

**NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE STANDARD**

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

DEFINITION

A pipeline and appurtenances installed in an irrigation system.

PURPOSE

Prevent erosion or loss of water quality or damage to the land, to make possible proper management of irrigation water, and 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 pipeline 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.

CRITERIA

Working pressure and flow velocity. The minimum acceptable class of pipe shall be that having a pressure rating for water of 80 pounds per square inch.

The pipeline shall be designed to meet all service requirements without an operating 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, and the design flow velocity at system capacity shall not be greater than 5 ft/s. If either of these limits is exceeded, special consideration must be given to the flow conditions and measures 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

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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 1/4 inch nominal size for each diameter inch of the pipeline and shall be set to open at a pressure no greater than 5 pounds per square inch above the pressure rating of the pipe.

The pressure 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 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, 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 continuous acting valve that has a small venting orifice, generally ranging between 1/16 inch 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, 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-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 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 pump system, such as permanently located sprinkler nozzles or other unclosed service outlets, adequately vent the particular location during filling and emptying operations.

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

- 1/2 inch for 5-inch or less pipelines
- 1 inch for 6- to 10-inches pipelines
- 1-3/4 inch for 12 to 15-inches pipelines

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 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 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 inline control valves.

Thrust blocks and anchors must be of sufficient size 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:

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

Where:

- A = Bearing area of thrust block required
- H = Maximum working pressure in feet
- D = Inside diameter of pipe in feet
- B = Allowable bearing pressure of the soil in pounds per square foot
- 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 the following:

	pounds per square inch
Sound shale	10,000
Cemented gravel and sand difficult to pick	4,000
Coarse and fine compact sand	3,000
Medium clay, can be spaded	2,000
Soft clay	1,000
Muck	0

The figures are applicable for a 4-foot cover measured from ground surface to the centerline of the thrust block. For other depths, divide the figures by 4 and multiply by the installation depth (in feet.).

Materials. All materials shall meet or exceed the minimum requirements indicated in "Specifications for Materials."

PLANS AND SPECIFICATIONS

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

OPERATION AND MAINTENANCE

All irrigation systems must be adequately maintained to perform as planned and designed. Provisions for maintenance access must be provided.

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NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE SPECIFICATION

FOR
IRRIGATION WATER CONVEYANCE
HIGH-PRESSURE, UNDERGROUND, PLASTIC PIPELINE SPECIFICATION
(feet)
CODE 430-DD

INSTALLATION

Minimum depth of cover. Pipe shall tubing 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 <i>inches</i>	Depth of cover <i>inches</i>
1/2 through 2-1/2.....	18
3 through 5.....	24
6 or more.....	30

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 <i>inches</i>	Depth of cover <i>inches</i>
1/2 through 1-1/2.....	6
2 through 3.....	12
4 through 6.....	18
More than 6.....	24

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.

Trench construction. Trench at any point below the top of the pipe line 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 sides 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 lays 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 sand or compacted fine-grained soils.

Pipelines having a diameter of 1/2 through 2-1/2 inch 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 insure safe working conditions where unstable soil, trench depth, or other conditions can be hazardous to personnel working 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 temperature it will have after it is completely covered 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.

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For pipe with bell joints, bell holes shall be excavated in the bedding material, 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 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 wrapping them with plastic tape or by applying a coating having high corrosion-preventative qualities. If plastic tape is used, all surfaces to be wrapped shall be thoroughly cleaned and coated with a primer compatible with the tape before wrapping.

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 trench wall shall be filled to the height of the outside diameter of the pipe or as specified by the manufacturer.

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 retested.

The pipeline shall be tested to ensure 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 steady delivery of water, damage to the pipeline, or detrimental discharge from control valves.

Initial backfill. Hand, mechanical, or hand 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 in and spread in approximately uniform layers so 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. Rolling equipment shall not be used to consolidate the final backfill until the specified minimum depth of cover has been placed.

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

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

Certifications and guarantee. If requested by the state conservation engineer, a qualified testing laboratory must certify with supporting test results that the pipe meets the requirements specified in this standard. The seal of approval of a recognized laboratory on pipe bearing one of the ASTM designations listed in this standard may be accepted for this certification.

The installing contractor shall certify that his 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. The certification identifies the manufacturer and markings of the pipe used.

MATERIALS

Quality of plastic pipe. The compound used in manufacturing the pipe shall meet the requirements of one of the following materials:

1. Polyvinyl chloride (PVC) as specified in ASTM D1784.

<u>Material</u>	<u>Code classification</u>
Type I, Grade 1.....	12454-B
Type I, Grade 2.....	12454-C
Type II, Grade 1.....	14333-D

2. Acrylonitrile-butadiene-styrene (ABS) as specified in ASTM D1788.

<u>Material</u>	<u>Code classification</u>
Type I, Grade 2.....	5-2-2
Type I, Grade 3.....	3-5-5
Type II, Grade 1.....	4-4-5

3. Polyethylene (PE) as specified in ASTM D1248.

<u>Material</u>	<u>Code classification</u>
Grade P14, Class C.....	IC-P14
Grade P23, Class C.....	IIC-P23
Grade P33, Class C.....	IIIC-P33
Grade P34, Class C.....	IVC-P34

The pipe shall be homogeneous throughout and free from visible cracks, holes, foreign matter, or other defects. The pipe shall be as uniform in color, opacity, density, and other physical properties as is commercially practicable.

Pipe requirements. All pipe installed under this standard shall be pressure rated for water.

The relationship between standard dimension ratios, dimensions, hydrostatic design stresses, and pressure ratings shall be determined by one of the following formulas:

For PVC, ABS, and PE pipe with outside diameter controlled:

$$\frac{2 S}{P} = \frac{D_o}{t} - 1 \text{ or } \frac{2 S}{P} = R - 1$$

For PE pipe with inside diameter controlled:

$$\frac{2 S}{P} = \frac{D_i}{t} + 1 \text{ or } \frac{2 S}{P} = R + 1$$

Where:

S = hydrostatic design stress, in pounds per square inch

P = pressure rating in pounds per square inch

D_o = average outside diameter in inches

D_i = average inside diameter in inches

t = minimum wall thickness in inches

R = standard thermoplastic pipe dimension ratio (SDR)

Hydrostatic design stresses for the plastic pipe material are given in table 1.

IPS-size (outside diameter same as that for iron pipe sizes) and I.D. controlled PE pipe manufactured, tested, and marked to meet one of the following ASTM specifications shall be acceptable under this standard. Water pressure ratings and pertinent dimensions for this pipe are given in tables 3, 4, 5, 6, and 7.

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ASTM- Standard specification for-

- D1785 Poly (vinyl chloride) (PVC) Plastic Pipe, Schedules 40, 80, 120
- D2241 Poly (vinyl chloride) (PVC) Plastic Pipe, (SDR-PR)
- D2672 Bell-End Poly (vinylchloride) (PVC) Pipe
- D2740 Poly (vinyl chloride) (PVC) Plastic Tubing
- D1527 Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe, Schedules 40 and 80
- ASTM- Standard specification for-
- D2282 Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe (SDR-PR)
- D2104 Polyethylene (PE) Plastic Pipe, Schedule 40
- D2239 Polyethylene (PE) Plastic Pipe (SDR-PR)
- D2447 Polyethylene (PE) Plastic Pipe, Schedules 40 and 80, based on outside diameter
- D2737 Polyethylene (PE) Plastic Tubing
- D3035 Polyethylene (PE) Plastic Pipe (SDR-PR), based on controlled outside diameter

PIP-size (plastic irrigation pipe) pipe shall meet the requirements of ASTM-D2241 or of ASTM-D2282 except that::

1. The outside diameters, wall thicknesses, and tolerances given in table 2 shall apply.
2. The sustained pressure test shall not be required.
3. The burst pressure tests shall be performed according to the procedures listed in ASTM D2241 or D2282 and shall meet the applicable requirements given in these ASTM's or those listed below for the standard dimension ratios (SDR's) currently not included in ASTM D2241 or D2282.

Burst pressure requirements for water at 23 degrees C (73.4 degrees F) for PVC 1120 and PVC 1220 plastic pipe are:

SDR	Minimum burst pressure ¹
	lb/in.2
51	260

¹ The design stress levels used to derive these test pressures are PVC 1120--6,400 pounds per square inch; PVC 1220--6,400 pounds per square inch.

Burst pressure requirements for water 23 degrees C (73.4 degrees F) for ABS plastic pipe are:

SDR	Minimum burst pressure ¹	
	ABS 2112	ABS 1316
	lb/in.2	lb/in.2
32.5	420	380
41	---	300

¹ The fiber stresses used to derive these test pressures are ABS 2112--6,600 pounds per square inch; ABS 1316--6,000 pounds per square inch. To simply testing, minor adjustments have been made to deep the test pressures uniform.

Markings. Markings on the pipe shall include the following, which shall be spaced at intervals of not more than 5 feet::

1. Nominal pipe size (for example, 2 inches)
2. Type of plastic pipe material, by designation code (for example, PVC 1120).
3. Pressure rating , in pounds per square inch, for water at 23o C (73.4o F) (for example, 160 pounds per square inch).
4. 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 designation PIP.
5. Manufacturer's name (or trademark) and code.

Fittings and couplers. All fittings and couplers shall meet or exceed the same

strength requirements as those of the pipe and shall be made of material that is recommended Listed below are the ASTM standard specifications for fittings suitable for use with IPS-size pipe and inside diameter controlled PE pipe covered by this standard:

ASTM	Standard specification for
D2466	Socket-type Poly (vinyl chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
D2467	Socket-type Poly (vinyl chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
D3036	Poly (vinyl chloride) (PVC) Plastic Line Couplings, Socket type.
D2468	Socket-type Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe fittings, Schedule 40.
D2469	Socket-type Acrylonitrile-Butadiene-Styrene (ABS) Plastic fittings, Schedule 80.
D2609	Plastic Insert Fittings for Polyethylene (PE) Plastic Pipe.
D2610	Butt Fusion Polyethylene (PE) Plastic Pipe Fittings, Schedule 40 (for PS pipe).
D2611	Butt Fusion Polyethylene (PE) Plastic Pipe Fittings, Schedule 80 (for IPS pipe).
D2683	Socket-type Polyethylene Fittings for SDR 11.0 Polyethylene pipe.
D3139	Standard Specification for Plastic Pressure Pipe using Flexible Elastomeric Seals.

Plastic irrigation pipe (PIP) shall have belled ends or separate couplers and fittings that are suitable for joining the pipe and appurtenances by solvent cement, rubber gaskets, or other methods recommended by the pipe manufacturer. Such fittings and joints shall be capable of withstanding a working pressure equal to or greater than that for the pipe.

Solvent cement joints. Solvent for solvent cement joints shall conform to ASTM Specification D2564 for PVC pipe and fittings and to ASTM D2235 for ABS pipe and fittings.

Solvent cement joints shall be used and constructed according to the recommendations of the pipe manufacturer.

for use with the pipe.

Rubber gasket joints. Rubber gasket joints shall conform to ASTM Specification D3139.

Table 1.--Hydrostatic design stress and designation--plastic pipe

Plastic pipe material	Hydrostatic design stress	Designation
	lb/in.2	
PVC Type I, Grade 1	2,000	PVC 1120
PVC Type I, Grade 2	2,000	PVC 1220
PVC Type II, Grade 1	1,000	PVC 2110
PVC Type II, Grade 1	1,250	PVC 2112
PVC Type II, Grade 1	1,600	PVC 2116
ABS Type I, Grade 2	800	ABS 1208
ABS Type I, Grade 2	1,000	ABS 1210
ABS Type I, Grade 3	1,600	ABS 1316
ABS Type II, Grade 1	1,250	ABS 2112
PE Grade P14	400	PE 1404
PE Grade P23	500	PE 2305
PE Grade P23	630	PE 2306
PE Grade P33	630	PE 3306
PE Grade P34	630	PE 3406

(Tables 2-8 are under construction)