United States Department of Agriculture

Natural Resources Conservation Service

CONSERVATION PRACTICE STANDARD

LIVESTOCK PIPELINE

CODE 516

(ft)

DEFINITION

A pipeline and appurtenances installed to convey water for livestock or wildlife.

PURPOSE

This practice is used to accomplish one or more of the following purposes:

- Convey water to points of use for livestock or wildlife
- Reduce energy use

CONDITIONS WHERE PRACTICE APPLIES

This standard applies to the conveyance of water through a closed conduit, from a source of supply to a watering facility, for use by livestock or wildlife.

This practice does not apply to the use of pipelines for irrigation. Use NRCS Conservation Practice Standard (CPS) Irrigation Pipeline (Code 430) for that purpose.

CRITERIA

General Criteria Applicable to All Purposes

Plan, design, and construct this practice to comply with all Federal, State, and local regulations. The landowner must obtain all necessary permissions from regulatory agencies, or document that no permits are required. The landowner and/or contractor is responsible for locating all buried utilities in the project area, including drainage tile and other structural measures.

Design the pipeline to provide sufficient volume, quality, and rate of delivery for practical and feasible use by livestock or wildlife.

Place pipelines only in or on soils with environmental conditions suitable for the type of material selected.

Capacity

Provide the capacity necessary to meet the seasonal high daily water requirements for the number and species of animals to be supplied.

Include reasonable water losses during conveyance and use in the capacity requirement calculations.

Friction and other losses

For design purposes, base head loss for hydraulic grade line computations using one of the following equations: Hazen-Williams, Darcy-Weisbach, or Manning's. Base equation selection on the given flow conditions and the pipe materials used. In computations for hydraulic grade line, include head losses (also called minor losses) from change in velocity and direction of flow due to inlet type, valves, bends, enlargements, or contractions, as appropriate. For closed, pressurized systems, maintain the hydraulic grade line for all pipelines above the top of the pipeline at all locations for all flows, unless specifically designed for negative internal pressures.

Pipe design
Design pipelines to meet all service requirements such that internal pressure, including hydraulic transients or static pressure at any point, is less than the pressure rating of the pipe.

Design flexible conduits such as plastic and metal pipe using NRCS National Engineering Handbook (NEH) (Title 210), Part 636, Chapter 52, “Structural Design of Flexible Conduits,” and the following criteria.

Plastic pipe
When operating at design capacity, limit the full-pipe flow velocity to 5 feet per second in pipelines with valves or other flow control appurtenances placed within the pipeline or at the downstream end. As a safety factor against transient pressures, limit the working pressure at any point to 72 percent of the pressure rating of the pipe at the planned operating temperature. If either of these limits must be exceeded, provide special design consideration to the flow conditions, and take measures to adequately protect the pipeline against transient pressures.

Metal pipe
Determine the specified maximum allowable pressure using the hoop stress formula, limiting the allowable tensile stress to 50 percent of the yield-point stress for the material selected. Design stresses for commonly used metal pipes are shown in 210-NEH-636-52.

Support of pipe
Where needed, provide support for pipelines installed aboveground to provide stability against external and internal forces. Design pipe support using 210-NEH-636-52.

Joints and connections
Design and construct all connections to withstand the pipeline working pressure without leakage, and leave the inside of the pipeline free of any obstruction that would reduce capacity.

Obtain permissible joint deflection from the manufacturer for the type of joint and pipe material used. Place expansion joints adjacent to and downhill from anchors or thrust blocks in sloping metal pipelines.

Install expansion joints as needed in pipelines with welded pipe joints to limit pipeline stresses to the allowable values.

Base the allowable longitudinal bending for the pipeline on type of material and the pressure rating, and in accordance with industry standards or as described in 210-NEH-636-52.

Design joints for suspended pipelines for pipe loading, including the water in the pipe, wind, ice, and the effects of thermal expansion and contraction.

Joints and connections for metal pipes should be of similar materials whenever possible. If dissimilar materials are used, protect the joints or connections against galvanic corrosion.

Depth of cover
Install buried pipe at sufficient depth below the ground surface to provide protection from hazards imposed by traffic loads, farming operations, freezing temperatures, or soil cracking, as applicable.

Pipelines will have sufficient strength to withstand all external loads on the pipe for the given installation conditions. Use live loads appropriate for the anticipated traffic conditions.

Where it is not possible to achieve sufficient cover or sufficient strength with the pipeline alone, use a carrier (encasement) pipe or other mechanical measures to provide the pipeline system with adequate strength to withstand all anticipated loading conditions.

Pressure reduction
Incorporate pressure-reducing valves or breaker tanks to protect the pipeline in circumstances such as pressure gain exceeding pressure loss by a significant amount, excessive static pressures, or excessive flow rates.

Valves and other appurtenances
Pressure ratings of valves and other appurtenances will equal or exceed the design working pressure. When lever-operated valves are used, perform an analysis to evaluate potential transient pressures, assuming rapid valve closure.

Check valves and backflow prevention
Install a backflow prevention device or air-gap between pump discharge and the pipeline if detrimental backflow may occur. If an air-gap is used, use a gap that is at minumum 2.5 times the diameter of the incoming pipe.

Use approved backflow prevention devices on all pipelines where back flow may contaminate the source water supply or ground water.

Pressure relief valves
Install a pressure relief valve between the pump discharge and the pipeline if excessive pressure can build up when all valves are closed. If needed to protect the pipeline against malfunction or failure of pressure-reducing valves, install pressure relief valves downstream of pressure-reducing valves.

Set pressure relief valves to open at a pressure as low as practical, but no greater than 5 pounds per square inch above the design working pressure rating or maximum allowable pressure of the pipe. The valves shall have sufficient flow capacity to reduce the excessive pressures in the pipeline. Mark the pressure at which the valves start to open on each pressure relief valve. Seal adjustable pressure relief valves or otherwise alter to prevent changing the adjustment from that marked on the valve.

In lieu of a detailed transient pressure analysis, the minimum size of pressure relief valve will be one-fourth inch nominal valve size per inch of the nominal pipeline diameter.

Air vents
Provide for entry and removal of air along the pipeline, as needed to prevent air locking, hydraulic transients, or pipe collapse. Include provisions for air release and vacuum relief, as needed to protect the pipeline. Design the pipeline to remain below the hydraulic grade line during operation. If parts of the pipeline will be located above the hydraulic gradient, periodic use of an air pump may be required.

Surge tanks and air chambers
Where surge tanks or air chambers are required for control of hydraulic transients or water column separation, they will be of adequate size to ensure the water volume needs of the pipeline are met without the tank/chamber being emptied, and the required flow rate into the pipeline for the calculated pressure drop is met.

Outlets and water level control
Appurtenances to deliver water from the pipe to the watering facility will have adequate capacity to deliver the required flow. Where water is supplied continuously to the watering facility, use automatic water level controls (such as float valves) to control the flow of water and to prevent unnecessary overflows.

Design outlets and water level controls to withstand or be protected from damage by livestock, wildlife, freezing, and ice damage. Design outlets to minimize erosion, physical damage, or deterioration due to exposure.

Thrust control
Abrupt changes in pipeline grade, horizontal alignment, or size reductions may require an anchor or thrust blocks to absorb pipeline axial thrust. Thrust control is typically needed at the end of the pipeline and at in-

line control valves. Follow the pipe manufacturer's recommendations for thrust control. In absence of manufacturer's data, design thrust blocks using 210-NEH-636-52.

Thermal effects
For plastic pipe, thermal effects must be properly factored into system design. Values and procedures for pressure rating reduction will follow information described in 210-NEH-636-52.

Physical protection
Galvanize steel pipe installed above ground, or protect with a suitable protective paint coating.

Plastic pipe installed aboveground will be resistant to ultraviolet light throughout the intended life of the pipe, or measures must be taken to protect the pipe from damage due to ultraviolet light.

Protect all pipes from hazards presented by traffic loads, farm operations, freezing temperatures, fire, thermal expansion, and contraction. Take reasonable measures to protect the pipe from potential vandalism.

Filling
Provide a means of filling the pipeline that will prevent entrapment of air or excessive transient pressures.

Filling velocities greater than 1 foot per second in a closed-to-the-atmosphere pipe system (i.e., all outlets closed), requires special evaluation and provisions to remove entrapped air and prevent excessive transient pressures.

If filling at a low flow rate is not possible, open the system to the atmosphere (outlets open) prior to pressurizing. Design the system for air removal and excessive transient pressures that may develop at higher filling rates.

Flushing
If the sediment load in the water is significant, design the pipeline with adequate velocity to ensure that sediment is moved through and flushed out of the pipeline.

If provisions are needed for flushing sediment or other foreign material, install a suitable valve at the distant end or low point of the pipeline.

Draining
Make provisions for the complete removal of water from the pipeline by gravity or other means when—

- Freezing temperatures are a hazard.
- Draining is required by the pipe manufacturer.
- Draining of the pipeline is otherwise specified.

The water drained from pipelines must not cause water quality, soil erosion, or safety problems upon release.

Safe discharge of water
Make provisions for water being discharged from valves, especially air valves and pressure relief valves. Locate these valves such that flows are directed away from system operators, livestock, electrical equipment, or other control valves.

Vegetation
Reestablish vegetation or otherwise stabilize disturbed areas as soon as practical after construction. Seedbed preparation, seeding, fertilizing, and mulching will meet applicable criteria in NRCS CPS Critical Area Planting (Code 342).

Safety
Pipeline systems may present a safety hazard to people during installation and operation. Ensure safe conditions by—

- Addressing trench safety in design and during construction.
- Providing protection for people from high pressure water blowing from pressure relief, air release, and other valves.
- Determining the existence or nonexistence of underground utilities prior to construction.

Additional Criteria for Reducing Energy Use
Provide analysis to demonstrate reduction of energy use from practice implementation.

Reduction of energy use is calculated as average annual or seasonal energy reduction compared to previous operating conditions.

CONSIDERATIONS

Economics
Consider economics in pipeline design by—

- Selecting pipe sizes based on lifetime energy requirements, versus initial costs of materials.
- Selecting pipe material based upon the expected service life of practice.
- Considering hydropower applications as alternatives to the use of pressure reducing valves or reduced pipe diameters to induce friction loss.

Other Resources
Consider potential impacts to other resources including the visual design of pipelines and appurtenances, especially in areas of high public visibility.

PLANS AND SPECIFICATIONS

Prepare plans and specifications for livestock pipelines that describe the requirements for applying the practice according to this standard. As a minimum, the plans and specifications will include—

- A plan view of the layout of the pipeline.
- Profile view of the pipeline.
- Pipe sizes and materials.
- Pipe joint requirements.
- Pipe support requirements, as applicable.
- Site-specific construction specifications that describe in writing the installation of the pipeline. Include requirements for pressure testing of the pipeline.
- Depth of cover and backfill requirements, as applicable.
- Vegetative establishment requirements, as applicable.

OPERATION AND MAINTENANCE

Develop an operation and maintenance (O&M) plan for each livestock pipeline system installed. The plan should document needed actions to ensure that practices perform adequately throughout their expected life. As applicable, include—

- Draining procedures.
- Marking crossing locations.
- Valve operation to prevent pipe or appurtenance damage.

- Appurtenance or pipe maintenance.
- Monitoring of cathodic protection systems.
- Recommended operating procedures.

Develop a filling procedure that details allowable flow rates and appurtenance operation at the various phases of the filling process to assure safe filling of the pipeline. Flow measuring devices, such as flow meters or other means (e.g., number of turns of a gate valve), should be used to determine the rate of flow into the pipeline system. Provide this information to the operator and incorporate it into the O&M plan as appropriate.

REFERENCES

USDA NRCS. 2008. National Engineering Handbook (Title 210), Part 636, Chapter 52, Structural Design of Flexible Conduits. Washington, D.C. https://directives.sc.egov.usda.gov