NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE STANDARD

IRRIGATION WATER CONVEYANCE
NONREINFORCED CONCRETE PIPELINE

(ft)
CODE 430CC

DEFINITION

A pipeline and appurtenances installed in an irrigation system.

SCOPE

This standard applies to low or intermediate pressure, nonreinforced concrete irrigation pipelines with rubber gasket joints, mortar joints, or cast-in-place without joints.

The standard includes the design criteria and minimum installation requirements for nonreinforced concrete irrigation pipelines and the specifications for the concrete pipe to be used.

PURPOSE

To prevent erosion, degradation of water quality, or damage to the land; to make possible the proper management of irrigation water; and to reduce water conveyance losses.

CONDITIONS WHERE PRACTICE APPLIES

All pipelines shall be planned and located to serve as integral parts of an irrigation water distribution or conveyance system designed to facilitate the conservation use and management of soil and water resources on a farm or group of farms.

Water supplies and irrigation deliveries to the area shall be sufficient to make irrigation practical for the crops to be grown and the irrigation water application methods to be used.

Concrete pipelines shall not be installed on sites where the sulfate-salt concentration in the soil or soil water exceeds 1.0 percent. On sites where the sulfate concentration is more than 0.1 percent but not more than 1.0 percent, concrete pipe may be used only if the pipe is made with Type V cement or Type II cement whose tricalcium aluminate content dose not exceed 5.5 percent.

Cast-in-place pipe shall be used as the outside soils that are capable of being used as the outside form for approximately the bottom half of the conduit.

PLANNING CONSIDERATIONS

Water Quantity

1. Effect on the water budget, especially on infiltration and evaporation.
2. Effects on downstream flows or aquifers that would affect other water uses or users.
3. Potential use for irrigation water management.
4. Effects of installing a pipeline on vegetation that may been located next to the original conveyance.

Water Quality

1. Effects of installing the pipeline, replacing other types of conveyances, on channel erosion or the movement of

sediment and soluble and sediment-attached substances carried by water.

2. Effects on the movement of dissolved substances into the soil, and on percolation below the root zone or to ground water recharge.

3. Effects of controlled water delivery on the temperatures of water resources that might cause undesirable effects on aquatic and wildlife communities.

4. Effects on wetlands or water-related wildlife habitats.

5. Effects on the visual quality of water resources.

DESIGN CRITERIA.

Working pressure. The pipelines shall be designed to meet all service requirements without a static working pressure, including surge, at any point greater than the minimum allowable working pressure of the pipe used at that point. The static or working pressure of pipelines open to the atmosphere shall include freeboard.

The maximum working pressure for rubber gasket joints shall not be more than one-third of the certified hydrostatic test pressure determined by the test procedure in ASTM-C-505 and shall not exceed 50 ft of head for sized 6 through 12 in. in diameter, 40 ft for sizes 15 through 18 in., 30 ft for sizes 21 and 24 in., and 25 ft for sizes 26 through 30

The maximum working pressure for mortar joints shall not be more than one-fourth the certified hydrostatic test pressure as determined by the hydrostatic test pressure prescribed in ASTM-C-118 and shall not exceed 40 ft of head for sizes 6 and 8 in., 35 ft for sizes 10 and 12 in., 30 ft for sizes 14 through 24 in., and 25 ft for sizes 26 through 30 in.

The maximum working pressure for cast-in-place pipe shall not exceed 15 ft of head above the centerline of the pipe.

External load limit. A safety factor of at least 1.25 shall be applied to the three-edge bearing test in computing allowable heights of fill over the precast pipe.

Friction losses. For design purposes, friction head losses shall be no less than those computed by Manning's formula, using a coefficient of roughness "n" of 0.011 for rubber-gasket-jointed pipe, 0.012 for mortar-jointed pipe, and 0.014 for cast-in-place pipe.

Capacity. The design capacity of the pipelines shall be based on whichever of the following criteria required the larger amount of water:

1. The capacity shall be sufficient to deliver the volume of water required to meet the peak-period consumptive use of the crop or crops to be irrigated.

2. The capacity shall be sufficient to provide an adequate irrigation stream for all methods of irrigation planned.

Outlets. Appurtenances to deliver water from the pipe system to the land, to a ditch or reservoir, or to any surface pipe system shall be known as outlets. Outlets shall have adequate capacity at design working pressure to deliver the required flow to: (1) the hydraulic gradeline of a pipe or ditch, (2) a point at least 6 in. above the field surface, or (3) the design surface elevation in a reservoir.

Stands open to the atmospheres. Stands shall be placed at each inlet to the irrigation pipe system and at such other points as required. All stand shall serve as vents in addition to their other functions. Stands shall be constructed of steel pipe or other approved material and shall be supported on a base adequate to support the stand and prevent movement or undue stress on the pipeline. Open stands shall be designed to meet or exceed the following criteria:

1. Each stand shall allow at least 1 ft of freeboard above design working head. The stand height above the centerline of the pipeline shall be such that neither the static head nor the design plus freeboard shall exceed the allowable working pressure of the pipe.
2. The top of each stand shall extend at least 4 ft above the ground surface except

for surface gravity inlets or where visibility is not a factor. Gravity inlets or stands shall be equipped with a trash guard.
3. Downward water velocities in stands shall not exceed 2 ft/s. The inside diameter of the stand shall not be less than the inside diameter of the pipeline. This downward velocity criterion applied only to stands having vertical offset inlets and outlets.
4. If the water velocity in the inlet (from the pump or other water source) equals or exceeds three times the velocity in the outlet pipeline, the centerline of the inlet shall have a minimum vertical offset from the centerline of the outlet at least equal to the sum of the diameters of the inlet and outlet pipes.
5. The cross-sectional area of stands may be reduced above a point 1 ft above the top of the upper inlet or outlet pipe, but the reduced cross section shall not be such that it would produce an average velocity of more than 10 ft/s if the entire flow were discharging through it.
6. Vibration-control measures, such as special couplers or flexible pipe, shall be provided as needed to insure that vibration from pump discharge is not transmitted to stands.

Sand traps, when combined with a stand, shall have a minimum inside dimension of 30 in. and shall be constructed so that the bottom is at least 24 in. below the invert of the outlet to the pipeline. The downward velocity of flow of the water in a sand trap shall not exceed 0.25 ft/s.

Gate stands shall be of sufficient dimensions to accommodate the gate or gates and shall be large enough to make the gates accessible for repair.

Float valves stands shall be large enough to provide accessibility for maintenance and to dampen surge.

Stands closed to the atmosphere. If pressure-relief valves and air-and-vacuum valves are used instead of open stands, all requirements detailed in “Stands Open to the Atmosphere” shall apply except as modified below.

The inside diameter of the closed stand shall be equal to or greater than that of the pipeline for at least 1 ft above the top of the uppermost inlet of outlet pipe. To facilitate attaching the pressure-relief valve and the air-and-vacuum valve, the stand may be capped at this point, or if additional height is required, the stand may be extended to the desired elevation by using the same inside diameter or a reduced cross section. If a reduced section is used, the cross-sectional area shall be such that it would produce an average velocity of no more than 10 ft/s if the entire flow were discharged though it. If vertical offset is required between the pump discharge pipe and the outlet pipeline and the discharge pipe is “doglegged” below ground, the stand shall extend at least 1 ft above the highest part of the pump discharge pipe.

An acceptable alternative design for stands requiring no vertical inlet offset (when inlet velocity is less than three times that of the outletting pipeline shall be to:

1. Construct the dogleg section of the pump discharge pipe with the same nominal diameter as that of the pipeline.
2. Install the pressure-relief valve and the air-and-vacuum valve on top of the upper horizontal section of the dogleg.

Pressure-relief and air-and-vacuum valves shall be installed on stands with the nominal size pipe required to fit the valves’ threaded inlets.

Vents. Vents may be designed into systems open to provide for the removal and entry of air and protection from surge. They shall:

1. Have a minimum freeboard of 1 ft above the hydraulic gradeline. The maximum height of the vent above the centerline of the pipeline must not exceed the maximum allowable working pressure of the pipe.
2. Have a cross-sectional area at least one-half the cross-sectional areas of the pipeline (both inside measurements) for a distance of at least one pipe-line diameter up from the centerline of the pipeline.

Above this elevation the vent maybe reduced to 2 in. in a diameter.

These cross-sectional requirements shall apply when an air-and-vacuum valve is used instead of a vent, but the reduced section shall be increased to the nominal size pipe required to fit the valve's threaded inlet. An acceptable alternative is to install this valve in the side of a service outlet, provided that the riser is properly located and adequately sized. If both an air-and-vacuum valve and a pressure-relief valve are required at the location, the 10-ft/s velocity criterion given under "Stands" shall apply to the reduced section.

3. Be located at the downstream end of each lateral, at summits in the line, and at points where there are changes in grade in a downward direction of flow of more than 10 degrees.

Air-and-vacuum valve. An air-vacuum valve, which has a large venting orifice, exhausts large quantities of air from the pipeline during filing operations and allows air to reenter the line to prevent a vacuum from forming during emptying operations. This type of valve is sometimes called air-vacuum or air-vent-and-vacuum relief valve. It is not continuous acting because it does not allow further escape of air at working pressure once the valve closes.

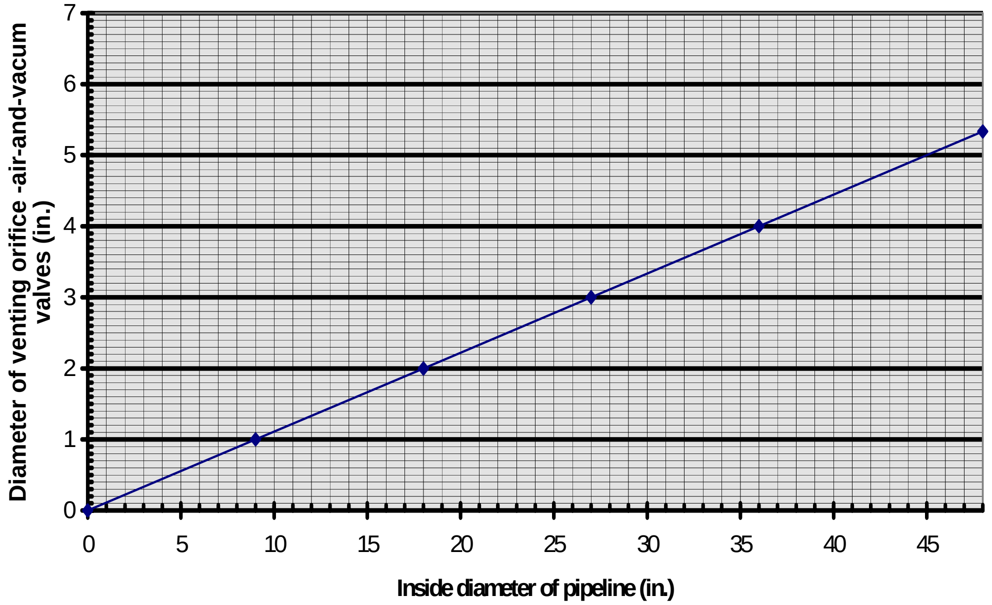
An air-and-vacuum valves may be used instead of vents at any or allocations listed under "Vents," conjunction with a pressure-relief valve as an alternative to open pump stands. A pipeline is considered open to the atmosphere is at least one stand, vent, or service outlet is unclosed and located so that it cannot be isolated from the system by line gated or valves.

On concrete pipelines not open to the atmosphere, air-and-vacuum valves shall be installed at all locations specified under "Vents," on all pump stands, and at inline control devices where there is a need for air removal and entry during filling and emptying.

The diameter of the orifice (opening that controls air-flow during filling and emptying operations) of and air-and-vacuum valve shall equal or exceed that specified in figure 1 for the appropriate diameter of the pipeline.

Manufacturers of air-and-vacuum valves marketed for use under this standard shall provide dimensional data, which shall be the basis for selection and acceptance these valves.

Figure 1. Sizing of air-and-vacuum valves



Pressure-relief valves. Pressure-relief valves may be used on concrete pipelines as an alternative to stands open to the atmosphere. A pressure-relief valve shall serve the pressure-relief function of the open stand or vent for which it is an alternative.

Pressure-relief valves do not function as air-release valves and shall not be used as substitute for such valves if release or entry of air is required. Pressure-relief valves shall be used in conjunction with air-and-vacuum valves at all pump stands and at the ends of pipelines if needed to relieve surge at the ends of the lines.

The flow capacity of pressure-release valves shall be pipeline design flow rate with a pipeline pressure not greater than 50 percent more than the permissible working pressure for the pipe.

The pressure at which the valve starts to open shall be marked on pressure-relief valves. Adjustable pressure-relief valves shall be sealed or otherwise altered to prevent changing the adjustment from the marked on the valve.

Manufacturers of pressure-relief valves marketed for use under this standard shall provide capacity tables, based on performance tests, that give the discharge capacity of the valves at the maximum permissible pressure and differential pressure settings. Such tables shall be basis for design of pressure setting and of acceptance of these valves.

Check valves. A check valve shall be installed between the pump discharge and the pipeline if detrimental backflow may occur.

Drainage. Provisions shall be made for completely drainage the pipeline if a hazard is imposed by freezing temperatures or drainage of the line is specified for the job. If provisions for drainage are required, drainage outlets shall be located at all low places in the line. These outlets may drain into dry wells or to points of lower elevation. If drainage cannot be thus provided by gravity, provisions shall be made to empty the line by pumping or by other means.

Flushing. If provisions are needed for flushing the line free of sediment or other foreign material, a suitable valve shall be installed at the distal end of the pipeline.

Thrust control. Abrupt changes in pipeline grade or alignment, require either:

1. A stand having a diameter greater than that of the pipeline,
2. An anchor or thrust block to absorb any axial thrust of the pipeline, or
3. A larger diameter pipe placed horizontally or placed vertically and capped below ground or an in place structure capped below ground.

An abrupt change shall be considered to be (a) an angle of 45 degrees or greater than the maximum working head is under 10 ft; (b) an angle of 30 degrees or greater when the maximum working head is between 10 and 20 ft; and (c) an angle of 15 degrees or greater when the maximum working head is greater than 20 ft

Suitable thrust control shall be provided to resist end thrust of rubber gasket pipelines.

$$A = ((98\ HD^2)/B)\sin(a/2)$$

Where:

A = Area of thrust block required
H = Maximum working pressure in ft
D = Inside diameter of pipe in ft
B = Allowable passive pressure of the soil in lb/ft^2
a = Deflection angle of pipe bend

Area of thrust blocks for dead ends and tees shall be 0.7 times the area of block required for a 90º deflection angle of pipe bend.

If adequate soil tests are not available, the passive soil pressure may be estimated from table 1.

Materials. All materials desired and required in this standard shall meet or exceed the minimum requirements indicated in "Specifications of Materials."

Table 1.—Allowable soil bearing pressure

Natural soil material	Depth of cover to center of thrust block			
	2 ft	3 ft	4 ft	5 ft
	------------------lb/ft^2------------------			
Sound bedrock	8,000	10,000	10,000	10,000
Dense sand and gravel mixture (assumed Ø = 40º)	1,200	1,800	2,400	3,000
Dense fine to coarse sand (assumed Ø = 35º)	800	1,200	1,650	2,100
Silt and clay mixture (assumed Ø = 25º)	500	700	950	1,200
Soft clay and organic soils (assumed Ø = 10º)	200	300	400	500