NATURAL RESOURCES CONSERVATION SERVICE

CONSERVATION PRACTICE STANDARD

IRRIGATION WATER CONVEYANCE, PIPELINE, HIGH-PRESSURE, UNDERGROUND, PLASTIC

(Ft.)

CODE 430DD

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 proper management of irrigation water, and to reduce water conveyance losses.

CONDITIONS WHERE PRACTICE APPLIES

This standard applies to underground thermoplastic pipelines ranging from ½ inch to 27 inches in diameter that are closed to the atmosphere and that are subject to internal pressures of 80 lb/in^2 or greater.

Pipelines can be planned and located to serve as 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.

Water supplies, water quality, and rates of irrigation delivery for the area served by the pipelines shall be sufficient to make irrigation practical for the crops to be grown and the irrigation water application method to be used.

CRITERIA

General Criteria Applicable to All Purposes

Laws and Regulations. This practice must conform to all federal, state, and local laws, rules, and regulations.

Working Pressure and Flow Velocity. The minimum acceptable class of pipe shall be that having a pressure rating for water of 80 lb/in^2.

The pipeline shall be designed to meet all service requirements without an operating pressure, including hydraulic transients, or static pressure at any point greater than the pressure rating of the pipe used at that point. As a safety factor against surge or water hammer, the working pressure should not exceed 72 percent of the pressure rating of the pipe, nor should the design flow velocity at system capacity exceed 5 ft/s. If either of these limits is exceeded, special consideration must be given to the flow conditions and measures taken to adequately protect the pipeline against surge.

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 are given in Table 1.

Table 1. Pressure Rating Factors for PVC and PE Pipe for Water at Elevated Temperatures

Degrees F	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 reduced pipe pressure rating, multiply the normal pipe pressure rating by the appropriate factor from the table.

Capacity. Capacity shall be sufficient to provide an adequate irrigation stream for the irrigation application methods or planned storage.

Design capacity of the pipeline conveyance or distribution system shall be based on one of the following:

- Adequate to meet the moisture demands of all crops to be irrigated in the design area.
- Sufficient to meet the requirements of selected irrigation events during critical crop growth periods when less than full irrigation is planned.
- For special-purpose irrigation systems, sufficient to apply a stated amount of water to the design area in a specified net operating period.
- Sufficient to meet the requirements for efficient application with the distribution system.

In computing the above capacity requirements, allowance must be made for reasonable water losses during application or use.

Friction Losses. Design friction head losses shall be no less than those computed by the Hazen-Williams equation using roughness coefficient, c, equal to 150.

Outlets. Such appurtenances are required to deliver water from the pipeline to an individual sprinkler or to a lateral line of sprinklers or surface pipe located on the ground surface shall be know as outlets. Outlets shall have adequate capacity to deliver the design flow to the individual sprinkler, surface lateral line of sprinklers, or surface pipe at the design operating pressure.

Check Valves. A check valve shall be installed between the pump discharge and the pipeline where backflow may occur.

Pressure-Relief Valves. A pressure-relief valve shall be installed between the pump discharge and the pipeline if excessive pressure can build up when all valves are closed. Pressure-relief valves shall be installed on the discharge side of the check valve where a reversal of flow may occur and at the end of the pipeline, if needed, to relieve surge at the end of the line.

Pressure-relief valves shall be no smaller than ¼ inch nominal size for each inch of the pipeline diameter and shall be set to open at a pressure no greater than 5 lb/in^2 above the pressure rating of the pipe.

The pressure at which the valves start to open shall be marked on each pressure-relief valve. 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 the design and acceptance of these valves.

Air-Release Valves. The three basic types of air-release valves for irrigation pipelines are:

- An **air-release valve** is a continuously acting valve that has a small venting orifice, generally ranging between 1/16 and 3/8 inch in size. This valve releases pockets of air from the pipeline once the line is filled and under working pressure.
- An **air-and-vacuum valve** has a large venting orifice, exhausts large quantities of air from the pipeline during filling and allows air to reenter the line and prevents a vacuum from forming during emptying. This valve is also called an air-vacuum-release 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 after the valve closes.
- A **combination air valve** is sometimes called a combination air-release and air-vacuum valve or combination air-and-vacuum-relief valve. It is continuous acting and combines the functions of both the air-release valve and the air-and-vacuum valve. Both valves are housed in one valve body.

If needed to provide positive means for air escape during filling and air entry while emptying, air-vent and vacuum-relief valves or combination air valves shall be installed at all summits, at the entrance, and at the end(s) of the pipeline. Such valves generally are needed at these locations if the line is truly closed to the atmosphere.

However, they may not be needed if other features of the pipeline system, such as permanently located sprinkler nozzles or other unclosed service outlets, adequately vent the particular location during filling and emptying operations.

The ratio of air-release valve diameter to pipe diameter for valves intended to release air when filling the pipe should not be less than 0.1. However, small-diameter valves may be used to limit water hammer pressures by controlling air release where control of filling velocities is questionable. Equivalent valve outlet diameters of less than 0.1 are permitted for continuously acting air-release valves. Adequate vacuum relief must be provided.

Air release valves or combination air valves shall be used as needed to permit air to escape from the pipeline while the line is at working pressure. Small orifices of these types shall be sized according to the working pressure and venting requirements recommended by the valve manufacturer.

Manufacturers of air valves marketed for use under this standard shall provide dimensional data, which shall be the basis for selection and 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 manufacturer 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 may drain into dry wells or to points of lower elevation. If drainage cannot be 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.

Design Capacity. Abrupt changes in pipeline grade, horizontal alignment, or reduction in pipe size normally require an anchor or thrust blocks to absorb any axial thrust of the pipeline. Thrust control may also be needed at the end of the pipeline and at in-line control valves.

Thrust blocks and anchors must be large enough to withstand the forces tending to move the pipe, including those of momentum and pressure as well as forces due to expansion and contraction.

The pipe manufacturer's recommendations for thrust control shall be followed. In the absence of the pipe manufacturer's requirements, the following equation must be used in designing thrust blocks:

$$A = \frac{98 * H * D^2}{B} \sin\frac{a}{2}$$

Where:

A = Area of thrust block required in ft^2
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 block area for a 90º pipe angle.

If adequate soil tests are not available, the passive soil pressure may 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
Sound Bedrock	8,000	10,000	10,000	10,000
Dense sand and gravel mixture (assume Φ=40º)	1,200	1,800	2,400	3,000
Dense fine to coarse sand (assume Φ=35º)	800	1,200	1,650	2,100
Silt and clay mixture (assume Φ=25º)	500	700	950	1,200
Soft clay and organic soils (assume Φ=10º)	200	300	400	500

Materials. All materials described and required in this standard shall meet or exceed the minimum requirements contained in the plans and specifications.

CONSIDERATIONS

Additional recommendations relating to design that may enhance the use of, or avoid problems with, this practice but are not required to ensure its basic conservation functions are as follows.

- If irrigation application methods (for example, trickle irrigation) have limiting working pressures, pressure-relief valves should be considered to ensure the pressure created in the pipeline does not exceed the allowable pressure.
- Chemigation valves (double-seated check valves with air relief and low pressure drain) should be used on all pipelines in which fertilizer, pesticides, acids, or other chemicals are added to the water supply and where drainage may contaminate the mainline, water supply, or ground water.
- Where pipelines are to be drained, consideration should be given to disposal of drained water.
- Consideration should be given to the direction of water leaving an air valve or pressure-relief valve. If possible, the flow should be directed away from electrical equipment and hook-ups.
- Design processes should consider safety elements when installations are effected by utilities.

PLANS AND SPECIFICATIONS

Plans and specifications shall be prepared in accordance with the criteria of this standard and shall describe the requirements for applying the practice to achieve its intended use.

The following list of Construction Specifications is intended as a guide to selecting the appropriate specifications for a specific project. The list includes most, but may not contain all, of the specifications needed for a specific project:

IA-1 Site Preparation
IA-5 Pollution Control
IA-6 Seeding and Mulching for Protective Cover
IA-21 Excavation
IA-24 Drainfill
IA-26 Salvaging and Spreading Topsoil
IA-32 Concrete for Nonstructural Slabs
IA-45 Plastic (PVC, PE) Pipe
IA-81 Metal Fabrication and Installation
IA-83 Timber Fabrication and Installation

OPERATION AND MAINTENANCE

An operation and maintenance (O&M) plan must be prepared for use by the owner/operator. Provide specific instructions for proper function, periodic inspection, and repair.

REFERENCES

USDA-NRCS, National Engineering Handbook (NEH), Part 650, Engineering Field Handbook (EFH), Chapter 3, Hydraulics and Chapter 15, Irrigation

Design, Installation, and Performance of Underground Thermoplastic Irrigation Pipelines, ASABE S376.1