NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE STANDARD

IRRIGATION WATER CONVEYANCE HIGH-PRESSURE, UNDERGROUND, PLASTIC PIPELINE (ft) CODE 430DD

DEFINITION

A pipeline and appurtenances installed in an irrigation system.

SCOPE

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

The standard includes the design criteria and minimum installation requirements for high-pressure, plastic irrigation pipelines and specifications for the thermoplastic pipe.

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

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

DESIGN CRITERIA

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.

Capacity. The design capacity of the pipeline shall be based on whichever of the following criteria is 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 stream for all methods of irrigation planned.

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.

Outlets. Appurtenances 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 known 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-in. 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 design of pressure setting and of acceptance of these valves.

Air-release valves. The three basic types of air-release valves for use on irrigation pipelines are described below:

An air-release valve, a continuously acting valve that has a small venting orifice, generally ranging between 1/16 and 3/8 in. 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, which 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 type of valve is sometimes called 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 once 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-and-vacuum 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 pipe 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 diameter 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 vales marketed for use under this standard shall provide dimensional data, which shall be the basis for selection and acceptance of these valves.

Drainage. Provision 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.

Thrust control. 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 absence of the pipe manufacturer's requirements, the following formula must be used in designing thrust blocks:

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

Where:

A=Area of thrust block required in ft
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 area of block required for a 90°-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 shall meet or exceed the minimum requirements indicated in "Specifications for Materials."

PLANNING CONSIDERATIONS

Water Quantity

1. Effects on components of the water budget, especially 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 soils and on 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.

PLANS AND SPECIFICATIONS

Plans and specifications for constructing high-pressure underground plastic pipeline shall be in keeping with this standard and shall describe the requirements for applying the practice to achieve its intended purposes.

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/ft²			
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

NRCS, AR
April, 2002

Construction Specification

IRRIGATION WATER CONVEYANCE

HIGH-PRESSURE, UNDERGROUND, PLASTIC PIPELINE

1. SCOPE

This specification covers the minimum requirements for materials, excavation, backfill, appurtenances, testing and installation of high-pressure underground plastic pipelines. Construction operations shall be accomplished in such a manner that erosion, water, air, and noise pollution will be minimized and held within legal limits. The completed job shall be workmanlike and present a good appearance.

2. MATERIALS AND INSTALLATION

Minimum depth of cover. Pipe shall be installed at sufficient depth below the ground surface to provide protection from hazards imposed by traffic crossings, farming operations, freezing temperatures, or soil cracking. The minimum depth of cover for pipe susceptible to any of these hazards shall be:

Pipe diameter in. Depth of Cover in.
1/2 through 2 1/2 18
3 through 5 24
6 or more 30

At low places on the ground surface, extra fill may be placed over the pipeline to provide the minimum depth of cover. The top width of the fill shall then be no less than 10 ft. and the side slopes no steeper than 6:1. If extra protection is needed at vehicle crossings, encasement pipe or other approved methods may be used. In areas where the pipe will not be susceptible to freezing and vehicular or cultivation hazards and the soils do not crack appreciably when dry, the minimum depth of cover may be reduced to:

Pipe diameter in. Depth of cover in.
1/2 through 1 1/2 6
2 through 3 12
4 through 6 18
More than 6 24

Trench construction. At any point below the top of the pipe the trench shall 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 side of the pipe. The maximum trench width shall be 36 inches. If the trench is precision excavated and has a semicircular 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 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 rocks, boulders, or any other material that can damage the pipe are encountered, the trench bottom shall be undercut a minimum of 4 inches below final grade and filled with bedding material consisting of sands or compacted fine-grained soils. Pipelines having a diameter of ½ through 2½ in. that are to be placed in areas not subject to vehicular loads and in soils that do not crack appreciably when dry may be placed by using "plow-in" equipment instead of conventional trenching. Provisions shall be made to ensure safe working conditions where unstable soil, trench depth, or other conditions can be hazardous to personnel working in and near the trench. Placement. Care shall be taken to prevent permanent distortion and damage when handling the pipe during unusually warm or cold weather. The pipe shall be allowed to come within a few degrees of the soil temperature before placing the backfill, other than that needed for shading, or before connecting the pipe to other facilities. 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 bell joints, bell holes shall be excavated in the bedding material, as needed, to allow for unobstructed assembly of joints. The body of the pipe shall be in contact with the bedding material throughout its length. 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 obstruction that may tend to reduce its capacity below design requirements. All fittings, such as couplings, reducers, bends, tees, and crosses, shall be installed according to the recommendations of the pipe manufacturer. Fittings made of steel or other metals susceptible to corrosion shall be adequately protected by plastic tape wrapping or by applying a coating having high corrosion-preventative qualities. If plastic tape wrapping is used, all surfaces shall be thoroughly cleaned and coated with a primer compatible with the tape. Thrust blocks. Thrust blocks must 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 top of the pipe using only the simplest of forms.

3. TESTING

Testing. The pipeline shall be tested for pressure strength, leakage, and proper functioning. The tests may be performed before backfilling or anytime after the pipeline is ready for service. Tests for pressure strength and leaks shall be accomplished by inspecting the pipeline and appurtenances while the maximum working pressure is maintained and all joints and connections are uncovered, or by observing normal operation of the pipeline after it is put into service. Partial backfills needed to hold the pipe in place during testing shall be placed as specified in "Initial Backfill." Any leaks shall be repaired and the system shall be retested. The pipeline shall be tested to insure that it functions

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 the pipeline, or detrimental discharge from control valves. Initial backfill. Hand, mechanical, or water packing methods may be used. The initial backfill material shall be soil or sand that is free from rocks or stones larger than 1 inch in diameter. At the time of placement, the moisture content of the material shall be such that the required degree of compaction can be obtained with the backfill method to be used. The initial backfill material shall be placed so that the pipe will not be displaced, excessively deformed, or damaged. If backfilling is done by hand or mechanical means, the initial fill shall be compacted firmly around and above the pipe as required to provide adequate lateral support to the pipe. If the water packing method is used, the pipeline first shall be filled with water. The initial backfill before wetting, shall be of sufficient depth to insure complete coverage of the pipe after consolidation. Water packing is accomplished by adding water to diked reaches of the trench in sufficient quantity to thoroughly saturate the initial backfill without excessive pooling of water. After the backfill is saturated, the pipeline shall remain full until after the final backfill is made. The wetted fill shall be allowed to dry until firm before beginning the final backfill. Final backfill. The final backfill material shall be free of large rocks, frozen clods, and other debris greater than 3 inches in diameter. The material shall be placed and spread in approximately uniform layers so that there will be no unfilled spaces in the backfill. The backfill shall be mounded above the natural ground in order to provide the minimum depth of cover after settlement. Rolling equipment shall not be used to consolidate the final backfill until the specified minimum depth of cover has been placed. Plastic pipe. Plastic pipe shall meet or exceed the requirements specified in the listed ASTM Specifications. Polyethylene pipe materials shall be Class C (black) as specified in ASTM D1248.

Pipe requirements. All pipe installed under this standard shall be pressure rated for water. Plastic pipe manufactured tested, and marked to meet one of the following ASTM specifications shall be acceptable.

ASTM D1785	Standard Specification for Polyvinylchloride (PVC) Plastic Pipe, Schedules 40, 80, and 120
D2241	Polyvinylchloride (PVC) Pressure-rated Pipe (SDR-Series)
D2740	Polyvinylchloride (PVC) Plastic Tubing
D1527	Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe, Schedules 40 and 80
D2282	Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe (SDR-PR)
D2104	Polyethylene (PE) Plastic Pipe, Schedule 40
D2239	Polyethylene (PE) Plastic Pipe, (SIDR-PR) Based on Controlled Inside Diameter
ASTM D2447	Standard Specification for Polyethylene (PE) Plastic Pipe, Schedules 40 and 80, Based on Outside Diameter.
D2737	Polyethylene (PE) Plastic Tubing
D3035	Polyethylene (PE) Plastic Pipe (DR-PR), Based on Controlled Outside Diameter

The specific pipe size, required pressure rating, minimum SDR, pipe schedule, and other requirements pertinent to the job shall be as shown on the drawings. Pipe conforming to other ASTM or AWWA specifications and meeting or exceeding specified requirements for this job may be used if approved by the responsible engineer.

Markings. Markings on the pipe shall include the following, which shall be spaced

at intervals of not more than 5 ft.:

- Nominal pipe size (e.g.: 2 in.)
- Type of plastic pipe material, by designation code (e.g.: PVC 1120).
- Pressure rating, lb./in.2 23°C (73.4°F) (e.g.: 160 lb./in.2).
- Specification designation with which the pipe complies:
  a. For IPS-size pipe, the ASTM designation (For example: D-2241). Pipe meeting one of the ASTM designations listed for IPS-size pipe and intended for the transport of potable water shall also be marked with the seal of a recognized laboratory making the evaluation for this purpose.
  b. For plastic irrigation pipe, the desination PIP.

- Manufacturer' s name (or trademark) and code.

Fittings, couplings and joints. All fittings, couplings, and joints shall meet or exceed the same strength requirements as those of the pipe and shall be made of material that is recommended for use with the pipe. Solvent cement and rubber gasket joints shall be assembled according to the manufacturers' recommendations.

Basis of acceptance. The acceptability of the pipeline shall be determined by inspections to check compliance with all the provisions of NRCS Engineering Standard 430-DD with respect to the design of the line, the pipe and pipe marking, the appurtenances used, and the minimum installation requirements. Details of construction shown in the plans, but not included in these specifications, shall be considered as a part of the specifications. To document acceptability, the design notes, records, and plans shall be in accordance with TR-62 and as supplemented.

Certification and guarantee. The manufacturer is to furnish written certification of compliance with the Specifications for Materials in NRCS Engineering Standard 430-DD, along with a description of the method to be used in identifying the certified pipe. The installing contractor shall certify that his installation complies with the requirements of these specifications. 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. The installing contractor shall furnish NRCS a copy of his certification and guarantee, which will be a part of the supporting records of the pipeline.

Measurement. The amount of pipeline completed as specified will be determined by measuring the length, in feet, of each size and kind of pipe installed.