

**Natural Resources Conservation Service
Conservation Practice Standard**

**IRRIGATION WATER CONVEYANCE
STEEL PIPELINE
(Ft.)
CODE 430FF**

DEFINITION

A pipeline and appurtenances installed in an irrigation system.

PURPOSE

To prevent erosion or loss of water quality or damage to land, to make possible the proper management of irrigation water, and to reduce water conveyance losses.

CONDITIONS WHERE PRACTICE APPLIES

This standard applies to the design and installation of buried steel irrigation pipelines and steel irrigation pipelines permanently installed above ground. If soil conditions do not permit below ground installation, on-ground installation is restricted to pipelines not greater than 6 in. in diameter. Pipelines greater than 6 in. installed under those conditions shall be placed on aboveground supports. This standard is restricted to pipelines not greater than 48 in. in diameter and does not apply to short pipes used in structures such as siphons, outlets from canals, and culverts under roadways.

The pipeline shall be planned and located to serve as an integral part of an irrigation water distribution or conveyance system that has been designed to facilitate the conservation use of soil and water resources on a farm or group of farms.

All areas served by the pipeline shall be suitable for use as irrigated land.

Water supplies and irrigation deliveries to the area shall be sufficient to make irrigation practical for the crops to be grown and the irrigation water application methods to be used.

CRITERIA

Design

Working pressure. The pipeline shall be designed to meet all service requirements without the use of a working pressure that will produce tensile stresses in the pipe greater than a design stress equal to 50 percent of yield-point stress. Design stresses for commonly used steel and steel pipe classes are shown in column two below:

Specification and grade of steel	Design stress 50 pct yield point <i>lb/in.²</i>
ASTM-A-283	
Grade B	13,500
Grade C	15,000
Grade D	16,500
ASTM-A-570	
Grade A	12,500
Grade B	15,000
Grade C	16,500
Grade D	20,000
Grade E	21,000
AWWA-C-200	
Furnace butt weld	12,500
Grade A	15,000
Grade B	17,500
Grade X42	21,000

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

In computing tensile stresses in steel pipe, the following items must be considered:

- The pressure to be delivered at the end of the pipeline.
- The friction head loss.
- The elevation differential between the outlet and the inlet of the pipe.
- Any pressure due to water hammer or surge that may be created by the closure of a valve in the pipeline.

Flow capacity. The design capacity shall be based on whichever of the following is greater:

- Capacity to deliver sufficient water to meet the weighted peak consumptive use rate of the crops to be grown.
- Capacity sufficient to provide an adequate irrigation stream for the methods of irrigation to be used.

Minimum wall thickness. Minimum pipe wall thickness shall be as follows:

Nominal diameter in.	Wall thickness
4 - 12	14 gage less 12.5 %
14 - 18	12 gage less 12.5 %
20 - 24	10 gage less 12.5 %
26 - 36	3/16 in. less 12.5 %
38 - 48	1/4 in. less 12.5 %

Friction loss. For design purposes, the pipeline friction loss shall be based on that computed with Manning's Formula with n equal to no less than 0.012 for unlined and no less than 0.010 for lined pipe.

Check, pressure-relief, vacuum-release, and air-release valves. If detrimental backflow may occur, a check valve shall be installed between the pump discharge and the pipeline.

A pressure-relief valve shall be installed at the pump location if excessive pressure can build up when all valves are closed. Also, in closed systems where the line is protected from reversal of flow by a check valve and excessive surge pressure can build up, a surge chamber or a pressure-relief valve shall be installed close to the check valve on the side from the pump.

Pressure-relief valves shall be no smaller than 1/4 in. nominal size for each diameter inch of

the pipeline and shall be set at a maximum of 5 lb/in.² above the safe working pressure of the pipeline. A pressure-relief valve or surge chamber shall be installed at the end of the pipeline if needed to relieve surge.

Air-release and vacuum-release valves or combination air-release and vacuum-release valves shall be placed at all summits in the pipeline, at the end of the line, and between the pump and check valve if needed to provide a positive means of air entrance or escape.

Air-release and vacuum-release valve outlets shall be at least 1/2 in. in nominal diameter when specified for lines 4 in. or less in diameter, at least 1 in. outlets for lines 5 to 8 in. diameter, at least 2 in. outlets for lines 10 to 16 in. diameter, at least 3 in. outlets for lines 18 to 28 in. in diameter, at least 6 in. outlets for lines 30 to 36 in. in diameter, and at least 8 inches outlets for lines 38 to 48 in. in diameter.

For pipelines larger than 16 in. in diameter, 8 in. air-release valves may be used in place of the sizes indicated if they are supplemented with vacuum-release valves that provide a vacuum-release capacity equal to the sizes shown.

Drainage and flushing. Provisions shall be made for completely draining the pipeline if freezing temperatures imposes a hazard or if drainage 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 at all low places in the line. If drainage cannot be provided by gravity, provisions shall be made to empty the line by pumping

Outlets. Appurtenances for delivering water from a pipe system to the land, to a ditch, or to a surface pipe system shall be known, as outlets. Outlets shall have capacity to deliver the required flow:

- To a point at least 6 in. above the field surface.
- To the hydraulic gradeline of a pipe or ditch.
- To an individual sprinkler, lateral line, or other sprinkler line at the design operating pressure of the sprinkler or line.

Pipe supports. Irrigation pipelines placed above ground shall be supported by suitably built concrete, steel, or timber saddles shaped to support the pipe throughout the arc of contact, which shall be not less than 90 degrees nor more than 120 degrees as measured at the central angle of the pipe. If needed to prevent overstressing, ring girder-type supports shall be used. Support spacing shall insure that neither the maximum beam stresses in the pipe span nor the maximum stress at the saddle exceed the design stress values.

Thrust control. For aboveground pipelines with welded joints, anchor blocks and expansion joints shall be installed at spacings that limit pipe movement due to expansion or contraction to a maximum of 40 percent of the sleeve length of the expansion coupling to be used. The maximum length of pipeline without expansion joints shall be 500 ft. Aboveground pipelines with rubber gasket-type joints shall have the movement of each pipe length restrained by steel hold-down straps at the pipe supports or by anchor blocks instead of normal pipe supports.

Anchor blocks usually are not required on buried pipelines. Expansion joints shall be installed, as needed, to limit stresses in the pipeline to the design values.

Thrust blocks shall be required on both buried and aboveground pipelines at all points of abrupt changes in grade, horizontal alignment, or reduction in size. The blocks 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.

Joints and connections. All connections shall be designed and constructed to withstand the working pressure of the line without leakage and to leave the inside of the pipeline free of any obstruction that would reduce the line capacity below design requirements. On sloping lines, expansion joints shall be placed adjacent to and downhill from anchors or thrust blocks. If cathodic protection is required, high resistance joints shall be bridged to insure continuous flow of current.

A dielectric connection shall be placed between the pump and the pipeline and between pipes with different coatings.

Corrosion protection. Interior protective coatings shall be provided if the pH of the water to be conveyed is 6.5 or lower. Cement mortar coatings may be used if the water to be conveyed has a pH of 5.5 or higher and a sulfate content of 150 ppm or less.

All pipe exteriors for underground lines must be fully protected against corrosion. To meet protection requirements, all pipe must be coated and must be provided with supplementary cathodic protection as specified below:

- A Class A protection coating shall be provided if the soil-resistivity survey shows that either (a) 20 percent or more of the total surface area of the pipeline will be in soil having a resistivity of 1,500 ohm-cm or less or (b) 10 percent or more of the total surface area of the pipeline will be in soil having a resistivity of 750 ohm-cm or less. A Class B coating shall be provided for pipe to be installed in soil having a resistivity greater than 1,500 ohm-cm.
- Supplementary cathodic protection shall be provided if the soil-resistivity survey shows that any part of the pipeline will be in soil whose resistivity is less than 10,000 ohm-cm unless galvanized pipe is used. Pipe to soil potential shall be not less than is used. Pipe to soil potential shall be not less than 0.85 V negative, referred to as a copper/copper-sulfate reference electrode, with the cathodic protection installed. The initial anode installation shall be sufficient to provide protection for a minimum of 15 years.
- Cathodic protection shall be provided for galvanized pipe if the soil-resistivity survey shows that any part of the galvanized pipe will be in soil whose resistivity is less than 4,000 ohm-cm. Galvanized pipe requiring cathodic protection shall have a Class B coating.

The total current required, the kind and number of anodes needed, and the expected life of the protection may be estimated as shown below:

The total cathode current required may be estimated from the formula.

$$I_t = C \left[\frac{A_1}{R_{e1}} + \frac{A_2}{R_{e2}} + \dots + \frac{A_n}{R_{en}} \right]$$

Where:

- I_t = total current requirement in mA
- A = surface area pipe in ft²
- R_e = soil resistivity in ohm-cm
- C = a constant for a given pipe coating

For design purposes, this constant shall be considered to be not less than 32 for Class A coatings and not less than 60 for class B coatings.

The kind of galvanic anode to be used depends on the resistivity of the soils in the anode bed location. If the resistivity of the anode bed is:

- Less than 2,000 ohm-cm, zinc anodes shall be used;
- Between 2,000 and 3,000 ohm-cm, either zinc or magnesium anodes shall be used;
- Between 3,000 and 10,000 ohm-cm, magnesium anodes shall be used.

Anodes shall not be required on pipelines if soil resistivity is greater than 10,000 ohm-cm.

The number of anodes needed to protect the pipeline may be estimated by dividing the total cathode current requirement of the pipeline by the current output per anode.

Thus:

$$N = I_t / I_m \text{ and } I_m = k / R$$

Where:

- N = number of anodes needed
- I_t = total current requirement in mA
- I_m = maximum anode current output in mA
- k = constant for a given anode
- R = soil resistivity of the anode bed in ohm-cm.

The expected life of an anode, based on the use of 17 lb / ampere year for magnesium and 26 lb / ampere year for zinc and a utilization factor of 0.80, shall be computed as follows:

- Magnesium $Y = 47W / I_o$
- Zinc $Y = 31W / I_o$

Where:

- Y = expected life in years
- W = weight of anode in lbs
- I_o = design anode current in mA = I_m unless resistors are used in anode circuit to reduce

output

If resistors are used to reduce anode current output to increase service life, the number of anodes required shall be based on the regulated output of the anode rather than on the maximum output, I_m .

- Preliminary soil-resistivity measurements to determine coating requirements and the approximate amount of cathodic protection needed may be made before the trench is excavated. For this purpose, field resistivity measurements shall be made, or samples for laboratory analysis shall be taken at least every 400 ft. long the proposed pipeline and at points where there is a visible change in soil characteristics. If a reading differs markedly from a preceding one, additional measurements shall be taken to locate the point of change. Resistivity determinations shall be made at two or more depths in the soil profile at each sampling station; the lowest depth shall be the strata in which the pipe will be laid. The lowest value of soil resistivity found at each sampling

station shall be used as the design value for that station.

After the pipe trench is excavated, a detailed soil resistivity survey shall be made as a basis for final design of the coating and the required cathodic protection. At this time, resistivity measurements shall be made in each exposed soil horizon at intervals not exceeding 200 ft. The lowest value of soil resistivity found at each sampling station shall be used as the design value for that station. If design values for adjacent stations differ significantly, additional intermediate measurements shall be made.

Steel pipelines placed on the ground shall be limited to sites where the soil resistivity along any part of the pipeline is greater than 4,000 ohm-cm. Pipe at anchor or thrust blocks shall be embedded or attached rigidly with a hold-down strap.

All pipe installed above ground shall be galvanized or shall be protected with a suitable protective paint coating, including a primer coat and two or more final coating.

Materials. All materials shall meet or exceed the minimum requirements of this standard.

CONSIDERATIONS

Water quantity

- Effects on the water budget, especially on infiltration and evaporation.
- Effects on downstream flows or aquifers that would affect other water uses or users.
- Potential use for irrigation management.
- Effects of installing a pipeline on vegetation that may have been located next to the original conveyance.

Water quality

- 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 soil 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 steel irrigation 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

Periodic inspection and maintenance of pipelines will be required. Leaks and breaks should be promptly repaired to prevent water loss and possible contamination of surface and ground water when pumping wastewater.

Pressure relief and air release valves should be checked for proper functioning, especially when pumping wastewater that may contain a significant quantity of solids.

REFERENCES

NRCS Conservation Practice Standards: Manure Transfer - Code 634. Engineering Field Handbook, Chapter 15, Irrigation.

**Natural Resources Conservation Service
Construction Specification**

**IRRIGATION WATER CONVEYANCE
STEEL PIPELINE**

1. SCOPE

The work shall consist of furnishing and installing steel pipe, fittings, and appurtenances as specified.

2. LOCATION

The pipeline shall be located as shown on furnished drawings or as staked in the field.

3. MATERIALS AND INSTALLATION

All materials shown on the drawings or in the Construction Details of the specifications shall conform to the minimum requirements under Engineering Specifications for Materials of the National Handbook of Conservation Practices, Practice 430-FF.

4. INSTALLATION REQUIREMENTS

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, or freezing temperatures. The minimum depth of cover for pipe subject to any of these hazards shall be 2 feet, but in soils susceptible to deep cracking, the cover shall be a minimum of 3 feet. At low places on the ground surface, extra fill may be placed over the pipeline to provide the minimum depth of cover. In such cases, the top width of the fill shall be no less than 10 feet and the side slopes no steeper than 6:1. Constructing a fence or other surface barriers, or using extra heavy gage pipe may be used as an alternative form of protection.

Trench construction. Trench width at any point below top of pipe should 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. The minimum trench width shall not be less than two pipe diameters, unless the trench is precision excavated with a semicircular bottom that closely fits the pipe and the width does not exceed the outside diameter of the pipe by more than 10 percent.

The trench bottom shall be uniform so that the pipe will lay on the bottom without bridging. Rocks that could damage the pipe shall be removed.

Where rocks, boulders, or any other material which might damage the pipe is 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.

Provisions shall be made to ensure safe working conditions where unstable soil, trench depth, or other conditions are such as to impose safety hazard to personnel working in the trench.

Placement. 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 within the trench. Coated pipe shall be handled in a manner to prevent abrasion of the coating during transportation, placement, and backfilling.

All aboveground pipelines and on-ground pipelines shall be painted as to conform to the minimum requirements under Engineering Specifications for Paint of the National Engineering Handbook, Section 2,

Engineering Practice Standard, Practice 430-FF.

Joints and connections. All joints and connections shall be made so as to withstand the design maximum working pressure for the pipeline without leakage and shall 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 in accordance with the recommendations of the pipe manufacturer.

Fittings made of steel or other metals subject to corrosion shall be adequately protected by wrapping with plastic tape or coating with high corrosion preventative qualities. Where plastic tape is used for corrosion protection, all surfaces to be wrapped shall be thoroughly cleaned and then coated with a primer compatible with the tape prior to wrapping.

High-resistance joints between pipe lengths shall be electrically bridged with a welded, brazed, or soldered copper wire not smaller than 4/0 gage in size.

Testing. The pipeline shall be tested for pressure strength, leakage and proper functioning. The tests may be performed prior to complete 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. Any leaks shall be repaired and the system retested.

It shall be demonstrated by testing that the pipeline will function 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.

5. 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-FF 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.

6. CERTIFICATIONS AND GUARANTEE

The manufacturer is to furnish material, test data and **written certification** of compliance with Specifications for Materials in NRCS Engineering Standard 430-FF 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 that protects the owner against defective workmanship and materials over a period of not less than 1 year and identifies the manufacturer and markings of the pipe used.

The installing contractor shall furnish the Natural Resources Conservation Service a copy of his certification and guarantee, which will be made a part of the supporting records of the pipeline.

7. 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.