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**Design Standards**  
**Section 11**  
**Water Pipe and Fittings**

**SECTION XI**

**WATER PIPE AND FITTINGS**

**11-1 GENERAL**

The materials used shall be all new and shall conform to the requirements for class, kind, size and materials as specified below. The Contractor will submit in writing a list of materials showing the manufacturer and designation of all materials. This must be accepted by the Engineer.

A copy of the manufacture's installation recommendations for each kind of pipe must be provided to each foreman and inspector prior to construction and must be followed during construction unless otherwise instructed.

Pipe materials shall conform to the following according to size.

3/4"-1"	Copper or polyethylene pressure pipe
1 1/2" -2"	Schedule 40 PVC (sand bedded) or polyethylene pressure pipe
over 2"	Ductile Iron Class 50; and Class 200 (to be approved on individual basis by City Engineer)

11-1.1 CONNECTING WATER METERS. Only authorized employees of the City Water Department shall be allowed to connect or disconnect water meters. All boxes set in concrete shall be flanged to prevent settlement.

**11-2 DUCTILE IRON PIPE**

All ductile Iron Pipe shall be Class 50 conforming to the latest Edition of AWWA Specification C-151 (ANSI A21, 51).

Pipe and accessories shall be gauged at sufficiently frequent intervals to assure that dimensions are in accordance with Table 51.3 and 51.4 AWWA C-I 51-76 for the gauge. The inside diameters of the sockets and the outside diameters of the spigot ends shall be tested with circular gauges.

Unless otherwise specified, all Ductile Iron Pipe furnished under these specifications shall be designed in accordance with AWWA C-1 50-76, "American National Standard for the Thickness Design of Ductile Iron Pipe."

The maximum allowance variation with the standard pipe thickness shall not be more than those shown in the following table and note:

SIZE	MINUS TOLERANCE
<u>INCHES</u>	<u>INCHES</u>
3-8	0.05
10-12	0.06
14-42	0.07
48	0.08

NOTE: An additional tolerance of 0.02 inches shall be permitted over areas not exceeding eight inches in length.

Each pipe shall be weighed before the application of any coating other than the standard bituminous coating, and the weight shall be shown on the outside or inside of the bell or spigot end. The weight of any single pipe shall not be less than the tabulated weight by more than five percent for pipe larger than twelve inches in diameter. The

total weight of any order twenty-five tons or more shall not be more than two percent under the total nominal weight.

The nominal laying length of the pipe shall be as shown in Table 51.3 and 51.4 AWWA C-1 51-76. A maximum of ten percent of the total number of pipe of each size of an order may be furnished as much as twenty-four inches shorter than the nominal laying length. An additional ten percent may be furnished as much as three inches shorter than the nominal laying length.

11-2.1 PHYSICAL AND MECHANICAL PROPERTIES. The Ductile Cast Iron Pipe shall conform with all requirements of the ANSI Specification A-21 .51. The physical properties shall not be less than 60-42-10.

(1) TENSILE TEST. A round tensile test specimen shall be cut longitudinally from the midsection of the pipe wall. This specimen shall be machined and tested in accordance with ASTM Designation E-8-61T, Tension Testing of Metallic Materials. The Acceptance values shall be as follows:

Grade of <u>Iron</u>	Tensile Strength <u>Minimum</u>	Yield Strength <u>Minimum</u>	Percent Elongation <u>Minimum</u>
60-42-10	60,000	42,000	10

(2) IMPACT TESTS. Tests shall be made in accordance with ASTM Designation E-23-60 "Notched Charpy Test," except specimens shall be 0.500 inch and full thickness of pipe wall. The corrected acceptance value shall be a minimum of seven feet for tests conducted at 70 degrees F ± 10 degrees F. In addition, low temperature impact tests shall be made at sufficiently frequent intervals to assure compliance with a minimum correct value of three foot pounds for tests conducted at -40 degrees F.

(3) HYDROSTATIC TEST. Each pipe shall be subjected to a hydrostatic test of not less than 500 psi. The test may be made either before or after the standard outside coating and bituminous inside coating have been applied, but shall be made before the application of a cement lining or of a special lining. The pipe shall be under the full test pressure for at least ten seconds. Any pipe that leaks shall be rejected.

11-2.2 MARKING. Each pipe shall be legibly marked "Ductile." The weight, a manufacturer's mark, and the year in which the pipe was produced shall be cast or marked on the pipe.

11-2.3 INSPECTION. The manufacture shall establish the necessary quality control and inspection practice to assure compliance with these specifications. The manufacturer shall, if required in the Special Provisions, furnish a certified statement that the inspection and all the specified tests have been made and the results thereof comply with the requirements of these specifications. When the Owner desires to inspect the pipe at the manufacturer's plant, the owner will so specify in the Special Provisions and state the extent of the inspection. The Owner's inspector shall have free access to those parts of the manufacturer's plant which are necessary to assure compliance with these specifications. The manufacturer shall provide the inspector with assistance to handle pipe as may be necessary.

11-2.4 REJECTION OF PIPE. At least one tensile and one impact sample shall be taken during each casting period of approximately three hours. Samples shall be selected to properly represent extremes of pipe diameters and thicknesses, If the results of any physical acceptance test fails to meet the requirements of these specifications, all pipe cast in the same sampling period shall be rejected. The manufacturer may determine the extent of rejections by making similar additional tests of pipe until the rejected lot is bracketed (in order of manufacturer) by an acceptable test at each end of the period in question. When a pipe of one size is rejected from a sampling period, the acceptability of pipe of different sizes from the same period may be established by making the routine acceptance test for these sizes.

11-2.5 JOINTS. Ductile Iron Pipe shall be of the following types as specified on the plans:

Mechanical Joints

### Rubber Gasket Slip-on Joint Flanged Joint

(1) **MECHANICAL JOINTS.** Mechanical joints and the rubber gaskets and lubricant, therefore, for Ductile Iron Pipe shall comply with the requirements and be dimensioned in accordance with the latest edition of the following specifications:

Mechanical Joint Gasket Dimensions . AWWA C-111

Mechanical Joint Dimensions & Tolerance AWWA C-151

Mechanical Joint Bolt & Nut Dimensions AWWA C-111

Bolts and rubber gaskets shall be furnished with mechanical joint pipe in sufficient quantity for the amount of pipe ordered.

(2) **RUBBER GASKET SLIP-ON JOINT.** Rubber gasket slip-on joints, and the rubber gasket and lubricant therefore, for Ductile Iron Pipe shall comply with the general requirements of AWWA C-I 51.

Rubber gasket slip-on joints shall be designed for assembly by prepositioning of a single continuous molded rubber ring gasket in an annular recess in the pipe socket and provide a positive seal. The plain end of the pipe shall be suitably beveled to facilitate assembly.

The design and shape of the gasket, and the annular recess therefore, shall be such that the gasket is locked in place against displacement as the joint is assembled. The gasket shall provide adequate compressive force between the plain pipe end and the socket after assembly to effect a positive seal under all combinations of joint and gasket tolerances.

Details of the joint and rubber ring gasket design and assembly shall be in accordance with the pipe manufacturer's standard practice. The Contractor shall furnish the Engineer detailed drawings in duplicate showing the design of the joint prior to casting said pipe. The design of the joint shall be subject to the approval of the Engineer.

The recess in the pipe socket for the rubber ring shall be free of all coating materials and sand pits.

Rubber gaskets and lubricant shall be furnished with rubber gasket joint pipe in sufficient quantity for the amount of pipe ordered.

(3) **FLANGED JOINTS.** Cast iron pipe flanges, and bolts and nuts therefore, shall be dimensioned in accordance with ASA B-16.2 for class 200. Threads for screw-on flange pipe shall comply with ANSI B-21. Flange bolts, nuts, and gaskets shall be furnished with flange joint pipe in sufficient quantity to make each joint for the pipe ordered.

**11-2.6 LINING AND COATING.** The waterway surfaces of all Ductile Iron water pipe and fittings shall be completely covered with a uniform thickness of cement-mortar which shall be covered with a bituminous seal coat, all in accordance with AWWA C-I 04. The bituminous seal coat may be omitted if the cement lining is given a seven day water cure, during which the lining is kept consistently damp.

Ductile Iron Pipe fittings lined in the field will not be accepted as conforming to AWWA C-104.

The outside surface of all Ductile Iron Pipe for general use under all normal conditions shall be bituminous coating of coal tar primer approximately one mill thick, unless otherwise specified. The finished coating shall be continuous and smooth. It shall be neither brittle when cold nor sticky when exposed to the sun, and shall strongly adhere to the pipe.

**11-2.7 POLYETHYLENE WRAPPING.** Polyethylene wrap will be required on all pipe laid in corrosive soils or where directed by the Engineer. The polyethylene wrap tubing shall be cut to provide for a minimum of one foot of lapover both the adjoining pipes. The ends of the tubing shall be wrapped using three circumferential turns of plastic adhesive tape. The loose wrap on the barrel is to be pulled snugly around the barrel of the pipe and excess folded over at the top. This fold will be held in place by means of six inch strips of the plastic tape placed at intervals of three feet along the pipe barrel.

Bends, reducers, and offsets shall be wrapped in the same manner as pipe. Valves shall be wrapped by bringing the tube wrap on the adjacent pipe over the bells of the valve and sealing with adhesive tape. The valve bodies are then wrapped with flat sheets passed under the valve bottom and brought up around the body to the stem and fastened with the tape.

**11-3 POLYVINYL CHLORIDE PIPE**

This specification provides the requirements for an Class 200 (SDR 21) PVC pressure rated pipe with rubber gasket couplings and fittings.

Rigid PVC pressure pipe as described in this specification is designed to carry potable water at pressures up to the maximum class rating.

Material used to produce the pipe, couplings, and fittings shall conform to ASTM D-1784, Type I, Grade I; 2,000 psi design stress.

The Standard dimensional ratio for the pipe shall be as follows:

SDR 21 (Class 200)

11-3.1 CONFORMANCE All PVC pipe shall conform to the latest revisions of the following specifications:

- AWWA Spec. C-900 (PVC Pressure pipe for water)
- ASTM Spec. D-2241 (PVC Plastic pipe SDR-PR and Class T)
- Commercial Standard CS-256-63 (pressure rated pipe)

National Sanitation Foundation Testing Laboratories (NSF)

Rubber gasketing shall conform to ASTM 1869.

11-3.2 PHYSICAL REQUIREMENTS The pipe and couplings shall be manufactured to meet the following requirements:

(1) Quick Burst Test - the hydrostatic strength shall meet the following based on method of test ASTM D-1599

90 Second min.

<u>Pipe Class</u>	<u>Burst Pressure</u>	<u>Hoop Stress</u>
200	740 psi	7400 psi

(2) Sustained Pressure Test - Test - A sample shall withstand without failure for 1,000 hours, the following pressures in accordance with ASTN 1598:

<u>Pipe Class</u>	<u>Hydrostatical Pressure</u>	<u>Hoop Stress</u>
200	420 psi	4200 psi

(3) Flattening - A two inch long specimen shall be compressed at a uniform rate of loading between parallel plates so that 100 percent flatness occurs within one minute. There shall be no evidence of cracking or breaking.

(4) Tensile Strength - Shall be conducted in accordance with ASTM D-638. Minimum tensile strength shall be 7400 psi.

(5) Impact Test - Shall be conducted in accordance with ASTM D-2444

11-3.3 CHEMICAL REQUIREMENTS Acetone Immersion - A sample shall be completely immersed in anhydrous acetone for a sixty minute period with examination at twenty minute intervals. This test shall meet the requirements of ASTM D-2152.

11-3.4 'PIPE DIMENSIONS. Standard lengths shall be available in twenty feet. Wall thickness shall be in accordance with CS-256-63 and ASTM D-2241. The outside diameter shall be as follows:

<u>Size</u>	<u>Nominal</u>	<u>Tolerance</u>
1 1/2"	1 900"	+0 005" -0 002"
2"	2 375"	+0 005" -0 002"
2 1/2"	2 875"	+0 005" -0 002"
3"	3 500"	+0 005" -0002"
3 1/2"	4 000"	+0 007" -0 002"

4	4 500"	+0007" -0 002"
6	6625"	+0009" -0 002"
8	8.625"	+0.009" - 0.002"

Pipe ends shall be believed to accept the gasketed coupling (four inch and larger).

**11-3.5 COUPLINGS AND FITTINGS.** The couplings and fittings shall be furnished by the pipe manufacturer and shall accommodate the pipe for which they are to be used. They shall have a minimum pressure rating of 200 psi. Insertion depth of the pipe in the coupling shall be controlled by gauge mark or mechanical stop in the coupling which will allow for a thermal expansion and contraction.

**11-3.6 MARKINGS.** Pipe markings shall include the following marked continuously down the length:

- Manufacturer's name
- Nominal Size
- Class pressure rating
- PVC 1120
- NSF logo, and Identification Code

**11-3.7 LUBRICATION.** Lubrication shall be water soluble, non-toxic, be nonobjectionable in taste and odor imparted to the fluid, be non-supporting of bacteria growth, and have no deteriorating effect on the PVC or rubber gaskets.

#### **11-4 POLYETHYLENE (PE) PRESSURE PIPE**

Polyethylene pressure pipe shall conform to the latest Edition of AWWA C-901 -78, "Polyethylene Pressure Pipe Tubing and Fittings, 1/2-inch Through 3-inch, for Water."

#### **11-5 FITTINGS**

Fittings shall be of cast iron and of a pressure rating as may be required by the static pressure along the pipeline. All fittings shall be dimensioned according to ANSI A-21.10 (AWWA C-I 10) "American Standard for Cast Iron Fittings, 2-inches Through 48-inches, for water and Other Liquids."

**11-5.1 SETTING OF BENDS AND REDUCERS.** Bends, tees, crosses, and reducers shall be lowered into the trench, inspected, cleaned and joined to the pipe.

The City will require a megalug retainer gland system be used on all mechanical joints. These shall meet Uni - B - 13 for PVC and be UL/FM approved through twelve inch for both ductile iron and PVC. The restraint mechanism shall consist of individually activated gripping surfaces to maximize restraint capability. Twist-off nuts, sized the same as the tee-head bolts, shall be used to insure proper activating of restraining devices. The gland shall be manufactured of ductile iron conforming to ASTM A536-80. The retainer-gland shall have a pressure rating equal to that of the pipe on which it is used (through fourteen inches) with a minimum safety factor of 2:1. Gland shall be Megalug by EBAA Iron, Inc., or approved equal. The type of model of retainer and amount for each connector is shown on Standard Drawings.

If a megalug retainer system can not be used, a concrete thrust block system can be substituted, if designed and approved by the City Water & Power Engineer on a case by case basis.

**11-5.2 PLUGGING OF DEAD ENDS.** Standard plugs shall be inserted into the bells of all dead-end fittings. Spigot ends of fittings and plain ends of pipe shall be capped. A concrete reaction or thrust backing shall be provided at all plugged outlets to fittings in the sizes indicated on the contract drawings or as directed by the Engineer. The concrete reaction or thrust backing shall be tied to the fittings with clamps and tie rods. The number and size of rods shall be as specified.

**11-5.3 SERVICE LINES.** All service lines shall be installed according to the details shown on the plans. All service lines shall be connected to the pipeline using an appropriately sized tee. The service lateral shall also include the installation of a gate valve.

**11-5.4 PIPE KEPT CLEAN.** All foreign matter or dirt shall be removed from the interior of the pipe before lowering into position in the trench. Pipe shall be kept clean

by means approved by the Engineer during and after laying.

11-5.5 JOINING PIPE SECTIONS. The sealing surface of the pipe, the bell to be joined, and the elastomeric gaskets shall be cleaned immediately before assembly. Assembly shall be made as recommended by the manufacturer. When pipe laying is not in progress, the open ends of installed pipe shall be closed to prevent entrance of trench water into the line. Whenever water is excluded from the interior of the pipe, enough backfill shall be placed on the pipe to prevent floating. Any pipe that has floated shall be removed from the trench and the bedding restored. No pipe shall be removed from the trench and the bedding restored. No pipe shall be laid when the trench conditions or the weather are unsuitable for the proper installations as determined by the Engineer.

11-5.6 CUTTING PIPE. The pipe shall be cut in a neat and workmanlike manner without damage to the pipe so as to have a smooth end at right angles to the axis of the pipe.

11-5.7 END PREPARATION. Pipe ends shall be cut square, deburred and beveled in accordance with the pipe manufacturer's recommendations.

11-5.8 PUSH - ON JOINTS. The push-on joint is a single elastomeric gasketed joint. It is assembled by positioning the elastomeric gasket in the annular groove of the bell and inserting the spigot end of the pipe into the bell. The spigot end of the pipe compresses the gasket radially to form a positive seal. The gasket and annular groove are designed, sized and shaped so that the gasket will resist movement. Care shall be taken so that only the correct elastomeric gasket, compatible with the annular groove of the bell, is used. Insertion by the elastomeric gasket in the annular groove of the bell must be in accordance with the manufacturer's recommendations.

11-5.9 MECHANICAL JOINT. The mechanical joint is a bolted joint of the stuffing box type. Each joint shall consist of: (1) a bell provided with an exterior gland having bolt holes or slots, and a socket with an annular recess for the sealing gasket and the spigot end of the plastic pipe; (2) a sealing gasket; (3) a follower gland with bolt holes matching those in the fitting; and (4) tee bolts and hexagonal nuts.

Installation recommendations from the manufacturer should be followed.

11-5.10 BACKFILL. All backfilling shall be done in conformance to Section 8-5 of these specifications.

## **11-6 VALVES AND BOXES**

All valves eight inches and smaller shall be gate valves and all valves over eight inches shall be butterfly valves unless otherwise specified in the Special Provisions.

11-6.1 GATE VALVES. All gate valves shall be NRS, iron body, fully bronze mounted, parallel seat, double gate valves conforming to the latest Edition of Specification AWWA C-500, "Standard for Gate Valves for Ordinary Service." In case of conflict, the requirements of this paragraph shall govern.

Valves shall have mechanical joint, flanged, flanged by mechanical joint, rubber gasket slip-on joint end connections as required by the joining pipe or fittings, and shall be List number four, "O" ring-type stuffing box.

Valves shall be installed vertically in a horizontal run of pipe, and shall be provided with a two inch square operating nut for manually operating the valve with a "T" handle wrench. The direction of rotation to open shall be to the left (counter clockwise).

11-6.2 BUTTERFLY VALVES. All butterfly valves shall be of the tight-closing, rubber seat-type with rubber seats that are securely fastened to the valve body. No metal-to-metal seating surfaces shall be permitted. Valves shall be bubble-tight at rate pressures with flow in either direction, and shall be satisfactory for applications involving valve operation after long periods of inactivity. Valve discs shall rotate 90° from the full open position to the tight shut position. Valves twenty inches and smaller shall meet the full requirements of AWWA Standard C-504-74 for Class 150B. The manufacturer shall have manufactured tight closing, rubber seat butterfly valves for a period of at least five years. All valves shall be as manufactured by the Henry Pratt Company or approved equal.

Valve bodies shall be constructed of cast iron ASTM A-1 26 Class B (for flanged end valves) or ASTM A-48 Class 40 for water-type valves. Flange drilling shall be in accordance with ANSI B-16.1 Standard for cast iron flanges. Two trunnions for shaft bearings shall be integral with each valve body. Body thickness shall be in strict accordance with AWWA Standard C-504.74.

Valve discs shall be constructed of alloy cast iron ASTM A-436 Type 1 (Ni-Resist).

Shafts of all valves shall be turned, ground and polished. Valve shafts shall be constructed of 18-8 Type 304 or Type 316 stainless steel. Shaft diameters must meet minimum requirements established by AWWA Standard 75 pounds pull under test procedure ASTM D-429, Method B.

Valves shall be fitted with sleeve-type bearings. Bearings shall be corrosion resistant and self-lubricating. Bearing load shall not exceed 1/5 of the compressive strength of the bearing of shaft material.

Packing shall be self-adjusting Chevron type.

Valve operators shall conform to AWWA C-504-74.

Manual operators shall be of the traveling nut, self-locking type and shall be designed to hold the valve in any intermediate position between fully open and fully closed without creeping or fluttering. Operations shall be equipped with mechanical stop-limiting devices to prevent over-travel of the disc in the open and closed positions. Valves shall close with a clockwise/counter clockwise rotation. Operators shall be fully enclosed and designed to produce the specified torques with a maximum pull of eighty pounds on the handwheel or chairwheel. Operator components shall withstand an input of 450 foot pounds at extreme operator position without damage.

11-6.3 VALUE BOXES. All valves shall be provided with a cast iron valve box of the extension sleeve type, and the correct adjustable height to bring the top of the valve box flush with ground surface. The valve box shall not be less than five inches in diameter, shall have a minimum thickness of 6 inch, and shall be provided with suitable base and cover. The word 'WATER' shall be cast on the cover. There shall be furnished one each one inch handle operating wrench for each five new valves installed on each project. Valve boxes shall be installed plumb and properly positioned to allow access of the operating wrench. To insure that the box is not displaced, the box shall be incased in concrete 18"x 18" x 6" the backfill around the concrete shall be tamped to a density of 95%:

## **11-7 WATER SERVICES**

11-7.1 COPPER SERVICE PIPE. Copper service pipe shall be seamless and suitable for use as copper underground service connections. Soft copper tubing shall conform to ASTM class K Specifications and U.S. Government Type K Specifications WWT-799. All joints shall be flare type.

11-7.2 POLYETHYLENE (TOUGH TUBE) SERVICE PIPE. Polyethylene service pipe shall conform to the latest edition of AWWA C-901-78, "Polyethylene Pressure Pipe, Tubing and Fittings, for Water."

11-7.3 CURB STOPS. Curb stops shall be Mueller or Ford Co. H-I 5175, suitable for flared copper inlet and inside pipe thread outlet.

11-7.4 CORPORATION STOPS. Corporation stops shall be Mueller Company H-150000; Ford 3/4-inch F-600, one-inch F-600 or equal, for 3/4-inch and one-inch services, with flare-type joint for service pipe and threaded on inlet end with AWWA corporation stop thread. For 1 1/2-inch and two inch services, Mueller Company H-I 5010 or Ford F-6125 corporation stops shall be used.

11-7.5 BUILDING SERVICE CONNECTIONS. At all points designated by the Engineer, the Contractor shall construct services for building connections, and shall extend such services to the property line, unless otherwise indicated on the drawings.

Water services shall be 3/4-inch from the water main to the curb stop for normal domestic services, but may be 1, 1 1/2 or 2-inch size as directed by the Engineer. Services shall have a minimum of three feet of cover and be laid where they are shown on the detail drawings. Expansion loops will be provided near the top and shall not

extend' above the top of the pipe.

### **11-8 FIRE HYDRANTS**

Fire hydrants shall conform to the latest Edition of AWI/VA C-502, "Fire Hydrants for Ordinary Water Works Service." All hydrants shall be designed for a working pressure of 200 psi.

11-8.1 HYDRANT DETAILS. The hydrant shall be of the design shown on the plans or specified in the Special Provisions. The hydrant valve shall be of a flanged joint type. All hydrants shall have a flanged bottom connection of the size specified on the plans or in the Special Provisions. The hydrant shall be of the dry barrel design.

All hydrants shall be so designed as to allow the flanges at sidewalk level to separate without material damage to the main barrel section when struck by a large object, such as a car. Upon such damage, the main gate must remain closed to avoid flooding or washout.

Where shown on the drawings or in the Special Provisions, hydrants with a four inch valve opening shall have two each 2 1/2-inch National Standard thread zone nozzles, and hydrants with a five inch valve opening shall be furnished with two each 2 1/2-inch National Standard Thread hose nozzles and one each five inch National Standard tread pumper nozzle. All nozzles shall be furnished with a cap and gasket with attaching chain.

All hydrants shall open counterclockwise with a pentagon operating nut conforming in Size to the specifications of the city.

11-8.2 SETTING HYDRANTS Hydrants shall be set so that at least the minimum pipe cover is provided for the branch supply line and the nozzles are at least eighteen inches above finished grade. Each hydrant shall be set on a concrete foundation at least eighteen inches square and six inches thick. Each hydrant shall be blocked against the end of the trench with concrete or other suitable anchorage system.

Hydrant drainage shall be provided by installing gravel or crushed rock around the hydrant and below the top of the hydrant supply pipe. One-third cubic yard of 1 1/2-inch gravel is to be placed around drain holes just above hydrant valve casing. All hydrants shall stand plumb. Hydrants with pumper nozzles shall be perpendicular to the curb line. Hydrants having hose nozzles 90° apart shall be set so the line bisecting the angle between the nozzles is perpendicular to the curb line. Hydrants shall be located inside the Street right-of-way and/or as directed by the Engineer.

It shall be the responsibility of the Owner to furnish hydrants with a finish paint above the ground line identical to the existing hydrant paint.

The seat must be made of moulded non-swelling rubber. The drop valve shall be located near the bottom of the hydrant. It shall be positive in operation and shall work directly from the main stem. It must be so designed that all water will drain away from the working parts when the hydrant is closed.

The main stem of the hydrant shall be of cold-rolled bronze, having a tensile strength of not less than 54,000 pounds per square inch. The stem must terminate at the top in a nut of pentagonal shape, finished with a slight taper to 1 1/2 inches from point of flat.

The stuffing box shall be of cast iron and have an internal diameter sufficient to allow at least 1/4 inch of packing on the side, the depth to be sufficient to insure hydrant against leaking and to withstand long wear. Stuffing box followers shall be solid bronze.

Hydrant cover must be designed so as to be as weather proof as possible. Provisions must be made for oiling, both for lubrication and to prevent corrosion. A reasonably tight fit should be made around the stem. On the cover an arrow and the word "open" shall be placed in raised characters to indicate the direction to turn to open the hydrant.

The hydrant must be marked with the name or particular mark of the manufacturer. The size of the hydrant shall also be cast in the barrel. All lettering is to be above the ground or sidewalk flange.

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