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.

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 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.

CRITERIA

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.

Utilities and Permits. The landowner shall be responsible for locating all buried utilities in the project area, including drainage tile and other structural measures.

The landowner shall obtain all necessary permissions from regulatory agencies, including the Illinois Department of Agriculture, US Army Corps of Engineers, US Environmental Protection Agency, Illinois Environmental Protection Agency and Illinois Department of Natural Resources – Office of Water Resources, or document that no permits are required.

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/sec. If either of these limits is exceeded, special consideration must be given to the flow conditions and

Conservation practice standards are reviewed periodically and updated if needed. To obtain the current version of this standard, contact your Natural Resources Conservation Service State Office or visit the electronic Field Office Technical Guide.

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 for 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 with a ratio of less than 0.1 is 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.

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 procedure of National Engineering Handbook, Part 636.5207 shall be used to design thrust blocks.

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

Protection. Plastic pipe installed above ground shall be resistant to ultraviolet light throughout the intended life of the pipe.

All pipes shall be protected from hazards presented by traffic, farm operations, freezing temperatures, fire, thermal expansion and contraction. Reasonable measures should be taken to protect the pipe from potential vandalism.

Unless otherwise specified, plastic pipe shall be buried at least 24 inches for ordinary field traffic. When crossing under a road, the pipeline shall be buried deeper or protected from collapsing by placing in a steel or concrete conduit.

Other means of protection must be provided if the depth required for protection is impractical because of shallow soils over rock or for other reasons. Abrupt changes in grade must be avoided to prevent damage to pipe.

Pipelines shall be buried below frost line or otherwise be protected from freezing. If pipeline cannot be protected from freezing, the pipeline will be provided with valves properly located so the pipe can be drained during periods of freezing temperatures.

Drainage. Provision shall be made for completely draining the pipeline if a hazard is imposed by freezing temperatures, if drainage is recommended by the manufacturer of the pipe, or if 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.

CONSIDERATIONS

Effects on components of the water budget, especially infiltration and evaporation.

Effects on downstream flows or aquifers that would affect other water uses or users.

Potential use for irrigation water management.

Effects of installing a pipeline on vegetation that may have been located next to the original conveyance.

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.

Effects on the movement of dissolved substances into the soils and on percolation below the root zone or to ground water recharge.

Effects of controlled water delivery on the temperatures of water resources that could cause undesirable effects on aquatic and wildlife communities.

Effects on wetlands or water-related wildlife habitats.

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.

OPERATION AND MAINTENANCE

An Operation and Maintenance (O&M) plan shall be prepared for and reviewed with the landowner or operator. The plan shall specify that the pipeline and associated practices are inspected annually and after significant storm events to identify repair and maintenance needs.

The O&M plan shall include, but not be limited to, the following provisions:

Protecting pipeline from damage by farm equipment, vehicles, and livestock;

Checking for leaks and improper operation. Repair any damage as soon as possible;

Repairing any eroded areas that are hazardous to the pipeline. Reestablish vegetative cover immediately where erosion has occurred;

Marking pipeline locations in areas where potential damage could occur by other activities;

Recording on a map the location of pipeline and approximate depth;

Checking to ensure needed volume of water is being supplied at the designed pressure;

Opening/closing valves to prevent excessive water hammer;

Inspecting quick connects to ensure proper operation and adequate designed delivery rate;

Inspecting and testing valves, pressure regulators, pumps, switches and other appurtenances;

Checking for debris, minerals, algae and other materials that may restrict system flow; and

Draining and/or providing for cold weather operation of the system.

REFERENCES

NRCS National Engineering Handbook, Part 636, Chapter 52, Structural Design of Flexible Conduits.

NRCS National Engineering Handbook, Chapter 15, Irrigation.

NATURAL RESOURCES CONSERVATION SERVICE
ILLINOIS CONSTRUCTION SPECIFICATION

HIGH-PRESSURE, UNDERGROUND, PLASTIC PIPELINE

General

Construction operations shall be carried out in a manner and sequence that erosion and air and water pollution are minimized and held within legal limits.

The completed job shall present a workmanlike appearance and shall conform to the line, grades, and elevations shown on the drawings or as staked in the field.

All operations shall be carried out in a safe and skillful manner. Safety and health regulations shall be observed and appropriate safety measures used. Contractor shall be assured that all state laws concerning buried utilities have been met.

All trees, stumps, roots, brush, weeds, and other objectionable materials shall be removed from designated work area.

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. Unless otherwise specified, plastic pipe shall be buried at least 24 inches for ordinary field traffic. When crossing under a road, the pipeline shall be buried deeper or protected from collapsing by placing in a steel or concrete conduit.

Other means of protection must be provided if the depth required for protection is impractical because of shallow soils over rock or for other reasons. Abrupt changes in grade must be avoided to prevent damage to pipe.

Pipelines shall be buried below frost line or otherwise be protected from freezing.

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 feet and the side slopes no steeper than 6:1.

Trench Construction

The trench at any point below the top of the pipe 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 %.

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 sand or compacted fine-grained soils.

Pipelines having a diameter of 1/2 through 2 1/2 inches 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 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.

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.

Materials

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.

Material	Classification
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-D-1788.

Material	Classification
Type I, Grade 2	5-2-2
Type 1, Grade 3	3-5-5
Type II Grade 1	4-4-5

3. Polyethylene (PE) as specified in ASTM-D-1248.

Material	Classification
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.

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

Iron pipe size (IPS) (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.

ASTM Standard Specification for Pipe	
D-1785	PVC, Schedules 40, 80 and 120
D-2241	PVC, SDR-PR
D-2672	Bell-End PVC
D-2740	PVC Plastic Tubing
D-1527	ABS, Schedules 40 and 80
D-2282	ABS, SDR-PR
D-2104	PE, Schedule 40
D-2239	PE, SDR-PR
D-2447	PE, Schedules 40 and 80, O.D.
D-2737	PE Plastic Tubing
D-3035	PE, SDR-PR, O.D.
F-771	PE Irrigation Pipeline Systems

Plastic irrigation pipe (PIP) shall meet the requirements of ASTM-D-2241 or of ASTM-D-2282.

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.

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 for use with the pipe. Listed below are the ASTM standard specifications for fittings covered by this standard.

ASTM Standard Specification for Fittings	
D-2466	Socket-type PVC, Schedule 40
D-2467	Socket-type PVC, Schedule 80
D-2468	Socket-type ABS, Schedule 40
D-2609	PE Plastic Insert Fittings
D-2683	Socket-type PE, SDR 11.0
D-3139	Flexible Elastomeric Seals
D-3261	PE Butt Heat Fusion Fittings

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 for solvent cement joints shall conform to ASTM Specification D-2564 for PVC pipe and fittings and to D-2235 for ABS pipe and fittings. Solvent cement joints shall be used and constructed according to the recommendations of the pipe manufacturer.

Rubber gasket joints shall conform to ASTM Specification D-3139.

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 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 ensure complete coverage of the pipe after consolidation. Water packing is accomplished by adding enough water to diked reaches of the trench to thoroughly saturate the initial backfill without excessive pooling. 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

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 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.

Mound soil over pipe to allow for settlement. Provisions shall be provided for stabilizing disturbed areas and controlling erosion, as necessary.

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

Vegetation

Topsoil shall be added, if needed to establish vegetation. Refer to Conservation Practice Standard 342, Critical Area Treatment, for seeding and mulching recommendations or equivalent.