

The Board Of Water Commissioners Denver Water

Engineering Standards Chapter 6 – Materials

6.01 MATERIALS AND TESTING:

Detailed technical specifications for purchase or approval of materials are included in the Materials Specifications of these Standards. Materials shall conform to the Materials Specifications and to limitations on acceptable makes and styles.

Materials furnished shall be new and undamaged. Everything necessary to complete installations in accordance with the Engineering Standards of Denver Water shall be furnished and installed whether shown on approved drawings or not; and installations shall be completed as fully operable, functioning parts of the Denver water system.

Where mains are extended by Applicants, it shall be their responsibility to provide materials necessary for the installation. No materials will be supplied to the Applicant by Denver Water.

Acceptance of materials, or the waiving of inspection thereof, shall in no way relieve the Applicant of the responsibility for furnishing materials meeting the requirements of the Materials Specifications.

New water industry products or materials will be tested if it is the opinion of the Engineer that the product or material has some merit. Denver Water will establish the criteria for testing and evaluating the product. Denver Water reserves the right to accept or reject any product or material regardless of the test results. See [Appendix A, Procedure For Evaluation Of Materials](#).

6.02 SIZE OF MAINS:

The size of mains shall be in accordance with [5.03](#). Standard acceptable nominal diameters of distribution mains are 4, 6, 8, and 12 inches. Standard acceptable nominal diameters of transmission mains are 16 and 20 inches. Standard acceptable nominal diameters for conduits are 24 inches and larger.

6.03 PIPE CLASSES:

Denver Water has established minimum design safety factors for system piping considering working pressures of 150 psi concurrent with water hammer surge pressure of 120 psi for 4, 6, and 8 inch pipe, 110 psi for 12 inch pipe and 70 psi for 16 inch and larger pipe.

Based upon these considerations, the following minimum AWWA Standard pressure classes for acceptable types of pipe are required:

Ductile Iron (DI)	Special Class 50 (6, 8, 12 & 16 inch)
	Special Class 51 (3, 4, 20 & 24 inch)

Plastic (PVC)	C 900 DR 14 (4 inch)
	C 900 DR 18 (6,8 & 12 inch)
	C 905 DR 18 (16 & 20 inch)
	C 909 Class 200 (4 inch)
	C 909 Class 150 (6, 8 & 12 inch)

6.04 **SELECTION OF PIPE:**

In general, selection of type of pipe shall be left to the discretion of the Professional Engineer in charge of design. However, Denver Water reserves the right to deny use of certain types of materials in specific circumstances.

Where joint restraint is required, the designer shall select a pipe together with an approved system of restraint. It should be noted that installation of any metallic pipe, rods, clamps, etc., in corrosive soil areas will require corrosion protection systems.

Installation of mains through hazardous areas, at depths greater than 10 feet and in the roadways of State and Federal highways may require the selection of pressure classes in excess of the minimum stated in [6.03](#). Special comprehensive studies of applicable laws, regulations, and detailed engineering calculations shall be submitted for review by Denver Water in these instances.

Whenever the installation of metallic pipe is contemplated, a soil resistivity survey of the construction area shall be performed. The survey data and calculations, together with the service history of other existing pipe in the area, shall be submitted to Denver Water. Resistivity surveys shall utilize the Wenner four-pin method. Denver Water will provide the resistivity surveys, free of charge, on request. This service will also be provided when installing non-metallic pipe in order to determine if protection is needed for metallic fittings and appurtenances.

When water mains are to be constructed in soils that have a resistivity of less than 1,000 ohm-centimeters, or where stray current corrosion is expected to be severe, an approved non-metallic pipe system shall be selected. When water mains are to be constructed in soils that have a resistivity of more than 1,000 ohm-centimeters, either metallic or non-metallic pipe material may be selected. All metallic pipe, joint restraint, fittings, tie rods and appurtenances, regardless of soil resistivity, shall be protected against corrosion by polyethylene wrap in accordance with [8.23](#).

Non-metallic pipe is not allowed in areas with soil contamination. Soil contamination will be determined on a case by case basis by Denver Water.

When a metallic pipe must be used in a low resistivity soil, additional cathodic protection may be required, the design of which will be specific to the project and will be subject to Denver Water approval.

* See [10.06](#) for Special Class 50 alternate for 24 inch.

6.05 **PIPE FITTINGS:**

A. Joints: Joints and fittings shall conform to the applicable AWWA Standards, and shall bear at least the pressure rating of the straight pipe involved. Acceptable types for straight lengths of pipe are push-on, mechanical joint and bell spigot restraint systems. Mechanical joints for straight lengths of pipe will be allowed only under specific situations receiving approval of Denver Water.

Within the City and County of Denver and Total Service Contract Areas, fittings shall be furnished with mechanical joint ends and shall conform to [MS-](#)

3. Private pipe extensions shall use mechanical joint fittings and shall conform to [MS-3](#).

Exception: Fire hydrant tees shall have mechanical joint ends. Flanged joints are permitted where specified in the Materials Specifications.

The use of wyes is strictly prohibited.

- B. Closure Fittings:** Bolted Sleeve Type Couplings in accordance with AWWA C219 shall be of a gasketed, sleeve-type, with diameter to properly fit the pipe. Tolerance on pipe and coupling, together with proper bolt and gasket arrangements, shall be sufficient to insure permanent watertight joints under all conditions. Couplings shall be sufficiently wide, so that each type of pipe joined will have as much pipe end inserted in the couplings as is provided by the standard push on or mechanical joint for the pipe size and type involved.

The following table contains the minimum center sleeve dimensions for bolted sleeve type couplings:

Pipe Diameter (Inches)	Center Sleeve Thickness (Inches)	Center Sleeve Width (Inches)
4	0.250	5
6	0.250	5
8	0.250	5
12	0.375	7
16	0.375	7
20	0.375	7
24	0.375	7

Ductile iron sleeves shall have mechanical joints of the proper size and tolerance to assure a water tight fit.

Split sleeve couplings adhering to AWWA C227 are also acceptable.

"Long bell" closure pieces shall be of at least equal strength to the straight pipe being joined and shall contain push on joints of the proper tolerance to insure watertight connections.

"Compression" fittings for small diameter pipe (less than 3 inch diameter) may be utilized for connection or repair only with approval of Denver Water.

Where pipes of different types are connected together, or where pipe is connected to fittings or valves of different materials, great care shall be taken to insure that the proper ring, insulating gasket, or adapter is selected.

- C. Miscellaneous Pipe Fittings:** Flanged adapters, plugs, end caps, bulkheads, cut-in sleeves, anchor couplings, repair fittings, and other appurtenances shall be used where appropriate throughout the system, subject to the approval of Denver Water. Denver Water does not intend to limit unreasonably, the installation of any type of fitting, joint, or proprietary device, however, the installation of any such fitting, not specifically approved by these Standards, is subject to the approval of Denver Water. Written

request for approval of deviating items shall be made in advance through Denver Water.

D. Clamps, Rods and Joint Restraint Devices: Harnessing of joints may be accomplished by use of the clamp and rod system shown on Sheets 21 through 26 of the [Standard Drawings](#) for the purposes of repair or retrofitting existing systems utilizing rods and clamps. New construction shall utilize mechanical joint restraint devices as described by section [6.05.E](#).

E. Mechanical Joint Restraint Devices: Harnessing of joints may be accomplished by the use of one of the mechanical joint restraint systems as shown on [Sheet 27](#) or [28](#) of the [Standard Drawings](#), and specified in [MS-29](#), or by use of one of the several proprietary joint restraint systems supplied by pipe manufacturers. The proprietary systems will require approval of Denver Water prior to use. Regardless of the system used, restrained lengths of pipe for various fittings, where harnessing is utilized or required, shall be at least equal to the lengths shown on [Sheet 21](#) of the [Standard Drawings](#).

Where joint restraint is required on PVC pipe, the designer may use a joint restraint system of the type supplied by pipe manufacturers and approved by Denver Water or switch to a metallic pipe. The use of rods and clamps on PVC pipe is not allowed unless specific approval is granted by Denver Water.

6.06 **LINE VALVES:**

Line valves shall be Resilient Seat Gate Valves, as specified in [MS-5](#). The valves shall be of the same size as the main. Valves shall open to the right (clockwise). Valves with operators which open to the left (counterclockwise) shall not be used, unless required by or approval is obtained from Denver Water.

6.07 **PRESSURE REGULATING VALVES:**

A PRV is used for keeping downstream pressure at a uniform pressure less than that in the upstream main.

PRVs shall conform to [MS-10](#). They shall be sized so that the velocity through the valve at maximum demand does not exceed 25 feet per second. If a wide range of flow rates is anticipated, more than one valve may be required. Care shall be taken to ensure adequate pressure differential across the valve under all ranges of flow to accomplish hydraulic throttling. When pressure differentials greater than 45 psi are expected, or when the downstream pressure will be low relative to the differential, special valve materials or a special valve design may be required.

PRVs shall be properly supported, and shall have an adequate clearance above and below the valve to facilitate servicing. A manual bypass is required for all single valve installations. Telemetry of data may be required. Each PRV shall have a gate valve on each side for isolation. General arrangement shall be as shown on Sheets 44 through 47 of the [Standard Drawings](#).

6.08 **TAPPING VALVES AND SLEEVES:**

A tapping valve and sleeve are used together to tap an existing main that is in service and under pressure, without interrupting service. A tapping valve does not replace a property line valve, which shall be required in addition to the tapping valve. A property line valve may not be required if a main's out-distance is 15 feet or less.

Connections 2 inches and smaller to mains shall be by a corporation stop of the same size as the service line.

Connections larger than 2 inches made to mains shall be either by an existing tee, by cutting a tee into a dewatered line if permitted by Denver Water, or by use of a

tapping valve and a tapping sleeve. Whichever method is used, care shall be exercised to select sleeves and gaskets which are properly sized to fit the type and class of pipe to be tapped. Where tapping sleeves larger than 2 inches are used, a thrust block shall be formed and placed behind the tapping valve to prevent possible damage to the main from pressure shocks, which develop as valves are first opened. Tapping sleeves shall conform to [MS-9](#). Thrust blocks shall conform to [Sheet 19](#) and [20](#) of the [Standard Drawings](#).

6.09 CHECK VALVES:

A check valve permits flow in one direction only, closing when the flow stops so that no reversal can occur. Check valves shall conform to [MS-7](#). They shall be used where shown in typical meter installations. They are otherwise prohibited unless specifically approved by Denver Water. Check valves shall be located in concrete manholes of the same specifications as required for PRV manhole installations as shown on Sheets 44 through 47 of the [Standard Drawings](#).

6.10 STOP AND WASTE VALVES:

All service lines shall have a stop and waste valve on the service line inside the residence near the location where the service line enters the residence. The stop and waste valve shall have a drain plug located on the valve body such that, when the valve is shut off, the drain plug can be removed and all water above the valve drained out. Stop and waste valves shall be approved by Denver Water. See Sheets 48 through 52 and 49 through 53 of the [Standard Drawings](#) for typical locations. Stop and waste valves shall conform to [MS 23](#).

6.11 Control Of Backflow And Cross Connection:

A. Cross Connection Control:

Denver Water is responsible for protecting its public water system from contamination due to backflows through the water service connection, otherwise known as "cross connections." Denver Water needs the assistance and cooperation of the public and property owners to assure this responsibility is met and may request access to a property or facility to assess the need for cross connection control or to conduct an on-site inspection of existing devices.

The most effective method of protecting the public water supply from cross connections is with a properly designed air gap. Unfortunately, an air gap is not practical in many applications. When an air gap cannot be applied, a "reduced pressure zone" RPZ backflow prevention assembly should be used. Denver Water requires the installation of these devices in specific circumstances and encourages their use on all commercial building/facilities. In certain situations, a less protective backflow prevention device (i.e., an approved double check valve backflow prevention assembly) may be installed.

B. Requirements for Backflow Prevention:

When required, a properly designed air gap or an approved backflow prevention device must be installed on each service line to a customer's facility or residence. Normally, the installation will be made immediately following the meter and before the first branch line. These devices will be installed at the property owner's expense.

The following are examples of facilities that **must** be isolated from Denver Water's distribution system by an air gap or an approved RPZ assembly.

- Hospitals, morgues, mortuaries, medical clinics, dental clinics, and autopsy facilities
- Laboratories, all types
- Sewage treatment plants or facilities
- Food and beverage processing plants
- Chemical plants
- Petroleum refineries
- Metal plating industries
- Electrical and electronic component manufacturers
- Radioactive material processing plants
- Car and truck wash facilities
- Hydraulic testing facilities
- Packing houses, rendering plants, tanneries, and stock yard facilities
- Steam generating facilities
- Laundries, dry cleaners, Laundromats
- Photographic film processing facilities
- Swimming pools and health spas
- Greenhouses
- Multi-storied buildings in excess of 30 feet above finished grade
- Taxidermy shops
- Battery shops
- Kennels, pet shops
- Printing shops, screen printing shops
- Jewelry manufacturers
- Radiator shops
- Warehouses

Other situations where an air gap or approved RPZ must be installed are:

1. Where security requirements or other restrictions make it is impossible or impractical for Denver Water to have access to inspect installed backflow prevention devices or to conduct a complete cross connection control survey of the property or facility, an air-gap separation or an approved reduced pressure principle backflow prevention assembly must be installed at the property line.
2. Where solar heating units are installed at a facility or residence, an air-gap separation or an approved RPZ assembly must be installed on each service line to the premises.
3. Where fire protection systems are installed and antifreeze or other fire fighting chemicals are added, an air-gap separation or an approved RPZ assembly must be installed on each service line to the premises.
4. Where a landscape irrigation system is designed with chemical injectors for fertilizer, pesticides or other chemicals, an air gap or RPZ must be installed on each service line to the premises.

Examples of conditions that do not require an RPZ and devices may be at locations somewhere other than each service line to the premises are:

1. Where there is an auxiliary water supply, Denver Water's water system must be protected by an approved air-gap separation or an approved double check valve (DC) backflow prevention assembly on each service line to the premises. Installation of the DC may be made within the residence or facility.
2. Where landscape irrigation systems are under constant pressure (due to the elevations of sprinkler head above the system supply or other design features) is subject to flooding, or winterized with compressed air an approved double check valve may be substituted for an RPZ and installed on the landscape irrigation system.
3. Where a fire protection system does not use antifreeze and no other chemicals are added to the system, an approved double check valve (DC) may be substituted for an RPZ and installed on each service line to the premises.
4. Where landscape irrigation systems are installed and the irrigation system is not under constant pressure an approved "Pressure Vacuum Breakers" (PVB) can be installed on the irrigation system. The PVB must be installed at least 12 inches above the highest sprinkler head.

These lists and examples are not intended to represent all conditions where cross connection control is required. If a property owner is uncertain of the need for a backflow prevention device they should contact the Cross Connection Control Section of Denver Water.

While not all building or commercial facilities are required to install backflow prevention devices, all building or commercial facility owners (regardless of business type) should seriously consider installing an approved reduced pressure principle backflow prevention assembly (RPZ) on their water service lines. This will help protect the public water supply from contamination should a combination of an accidental cross connection within their property and a siphonage into the distribution system occur.

C. Approved Devices:

Any backflow prevention device required will be a model that has been manufactured in full conformance with AWWA C511 and have met the specifications of the Foundation for Cross Connection Control and Hydraulic Research (FCCC&HR) of the University of Southern California.

Foundation for the Cross Connection Control and Hydraulic Research
University of Southern California
University Park
Los Angeles, CA 90007

D. Testing Requirements:

It is the responsibility of the customer at any premises where backflow prevention devices are installed to have certified inspections and operational tests made at least once per year. These devices will be repaired, overhauled

or replaced whenever devices are found to be defective. These inspections and tests will be at the expense of the customer and will be performed by a certified tester approved by the CDPHE. If the device fails (at any time) and cannot be repaired the day of the failure, Denver Water must be notified within 3 business days. Records of such tests, repairs and replacements will be kept by the customer and a copy of the annual test reports must be provided to Denver Water.

E. Exceptions:

At this time, Single Family Residential customers are exempt from Denver Water's cross connection control requirements unless the premises is served by an auxiliary water supply (well/pond), has an irrigation system with chemical injection, or has a fire protection system on the property.

In general, commercial-residential properties do not represent a cross connection risk that is greater than that of single family residential customers. Therefore, commercial-residential properties will be exempt from cross connection control requirements **unless one or more of the following condition exist:** 1) the property has non-residential commercial units; 2) any building on the property is higher than three stories; 3) any building on the property has a fire protection system; 4) any building has a common boiler for all units, and: 5) any building has an auxiliary water supply and/or has a water storage facility.

Presently, installed backflow prevention devices which do not meet the requirements of Section C but were approved devices at the time of installation and which have been properly maintained and pass annual testing, will be excluded from the requirements of Section C. Whenever such a device is moved from its present location or requires the replacement of internal, the unit shall be replaced by an approved backflow prevention device meeting the requirements of Section C.

If there are questions concerning any cross connection issue, please call Denver Water's Cross Connection Control Office.

6.12 VALVE BOXES:

All buried gate valves 12 inches and smaller shall be provided with a 6 inch cast iron valve box, and large oval base. The valve box shall be of a design, which will not transmit shock or stress to the valve and shall have enough extension capability to be raised to final street grade. Valve boxes shall conform to [MS-12](#). The top section of the valve box shall be acceptable for use with a butterfly valve as shown on [Sheet 18](#) of the [Standard Drawings](#).

6.13 VALVE REFERENCE MARKER POSTS:

When valves are installed where adequate physical reference points are not available, as determined by Denver Water, a valve reference marker post may, be required. Reference marker posts shall conform to [Sheet 33](#) of the [Standard Drawings](#).

6.14 METERS:

Meters installed for billing purposes shall be under the control of Denver Water, but shall be owned by the Licensee. No meter shall be installed until the proposed installation has been approved, and the meter tested and numbered by Denver

Water. Services shall have outside meter settings, unless otherwise approved in writing by the Customer Service Field Manager.

Meters used to record usage by the retail consumer are called service meters. Meters used by wholesale customers and which supply water to other service meters are known as master meters. Other temporary meters may exist in the system for the purpose of Denver Water tests and for measuring use of water from fire hydrants.

The characteristics which are of special importance in meters are accuracy and sensitivity, durability, low pressure loss, life cycle cost, ease and low cost of maintenance, and compatibility with Denver Water's radio-frequency AMR systems. Denver Water shall determine the manufacturer(s) and model(s) of meter that are acceptable.

Registers and the associated AMR devices must be fully compatible with the meter reading system in use in the area where the meter is installed. Pit-installed AMR devices shall be used for most pit installations of 5/8 inch, 3/4 inch and one inch meters and for some vault installations of larger meters. Remote AMR devices shall be used for indoor meter installations and for outdoor installations where there may be difficulty obtaining a drive-by reading from a public street or a network reading from central collection points. The determination of the AMR system to be used at any location shall be made by the Customer Service Field Section of Denver Water.

Meter installations shall be inspected by Denver Water upon completion of the installation, prior to backfilling. The proper AMR device shall be installed by Denver Water personnel at the time the meter installation is inspected, at the expense of the Owner of the premises.

6.15 SIZE OF METER:

Meters shall be of the same size as the corporation stop or service tee and that portion of the service pipe between the meter and the corporation stop. In no case shall a meter smaller than 3/4 inch be installed, except as a replacement for an existing smaller meter.

Denver Water may allow the installation of a meter of a size smaller than the service pipe in cases where the full capacity of a previously used service pipe is not required, provided that the service pipe is reduced to the size of the meter for a distance of not less than 10 times the larger pipe diameter on the inlet (supply) side of the meter pit or vault or 5 feet, whichever is longer.

6.16 TYPE OF METER:

The type of meter installed will be determined by Denver Water at the time of application based upon size, service requirements, location of meter and other conditions, which may exist. Denver Water may change the type of meter at any time based on the water usage patterns of the licensee.

6.17 MAGNETIC DRIVE DISPLACEMENT METERS:

The displacement meters, known as nutating-disc or oscillating piston meters, are positive in action in that the pistons and discs displace or carry over a fixed quantity of water for each nutation or oscillation when operated under positive pressure. Displacement meters are generally used for all residential, industrial and commercial uses requiring a service 2 inches and smaller, and for irrigation services one inch and smaller. The magnetic drive displacement type water meter size one inch and smaller shall be furnished with a cast-iron "frost bottom" (also referred to as "frost-proof").

Meter sizes 5/8 inch through one inch shall conform to [MS-15](#).

Meter sizes 5/8 inch through one inch to be installed inside a building and all 1-1/2 inch and 2 inch displacement type meters shall conform to [MS-16](#). Meter sizes 1-1/2 inch and larger shall be brass, 2 hole, oval flange construction and shall not be slotted. Companion flanges shall be brass. Screw-on flanges are not acceptable.

6.18 COMPOUND AND TURBINE METERS:

Compound meters consist of two meters in a single case, one to measure small flows and the other to measure large flows. Some fireline meters are made with the two meters in separate cases coupled together as an integral unit. Compound meters are so designed that the small meter operates during low flows and as flows begin to increase, the large meter takes over. When the large meter is in operation the small meter may or may not be in operation. Compound meters are generally used for residential, industrial and commercial applications requiring a service larger than 2 inches, except for irrigation and certain industrial uses where flow rates are relatively constant. Compound meters are used for applications where human domestic use is provided.

Turbine meters are designed to measure primarily large, fairly constant flows, and should not be used where the possibility of small flows below the manufacturer's stated minimum flow exists. Turbine meters are used for all irrigation applications requiring a service larger than one inch, and for certain industrial applications with relatively constant high flows and no human domestic use.

Turbine meters 3 inch and larger shall have a flanged in-line basket strainer installed on the upstream side. Turbine meters smaller than size 3 inch shall include an integral stainless steel strainer with removable top plate as described in [MS-18](#).

Fireline-type meters, a specialized type of compound meter, shall be used on any service which includes fire sprinklers, fire hydrants, or other fire protection behind the meter, and in such other cases as may be determined by Denver Water. Fireline meters are required to meet specialized standards of Underwriters Laboratories and other certifying agencies. Single family residences and duplexes with a limited number of sprinkler heads may be excepted from this requirement.

6.19 OUTSIDE METER SETTINGS:

Outside meters shall be installed in a horizontal position and housed in a concrete or approved composite meter pit or vault, and shall conform to [Sheets 48, 49, 50, 55, 56, 60, 61, 62, 71, 72](#) and [73](#) of the [Standard Drawings](#).

Each register of each meter shall be equipped with an AMR device as directed by the Meter Inspector, mounted in accordance with Denver Water's Standards. In most cases, the meter will be equipped with an Itron pit ERT mounted through the meter pit/vault lid. In special circumstances, identified by the Meter Inspector, a remote AMR device may be required at a distance of up to 250 feet from the meter pit or vault, mounted on the building, a post, or another structure. Signal wire for remote ERT installations shall be run through conduit.

6.20 INSIDE METER SETTING AND REMOTE READERS:

Inside meter settings shall not be permitted on water service connections without prior written approval of Denver Water's Customer Service Field Manager. Current inside settings on water service connections shall be permitted to remain, provided there are no changes made to the tap, service line or meter setting. If the structure containing an inside meter is to be reconstructed or considerably remodeled, or the service line is to be reconstructed, relocated, or replaced, the meter shall be relocated to an outside pit or vault setting.

Inside meter settings are to be used only for meters larger than 2 inch size where there is inadequate room for proper installation of a meter pit or vault, after exhausting all other reasonable alternatives. Inside settings will be permitted only for industrial, commercial and multi-family premises where full-time on-site management is provided. Safe, unimpeded access during Denver Water's normal work hours must be provided. Written approval to use an inside meter must be obtained from the Customer Service Field Manager prior to tapping the water main, or, if the tap is already installed, prior to converting the stub-in to a service line. Specific details of meter type, location, access requirements, AMR configuration, piping and valves, and other requirements shall be assessed and approved on a case-by-case basis by the Customer Service Field Manager in consultation with the Meter Inspector.

The following information is the minimum required for the initial review of a project that is proposed to contain an inside meter installation:

- A. Site plan showing the building footprint and the extent of the foundation, clearly indicating proposed domestic water service and showing all paved and landscaped areas around the building.
- B. Drawings of the room where the meter will be installed. Drawings must show dimensions of the room, location of floor drain(s), all piping, valves, meters, pumps, backflow devices, pressure reducing valves, and any other piping equipment for the domestic service and for the fire service, if located in the same room.
- C. Plan view of the entire meter room with dimensions and piping shown, including dimensions between major components.
- D. Elevation views of each wall of the room that has piping or equipment, with the dimensions showing elevation of the pipe and of the top of the meter.
- E. Indication of the means by which safe, unimpeded access will be granted to Denver Water employees

Where approved, inside meter installations shall conform to the following requirements:

- A. The total length of the service line, measured from the street main to the inlet valve of the meter, must be 60 feet or less.
- B. The space containing the meter shall be heated to prevent freezing of pipes and equipment, and shall contain a floor drain within 10 feet of the meter location.
- C. The space shall be accessible to Denver Water meter maintenance and meter reading employees during Denver Water's normal working hours with minimal delay.
- D. The meter shall be located immediately adjacent to the point where the domestic service enters the building through the foundation wall, with a minimum amount of exposed pipe before the meter
- E. One and one-half inch and 2 inch meters will be installed in a coppersetter with bypass pipe and angle valves on the inlet and outlet, at least 12 inches from the wall. Three inch and larger meters shall be bolted in place in a flanged ductile iron pipe system with a bolted sleeve type coupling on the downstream side of the meter.
- F. For 3 inch and larger meters, gate valves shall be used on the meter inlet and outlet and on the bypass. All valves will be non-rising stem, right-hand opening, mounted vertically. The bypass pipe shall be no more than 6 feet

above the floor, and a minimum of 2'6" above the meter. Allow 2'0" minimum clearance to the wall.

- G. For any installation where a backflow preventer is not required, a check valve must be installed downstream of the meter.
- H. The top of the meter should be no more than 40 inches above the floor.
- I. Backflow preventers, pressure reducing valves and other components must be installed after the meter and downstream bypass tee. In most cases, there should be 5 feet of pipe between the bypass tee and the first component.
- J. One or more outdoor remote AMR device(s) are required for inside meter settings. The exact location for the AMR device(s) will be determined during the review of the inside meter request.

6.21 METER BYPASS LINES:

A bypass line is required for meters 1-1/2 inch and larger, unless otherwise specified by Denver Water, whether installed in an outside or inside setting. Bypass lines shall contain an independent control valve and shall contain no tees, plugs, or other outlets through which water could be withdrawn. Bypass lines permit the consumer to have water while their meter is being repaired or replaced. Bypass lines must be locked, in the closed position, at all other times. Only a Denver Water employee is authorized to unlock and turn on a bypass line. Bypass lines are not permitted on meters intended solely for irrigation purposes.

6.22 METER CHECK VALVES:

Check valves are required for meters 1-1/2 inch and larger unless otherwise specified by Denver Water, whether installed in an inside or outside setting. Check valves may be required on meters smaller than 1-1/2 inch where any condition might exist that could cause a flow of water from the property to the main. Also see [6.09](#).

6.23 VALVES FOR USE WITH METERS:

Type of valve for size 2 inches and smaller shall depend on the size and type of setting as follows:

- A. For inside and outside meter settings for a 1-1/2 inch or 2 inch meters, as shown on [Sheet 56](#) and [57](#) of the [Standard Drawings](#) the valve shall be a curb stop.
- B. For an inside meter setting for a 3/4 inch or one inch meter, as shown on [Sheets 49](#) and [50](#) of the [Standard Drawings](#), the gate valve shall be installed downstream of the meter and the stop and waste valve shall be upstream of the meter.
- C. For an outside meter setting for a 5/8 inch x 3/4 inch, 3/4 inch or one inch meter, as shown on [Sheets 50](#) of the [Standard Drawings](#), the valve shall be an angle valve. (**NOTE:** *5/8 inch x 3/4 inch meters may only be used to replace existing meters of the same size; if the meter setting is changed, it must be upgraded to a 3/4 inch setting and meter.*)
- D. For detector check valve assemblies, two angle valves, one before and one after the meter, are required as part of the meter setting.

All valves shall be in accordance with AWWA C800 and [MS-23](#).

Valves 3 inches and larger for use with ductile iron service pipe shall be gate valves conforming to [MS-5](#). All gate valves larger than 3 inches for use with meters shall be supported by adjustable steel valve supports. This support shall conform to [Sheet 40](#) of the [Standard Drawings](#)

See also [3.12](#).

6.24 METER COUPLINGS:

Meters 1-1/2 inches and larger shall be installed with a coupling to allow removal of the meter without disturbing the pipe. Couplings shall conform to [MS-22](#).

6.25 METER YOKES (LINE SETTERS):

A yoke is a metal pipe frame attached to the inlet and outlet sides of the meter providing support, and conveying water to the meter. Meter yokes shall conform to [MS-21](#). A meter yoke is required for displacement meters up through 2 inch, and may be required for other types or sizes of meters.

To assure safety, the water meter setting shall provide a continuous, electrically conductive, path around the water meter. If a bonding jumper is required, it shall be made of copper with fittings suitable for the bonding jumper and the water pipe material. The meter setting installation shall be in compliance with the NEC.

6.26 VALVE AND METER SUPPORTS:

Meter supports shall be a solid concrete block as shown on [Sheets 56, 57, 59, 60, 62, 72, 74, 75](#) and [76](#), of the [Standard Drawings](#). Fabricated metal supports shall be used to support valves 4 inches and larger and shall conform to [Sheets 47, 59, 60, 62, 72](#) and [79](#) of the [Standard Drawings](#).

6.27 METER PITS AND LIDS FOR 3/4 INCH AND ONE INCH METERS:

Meter settings for 3/4 inch and one inch meters shall be installed in meter pits with a 24 inch nominal diameter and a total depth of 52 inches minimum from grade. The pit shall consist of a 24-inch nominal diameter by 48 inch high cylinder of either concrete or composite, with a dome or bell housing holding an internal frost lid and a locking top lid. The base unit shall have two "doghouse" cutouts 3 inches wide by 4 inches high, located 180 degrees apart to accommodate the service line tubing. The top unit shall have a shelf or tapered design to support a standard dome or bell housing with a 20 inch nominal diameter.

Concrete meter pits shall consist of a combination of two to four pre-cast concrete rings that total 48 inches in height with a top ring not to exceed 12 inches in height. The rings shall have an inside diameter of 24 inches. Concrete rings shall have a 2 inch minimum wall thickness, suitably reinforced to minimize breaking during installation and use, The rings shall be constructed of concrete in accordance with [MS-20](#) and comply with all requirements of ASTM C 478. Meter pits shall comply with [MS-25](#).

Composite meter pits shall be of a two-piece design with a 24 inch diameter by 36 inch high base unit and a 12 inch high top unit that tapers from 24 inch diameter to 20 inch diameter. Units shall conform fully to the requirements for Composite meter pits in [MS-25](#). The pit shall be installed plumb and at sufficient depth for the top of the dome to sit at finished grade or up to one inch below finished grade. Grade adjustment rings from the same manufacturer shall be used to raise the top of the pit or to accommodate the plumb pit to an angled ground surface.

An aluminum or cast iron dome or bell housing shall be mounted on the top of the pit; the dome or bell housing shall have a support for an interior frost lid and a rim for locking the meter pit cover. Cast iron domes are required in locations where the meter pit may be subject to occasional traffic loads; aluminum domes will be used in all other locations. Composite or plastic domes are not permitted; see [MS-25](#).

The cap-type meter pit top lid shall be of cast iron or approved composite material construction. Lids shall be of the cap type, with a locking screw and bolt that

provides a tight locking of the cover to the dome or bell housing of the meter pit. See [Sheet 50](#) of the [Standard Drawings](#) and [MS-25](#). All lids shall be capable of withstanding HS-20 traffic loading. Cast iron lids shall have a recess approximately 7 inches in diameter by 3/4 inch deep, with at least three drainage holes and a 2 inch diameter center hole designed for mounting an AMR device through the lid. Composite lids shall be made of high-impact, no-break polymer Hydrozone HD or of fiber-reinforced polymer, capable of withstanding a temperature range from -40°F to +190°F and resistant to UV degradation. Composite lids shall withstand a loading of 20,000 pounds applied to a 9 inch square plate with no permanent deformation. Covers shall be available in various colors as required by Denver Water, and shall have "Denver Water Meter" imprinted on the lid. When completed, the top of the meter pit lid must be set at finished grade or up to one inch below finished grade.

The inner frost lid shall be high density polyethylene. The frost lid shall be dish shaped, with a 3 inch depth, and shall have 3 to 5 drainage holes and an integral lifting handle. See [Sheet 50](#) of the [Standard Drawings](#) and [MS-25](#).

6.28 VAULTS:

Vaults may be pre-cast or cast-in-place. Pre-cast vaults shall be so designed that all joints and corners are waterproof. The roof and walls of pre-cast and cast-in-place vaults shall be made waterproof after construction by use of sealants, epoxies or other approved methods.

Vaults used for 1-1/2 inch and 2 inch meters shall be 48 inches in diameter and of sufficient depth to extend below the 4'6" to 6'0" bury depth of the service line. The vault shall have a flat top with concrete grade rings supporting a manhole ring and cover at finished grade. The manhole opening shall be placed to one side of the top so as to line up with the inside wall of the vault. Copolymer manhole steps will be cast into the wall of the vault on 12 inch centers. Vaults will sit on reinforced concrete manhole beams. See [Sheets 16](#) and [56](#). The completed installation must be adjusted so that the top of the manhole cover sets at finished landscape grade or up to one inch below finished landscape grade. Vaults in paved areas must be adjusted to the manhole cover is flush with the surrounding pavement.

Rectangular vaults to be used for water meters larger than 2 inch size shall be of a size and configuration conforming to [Sheets 60, 61 and 62](#) and [Sheets 72, 73, 75 and 76](#) of the [Standard Drawings](#), and shall be approved by the Meter Inspector. Vaults may be cast-in- place or may be pre-cast vaults from an approved manufacturer. Vaults shall be designed to support the street fill and HS-20 traffic loading in accordance with AASHTO Standards. Meter vault lids shall be cast iron manhole covers, either without a recess or with one or two recessed for AMR devices as specified by Denver Water, or shall be of a composite material meeting the requirements of [6.31](#). AMR devices shall be mounted inside the vault, in a remote location on the side of a building or on a pole, or through the access cover to maximize radio signal penetration, as directed by the Meter Inspector.

Meter vaults shall include ladders as shown in the Standard Drawings.

6.29 CONCRETE STRUCTURES:

Structures shall be designed to support applicable loads. Design calculations, drawings, and contract specifications shall be submitted to Denver Water for review. Concrete used in structures shall be Class "A". See [MS-20](#), and [8.20](#).

6.30 STEEL REINFORCEMENT FOR CONCRETE:

Steel reinforcement shall be either deformed bars or welded steel fabric and shall conform to [MS-22](#).

6.31 **MANHOLES:**

Manholes and reducing sections shall be pre-cast concrete and conform to ASTM C 478 and [MS-20](#). All manhole coverings shall be rated as traffic lids shall be designed for HS-20 traffic loading in accordance with AASHTO Standards. All ladder rungs or manhole steps shall be cast into the manhole barrel when the manhole barrel is cast.

Concentric reducing sections shall not be used. The top of the manhole vault shall be a minimum of 12 inches and a maximum of 18 from the official street or ground surface elevation. Concrete extension collars shall be used to bring the manhole ring and cover up to official street or ground surface elevation. Meter pit vault lids should be adjusted so they are at or up to one inch below finished landscape grade. These grade rings shall be constructed of concrete in accordance with [MS-20](#), and shall comply with the requirements of ASTM C 478.

Manhole rings and covers:

- A. Twenty-four inch manhole rings and covers shall be "City of Denver, Colorado Standard" pattern and shall be of cast iron or an approved composite material.
- B. Twenty-four inch cast iron manhole cover shall weigh approximately 165 pounds. Twenty-four inch cast iron ring shall weigh approximately 240 pounds.
- C. Twenty-four inch recessed manhole covers for meter vaults shall be cast iron "Denver Water Standard" pattern with one or two recesses approximately 7 inches in diameter by 3/4 inch deep with a 2 -inch hole for mounting an AMR device through the lid. The lid shall be cast with the words "Denver Water Meter" on the top.
- D. Twenty-four inch x 36 inch double ring and cover: The 36 inch cover shall have an auxiliary 24 inch opening and cover. Thirty-six inch cover weighs approximately 250 pounds. Cast iron thirty-six inch ring weighs approximately 280 pounds.
- E. Composite manhole covers for meter vaults shall be of fiber reinforced polymer construction. They shall be furnished with a locking mechanisms that will prevent the lid from "popping" from its frame under traffic conditions, and shall be cast with the words "Denver Water Meter" on the top. Composite covers must retain traffic rating and other performance characteristics over a temperature range of -60°F to +160°F. Composite manhole covers for meter vaults shall in all other matters meet or exceed the requirements for cast iron manhole covers, and shall fit equally well in cast iron or composite frames. Composite covers shall weigh less than 50 pounds.

6.32 **MANHOLE BASE SLABS AND BASE BEAMS:**

Manhole base beams shall be pre-cast, reinforced concrete. The beams shall be 12 inches wide by 9 inches deep by 8 feet long. The reinforcement shall consist of three No. 5 bars, evenly spaced, and No. 4 bars at 12 inch centers transversely.

Manhole base slabs may be cast-in-place or pre-cast. The slab shall be designed to uniformly support the earth load and any other reasonable loads that may occur. The minimum slab thickness shall be 6 inches. The minimum reinforcement shall be welded wire fabric, 4 x 4 - W4 x W4. Splicing of the welded wire fabric shall be by lapping one space and securing the wire mesh together. The concrete shall conform to [MS-20](#) and the reinforcement shall conform to [MS-22](#).

6.33 **SUMP PITS FOR VAULTS AND MANHOLES:**

Sumps are required for vaults or manholes in areas where there is seepage into existing vaults, all Pressure Regulating Valve installations and as determined by Denver Water.

A gravity drain line or sump pump shall be used in conjunction with a sump where telemetry equipment is to be installed. See [Sheets 44](#) and [45](#) of the [Standard Drawings](#).

Normal practice in constructing a sump is to excavate a 30 inch diameter hole about 3 feet deep. A 6 inch floor is placed and allowed to set. Then a 24 inch section of cardboard tubing is used for an inside form, and concrete is poured behind it approximately 3 inches thick. See [Sheets 44](#) and [45](#) of the [Standard Drawings](#) showing a sump as part of a typical Pressure Regulating Valve installation. A cast in place floor shall incorporate a monolithic sump pit.

6.34 **VENT PIPES:**

Vent pipes are used in vaults and pits to provide proper ventilation. Installations that contain electrical equipment shall have a locally controlled, power operated blower attached to the vent system. Vent pipes shall be field located at the nearest intersection of the street property line and the side lot line. See Sheets 41 through 43 of the [Standard Drawings](#) for vent pipe installation details. A residential vent pipe assembly as shown in [Sheet 43](#) of the [Standard Drawings](#) may be used where an inconspicuous installation is desirable.

Above ground vent pipe shall be 6 inch nominal diameter galvanized steel pipe, conforming to ASTM A 53. The vent screen shall be a 3/4 inch No. 9-11 flattened expanded galvanized metal screen. See [Sheet 41](#) of the [Standard Drawings](#). Below ground vent pipe shall be 6 inch, schedule 40 PVC with glued joints. A PVC glued joint by standard pipe thread female adapter shall be used to connect the steel pipe to the PVC pipe at ground level. Where the residential vent pipe assembly is used this adapter is not needed. PVC pipe is not allowed with 8 foot above ground risers.

6.35 **MANUFACTURER AND MODEL OF FIRE HYDRANTS:**

Within the City and County of Denver and Total Service Areas, where maintenance, repair, replacement, and parts stocking is the responsibility of Denver Water, only the four manufacturer's brands of hydrants listed in [MS-13](#), are acceptable.

In Distributor Contract Areas, fire hydrants conforming to [MS-13](#), but without limitation to the brand names chosen by Denver Water for their own use, shall be used. Any brand and model used, however, must have prior Denver Water approval.

6.36 **FIRELINE CONNECTIONS TO MAINS:**

Firelines supplying sprinklers shall be sized by the appropriate Fire Protection Bureau and the persons responsible for the structure it protects. Denver Water will not size firelines.

6.37 **SERVICE LINES:**

Service lines shall be sized to adequately supply the requirements of the property being served. The minimum size line shall be 3/4 inch. The only acceptable material for a service line is seamless copper pipe, Type K (soft) for sizes through 2 inch and ductile iron pipe for sizes 3 inches and larger. Service lines shall be of the same type material from beginning to end, unless the appropriate insulator is installed at the junctions of the dissimilar metals. See [3.10](#) and [3.11](#), and Sheets 48 through 62 of the [Standard Drawings](#). Unless otherwise approved by the Customer Service Field Section, there shall be no bends or changes in the size of the service line between

the tap and a point 5 feet past the meter pit or vault for outdoor meter settings, or between the tap and a point 5 feet past the curb stop for indoor meter settings.

6.38 CORPORATION STOPS:

Corporation stops provide the connection for the service line to the main. By utilizing a corporation stop, a service can be connected to the main without taking the main out of service. Corporation stops are also used in air and vacuum valve and large butterfly valve installations as shown in Sheets 16 through 18 of the [Standard Drawings](#). Corporation stops are made in standard sizes 3/4, one inch, 1-1/2 inch, and 2 inch. See [Chapter 3, MS-23](#) and [Sheets 49](#) and [51](#) of the [Standard Drawings](#).

6.39 CURB STOPS:

Curb stops are set on the service line near the property line and provide a means to shut off the service line. For outside meter settings, the curb stop must be placed from two to five feet from the inlet side of the meter pit. The curb stop and box shall be placed in the tree lawn (between the curb and sidewalk) where possible. Otherwise, the curb stop and box shall be placed to produce the shortest possible length of service line between the corporation stop and the curb stop. Unless otherwise approved in writing by the Meter Inspector, the curb stop shall not be located on the customer's side of the front property line. Curb stops and boxes shall be located in landscaped areas unless otherwise approved by the Meter Inspector. Where the curb stop must be placed beneath a roadway, street or parking lot, with the approval of the Meter Inspector, it shall be located where vehicles cannot park over it and not in the flow line of the street, and the stop box shall be a roadway valve box instead of the standard stop box. See [Sheets 49](#) and [51](#) of the [Standard Drawings](#) and [MS-23](#) for further details.

6.40 CURB STOP SERVICE BOXES:

Curb stop service boxes (or stop boxes) shall be cast iron, Buffalo type. The bottom part shaped like an inverted U straddling the service line shall have a flanged bottom so as to support itself. Curb stop service boxes shall conform to [MS-24](#). If the stop box is located in an area subject to traffic, it shall be a roadway valve box. See [6.12](#).

6.41 CORROSION PROTECTION SYSTEMS:

Metallic pipe and fittings shall be protected against corrosion.

A. Polyethylene Encasement Material: Polyethylene wrap shall be used on all metallic pipe fittings, rods, and appurtenances. Polyethylene material shall conform to [MS-14](#) and [Sheet 38](#) of the [Standard Drawings](#).

Twenty-four inch flat width tubing shall be used with 4 inch, 6 inch, and 8 inch pipe. Thirty inch flat width tubing shall be used with all 12 inch pipe. Thirty-six inch flat width tubing shall be used for 16 inch pipe. Fifty-two inch flat width tubing shall be used with 20 inch and 24 inch pipe.

Harness rods shall be covered by 4 inch flat width polyethylene tubing. The entire joint shall be covered by a cigarette-wrap of 48 inch wide polyethylene sheet material over each set of lugs. Irregular shaped valves and fittings shall be covered with flat 48 inch wide polyethylene sheet material.

B. Insulators: Insulators shall be installed at the outlet end of the corporation stop as shown on [Sheets 49](#) and [51](#) of the [Standard Drawings](#). Insulators shall be in accordance with [MS-24](#). See [Sheet 37](#) of the [Standard Drawings](#) and [MS 24](#) for other insulators, which may be required.

- C. **Pipe Joint Bonding:** In areas where the soil resistivity is 1000 ohm centimeters or less and metallic pipe must be used, all joints shall be bonded with #4 solid copper wire. See [Sheet 39](#) of the Standard Drawings. Cadwelds will be covered by an approved method.

6.42 **KICKBLOCKS:**

Concrete kickblocks shall be sized for the working pressure plus water hammer surge pressures as stated in [8.18](#) and the soil bearing capacity. Standard shapes and sizes of kickblocks are shown on [Sheets 19](#) and [20](#) of the [Standard Drawings](#).

The kickblocks shall be of Class B concrete conforming to MS-20, or of a pre-measured, sacked industrial mix such as Sakcrete, Dri-mix, or an approved equal. Ready-mixed concrete mixes shall be approved by Denver Water.

Kickblocks shall be placed per Section [8.18](#).

6.43 **PROTECTIVE CONCRETE PADS OVER PIPE:**

Under unusual circumstances it may be necessary to lay pipe at shallow depths. Concrete pads shall be used over the pipe to protect it from the traffic loading. The pads shall be designed to support loads from traffic without transmitting the load, to the pipe. Approved Insulation as approved by Denver Water shall be required between the pipe and the concrete pad to protect the pipe from frost. This situation, and its solution, shall be subject to approval by Denver Water.

6.44 **CASING PIPE:**

Installation of mains through Denver Water rights-of-way or rights-of-way or easements of others, such as highways, railroads, etc., may require casing pipes to facilitate the installation of the main. The casing pipe may be required by either the permitting agency or Denver Water. The type of casing material and its properties will be specified by the agency granting permission to cross. In the absence of such a casing specification, Denver Water will specify casing material. Such crossing shall be subject to approval by Denver Water to avoid conflicts in requirements or standards between Denver Water and the persons or agency granting permission to cross.

See [Sheets 28](#) and [29](#) of the [Standard Drawings](#) for details. Final approval of the boring and casing methods and materials shall be obtained from Denver Water prior to construction. Where a bore is not required to cross interference, Denver Water may require the installation of the main under the interference in conformance with [Sheet 28](#) and [29](#) of the [Standard Drawings](#).

6.45 **MISCELLANEOUS METALWORK AND PIPING:**

Fabrication shall be equal to the best practice in modern fabricating shops. Welding shall be performed by certified welders, with all exposed welds ground smooth. Weld spatter shall be properly removed to the satisfaction of Denver Water.

Exposed hardware, including nuts, washers, bolts and anchor bolts, shall be galvanized.

Exposed metal that is to be buried shall be given two coats of CA-1200 mastic cold coating as manufactured by Protecto Wrap Company, Denver, Colorado, or equal, except for metal with shop applied coating approved by Denver Water.

All metal exposed to weather shall be painted with one coat of a rust inhibiting priming paint and two coats of aluminum paint, unless otherwise directed by Denver Water. Surfaces to be painted shall be cleaned of oil, grease, weld spatter, burrs, grit, dust or other objectionable surface irregularities. Cleaning solvent used shall be

mineral spirits. Copper, aluminum or galvanized pipe need not be painted, unless so directed by Denver Water.

Miscellaneous piping shall be installed in the best workmanlike manner. All threads on steel pipes shall be cut with sharp dies to standard depth, left clean cut, and tapered. Threaded pipe joints shall be properly sealed with an approved joint compound applied on the male threads only. Concealed joints for copper water tubing within buildings shall be soldered or brazed in conformance with the appropriate building code. The joint of the copper pipe shall be properly cleaned, flux applied, and soldered with 95-5 tin-antimony solder, applied in accordance with the best plumbing practice. Parts to be soldered shall be thoroughly cleaned before flux is applied. Copper piping, where the pipe is in direct contact with pipe hangers or other metal supports, shall be protected with a copper saddle soldered to the underside of the pipe. Saddles may be made of split copper pipe.

Copper joints installed underground shall be flared or brazed. Flaring and brazing shall be performed with the best plumbing practices.

6.46 AIR AND VACUUM VALVES:

Combination air release and vacuum valves shall be required for Conduits and may be required for transmission mains at the discretion of Denver Water. Air release and vacuum valve assemblies as shown on [Sheet 16](#) and [17](#) of the [Standard Drawings](#) shall be installed at high points in the Conduit, where there is an abrupt change of slope and at line valves where the Conduit slopes away from the valve or as determined by Denver Water; see [MS-11](#).