuts. Valves shall be equipped with double O-ring stem seals with both rings located above the collar. Valves shall have either push-on, mechanical joint or flanged joint ends as designated on the plans or called for in the Bid.

Sixteen-inch and larger valves shall be provided with cast steel cut tooth, bevel gears with integral or extended gear case, lubricated and supplied with watertight gland enclosure. Valves shall be equipped with by-passes as shown in Table 200-7: *(For Maui only: Gate valve shall be fusion bonded epoxy coated.)*

Table 200-7 - BY-PASS VALVES	
Size of Valve (Inches)	Size of By-Pass Valve (Inches)
16-20 Inclusive	3
24-30 Inclusive	4
36-42 Inclusive	6

The by-passes shall be in the horizontal plane when the gate valves are installed in the line.

All valves except bevel geared gate valves shall operate "upright" (vertical in horizontal pipe). Bevel geared gate valves shall operate on "edge" (horizontal in horizontal pipe) and shall be equipped with solid bronze rollers, tracks, and scrapers.

Valves shall be either Class 150, Class 200, or Class 250 as designated on the plans or called for in the bid. Class 250 valves shall be designed for 250 pounds working pressure and tested to 400 pounds.

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All bolts and nuts shall be either silicon bronze (ASTM F467 and F468) or stainless steel (ASTM F593 and F594, type 316). All bolts and nuts shall be silicon bronze only if submerged in water. Bolts and nuts installed shall be compatible in strength and material characteristics. Bolts shall protrude beyond the nuts and protrusion shall be a minimum of 1/8-inch but shall not exceed 1/2-inch. All stainless steel bolt and nut threads shall be pre-coated with anti-seizing graphite compound before installation. Dimensions of bolting material shall meet ANSI B18.2.1 specifications. Bolting of the valve body parts shall be by bolts and nuts. Tapped bolt holes into the valve body are unacceptable.

D. Resilient-Seated Gate Valves.

1. General. Resilient-seated gate valves shall be manufactured to meet all applicable requirements of AWWA C509, "Resilient-Seated Gate Valves For Water And Sewerage Systems". Valves shall be either 4, 6, 8, or 12-inch in size and rated for service at 200 psi working pressure. Valves shall have non-rising stems, opening by turning left and provided with 2-inch square nut with arrow cast in metal to indicate direction of opening. Each valve shall have manufacturer's name, pressure rating and year in which manufactured cast on the body.

All bolts and nuts shall be either silicon bronze (ASTM F467 and F468) or stainless steel (ASTM F593 and F594, type 316). All bolts and nuts shall be silicon bronze only if submerged in water. Bolts and nuts installed shall be compatible in strength and material characteristics. Bolts shall protrude beyond the nuts and protrusion shall be a minimum of 1/8-inch but shall not exceed 1/2-inch. All stainless steel bolt and nut threads shall be pre-coated with anti-seizing graphite compound before installation. Dimensions of bolting material shall meet ANSI B18.2.1 specifications. Bolting of the valve body parts shall be by bolts and nuts. Tapped bolt holes into the valve body are unacceptable.

Stuffing boxes shall be of an O-ring design with a minimum of three O-rings. No gasket material made of asbestos shall be used.

Interior and exterior coating shall be fusion epoxy meeting AWWA C550, "Standard For Protective Interior Coatings For Valves and Hydrants".

Stem shall be bronze meeting the requirements of Grade D or Grade E Bronze as specified in AWWA C509.

Low friction torque reduction thrust bearings shall be located both above and below the stem collar.

If guides for the gate are required, there shall be no metal-to-metal contact, only metal-to-rubber.

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205.03 BUTTERFLY VALVES AND MANUAL OPERATORS.

A. General. The manufacturer of the rubber-seated butterfly valve and manual operator shall be a nationally advertised firm with at least ten years' experience in the design and manufacture of valves of this type.

B. Butterfly Valves. The butterfly valve shall conform in all respects with AWWA C504, Class 150B, unless otherwise approved. The valve shall be short body valve with a cast iron body. The valve disc shall be cast or ductile iron, unless otherwise specified. If the rubber seat is mounted on the valve body, the valve disc shall be made of Ni-Resist unless a stainless steel seat ring is furnished. Valves shall have either push-on joint, mechanical joint, or flanged joint ends as designated on the plans or called for in the Bid. External surfaces of valves shall be shop coated with fusion-bonded epoxy coating or with two coats of an asphalt coating conforming to Federal Specifications TT-C-494B. Interior surfaces of butterfly valves shall be fusion bonded epoxy-coated.

All bolts and nuts shall be either silicon bronze (ASTM F467 and F468) or stainless steel (ASTM F593 and F594, type 316). All bolts and nuts shall be silicon bronze only if submerged in water. Bolts and nuts installed shall be compatible in strength and material characteristics. Bolts shall protrude beyond the nuts and protrusion shall be a minimum of 1/8-inch but shall not exceed 1/2-inch. All stainless steel bolt and nut threads shall be pre-coated with anti-seizing graphite compound before installation. Dimensions of bolting material shall meet ANSI B18.2.1 specifications. Bolting of the valve body parts shall be by bolts and nuts. Tapped bolt holes into the valve body are unacceptable.

C. Manual Actuator. The manual actuator shall conform in all respects with AWWA C504 unless otherwise stated in these specifications. The manual operator shall be furnished with a two-inch square operating nut, and a valve position pointer.

D. Manufacturer's Identification. The manufacturer's name and catalog number shall be molded or stamped on the valve where it can be easily seen after the valve is installed.

E. Submittals for Approval. The following submittals shall be furnished to and must be approved by the Department for each project before the valve is installed.

1. Certification from the valve manufacturer that both the valve and the actuator conform to all requirements of AWWA C504.
2. Certified drawings of valve and operator as specified in AWWA C504.
3. Certified copies of reports of the torque rating of the manual operator as specified in AWWA C504.

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4. Calculations showing required operator input torque to develop the operating torque specified for Class 150B, of AWWA C504.

205.04 TAPPING VALVES AND SLEEVES.

Tapping valves and sleeves shall fit the A.P. Smith and Mueller tapping machines. All tapping valves and sleeves shall be furnished complete with bolts, nuts, and other standard accessories.

Valve ends to accommodate tapping machines shall be mechanical or flange joint for taps up to 24-inches in diameter. For taps larger than 24-inch mains, the materials, tools and equipment shall be provided by the Contractor and shall be verified with pipe manufacturer prior to approval by the Manager. *(For Hawaii and Kauai Only: The nominal tap size shall be smaller than the nominal main size.) (For Oahu only: The nominal tap size shall be smaller than the nominal main size for concrete cylinder pipe only.)*

Ends of sleeves shall be mechanical joint to fit Class 52 cast iron pipe, Class 150 or 200 PVC C-900 pipe, or Class 150 PVC C-905 pipe. Sleeves shall have flanged end outlets for the valve connections. External surfaces of valves shall be shop coated with fusion-bonded epoxy coating or with two coats of an asphalt coating conforming to Federal Specifications TT-C-494B.

Tapping sleeves for use with concrete cylinder pipe shall be modified according to the drawing shown in the Standard Details, unless otherwise approved. Contractor shall submit shop drawings for approval prior to installation.

All bolts and nuts shall be either silicon bronze (ASTM F467 and F468) or stainless steel (ASTM F593 and F594, type 316). All bolts and nuts shall be silicon bronze only if submerged in water. Bolts and nuts installed shall be compatible in strength and material characteristics. Bolts shall protrude beyond the nuts and protrusion shall be a minimum of 1/8-inch but shall not exceed 1/2-inch. All stainless steel bolt and nut threads shall be pre-coated with anti-seizing graphite compound before installation. Dimensions of bolting material shall meet ANSI B18.2.1 specifications. Bolting of the valve body parts shall be by bolts and nuts. Tapped bolt holes into the valve body are unacceptable.

For Maui only: Use of stainless steel tapping sleeves is not permitted.

205.05 BALL VALVES AND APPURTENANCES.

Ball valves shall have a full port opening and have female threaded ends, unless otherwise noted, meeting dimensions stated in AWWA C800. Valves shall be rated for a minimum of 200 pound water service. Valves shall be between 3/4" to 2½" in size. The valve body shall be made of bronze conforming to ASTM B62. The ball shall be made of bronze, ASTM B62 and be Teflon- or chrome-plated. All seals, thrust washers, and packing rings shall be made of Teflon or Buna-N.

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Handwheels shall be provided and made of bronze, ASTM B62. Handwheel shall be removable when valve is in service and under pressure. Lever handles may be substituted for handwheels. Lever handles shall be made of bronze, ASTM B62 and sturdily bolted to the ball valve with bronze ASTM B62 bolting material; or Type 316 stainless steel, ASTM A193, ASTM A194, ASTM F593, and/or ASTM F594, bolting material.

For ball valves between 3/4" to 1-1/4" in size, handwheels shall have a maximum radius of 1 1/2" from the vertical center of the valve. Lever handles shall have a maximum width of 1" and a radial length between 2 1/2" to 3" from the vertical center of the valve to the end of the handle.

For ball valves between 1 1/2" to 2 1/2" in size, handwheels shall have a maximum radius of 3" from the vertical center of the valve. Lever handles shall have a maximum width of 1" and a radial length between 3" to 4" from the vertical center of the valve to the end of the handle.

All ball valves shall have locking capability and shall be blowoff-proofed to the atmosphere.

205.06 AIR RELIEF VALVES/COMBINATION AIR VALVES AND APPURTENANCES.

Air Relief Valves/Combination Air Valves and Appurtenances (ARV) shall conform to AWWA C512, "Standard For Air-Release, Air/Vacuum, and Combination Air Valves For Water Services". ARV shall be configured for underground installation with a threaded body inlet and a threaded cover outlet. Air relief valve bodies and covers shall be of gray cast iron conforming to ASTM A126, Class B or ASTM A48, Class 35 or ductile iron conforming to ASTM A536, Grade 65-45-12. ARV inlet size and rated maximum working pressure shall be as called for on the plans.

Valve and valve seat shall be of bronze, conforming to ASTM B62, type 316 stainless steel, or Buna-n-rubber. However, no stainless steel to stainless steel or Buna-n-rubber to Buna-n-rubber shall be allowed.

Valve trim, including the levers, float arms, pins, and vent cocks shall be bronze conforming to ASTM B62 or type 316 stainless steel.

Floats shall be of the highest quality seamless copper or stainless steel and shall operate with adequate force to insure positive valve action.

External surfaces of ARVs shall be shop coated with fusion-bonded epoxy coating or with two coats of an asphalt coating conforming to Federal Specifications TT-C-494B.

Fittings and nipples for connections of air relief valves shall be cast bronze or "Standard" brass (Grade A) screwed joint with metal conforming to Section 211 - BRASS PRODUCTS.

Vertical check valve shall be designed to operate on upward flow only and shall be brass or bronze. Valves shall be for 200-pound working pressure unless otherwise specified.

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Ball corps and ball stops shall be as specified under "Service Laterals and Appurtenances".

Orifice size for ARV shall be as shown in Table 200-8.

Table 200-8 - ARV			
ARV Inlet Size	Maximum Working Pressure (PSI)	5% Air Content (Standard Cubic Feet Per Minute)	Corresponding Orifice Size
3/4-inch	150	25	1/8-inch
3/4-inch	250	25	7/64-inch
1-inch	150	32	5/32-inch
1-inch	250	32	1/8-inch
2-inch	150	88	1/4-inch
2-inch	250	88	7/32-inch

All air relief valve nuts and bolts shall be silicone bronze or stainless steel.

SECTION 206 - HYDRANTS AND APPURTENANCES

206.01 GENERAL.

Hydrants shall be manufactured in accordance with the requirements of AWWA C502 or C503 unless otherwise approved by the Manager.

All hydrants shall be subjected to a hydrostatic pressure test of 300 pounds per square inch, and the pressure test shall be guaranteed by the manufacturer. Two copies of the Certification of Test shall be furnished before delivery.

Lengths of hydrant buries are from the face of the flange to the centerline of the 6-inch intake pipe.

Unless noted otherwise, the bell end of the 6-inch intake pipe (hydrant bottom elbow) shall be mechanical joint or push on joint and shall conform to all applicable requirements of ANSI A-21.11 and AWWA C111.

All hydrant parts shall be distinctly marked with its name, part number, length, size, and maker's name. The markings shall be on cloth tags securely fastened to the parts with wire or shall be painted on the parts by such other means as will insure the positive identification of the parts upon delivery.

Each hydrant body shall be furnished with a set of break-off bolts, nuts, and full face gasket. Bolts shall be stainless steel 5/8" x 3" machine bolts with hexagon heads American Standard heavy. Bolts shall be break-off type drilled 11/32" x 1-3/8". Nuts shall be stainless steel American Standard heavy cold punched, hexagon nuts. Gaskets shall be 1/8-inch cloth inserted rubber. Hydrant flange shall have six (6) 3/4-inch bolt holes on 9.375-inch diameter.

The manufacturer shall make and test at least one test bar from each heat of metal used in accordance with ASTM Specifications pertaining thereto.

Hydrants shall receive minimum SSPC SP3 surface preparation and coated as follows:

Primer: Mobil 13-W-10 water epoxy enamel or approved equal.

Intermediate Coat: Mobil 98 Series water epoxy hi-build or approved equal 0.5 mil DFT.

Finish: Mobil 91 Series water epoxy enamel 2 mil DFT (Color: OSHA Yellow).

Prepare surface between coats to proper condition for painting. Coating shall not be applied until preceding coat is hard and dry.

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Fire hydrants shall be provided with bonnets, stuffing boxes and other appurtenant features all made of silicon bronze conforming to ASTM B98 and as specified in the approved material list. Fire hydrants shall be provided with bolts and nuts made of silicon bronze (ASTM F467 and F468) or stainless steel (ASTM A738 and A836). The break-off bolts and nuts shall be heavy stainless steel drilled as previously described.

No plastic caps allowed for all fire hydrants.

206.02 WET-BARREL HYDRANTS *(Not Applicable for Hawaii).*

All hydrants shall comply with AWWA C503 "Wet-Barrel Fire Hydrants for Ordinary Water Works Service". All hydrants shall have one (1) 4½-inch and one (1) 2½-inch outlet with Type B valves.

Body design shall be as approved by the Manager.

Composition of valving shall be Balata Gum. Valve and valve carrier shall be attached to the operating stem utilizing an "O" ring seal to prevent leakage through the valve. Stem packing shall be of the "O" ring type incorporating two "O" rings in the stem sleeves.

For Oahu only: All bronze fire hydrants shall be installed with bronze caps.

206.03 DRY-BARREL HYDRANTS *(For Hawaii Only).*

All hydrants shall comply with AWWA C502 "Dry-Barrel Fire Hydrants". All hydrants shall have one (1) 4½-inch and two (2) 2½-inch outlets as approved by the Manager.

All hydrants shall be furnished with "O" ring seal packing.

All hydrants shall be furnished with a breakable coupling device.

The barrel and operating mechanism shall be so designed that in the event of an accident, damage or breaking of the hydrant above or near the grade level the main valve will remain closed and tight against leakage. A positive operating drain valve or valves shall be provided to drain the hydrant properly by opening as soon as the main valve is closed. The drain valve shall close when the main valve is opened. The seat of the drain valve shall be bronze, fastened securely in the hydrant.

Body design shall be as approved by the Manager.

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206.04 HYDRANT MARKERS.

Hydrant markers shall be reflective, Type DB (Two-Way blue reflective), and shall conform to Section 712.40(c) Reflective Pavement Markers of the Hawaii Standard Specifications for Road, Bridge and Public Works Construction, of the State of Hawaii, Department of Transportation, Highways Division.

Adhesive for hydrant markers shall be standard set type epoxy. The Manager may require, in writing, the use of rapid set type adhesive at no additional cost to the Department. Adhesives shall conform to the requirements of Section 712.41 Adhesives for Pavement Markers of the Hawaii Standard Specifications for Road, Bridge and Public Works Construction, of the State of Hawaii, Department of Transportation, Highways Division. Contractor shall submit certification that adhesive conforms to the specifications.

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**SECTION 207 - CAST IRON MANHOLE COVERS, FRAMES, RUNGS,
EYEBOLTS, METER BOX AND VALVE BOX COVERS AND FRAMES,
AND STANDPIPE**

207.01 GENERAL.

Cast iron for frames and covers shall conform to ASTM A48.

All castings shall be of tough, close-grained, gray iron, sound, smooth, clean, and free from blisters, blowholes, shrinkage, and cold shuts.

Allowance shall be made in the patterns so that the finished castings shall have the specified dimensions.

The seats of manhole and valve box frames and covers shall be machined, not ground, to secure FLAT AND TRUE SURFACES. Castings for Cover and Reading Lid seats shall be chipped and ground where necessary to secure FLAT AND TRUE SURFACES.

All castings shall be thoroughly cleaned and painted before leaving the shop with one coat of high-grade asphaltum.

207.02 MANHOLE COVERS AND FRAMES.

All manhole covers and frames shall be made in accordance with the dimensions and notes shown on the Standard Details. The minimum weight for manhole covers and frames shall conform to Table 200-9.

Table 200-9 - MINIMUM WEIGHT FOR MANHOLE/VALVE BOX COVERS AND FRAMES		
Manhole/Valve Box Size	Cover Weight (Pounds)	Frame Weight (Pounds)
6-inch	10	40
12-inch	45	80
24-inch	140	195

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207.03 MANHOLE RUNGS.

Rungs shall be fabricated in accordance with the dimensions and notes shown on the Standard Details.

A. Hot-Dip Galvanized or Stainless Steel Rungs shall be 3/4-inch in diameter, hot-dipped galvanized carbon steel or stainless steel, Type 302, 304, or 316, or an approved equal. Rungs shall be in place before pouring of concrete or grout.

B. Steel Reinforced Copolymer Polypropylene Plastic Rungs (*For Oahu and Kauai only*) shall be as follows:

1. Conforms to ASTM D478 and C497, except that the minimum horizontal pullout load shall be 1,500 pounds.
2. Steel reinforcing shall conform to ASTM A615 for deformed reinforcing steel bars.
3. The minimum total cross-sectional area of the exposed portion of the step, including the 1/2-inch deformed reinforcing steel bar, and excluding the non-slip tread surface shall be one square inch.
4. The entire polypropylene plastic material surrounding the reinforcing steel bar shall be cast monolithically. Minimum cover shall be 3/16-inch.
5. Rungs shall be capable of withstanding an impact load of 70 foot-pounds at 20 degrees Fahrenheit without cracking or fracturing.

The rungs shall be installed level, plumb and in accordance with manufacturer's approved procedure.

207.04 EYEBOLTS, NUTS, AND WASHERS FOR TYPE "A" MANHOLE.

Eyebolt shall be one-inch diameter, 6-inches long, galvanized and with one-inch eye. Washer shall be 1/4"x 6"x 6" steel plate. Nuts shall be galvanized American Standard heavy cold-punched hexagon nuts.

207.05 METER BOX COVERS AND FRAMES.

Covers and frames for Type "B", "X", and Type III, IV and V meter boxes shall be made in accordance with the dimensions and notes shown on the Standard Details.

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207.06 VALVE BOX COVERS AND FRAMES AND STANDPIPES.

Valve box covers and frames shall be made in accordance with the dimensions and notes shown on the Standard Details. The minimum weight for valve box covers and frames shall conform to Table 200-9.

Valve box standpipes shall be either cast iron pipe, reinforced concrete pipe, PVC pipe, or approved equal. Standpipes shall be as shown on the Standard Details.

207.07 BRASS PLATES (*For Oahu and Hawaii Only*).

Brass plate shall be of materials conforming to specification of Section 211 - BRASS PRODUCTS and shall be affixed to the underside of the valve box or manhole covers as shown on the Standard Details.

SECTION 208 - SERVICE LATERALS AND APPURTENANCES

208.01 COPPER TUBING.

Copper Service Lateral shall be soft temper Type "K" and shall conform to ASTM B88.

Solder-joint fittings shall be cast bronze or wrought copper and shall conform with ANSI B-16. Cast bronze shall conform with ASTM B62. Wrought copper fittings shall be made of copper conforming with ASTM B251 or 85-5-5-5 brass.

Compression fittings shall be of cast bronze or stainless steel and conform to applicable AWWA, ANSI, and/or ASTM Standards.

Fittings conforming with AWWA C800 shall be required for the various sizes and combination of service laterals and connections and shall be as shown on the Standard Details.

Nipples shall be of the same quality as copper pipe.

Solder shall be 1/8-inch diameter and shall not contain more than 0.2 percent lead.

Flux shall be 'LA-CO' Flux Regular Stay-Clean Flux, Oatey Paste Flux, #95 Tinning Flux, General Purpose Soldering Flux or approved equal. Flux shall conform with Federal specifications O-F-506C Type I.

Solder and flux shall be delivered in their original containers.

See Division 500 for additional corrosion control requirements as applicable to the project.

208.02 BRASS PIPE.

Brass Pipe shall be Standard or Extra Strong as called for in the proposal. Pipe shall be as specified in Section 211 - BRASS PRODUCTS. See Division 500 for additional corrosion control requirements as applicable to the project.

208.03 PLASTIC TUBING.

All plastic tubing shall be approved by the Manager and shall be polyethylene (PE), copper tubing size as specified on the plans and specification.

A. Polyethylene Tubing. PE tubing shall conform to all applicable requirements of the following standards, unless otherwise specified in these Standards:

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1. AWWA C901 - Standard for Polyethylene (PE) Pressure Pipe, Tubing, and Fittings, ½-inch through 3-inch, for Water.
2. ASTM D1248 - Specification for Polyethylene Molding and Extrusion Materials.
3. ASTM D2737 - Specification for Polyethylene Plastic Tubing.

PE tubing shall be manufactured from ultra-high molecular weight polyethylene, meeting the requirements of ASTM Material Classification PE3408. PE tubing shall meet the requirements of Type III, Class C, Category 5-P34 as defined by ASTM D1248. PE tubing shall be made from all virgin material approved for potable water service by the National Sanitation Foundation (NSF) and shall conform to ASTM D2737. PE tubing shall not fail, balloon, burst, or weep as defined in ASTM D1598 when tested in accordance with the sustained pressure test method of ASTM D2737.

PE tubing shall be rated for use with water at 73.4°F at a hydrostatic design stress of 630 psi and a minimum pressure class of 200 psi.

PE tubing shall have a Dimension Ratio (DR) of 9. The average outside diameter, minimum wall thickness and respective tolerances for any cross-section shall be as specified Table 200-10 when measured in accordance with ASTM D2122.

Table 200-10 - POLYETHYLENE TUBING			
Nom. Tubing Size (in.)	Outside Diameter (in.)	Minimum Wall (in)	Wall Tolerance (in)
3/4	0.875 ± .004	0.097	+0.010
1	1.125 ± .005	0.125	+0.012
1-1/4	1.375 ± .005	0.153	+0.015
1-½	1.625 ± .006	0.181	+0.018
2	2.125 ± .006	0.236	+0.024

All PE tubing shall be permanently imprinted with manufacturer's brand name or trade mark, pipe size, identification of National Sanitation Foundation approval, ASTM Specification No., maximum working pressure and production code.

PE tubing shall be packaged for protection against sunlight, dirt, and damage during shipment, handling and storage. Packages shall be fully labeled with brand name and manufacturer, NSF seal, size, and coil length.

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B. Plastic Tubing Markings. Plastic tubing markings shall be permanently imprinted with the following markings:

1. Nominal size.
2. Material code designation (PE3408).
3. The word "Tubing" and dimension ratio (DR9 for PE).
4. AWWA pressure class (PC200).
5. AWWA designation number (AWWA C901 for PE).
6. Manufacturer's name or trademark and production record code.
7. Seal (mark) of the testing agency that certified the suitability of the tubing material for potable water products.

All tubing shall be packaged for protection against sunlight, dirt, and damage during shipment, handling, and storage. Cartons shall be labeled with manufacturer's name or trademark, AWWA designation number, nominal size, and total length.

Fittings to be used with plastic tubing shall be approved by the Manager. Fittings shall be compression type, brass (with stainless steel stiffeners) or PVC, or approved equal.

Solvent cement type jointing shall not be used.

208.04 BALL CORPS.

Ball Corps shall conform to the requirements of AWWA C800 and the following:

1. Components shall be constructed of heavy brass conforming to ASTM B62, 85-5-5-5.
2. Shall have a rated pressure of 300 psig.
3. Shall be full port, straight through design. Ball corp waterway shall be the same size as the corp, except for 2-1/2-inch laterals. For example: 1" ball corp shall have a 1" waterway. For 2-1/2-inch laterals, install 2" x 2-1/2" bushings or adapters as required.
4. Inlet threads shall be AWWA taper (Mueller) threads.

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5. Outlet threads shall be male iron pipe threads. *(For Maui only: Female iron pipe threads are also acceptable.)*
6. Ball shall be Polytetrafluoroethylene (PTFE) coated, capable of full 360 degrees rotation with nitrile (Buna-N) seals that provide shut-off from either direction.
7. Shall have double O-Ring seals at top.
8. Head shall have a raised boss or groove indicating the position of the ball.
9. Shall have a blowout proof stem design.
10. Shall have suitable marking indicating the manufacturer.

208.05 BALL STOPS.

Ball Stops shall conform to the requirements of AWWA C800 and the following:

1. Components shall be constructed of heavy brass conforming to ASTM B62, 85-5-5-5.
2. Shall have a rated pressure of 300 psig.
3. Shall be full port, straight through design. Waterway shall be the same size as the stop. For example: 1" ball stop shall have a 1" waterway.
4. Shall have female IPT threads, unless otherwise noted. *(For Kauai only: Shall have female IPT threads by meter coupling nut.)*
5. Ball shall be PTFE coated, capable of full 360 degrees rotation with two nitrile (Buna-N) seals that provide shut-off from either direction. Seals shall be blow-off proof to the atmosphere.
6. Shall have double O-Ring seals at top.
7. Head shall have a raised boss or groove indicating the position of the ball.
8. Shall have a blowout proof stem design.
9. Shall have suitable marking indicating the manufacturer.
10. *For Hawaii only: Shall have padlock lock wings.*

208.06 COUPLINGS *(For Oahu only).*

1. Coupling nuts shall conform with Section 2.11 and 4.2.1.1 of AWWA Standard C700-90. All couplings nuts shall be provided with 1/8-inch leather washers. Coupling nuts shall be made of a copper alloy containing not less than 75 percent copper. Coupling nuts shall be drilled for wire seal. Coupling nuts shall be an equal-sided hexagon without taper along the longitudinal axis of the coupling. No projections shall extend past the plane of the hexagon sides. For 3/4-inch meter coupling nuts, the distance between opposite sides of the coupling nut shall be between 1-1/2 and 1-5/8 inches. For 1-inch meter coupling nuts, the distance between opposite sides of the coupling nut shall be between 1-7/8 and 2 inches.
2. Coupling tail pieces shall conform with Section 2.11 and 4.2.1.2 of AWWA Standard C700-90. Overall length of tail pieces for 3/4-inch meters shall be 2-1/2 inches and for 1-inch meters shall be 2-5/8 inches, unless otherwise specified. Tail pieces shall be straight and shall be made of a copper alloy containing not less than 75 percent copper.

208.07 SERVICE SADDLES.

Service saddles, straps, nuts, and washers shall be made of bronze or approved equal. *(For Oahu only: Service saddles allowed for taps to existing pipes only.)*

Unless otherwise specified, service saddles shall be furnished with single or double straps *(double strap only for Maui and Oahu)* and shall be used as called for on the plans or as directed by the Manager.

Service saddles on PVC pipes shall provide full support and contact around the complete circumference of the pipe with the clamping arrangement fully contoured to the outside of the PVC pipe. Metal composition for service saddles, including saddles, straps, nuts, and washers shall be of bronze, Type 304 stainless steel *(not applicable for Oahu)*, or approved equal. *(For Oahu only: Stainless steel service saddles and bronze service saddles with stainless steel straps are not allowed.)*

All service saddles shall have outlets tapped with Mueller tapered threads of the sizes called for on the plans. Saddles shall be furnished with closed cell neoprene gaskets.

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208.08 METER BOX.

Meter boxes shall be made in accordance with the dimensions and notes shown in the Standard Details.

For concrete boxes, the cement shall be Portland cement conforming to ASTM C150, Type I. Fine and coarse aggregates shall conform to ASTM C33 or C330. Mixing water shall be clean and free from injurious amounts of oils, acids, alkalis, organic materials, or other deleterious substances. An admixture which increases durability and reduces permeability, and when used properly is in no way detrimental to the concrete, may be used. The combined aggregates shall be of such composition of sizes so that the surface of the finished product shall be continuous and of a uniform texture.

The maximum density of the concrete in the finished product shall be 115 pounds per cubic foot and the maximum absorption shall be 15 pounds per cubic foot. The compressive strength of the concrete shall be at least 2500 psi to be determined in a manner and at intervals satisfactory to the Manager.

**SECTION 209 - PREMOLDED FILLER, CRUSHED ROCK,
PIPE CUSHION, BACKFILL MATERIAL AND BRICKS**

209.01 PREMOLDED FILLER.

Premolded filler to be used between pipes and manhole walls shall be a closed cell neoprene material such as Rubatex R-431-N or an approved equal.

209.02 PIPE CUSHION.

A. For Kauai, Maui and Oahu: The various materials used for pipe cushion are natural sand, manufactured sand, coral, and crusher screenings as specified on Table 200-11. Cinders are not allowed.

1. *Natural sand shall be free from hard lumps, debris, salt, and other foreign matter.*
2. *Manufactured sand shall be approximately equal to that specified under concrete Work.*
3. *Coral shall be dredged coral, free from salt, silt, clay, and other deleterious substances.*
4. *Crusher screenings "S4C" shall have a minimum amount of fines and shall conform to Table 200-11, or shall be subjected to tests conducted by the Manager for approval.*

Table 200-11 - S4C for PIPE CUSHION	
Sieve Size	Total Percent Passing By Weight
1/2"	100
3/8"	90 - 100
No. 16	25 - 45
No. 100	5 - 15
No. 200	≤2.5
0.006 mm	≤1.5

The pipe cushion material shall have a resistivity of 5,000 ohm-cm or greater when saturated with distilled water and measured using the soil box method explained in ASTM G57. Pipe cushion material shall have a pH greater than 6.0. Pipe cushion material shall contain no hazardous substances above its corresponding regulatory action level. Hazardous substances include, but not limited to, lead, asbestos, mercury, chromium, cadmium, zinc, strontium and polychlorinated biphenyls (PCB). The Contractor shall submit a soil certification that high resistant cushion material has a resistivity greater than 5000 ohm-cm.

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No crusher screening "S4C" shall be used in areas where the invert of the pipe is at or lower than the 4-foot elevation, USGS Datum, or in areas where the ground is wet.

B. For Hawaii only: Pipe cushion for ductile iron pipes 4-inches and larger shall be 1½" base course material. Pipe cushion for copper services shall be fine aggregate, conforming to Table 200-12 and as specified in Section 703.01 (Fine Aggregate for Concrete) of the Hawaii Standard Specifications for Road, Bridge, and Public Works Construction. No soil or native material shall be allowed.

Sieve Size	Total Percent Passing By Weight
3/8"	100
No. 4	95 - 100
No. 8	80 - 100
No. 16	50 - 85
No. 30	25 - 60
No. 50	10 - 30
No. 100	2 - 12

209.03 CRUSHED ROCK.

Crushed rock shall consist of broken stone which shall be obtained from clean, hard, blue lava rock, and shall be free from disintegrated stone, organics or other deleterious substances.

Size of rocks shall range from 2½-inches to ¾-inch.

209.04 BACKFILL MATERIAL.

Material used for backfilling shall contain no stone, rock, concrete, or other material larger than 6 inches in its greatest dimension and shall contain no organic matter or debris of any kind. No cinders, "adobe" or similar material shall be used. Material shall contain no hazardous substances including but not limited to lead, asbestos, mercury, chromium, cadmium, zinc, strontium and polychlorinated biphenyls (PCB), above the regulatory action levels.

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For mains and laterals to be installed in State DOT rights-of-way or highways, the trench backfill material shall meet applicable requirements of the “STANDARD SPECIFICATIONS FOR ROAD AND BRIDGE CONSTRUCTION”, of the Hawaii Highways Division, DOT.

209.05 BRICKS.

Bricks for manhole, meter boxes and other water system applications shall be concrete bricks conforming with ASTM C55, Grade A.

**SECTION 210 - VALVE MARKERS, PIPE HANGERS,
LATERAL BRACINGS AND INSERTS**

210.01 VALVE MARKERS.

Valve markers shall be as shown on the Standard Details. Concrete for the footings shall be as specified under Concrete Work.

210.02 PIPE HANGERS, LATERAL BRACINGS, AND INSERTS.

Pipe hangers and lateral bracings shall be of carbon steel, galvanized and shall be fabricated to the dimensions shown on the plans. Pipe hangers shall be furnished complete with hanger rods, inserts, lateral bracings, bolts and nuts. Pipe hangers shall be capable of vertical adjustments.

Pipe hanger inserts shall be bronze conforming with ASTM B22, Class "D" Grade, or gray iron castings conforming with ASTM A48, Class 30. Inserts shall be made in accordance with the dimensions and notes shown on the plans.

SECTION 211 - BRASS PRODUCTS

211.01 GENERAL.

All brass fittings shall conform to NSF Standard 61, Section 9 and Section 1417 of the Safe Drinking Water Act. Brass products shall meet applicable standards of AWWA C800 - "Standard For Underground Service Lines, Valves And Fittings". Written certification will be submitted to the Department certifying that all brass fittings and couplings for water meters, service valves, and fittings are manufactured from a brass alloy with a metal content consisting of 85% copper and 5% each of tin, lead, and zinc (85-5-5-5 spec.).

SECTION 212 - MISCELLANEOUS

212.01 ASPHALT SEAL FOR RESERVOIR INTERIOR PERIMETER.

Asphalt for interior perimeter of reservoirs shall meet the requirements of ASTM D449 for Type II asphalt and shall be poured at a temperature of not more than 300°F and at a slow rate to avoid air entrapment. All concrete surfaces to receive the asphalt shall be clean, dry and primed with a coat of quick-drying asphalt primer approved by the manufacturer of the asphalt. The Contractor shall submit written certification to the Manager that the asphalt seal used conforms to ASTM D449 Type II.

212.02 ASPHALTUM.

An asphaltum coating that will effectively waterproof immersed structures is required for the exterior of manholes as specified in the standard details. Surfaces shall be clean and dry, free from grease, oil, sand, and other foreign matter prior to placement of coating. Waterproofing materials shall conform with the following:

- a. Primer shall conform to AASHTO M 116.
- b. Fabric for waterproofing shall conform to AASHTO D 1668.
- c. Asphalt for waterproofing shall conform to AASHTO M 115.

Materials shall be submitted for Manager's approval prior to installation.

212.03 BITUMASTIC COATING.

Bitumastic coating shall be a thick, heavy-duty cold applied, water emulsion-type protective coating. This material shall meet the following criteria:

- a. Has high solids content.
- b. Provides resistance to water and moisture vapor transmission.
- c. Provides coatings that are resistant to deterioration from below ground acids and alkalies that are encountered in normal soil.

Materials shall be submitted for Manager's approval prior to application.

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212.04 CRYSTALLIZATION PRODUCTS.

Crystallization products shall prevent the penetration of water and other liquids from any direction by causing a catalytic reaction that produces a non-soluble crystalline formation within the pores and capillary tracts of concrete and cement-based materials. This material shall:

- a. Resist extreme hydrostatic pressure.
- b. Seal hairline cracks up to 0.4 mm.
- c. Become an integral part of the substrate.
- d. Repair faulty construction joints and honeycombs.

Materials shall be submitted for Manager's approval prior to application.

212.05 GEOTEXTILE FABRICS.

A non-woven geotextile fabric is required to be used as a permeable separator for the base course or for other uses as indicated on the plans. The fabric shall be made of a non-woven geotextile material composed of polypropylene fibers conforming with ASTM D 4632, D 4533, D 3786, D 4833, D 4751, D 4491 and D 4355 and shall meet the following minimum strengths and criteria:

- a. Grab Tensile Strength of 180 lbs.
- b. Grab Tensile Elongation of 50%.
- c. Trapezoid Tear Strength of 75 lbs.
- d. Mullen Burst Strength of 330 psi.
- e. Puncture Strength of 105 lbs.
- f. Apparent Opening Size (AOS) of 70 sieve.
- g. Permittivity of 1.4 sec^{-1} .
- h. Flow rate of 100 gal/min/ft².
- i. Retained UV Resistance (at 500 hours) of 70% strength.

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Geotextile fabrics shall also meet the applicable requirements of the “STANDARD SPECIFICATIONS FOR ROAD AND BRIDGE CONSTRUCTION”, of the Hawaii Highways Division, DOT. Materials shall be submitted for Manager’s approval prior to installation.

212.06 PETROLEUM ASPHALTIC COATINGS (FACTORY APPLIED).

Exterior surfaces of pipes, valves (unless provided with a factory applied fusion-bonded epoxy coating), fittings and special castings shall be covered with two coats of petroleum asphaltic coating. This material will:

- a. dry to a hard, tough, durable film,
- b. effectively resist abrasion and peeling due to handling, transportation, and installation of the pipe, and
- c. not crack nor chalk due to loss or evaporation of its ingredients.

Surfaces shall be clean and dry, free from grease, oil, sand, and other foreign matter prior to placement of coating.

212.07 WALL SLIDING JOINT MATERIAL.

Material for wall sliding joints shall be 1/16-inch thick of non-asbestos fibers bonded together with a cementing medium rendering it tough and pliable without plies or laminations. Material shall conform to ASTM F104 and shall meet the minimum operating conditions:

- a. Pressure rating of 1,450 psi
- b. 30% Creep Relaxation
- c. Sealability of 0.25 ml/hr
- d. Tensile Strength of 2,200 psi
- e. Deformation of the pad under a load of 10,000 pounds per square inch shall not be more than 0.01 inch.

212.08 WARNING TAPE.

Warning tapes shall be four mil thick, non-metallic, acid and alkali resistant polyethylene and 6-inches wide with minimum strength of 1750 psi lengthwise and 1500 psi crosswise.

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Tape color shall be “safety precaution blue” and shall bear a continuous printed inscription “CAUTION WATER LINE BURIED BELOW”. Inscription shall be 2-inches high, black text.

212.09 WATERSTOPS.

Waterstop shall be rubber or neoprene. When tested in accordance with the applicable provisions of ASTM D395, "Standard Method of Test for Compression Set of Vulcanized Rubber", ASTM D412 "Standard Method of Tension Testing of Vulcanized Rubber", ASTM D573, "Standard Method of Test for Accelerated Aging of Vulcanized Rubber by the Oven Method", and ASTM D2240, "Standard Method of Test of Indentation Hardness of Rubber and Plastics by Means of a Durometer", it shall conform to the following physical requirements:

- a. Tensile strength shall be a minimum of 3000 psi.
- b. The Shore A durometer hardness shall be 60 to 70.
- c. The tensile strength of the test specimen after accelerated aging test of 7 days at 158°F shall be not less than 80 percent of the original test strength. The tensile strength of the test specimen after aging test of 48 hours in oxygen at 70°C and 300 psi shall be not less than 80 percent.
- d. The compression set after 22 hours at 158°F shall be not more than 30 percent.
- e. The specific gravity shall be 1.17 plus or minus 0.03.
- f. The elongation shall be a minimum of 450 percent.
- g. The water absorption shall be a maximum of 5 percent by weight after immersion in water for two days at 158°F. Test shall be made on specimen of the waterstop not more than 60 days prior to delivery.
- h. Two certified copies of the test results shall be furnished to the Manager for approval.

Waterstops shall also meet the applicable requirements of the “STANDARD SPECIFICATIONS FOR ROAD AND BRIDGE CONSTRUCTION”, of the Hawaii Highways Division, DOT.