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.

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

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.

Pipelines shall be planned and located as part of an integral part 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.

The pipeline should convey sufficient water supplies to make irrigation practical for the crops to be grown and the irrigation 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.

CRITERIA

Laws and Regulations. This practice must conform to all federal, state, and local laws and regulations. Laws and regulations of particular concern include those involving water rights, land use, land disturbance by construction, pollution control, property easements, wetlands, preservation of cultural resources, and endangered species.

General. All irrigation systems shall be operated in accordance with an Irrigation Water Management (IWM) Plan. IWM plans shall be in accordance with the Conservation Practice Standard Irrigation Water Management (449).

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 feet of head for sized 6 through 12 inches in diameter, 40 feet for sizes 15 through 18 inches, 30 feet for sizes 21 and 24 inches, and 25 feet for sizes 26 through 30 inches.

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 feet of head for sizes 6 and 8 inches, 35 feet for sizes 10 and 12 inches, 30 feet for sizes 14 through 24 inches, and 25 feet for sizes 26 through 30 inches

The maximum working pressure for cast-in-place pipe shall not exceed 15 feet 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:

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.

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 six inches 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 stands 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:

Each stand shall allow at least one foot 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.

The top of each stand shall extend at least four feet 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.

Downward water velocities in stands shall not exceed two ft/s. The inside diameter of the stand shall not be less than the inside diameter of the pipeline. This downward velocity criterion applies only to stands having vertical offset inlets and outlets.

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.

The cross-sectional area of stands may be reduced above a point one foot 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.

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 inches and shall be constructed so that the bottom is at least 24 inches 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 one foot 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 one foot 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:

Construct the dogleg section of the pump discharge pipe with the same nominal diameter as that of the pipeline.

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:

Have a minimum freeboard of one foot 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.

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 pipeline diameter up from the centerline of the pipeline. Above this elevation, the vent maybe reduced to two inches 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.

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.

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

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 draining 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:

A stand having a diameter greater than that of the pipeline;

An anchor or thrust block to absorb any axial thrust of the pipeline;` or

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 feet; (b) an angle of 30 degrees or greater when the maximum working head is between 10 and 20 feet; and (c) an angle of 15 degrees or greater when the maximum working head is greater than 20 feet.

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 in feet^2
H = Maximum working pressure in feet
D = Inside diameter of pipe in feet
B = Allowable passive pressure of the soil in lb/ft^2
a = Deflection angle of pipe bend in degrees

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

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

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

Depth of cover. The pipeline shall be placed deep enough below the ground surface to protect it from the hazards imposed by traffic crossings, farming operations, freezing temperatures, or soil cracking.

Trench Construction. The trench at any point below the top of the pipe shall only be wide enough to permit the pipe to be easily placed and joined and to allow the initial backfill material to be uniformly placed under the haunches and along the sides of the pipe.

If the trench is precision excavated and has a semicircular bottom that closely fits the pipe, the width shall not exceed the outside diameter (OD) of the pipe by more than 10 percent.

The trench bottom shall be uniform so that the pipe lies on the bottom without bridging. Clods, rocks, and uneven spots that can damage the pipe or cause non-uniform support shall be removed.

If there are rocks, boulders, or other material that might damage the pipe, the trench bottom shall be undercut a minimum of four inches below final grade and filled with bedding material consisting of sand or compacted fine-grained soils.

Provisions shall be made to insure safe-working conditions where unstable soil, trench depth, or other conditions exist that can be hazardous to personnel working in the trench.

Materials. All materials desired and required in this standard shall meet or exceed the minimum requirements indicated in the material specifications.

PLANS AND SPECIFICATIONS

Plans and specifications for installing nonreinforced concrete irrigation ditch and canal linings shall be in keeping with this standard and shall describe the requirements for applying the practice to achieve its intended purpose.

OPERATION AND MAINTENANCE (O&M)

An O&M Plan must be prepared for use by the landowner or operator responsible for operation and maintenance. The plan should provide specific instructions to insure the practice functions properly. Minimum requirements to be addressed in the O&M Plan are:

Prompt repair or replacement of damaged components as necessary. Check to make sure all valves and air vents are set at the proper operating condition so they may provide protection to the pipeline. Remove foreign materials and vegetation that can interfere with proper valve operation.

Maintain backfill over pipe and maintain vigorous vegetative growth where applicable.

Remove debris, litter, and any blockage that restricts capacity.

Avoid travel and tillage over pipelines.

Control rodents to prevent damage to pipeline and appurtenances.

REFERENCES

UDSA-NRCS National Engineering Field Handbook of Conservation Practices, Chapter 3 and 15.