SOIL CONSERVATION SERVICE

Engineering Standard and Specifications No. Colo 430-AA ~~432-A~~

~~IRRIGATION PIPELINE~~
Irrigation Water Conveyance – Pipeline – Aluminum Tubing
~~UNDERGROUND ALUMINUM IRRIGATION TUBING,~~
~~PLASTIC COATED, EXTERIOR AND INTERIOR~~

STANDARD

Definition

A pipe line and appurtenances installed in an irrigation system.

Scope

This standard applies only to buried aluminum pipelines, coated with plastic tape on the exterior and interior surfaces.

Purpose

The conservation objectives of this pipeline practice are to prevent erosion or loss of water quality or damage to land, to make possible proper water use, and to reduce water conveyance losses.

Conditions Where Practice Applies

All pipelines shall be planned and located to serve as integral parts of an irrigation water distribution system that has been designed to facilitate the conservation of water on a farm or group of farms.

All lands served by the pipelines 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.

Design Criteria

Working Pressure

The maximum permissible working pressure in the line will be determined by the following equation:

$$P = \frac{2St}{d}$$

Where:

- S = 7500 pounds per square inch
- P = Maximum working pressure in pounds per square inch
- d = Inside diameter of tube in inches
- t = Tube nominal wall thickness in inches

Capacity

Design capacity shall be based on the following, whichever is greater:

1. The capacity shall be sufficient to deliver the volume of water required to meet the peak consumptive use of the crop.
2. The capacity shall be sufficient to provide an adequate irrigation stream for all methods of irrigation planned.

For design purposes, the value of "n" in Manning's formula shall be considered to be 0.01, except where joints, connections, condition of the pipe, etc. indicate that a higher value is required.

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Stands for Low Pressure Lines Open to the Atmosphere

Stands will be used wherever water enters the pipeline from a closed pipeline or pump to avoid entrapment of air, to prevent surge-pressures, collapse due to vacuum failure, and prevent pressure from exceeding the design working stress of the pipe. The stand will be designed to:

1. Allow a minimum of 1 foot of freeboard. The stand height maximum above the centerline of the pipeline must not exceed the maximum working head of the pipe.

2. Have the top of each stand at least 4 feet above the ground surface except for surface gravity inlets which shall be equipped with trash racks and covers.

3. Have downward water velocities in stands not in excess of 2 feet per second. In no case shall the inside diameter of the stand be less than the inside diameter of the pipeline.

The cross sectional area of stands may be reduced above a point 1 foot above the top of the upper inlet but in no case shall the reduced cross section be such that it would produce an average velocity of more than 10 feet per second if the entire flow were discharging through it.

When the water velocity of an inlet pipe exceeds 3 times the velocity of the outlet, the centerline of the inlet shall have a minimum vertical offset from the centerline of the outlet at least equal to the sum of the diameters of the inlet and outlet pipes.

Sand traps, when combined with a stand, shall have a minimum inside dimension of 30 inches and shall be constructed so that the bottom is at least 24 inches below the invert of the outlet pipeline. The downward velocity of flow of the water in a sand trap shall not exceed 0.25 feet per second. Suitable provisions for cleaning sand traps shall be provided.

Gate stands will be of sufficient dimensions to accommodate the gate or gates required and will be large enough to make the gates accessible for repair.

Float valve stands shall be of sufficient size to provide accessibility for maintenance and to dampen surge.

Construction shall be such as to insure that vibration from the pump discharge pipe is not carried to the stand.

Vents for Low Pressure Lines Open to the Atmosphere

Vents must be designed into the system to provide for the removal of air and prevention of vacuum collapse. They shall:

1. Have a minimum freeboard of 1 foot above the hydraulic grade line. The maximum height of the vent above the centerline of the pipeline must not exceed the maximum working head of the pipe.

2. Have a cross sectional area at least one half the cross sectional area of the pipeline (both inside measurements) for a distance of at least 1 pipeline diameter up from the centerline of the pipeline. Above this elevation the vent may be reduced to 2 inches in diameter.

3. An air-vacuum release valve may be used in lieu of an open vent. It shall have a 2-inch minimum diameter. Two-inch valves shall be used for lines of 6-inch diameter or less, 3-inch valves for diameters from 7 inches through 10 inches, and 4-inch valves for 12-inch pipe.

4. Vents shall be located:

   a. At the downstream end of each lateral.

   b. At summits in the line.

   c. At points where there are changes in grade in a downward direction of flow of more than 10 degrees.

   d. Immediately below the pump stand if the downward velocity in the stand exceeds 1 foot per second.

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Outlets

Appurtenances to deliver water from a pipe system to the land, a ditch, or any surface pipe system shall be known as outlets. Outlets shall have a capacity to deliver the required flow, (1) to the hydraulic grade line of a pipe or ditch, or (2) to a point at least 6 inches above the field surface.

Drain Requirements

Stagnant water in aluminum pipe is conducive to corrosion, therefore, provisions shall be made to completely drain the pipeline. Drainage outlets should be provided at all low points in the system and may either discharge into a dry well or to a point of lower elevation. If these cannot be provided, provisions shall be made to empty the line by pumping.

Pressure Relief, Vacuum Release, Air Release, and Check Valves for High Pressure Closed Systems

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

A pressure relief valve shall be installed at the pump location when excessive pressures can be developed by operating with all valves closed. Also in closed systems where the line is protected from reversal of flow by a check valve and excessive surge pressures could be developed, a surge chamber or pressure relief valve shall be installed.

Pressure relief valves shall be no smaller than 1/4 inch nominal size for each diameter inch of the pipeline, and shall be set at a maximum of 5 p.s.i. above the pressure rating of the pipe.

Pressure relief valves or surge chambers shall be installed at the end of the pipeline when needed to relieve surge.

Air release and/or vacuum release valves shall be placed at all summits in the pipeline and at the end of the line when needed to provide a positive means of air release or escape.

Air release and vacuum release valve outlets of at least 1/2 inch nominal diameter shall be used in lines of 4 inches or less in diameter, at least 1-inch outlets shall be used in lines 5-8 inches in diameter, and at least 2-inch outlets in lines 10-16 inches in diameter.

Joints and Connections

All connections shall be constructed to withstand the working pressure of the line without leakage and leave the inside of the line free of any obstruction which would reduce the line capacity below design requirements. All fittings such as risers, ells, tees, couplings, and reducers shall preferably be of similar metal. However, if dissimilar metals are used, proper protection against galvanic corrosion, such as separating dissimilar metals with a rubber or plastic insulator, shall be taken. The connection between the pump discharge pipe and the aluminum line shall be made with a suitable insulating material such as rubber or plastic.

Quality of Water

Water quality tests shall be made for all aluminum pipeline installations. Copper content in excess of 0.02 p.p.m. will produce nodular pitting and rapid deterioration of the pipe, if water is allowed to remain stagnant.

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SOIL CONSERVATION SERVICE

Engineering Standard and Specifications No. Colo-S-432-A_o

IRRIGATION PIPELINE

(UNDERGROUND ALUMINUM IRRIGATION TUBING,
PLASTIC COATED, EXTERIOR AND INTERIOR)

SPECIFICATIONS

General Specifications

Design and layout shall be in keeping with SCS Engineering Standard No. Colo-432-A_o IRRIGATION PIPELINE (UNDERGROUND ALUMINUM IRRIGATION TUBING, PLASTIC COATED, EXTERIOR AND INTERIOR) and with good engineering practice. Construction shall be in accordance with the plans and specifications.

Construction Specifications

Specifications shall be in keeping with the preceding standard, shall describe the essential requirements for proper installation of the pipeline, and shall include consideration of the following items:

Handling of Plastic Coated Tubing

Tubing shall be handled in a manner so as to prevent abrasion to the coating during transportation and handling. It shall not be dropped, dragged, or rolled on the ground. If it becomes necessary to move the pipe longitudinally on the ground or in the ditch, it shall be done in such a manner as not to injure the tubing or coating. When stockpiled, the coated tubing shall be carefully piled and blocked so as to prevent damage to the coating.

Placement

All pipe shall be placed deep enough below the land surface to protect it from hazards imposed by traffic crossings, farm operations, freezing temperaturs, or soil cracking. Two feet minimum cover shall be provided except in soils subject to deep cracking, where the cover shall be a minimum of three feet. Extra fill may be placed over the pipeline to provide the minimum depth of cover if the top width of the fill is not less than ten feet and the side slopes are not steeper than six to one.

The width of the trench shall be at least six inches greater than the diameter of the pipe being installed. When trenches are excavated in soils containing rock or other hard materials which might damage the pipe or coating material, they shall be excavated deeper than required, and then backfilled to grade with selected fine earth or sand.

Installation

The line may be assembled above ground or in the ditch taking care to align the joints at time of placement. Every care shall be taken to prevent impact or scuffing against the sides of the trench.

Depending on the type of joint used between lengths of tubing, it may be necessary to partially backfill the ditch to hold the tubing in place during testing. If this is done the partial backfill will be on the body of the tubing, but not at the joints. Thrust blocks or anchors shall be used at line ends or bends in the line where necessary.

Testing

Testing the pipe shall be accomplished before backfilling. The pipe shall be filled with water taking care to bleed the air and slowly build up the pressure to the maximum working pressure. The pipeline shall be walked and all leaks repaired before proceeding with backfill. Pipelines shall be tested at the working pressure.

It shall be demonstrated that all pipelines function properly at design capacity. At or below design capacity there shall be no objectionable surge or water hammer. To be objectionable there shall be either (1) continuing, unsteady delivery of water, (2) damage to the system, or (3) detrimental overflow from vents, stands, or valves.

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Backfilling

The initial backfill shall be of selected material, free from rocks, stones or hard clods. This initial fill shall be compacted firmly around the pipe to achieve a soil density equal to or exceeding the natural density of the undisturbed sidewalls of the trench. Care must be taken to avoid deformation or displacement of the pipe during this phase of the operation.

Corrosion Protection

All aluminum tubing installed under this standard shall be covered with plastic for corrosion protection in accordance with the following specifications:

1. Tubing Exterior and Interior - Surface Protection. The surface of the tubing to be coated shall be cleansed of all foreign material such as oil, grease, dirt, mud, etc. Any knurls, burrs, or other sharp points will be removed by filing, peening, or wire brushing.

2. Coating. The coating that is applied to the tubing shall be of a plastic material capable of withstanding the moisture and soil conditions to which it will be subjected on buried aluminum tubing. "Plastic coating," as used in this standard, shall be understood to mean a coating formed from thermoplastic or thermosetting polymer which do not rely on mechanical means to hold them to the pipe. The term "plastic coating" is synonymous with the term "plastic lining" with respect to composition.

The plastic, or combination of other materials used to aid in protecting the tubing and bonding the plastic to the tubing shall have the minimum physical and electrical properties listed under "Quality of Plastic" in this standard.

Plastic Coating of Joints and Connections

Where possible, fittings shall be coated at the fabricating shop in such a manner as to provide a uniform, tightly and intimately bonded coating allowing no voids or bridging of coating to metal surface. The surface preparation and the coating materials employed shall conform to the minimums set forth in the paragraphs under "Corrosion Protection."

Inspection

After final assembly of the line and coating of the joints and connections, the entire system shall be visually checked for breaks or ruptures in the plastic coating. All breaks or ruptures shall be marked and repaired in the following manner:

1. Remove plastic coating (if necessary) from the area adjacent to the damage.

2. Trim off scuffed and broken material. Apply a field coating to the exposed area and one inch beyond. Minimum thickness of the repair to be equal to or exceed the original thickness of the plastic coating.

The continuity of the plastic coating shall be of such quality that all tubing, joints, and fittings, after assembly, shall be capable of passing an inspection test conducted with a spark discharge holiday detector at 1500 volts.

Marking

Each pipe section shall be plainly marked, after wrapping, with the manufacturer's symbol or name, size of pipe, wall thickness, and working pressure or class.

Certification and Guarantee

The installing contractor shall certify that his installation complies with requirements of this standard. He shall furnish a guarantee against defective workmanship and materials for ~~two~~ one years from date of installation.

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Construction Materials

Quality of Aluminum Tubing

The tubing shall be rigid and composed of aluminum alloys that contain properties and characteristics found suitable for irrigation service by the Sprinkler Irrigation Association (SIA) and the American Society of Agricultural Engineers (ASAE), "Minimum Standards for Irrigation Equipment," approved January, 1957.

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All alloys used for buried irrigation lines shall be clad on the inside of the tubing with an alloy which is anodic to the base alloy to a thickness of at least 5 percent of the nominal wall thickness of the tubing.

Tubing with nominal wall thickness as listed in Column A of Table 1 shall be acceptable for all installations where the operating pressure does not exceed 150 p.s.i. The minimum permissible wall thickness of the tubing and the associated maximum permissible working pressures are given in Column B of Table 1. Should tubing be used with wall thickness between the range listed for the pipe size, the maximum working pressure shall not exceed that obtained by the equation specified under "Working Pressure."

TABLE 1

Tube Diameter Inches	Column A Nominal Wall Thickness, Inches Acceptable All Installations to 150 psi Working Pressure	Column B Min. Wall Thickness and Assoc. Maximum Working Pressure	
		Inches	psi
2	.050	.05	150
3	.050	.05	150
4	.050	.05	150
5	.052	.05	150
6	.058	.05	125
7	.064	.05	108
8	.072	.05	94
9	.082	.058	97
10	.094	.058	87
12	.110	.058	73

In cases where tubing 6 inches and larger in diameter having a wall thickness less than specified in Column A of Table 1 is buried, the installer shall take all necessary precautions for proper bedding and backfilling of the tubing to prevent damage and partial or complete collapsing of the tubing. In addition, adequate safeguards shall be taken to prevent negative pressures from causing collapse of the tube under normal service conditions.

Quality of Plastic

Minimum Physical Properties for the Applied Thickness of Plastic Corrosion Preventative Coating

		Test Method
Minimum plastic coating, applied thickness, inches	0.012	ASTM C-541
Tensile strength, min, psi	1500	ASTM D-2219
Elongation of coating at rupture, min percent	100	ASTM D-2219
Adhesion to aluminum		As Specified below
Dielectric Breakdown		
After standard conditions, volts	7000	ASTM 1000
After water immersion, volts	6000	ASTM 1000
Resistance to impact, cm	60	As Specified below

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		Test Method
Salt water resistivity, ohm/ft	2×10^{11}	As Specified below
Resistance to abrasion, milligrams	max. 300	As Specified below

Adhesion of Coating to Aluminum
Temperature test (thermal shock): A 1" x 6" x .051" coated specimen shall be immersed in boiling water for 30 minutes, then placed in a freezer at 0^{o} F. until specimen reaches this temperature, then removed and brought to room temperature. Coating shall not have cracked or lost adhesion.

Flexibility: A 1" x 6" x .051" coated sample shall be bent 180^{o} over a one inch mandrel without fracture or loss of adhesion. The coating must adhere to the metal surface even after the metal has fractured under tension. Loss of adhesion as evidenced by flaking of the aluminum surface will be judged unsatisfactory.

Resistance to Impact
Apparatus: The following apparatus shall be required:

1. A steel ball bearing with a diameter of 1-3/8 inches weighing 173.5± 1.0 grams.
2. A suitable device to release the ball in free-fall.
3. An ohmmeter.
4. An electrolytic (saturated) solution of cupric chloride in butyl-cellosolve.

Test Procedure and Results

A 2-inch by 2-inch hoop section of the pipe and plastic coating shall be taken for testing. If the pipe section is plastic coated inside and out, the coating shall be completely removed from the side not being tested. The specimen shall be supported on a solid surface conforming to the curvature of the pipe and the steel ball dropped perpendicular to the pipe surface. The steel ball shall be dropped from 60 cm. onto the specimens. A few drops of the electrolytic solution shall be applied to the indentation and one of the probes of the ohmmeter placed in the solution and the other probe on the aluminum pipe section. A puncture occurs if the ohmmeter reads 50 megohms or less. Six of the 10 ball drops must not puncture at specified drop height in order to pass this test.

Salt Waster Resistivity
Apparatus: The following apparatus shall be required:

1. A 26-inch length of the coated pipe.
2. Six pint cans with covers - I.D. approximately 3.25 inches.
3. Four 1-1/2 volt number 6 dry cells.
4. A short circuit jack box containing 6 short circuit jacks.
5. 1-1/2 pints saturated NaCl solution.
6. An electrometer with appropriate shunt to measure 10^{-3} to 10^{-14} amps.
7. Roller, sealing material, and miscellaneous wire, solder, etc.

Test Procedure and Results

The bottoms shall be removed from the pint cans and the cans shaped to fit the pipe. Six cans shall be evenly spaced bottom side down on the pipe specimen and sealed to the surface of the specimen. The four dry cells shall be connected in series. A bare spot on the pipe specimen shall be connected to the negative terminal of the battery bank. Each pint can shall be connected to the positive terminal of the battery bank through a short circuit jack so that an ammeter can be inserted into each individual circuit without interrupting the current flow. Each can shall then be filled 1/4 full with saturated salt solution and the can cover placed on the can to prevent evaporation. The resistivity of the coating in ohms-ft. shall be determined after 15 weeks by measuring the current flowing to each can. The current shall be measured by inserting the electrometer and shunt into the circuit for each can using the short circuit jacks. The resistivity of each sample shall be calculated according to the following formula:

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Resisitivity (ohm-ft) = $\frac{\text{(Voltage applied in volts)(Area in sq. ft.)}}{\text{(Current in amperes)(Coating thickness in ft.)}}$

The average of the six determinations shall be reported as the salt water resistivity.

Resistance to Abrasion

Apparatus: The following apparatus shall be required:

1. Taber Abraser, Model 140, and parts or equivalent.
2. Analytical balance.

Test Procedure and Results

An approximately 4-inch by 4-inch hoop section of the pipe and plastic coating shall be taken as a test specimen. The specimen shall be weighed on an analytical balance to the nearest milligram and then placed in the Taber Abraser. The Abraser wheels, covered with fresh NEMA sandpaper strips and loaded at 1000 grams per wheel, shall abrade the specimen for 400 cycles. The specimen plate shall be reweighed to the nearest milligram. The weight loss in milligrams shall be reported as Abrasion Resistance.

Irrigation Water Conveyance
Aluminum Tubing Pipeline (ft)

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Planning considerations for water quantity and quality

Quantity

1. Effects on the 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.

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 soil 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 undesireable effects on aquatic and wildlife communities.
4. Effects on wetlands or water-related wildlife habitats.
5. Effects on the visual quality of water resources.