

**NATURAL RESOURCES CONSERVATION SERVICE  
CONSERVATION PRACTICE STANDARD  
SOUTH DAKOTA SUPPLEMENTS ITALICIZED**

**IRRIGATION WATER CONVEYANCE  
LOW PRESSURE, UNDERGROUND, PLASTIC PIPELINE**

(ft.)  
CODE 430EE

**DEFINITION**

A pipeline and appurtenances installed in an irrigation system.

**PURPOSE**

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

This standard applies to underground thermoplastic pipelines from 4 to 18 in. in diameter that are subject to internal pressures up to 50 lb./in.<sup>2</sup>.

The standard includes the design criteria for these irrigation pipelines, the minimum installation requirements, and the specifications for the thermoplastic pipe to be used. It applies to pipelines with stands and vents open to the atmosphere and to pipelines not open to the atmosphere but provided with pressure-relief valves and air-and-vacuum valves.

**CONDITIONS WHERE PRACTICE APPLIES**

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

The water supply and quality and rate of irrigation delivery for the area served by the pipeline shall be sufficient to make irrigation practical for the crops to be grown and the irrigation water application methods to be used.

Plastic pipelines installed according to this standard shall be placed only in suitable soils where the bedding and backfill requirements can be fully met.

**CONSIDERATIONS**

**Water 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.

**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, percolation below the root zone or to ground water recharge.
3. Effects of controlled water delivery on the temperatures of water resources that could 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.

**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, pollution control, property*

Conservation practice standards are reviewed periodically and updated if needed. The current version of this standard is posted on our website at [www.sd.nrcs.usda.gov](http://www.sd.nrcs.usda.gov) or may be obtained at your local Natural Resources Conservation Service.

*easements, wetlands, preservation of cultural resources, and endangered species.*

**CRITERIA**

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

Maximum allowable working pressure for low-head plastic irrigation pipe shall be 50 ft. or head or 22 lb./in.<sup>2</sup>.

Pipelines constructed of 50-lb/in.<sup>2</sup> plastic irrigation pipe or the IPS pipe covered by this standard shall have a working pressure no greater than 50 lb/in.<sup>2</sup>.

Plastic pipeline requiring a working pressure greater than 50 lb./in.<sup>2</sup> shall be constructed according to the requirements specified in *the* 430DD standard.

Plastic pipe pressure rating normally is based on a water temperature of 73.4 degrees F. Factors for adjusting allowable working pressure for higher water temperature given in Table 1.

Table 1. Pressure rating factors for PVC and PE pipe for water at elevated temperatures

Temperature <i>deg F</i>	PVC	PE
73.4	1.00	1.00
80	.88	.92
90	.75	.81
100	.62	.70
110	.50	—
120	.40	—
130	.30	—
140	.22	—

Note: To obtain the pipe’s reduced pressure rating because of a water temperature greater than 73.4 deg F, multiply the normal pressure rating by the appropriate factor from table.

**Friction losses.** For design purposes, friction head losses shall be no less than those computed by the Hazen-Williams equation, using a roughness coefficient, c, equal to 150 or *Mannings equation using an “n” valve of 0.009.*

**Flow velocity.** The full-pipe design water velocity in the pipeline when operating at system capacity should not exceed five ft./s.

**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 a 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 in. above the field surface, or (3) a reservoir.

**Check valves.** A check valve shall be installed between the pump discharge and the pipeline if backflow may occur. *Backflows must consider contamination of the water supply as well as damage to the system.*

**Stands open to the atmosphere.** Stands shall be used wherever water enters the pipeline system to avoid entrapment of air, to prevent surge pressures, to avoid collapse because of negative pressures, and to prevent the pressure from exceeding the maximum allowable working pressure of the pipe. Open stands may be required at other locations in low-head systems to perform other functions. Stands shall be constructed of steel pipe or other approved material and 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 one 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 exceeds the allowable working pressure of the pipe.
2. The top of each stand shall extend at least four 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. The downward water velocity 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.
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 one 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 pipes 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 of 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 dimension 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-vacuum valves are used instead of open stands, all requirements under "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 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 no 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 to at least one ft. above the highest part of the pump discharge pipe.

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

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

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

**Vents.** Vents must 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 *one* 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 two 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 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

Open to the Atmosphere” 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 and prevents a vacuum from forming during emptying operations. This type of valve is sometimes called air-vacuum valve 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 installed according to the standards for “Vents” can be used instead of open vents at any or all the locations listed in (3) under “Vents.”

Air-and-vacuum valves installed according to the standards for “Stands Closed to the Atmosphere” can be used in conjunction with pressure-relief valves 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.

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

Diameter of orifice	Diameter of pipeline
(in)	(in)
3/4	4
1 1/4	6
1 3/4	8
2 1/4	10
2 3/4	12
3 1/4	14
3 1/2	15
3 3/4	16
4	18

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 can be used on low-pressure plastic 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 if 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 end of pipelines if needed to relieve surge at the end of the lines.

The flow capacity of pressure-release valves shall be the pipeline design flow rate with a pipeline pressure no 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 each pressure-relief valve. Adjustable pressure-relief valves shall be sealed or otherwise altered to insure that the adjustment marked on the valve is not changed.

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 the basis for design of pressure setting and of acceptance of these valves.

**Drainage.** Provisions shall be made for completely draining the pipeline if a hazard is imposed by freezing temperatures, drainage is recommended by the manufacture of the pipe, 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 can drain into dry wells or to points of lower elevation. If drainage cannot be thus provided by gravity, provisions shall be made for emptying the line by pumping or by other means.

**Check Valves.** A check valve must be installed between the pump discharge and the pipeline where backflow could cause damage to the system or contamination of the water supply.

**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.** Anchors or thrust blocks shall be provided on pipelines having a working pressure of 25 pounds per square inch or greater at abrupt changes in pipeline grade, changes in horizontal alignment, or reduction in pipe size to absorb any axial thrust of the pipeline. Thrust blocks may also be needed at the end of the pipeline and at inline control valves.

The pipe manufacturer’s recommendations for thrust control shall be followed. In absence of such recommendations, the following formula should be used to design thrust blocks:

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

Where:

- A = Area of thrust block required in square feet.
- H = Maximum working pressure in feet
- D = Inside diameter of pipe in feet
- B = Allowable passive pressure of the soil in pounds per square foot
- 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° deflection angle of pipe bend.

If adequate soil tests are not available, the allowable bearing soil pressure can be estimated from Table 2.

Table 2.—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 <sup>2</sup> -----			
Sound bedrock	8,000	10,000	10,000	10,000
Dense sand and gravel mixture (assumed Ø = 40°)	1,200	1,800	2,400	3,000
Dense fine to coarse sand (assumed Ø = 35°)	800	1,200	1,650	2,100
Silt and clay mixture (assumed Ø = 25°)	500	700	950	1,200
Soft clay and organic soils (assumed Ø = 10°)	200	300	400	500

*Thrust block shall be constructed of concrete and shall have a minimum thickness of six inches and a minimum height equal to the outside diameter of the pipe. The blocks shall fill the space between the pipe and the undisturbed earth at the side of the trench at bends and tees. Blocks at ends of lines shall bear against undisturbed earth or earth compacted at least to the density of the surrounding natural material. Thrust blocks shall be allowed to cure for a seven-day period prior to pressure testing the pipeline.*

**Materials.** All materials described and required in this standard shall meet or exceed the minimum requirements listed for materials under “Plans and Specifications.”

**Minimum Depth of Cover.** *Pipe shall be installed at sufficient depth below the ground surface to provide protection from hazards imposed by traffic crossing, farming operations, freezing temperatures, or soil cracking. Thirty inches minimum cover shall be provided except in soils subject to deep cracking where the cover shall be a minimum of 36 inches. The maximum depth of cover for all pipe sizes shall be four feet.*

*In areas where the pipe will not be subject to freezing, vehicular, or cultivation hazards, and the soils do not crack appreciably when dry, the minimum depth of cover may be reduced to 18 inches for pipes 4 through 6 inches in diameter and 24 inches for pipes over 6 inches in diameter.*

*At low places on the ground surface, extra fill may be placed over the pipeline to provide the minimum depth cover. In such cases, the top width of the fill shall be no less than 10 feet and the side slopes no steeper than 6 horizontal to 1 vertical. The fill material shall be placed and compacted prior to trench excavation. Where needed, extra protection shall be provided at vehicle crossings with encasement pipe or other approved methods.*

**Trench Construction.** *Trench width at any point below top of pipe should be only 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. The maximum trench width shall be 30 inches. Where the trench is precision excavated with a semi-circular bottom that closely fits the pipe, the width shall not exceed the outside diameter of the pipe by more than 10 percent.*

The trench bottom shall be uniform so that the pipe will lay on the bottom without bridging. Clods, rocks, and uneven spots which could damage or cause nonuniform support to the pipe shall be removed.

Where rocks, boulders, or any other material which might damage the pipe are encountered, the trench bottom shall be undercut a minimum of four inches below final grade and filled with bedding material consisting of sands or compacted fine-grained soils.

Provisions shall be made to insure safe working conditions where unstable soil, trench depth, or other conditions are such as to impose safety hazards to personnel working in the trench.

**Placement.** Pipe shall be placed in the trench and allowed to come to within a few degrees of the temperature that it will have after complete covering prior to any backfill beyond shading and prior to connecting to other facilities. Care shall be taken to prevent permanent distortion and pipe damage when handling during unusually warm or cold weather. The pipe shall be uniformly and continuously supported over its entire length on firm stable material. Blocking or mounding shall not be used to bring the pipe to final grade.

For pipe with belled ends, bell holes shall be excavated in the bedding materials as needed to allow for unobstructed assembly of the joint and to permit the body of the pipe to be in contact with the bedding material throughout its length.

**Joints and Connections.** All joints and connections shall be made so as to withstand the design maximum working pressure for the pipeline without leakage and shall leave the inside of the line free of any obstruction that may tend to reduce its capacity below design requirements.

All fittings, such as couplings, reducers, bends, tees, and crosses, shall be installed in accordance with the recommendations of the pipe manufacturer.

Fittings and appurtenances made of steel or other metals subject to corrosion shall be adequately protected by wrapping with plastic tape or coating with high corrosion preventative qualities. Where plastic tape is used for corrosion protection, all surfaces to be wrapped shall be thoroughly cleaned and then coated with a primer compatible with the tape prior to wrapping.

**Testing.** The pipeline shall be thoroughly and completely tested at the design pressure for pressure strength and leakage while uncovered or only partially backfilled. If it is necessary to partially backfill the line before testing to hold the pipeline in place, the partial backfill shall be undertaken as specified under Initial Backfill, except for the design working pressure requirement. All joints and connections shall be left uncovered for inspection, with only the body of the pipe sections covered.

The line shall be filled with water slowly. Adequate provision shall be made for air release while filling, taking care to bleed all entrapped air in the process. The pressure shall be slowly built up to the maximum design working pressure of the system. While this pressure is maintained, all exposed pipe, fittings, valves, hydrants, joints, appurtenances, and the covered portions of the line shall be examined for leaks. Any leaks shall be repaired and the system retested.

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. Objectionable flow conditions shall include water hammer, continuing unsteady delivery of water, damage to pipeline, or detrimental discharge from control valves, vents, or stands.

**Initial Backfill.** The pipeline shall be filled with water and maintained near design working pressure during backfill operations.

The initial backfill material shall be selected soil and sand free from rocks or stones large than one inch in diameter and earth clods greater than approximately two inches in diameter. The material shall be so placed that the pipe will not be displaced, excessively deformed, or damaged.

Water packing shall be used whenever possible to consolidate the initial backfill around the pipe. The initial backfill, before wetting, shall be of sufficient depth to insure complete coverage of the pipe after consolidation has taken place. Water packing is accomplished by adding water to diked reaches of the trench in such quantity as to thoroughly saturate the initial backfill without excessive pooling of water. After saturation of the initial fill, the pipeline shall remain full until after final backfill is made. The waterpacked backfill shall be allowed to dry until firm enough to walk on before final backfill is begun.

Where conditions will not permit water packing, the initial backfill shall be placed in layers and compacted around and about six inches above the pipe by hand or mechanical methods to a soil density as required to provide adequate lateral support to the pipe.

An exception to water packing or to completely compacting the initial backfill as described above is permitted where the trench is precision excavated with a semicircular bottom that closely fits the pipe and the width does not exceed the outside diameter of the pipe by more than 10 percent. With this type trench construction, all other initial and final backfill requirements shall apply including having the pipe under water pressure during backfilling.

**Final Backfill.** Final backfill material shall be free of large rocks, frozen clods, and other debris greater than three inches in diameter. The material shall be placed and spread in approximately uniform layers in such a manner that there will be no unfilled spaces in the backfill and the backfill will be level with the natural ground or at the design grade required to provide the minimum depth of cover after settlement has taken place. Rolling equipment shall not be used to consolidate the final backfill.

All special backfilling recommendations of the pipe manufacturer shall be met.

**Water Bars.** Small diversion dikes (water bars) should be installed across the trench on long slopes or other locations of runoff water can concentrate.

**Basis of Acceptance.** The acceptability of the pipeline shall be determined by inspections to check compliance with all the provisions of the standard with respect to the pipe and pipe marking, the appurtenances used, and the minimum installation requirements.

**Certification and Guarantee.** If requested by the state conservation engineer, the pipe shall be certified by the manufacturer for compliance with this Natural Resources Conservation Service engineering standard.

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

## PLANS AND SPECIFICATIONS

Plans and specifications for constructing low-pressure, underground, plastic irrigation pipelines shall be in keeping with this standard and shall describe the requirements for applying the practice to achieve its intended purpose.

## OPERATION AND MAINTENANCE

A plan of operation and maintenance shall be prepared for use by the owner or others responsible for the system to insure that each component functions properly.