NATURAL RESOURCES CONSERVATION SERVICE

CONSERVATION PRACTICE STANDARD

IRRIGATION WATER CONVEYANCE

LOW PRESSURE, UNDERGROUND, PLASTIC PIPELINE

(Ft.)

CODE 430-EE

DEFINITION

A pipeline and appurtenances installed in an irrigation system.

SCOPE

This standard applies to underground thermoplastic pipelines from 4 to 18 inches in diameter that are subject to internal pressures up to 50 lb/in.^{2}.

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 includes pipelines with stands and vents open to the atmosphere and pipelines not open to the atmosphere but provided with pressure relief valves and air and vacuum valves.

PURPOSE

The conservation objectives of this pipeline practice are 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.

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 under this standard shall be placed only in suitable soils where the bedding and backfill requirements can be fully met.

DESIGN CRITERIA

A. Working Pressures

The pipeline shall be designed to meet all service requirements without a static or working pressure 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 of head or 22 lb\in.^{2}.

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

Plastic pipeline requiring a working pressure greater than 50 lb/in.^{2} shall be constructed according to the requirements specified in the Nebraska Technical Guide Engineering Standard 430-DD, Irrigation Water Conveyance Pipeline (High Pressure Underground Plastic).

Conservation practice standards are reviewed periodically, and updated if needed. To obtain the current version of this standard, contact the Natural Resource Conservation Service.

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	PVC	PE
deg F		
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.

B. 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.

C. Flow Velocity

The design water velocity in the pipeline when operating at system capacity should not exceed 5 feet per second.

D. Capacity

The design capacity of the pipeline shall be based on whichever of the following criteria is the greater:

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.

E. 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 grade line of a pipe or ditch; (2) to a point at least 6 inches above the field surface; or (3) to the design surface elevation in a reservoir.

F. Check Valves

A check valve shall be installed between the pump discharge and the pipelines when backflow may occur.

G. 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 due to negative pressures, and to prevent 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 1 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 working head plus freeboard shall exceed the allowable working pressure of the pipe.
2. Top of each stand shall extend at least 4 feet above the ground surface except for surface gravity inlets, which shall be equipped with trash, racks and covers.
3. Downward water velocities in stands shall not exceed 2 feet per second. In no case shall the inside diameter of the stand be less than the inside diameter of the pipeline. This downward velocity criterion applies only to stands having vertical offset inlets and outlets.

4. When the water velocity in the inlet (from the pump or other water source) equals or exceeds 3 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 foot above the top of the upper inlet or outlet pipe, but in no case shall the reduced cross section be such that it would produce an average velocity of more than 10 feet per second 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.
7. 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 feet per second.
8. 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.
9. Float Valve Stands shall be large enough to provide accessibility for maintenance and to dampen surge.

H. Stands Closed to the Atmosphere

Where pressure relief valves and air and vacuum valves are used in lieu of open stands, all requirements under Stands Open to the Atmosphere shall apply except as modified below.

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 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 with the same inside diameter or a reduced cross section. When a reduced section is used, the cross sectional area shall be such that it would produce an average velocity of no more than 10 feet per second if the entire flow were discharged through it. In the case where no vertical offset between the pump discharge pipe and the outlet pipeline is required and the discharge pipe is "dog-legged" below ground, the stand shall extend to at least 1 foot above the highest part of the pump discharge pipe.

An acceptable alternative design for stands where no vertical inlet offset is required (when inlet velocity is less than 3 times that of the outletting pipeline) shall be to:

1. Construct the "dog-leg" section of the pump discharge pipe with same nominal diameter as 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 nominal size pipe required to fit the valves' threaded inlets.

I. 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 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.
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 1 pipeline diameter up from the centerline of the pipeline. Above this elevation the vent may be reduced to 2 inches in diameter.

   These cross sectional requirements shall apply when an air and vacuum valve is used in lieu of a vent except 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 riser if properly located and adequately sized. When both an air and vacuum valve and a pressure relief valve are required at the location, the 10 feet per second velocity criterion under Stands shall apply to the reduced section.

3. Be located:

   a) At the downstream end of each lateral.

   b) At summits in the line.

   c) At points where there are changes in grade in a downward direction of flow of more than 10 degrees.

J. Air and Vacuum Valves

An air and vacuum valve, which has a large venting orifice, exhausts large quantities of air from the pipeline when filling and allows air to reenter the line and prevents a vacuum from forming when emptying. This type valve is sometimes called air-vacuum valve or air vent and vacuum relief valve. It is not continuous acting since it will not allow further escape of air at working pressure once the valve closes.

Air and vacuum valves may be used at any or all of the locations listed in item 3 under Vents in lieu 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 low pressure 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 in-line control devices where there is a need for air removal and entry during filling and emptying.

Diameter of the orifice (opening which controls airflow during filling and emptying) of an air and vacuum valve shall equal or exceed that specified below for the appropriate diameter of pipeline.

3/4" for 4" pipeline	2-3/4" for 12" pipeline
1-1/4" for 6" pipeline	3-1/4" for 14" pipeline
1-3/4" for 8" pipeline	3-1/2" for 15" pipeline
2-1/4" for 10" pipeline	3-3/4" for 16" pipeline
	4" for 18" 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 of these valves.

K. Pressure Relief Valves

Pressure relief valves may 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 where release of entrapped air is required. Pressure relief valves shall be used in conjunction with air and vacuum valves at all pumpstands and at the ends of pipelines when 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 no greater than 50 percent above the permissible working pressure for the pipe.

Pressure relief valves shall be marked with the pressure at which the valve starts to open. Adjustable pressure relief valves shall be sealed or otherwise altered to prevent changing of 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, which give the discharge capacities of the valves at the maximum permissible pressure and differential pressure settings. Such manufacturer's tables shall be the basis for design of pressure setting and of acceptance of these valves.

L. Draining Requirements

Provisions shall be made for draining the pipeline completely where a hazard is imposed by freezing temperatures, draining is recommended by the manufacturer of the pipe, or drainage of the line is specified for the job for any reason. Where 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 other means.

M. Flushing Requirements

Where provisions are needed to flush the line free of sediment or other foreign material, a suitable valve shall be installed at the distal end of the pipeline.

N. Thrust Control

Anchors or thrust blocks shall be provided on pipelines with working pressures of 25 psi 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 in-line control valves.

An abrupt change shall be considered to be:

(a) an angle of 45 degrees or greater when 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.

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

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

Where A = Bearing area of thrust block required

H = Maximum working pressure in feet

D = Inside diameter of pipe in feet

B = Allowable passive pressure of the soil in lbs. per sq. ft.

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 deflection angle of pipe bend.

Where adequate soil tests are not available the passive soil pressure may be estimated from the following table:

Sound Shale	10,000 lb/ft^2
Cemented Gravel and Sand difficult to pick	3,000 lb/ft^2
Coarse and fine compact Sand	2,000 lb/ft^2
Medium Clay – can be spaded	1,000 lb/ft^2
Soft Clay	500 lb/ft^2
Muck	0 lb/ft^2

0. Materials

All materials described and required in this Engineering Standard shall meet or exceed the minimum requirements of the Engineering Specifications for Materials,

PLANS AND SPECIFICATIONS

Plans and specifications for construction of Low Pressure Underground Plastic Irrigation Pipelines shall be in keeping with the Standard and shall describe the requirements for application of the practice to achieve its intended purposes.