NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE STANDARD
IRRIGATION WATER CONVEYANCE
(FT)
NONREINFORCED CONCRETE PIPELINE
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 that has been designed to facilitate the conservation use of soil and water resources on a farm or group of farms.

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

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 does not exceed 5.5 percent.

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

PLANNING CONSIDERATIONS FOR WATER QUANTITY AND QUALITY

Quantity

1. Effects 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 have been located next to the original conveyance.

Quality

1. Effects of installing the pipeline (replacing other types of conveyances) on channel erosion of 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 temperature 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 pipeline shall be designed to meet all service requirements without a static or working pressure, including surge, at any point greater than the maximum allowable working pressure of the pipelines open to the atmosphere shall include freeboard.

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

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 procedure 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 pipeline shall be based on whichever of the following criteria requires 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 (1) to the hydraulic gradeline of a pipe or ditch, (2) to a point at least 5 in. above the field surface, or (3) to the design surface elevation in a reservoir.

Stands open to the atmosphere

Stands shall be placed at each inlet to a concrete 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 concrete or steel pipe or other approved material and be supported on a base adequate to support the stand and prevent movement or under 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 working head 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 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 applies 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 pumping 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 valve 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 or 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 through it. If vertical offset is required between the pump discharge pipe is "doglegged" below ground, the stand shall extend to 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 shall be installed on stands with nominal size pipe required to fit the valves' threaded inlets.

Vents

Vents may be designed into systems open to the atmosphere 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 area 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 may be reduced to 2 in. in 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 valves' 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 valves

An air-and-vacuum valve, which has a large venting orifice, exhausts large quantities of air from the pipeline during filling 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 at any or all the locations listed under "Vents," item 3, instead of the vents. An air-and-vacuum valve also may be used 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) of an air-and-vacuum valve shall equal or exceed the 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 selecting and accepting 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 substitutes for such valves where release of entrapped 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 the 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 that 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 capacities of the valves at the maximum permissible pressure and differential pressure settings. Such tables shall be the 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 the pipeline grade of 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 inplace structure capped below ground.

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

$$A = \frac{98\ HD2}{B}\ \sin\frac{a}{2}$$

Where:

A = Area of thrust block required in ft2
H = Maximum working pressure in ft
D = Inside diameter of pipe in ft
B = Allowable passive pressure of the soil in lb/ft2
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 90-degree 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 described 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 2ft	3ft	4ft	5ft
	--------lb/ft2--------			
Sound bedrock	8000	10000	10000	10000
Dense sand and gravel mixture (assumed 0=40 degrees)	1200	1800	2400	3000
Dense fine to coarse sand (assumed 0=35 degrees)	800	1200	1650	2100
Silt and clay mixture (assumed 0=25 degrees)	500	700	950	1200
Soft clay and organic soils (assumed 0=10 degrees)	200	300	400	500

INSTALLATION

Minimum depth of cover

The pipeline shall be placed deep enough below the land surface to protect it from the hazards imposed by traffic crossing, farming operations, freezing temperatures, or soil cracking. The minimum depth of cover shall be 18 in. for pipe sizes 12 in. and less in diameter. For pipelines greater than 12 in. in diameter, the minimum depth of cover shall be 24 in.

Exceptions to these depths may be specified for rocky areas or other local conditions. If a shallower covering is specified, there shall be provisions to protect the line from damage by vehicular traffic. Greater depths of cover shall be specified when local conditions indicate a need.

Trench construction

If trenches are excavated in soil containing rock or other hard materials or in soil susceptible to appreciable swelling and shrinking on wetting or drying, or if the trench bottom is unstable, the trenches shall be overexcavated and backfilled with selected materials to sufficient depth to provide a suitable base. If water is in the trench, it shall be drained away or controlled in such a manner as not to damage the joint mortar, and a suitable base shall be maintained.

Openings

Openings into mortar joint and cast-in-place concrete pipelines shall be covered to prevent air circulation except when work is actually in progress. Such openings shall be kept closed until pipeline is completed and is to be filled with water.

Joints and connections

All joints and connections shall be designed and constructed to withstand the design maximum working pressure for the pipeline without leakage and to leave the inside of the line free of any obstructions that may tend to reduce its capacity below design requirements.

Mortar joints shall be protected from drying out. If the soil used in the initial backfill is not thoroughly moist, a suitable membrane shall be used over the mortar. Membranes consisting of one layer of kraft paper or paper cut from cement sacks or membrances conforming to specifications in ASTM-C-171 or C-309 shall be considered suitable.

Thrust blocks

Thrust blocks may be formed against a solid hand-excavated trench wall undamaged by mechanical equipment. They shall be constructed of concrete, and the space between the pipe and the trench wall shall be filled to the height of the outside diameter of the pipe. The block shall have a minimum thickness of 6 in. and the bearing area specified.

Backfill

The backfill material shall be placed so that the pipe will not be displaced or damaged and so that the backfill is level with the natural ground or at the design grade required to provide the minimum depth of cover after settlement.

An initial backfill of soil shall be placed around the mortar joint pipe and over it to a depth of 6 in. for the full width of the trench. The initial backfill shall not lag behind pipe laying by more than seven sections of pipe.

If laying ceases for 2 hours or more, the initial backfill shall be brought up to and cover the last completed joint. Nothing in this section shall prohibit the complete backfilling while mortar bans are still plastic. If complete backfilling is not done at this time, completion shall be delayed at least 20 hours. To prevent damage to mortar joints, the trench shall be backfilled to the minimum specified cover or to 2 ft, whichever is less, before the pipe is filled with water.

Cast-in-place pipelines

Cast in place pipe shall be installed, cured, and backfilled according to the requirements set forth ACI 346-70.

Testing

Concrete pipelines shall be tested for leaks by observing their normal operation any time after 2 weeks of continuous wetting. All visible leaks shall be repaired. Seasonal cold water shall not be used for this test.

It shall be demonstrated by testing that the pipeline will function properly at design capacity. At or below design capacity there shall be no objectionable flow conditions such as water hammer, continuing unsteady delivery of water, damage to the pipeline, or detrimental discharge from control valves, vents, or stands.

Basis of acceptance

The acceptability of the pipeline shall be determined by inspections to check compliance with all the provisions of this standard with respect to the design of the line, the pipe and pipe markings, the appurtenances used, and the minimum installation requirements.

Certification and guarantee

If requested by the State Conservation Engineer, the manufacturer shall certify that the pipe complies with the standards of these SCS specifications.

The installing contractor shall certify that this installation complies with the requirements of this standard. He shall furnish a written guarantee that protects the owner against defective workmanship and materials for not less than 1 year and that identifies the manufacturer and markings of the pipe used.

MATERIALS

Pipe

Nonreinforced concrete pipe laid with mortar joints shall conform to or exceed the requirements in ASTM-C-118.

If nonreinforced concrete pipe are laid with rubber gasket joints, the rubber gaskets shall conform to or exceed the requirements in ASTM-C-505.

Nonreinforced cast-in-place concrete pipe shall conform to or exceed the requirements of American Concrete Institute Standard 346-70.

Stands

If constructed of concrete pipe having a diameter greater than 24 in., the pipe shall conform to the standards in ASTM-C-76 or C-478.

Cast-in-place stands shall contain steel reinforcing on not more than 1-ft centers to provide steel areas equal to or greater than the least valves specified for Class II (1500-D-Ultimate) pipe in ASTM-C-76.