NATURAL RESOURCES CONSERVATION SERVICE

CONSERVATION PRACTICE STANDARD

LIVESTOCK PIPELINE

(Ft.)

CODE 516

DEFINITION

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

PURPOSE

This practice may be applied as part of a resource management system to achieve one or more of the following purposes:

- Convey water to points of use for livestock or wildlife.
- Reduce energy use.
- Develop renewable energy systems.

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, which are addressed by NRCS Conservation Practice Standard, Irrigation Pipeline (430).

CRITERIA

General Criteria Applicable to All Purposes

The volume, quality, and rate of delivery by the pipeline shall be sufficient to make use for livestock or wildlife practical and feasible.

Pipelines shall be placed only in or on soils with environmental conditions suitable for the type of material selected.

Only new materials are approved for installation. No PVC pipe will be installed above ground. All above-ground piping will be steel, galvanized or HDPE.

Capacity. Capacity shall be sufficient to convey the design delivery flow rate for the planned conservation practices.

For livestock or wildlife, provide the capacity necessary to meet the seasonal high daily water requirements for the number and species of animals to be supplied.

In computing the capacity requirements, allowance must be made for reasonable water losses during conveyance and use.

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

Pipe Design. Pipelines shall be designed 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.

Flexible conduits such as plastic and metal pipe shall be designed using NRCS National Engineering Handbook (NEH), Part 636, Chapter 52, Structural Design of Flexible Conduits, and the following criteria:

Plastic Pipe. **Minimum pipeline diameter is 1-1/4 inch nominal.** When operating at design capacity, the full-pipe flow velocity should not exceed 5 feet per second in pipelines with valves or some other flow control appurtenances placed within the pipeline or at the downstream end. As a safety factor

against transient pressures, the working pressure at any point should not exceed 72 percent of the pressure rating of the pipe. If either of these limits is exceeded, special design consideration must be given to the flow conditions, and measures must be taken to adequately protect the pipeline against transient pressures.

Pressure ratings for pipes are normally based on a pipe temperature of 73.4ºF. When operating temperatures are higher, the effective pressure rating of the pipe shall be reduced accordingly.

Minimum pipe size is 1-1/4 inches, nominal.

Metal Pipe. The specified maximum allowable pressure shall be determined 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 NEH, Part 636, Chapter 52.

Support of Pipe. Pipelines installed above ground shall be supported, where needed, to provide stability against external and internal forces. Pipe support shall be designed using NEH, Part 636, Chapter 52.

Joints and Connections. All connections shall be designed and constructed to withstand the pipeline working pressure without leakage and leave the inside of the pipeline free of any obstruction that would reduce capacity.

Permissible joint deflection shall be obtained from the manufacturer for the type of joint and pipe material used.

For sloping metal pipe, expansion joints shall be placed adjacent to and downhill from anchors or thrust blocks.

For welded pipe joints, expansion joints shall be installed, as needed, to limit pipeline stresses to the allowable values.

The allowable longitudinal bending for the pipeline shall be based on type of material and the pressure rating, and shall be in accordance with industry standards, or as described in NEH, Part 636, Chapter 52.

For suspended pipelines, joints shall be designed 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, the joints or connections shall be protected against galvanic corrosion.

Depth of Cover. Buried pipe shall be installed 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.

The minimum cover for buried pipelines shall be 18 inches unless other means are provided to limit hazards from traffic and farm operations (i.e., earth mounding, fencing, etc.). Pipelines designed for winter use shall be designed with a minimum of 36 inches of cover. In areas of greater frost penetration, use a greater depth as local conditions dictate.

Pipelines shall have sufficient strength to withstand all external loads on the pipe for the given installation conditions. Appropriate live loads shall be used for the anticipated traffic conditions.

Where it is not possible to achieve sufficient cover or sufficient strength, a carrier (encasement) pipe or other mechanical measures shall be used.

Pressure Reduction. Pressure Reducing Valves or Breaker Tanks shall be incorporated in circumstances such as head 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 shall equal or exceed the design working pressure. When lever operated valves are used, an analysis shall be performed to evaluate potential transient pressures, assuming rapid valve closure.

Check Valves and Backflow Prevention. A Check Valve shall be installed between the pump discharge and the pipeline if detrimental backflow may occur.

Approved backflow prevention devices shall be used on all pipelines where back flow may contaminate the source water supply or groundwater.

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. If needed to protect the pipeline against malfunction or failure

of Pressure Reducing Valves, Pressure Relief Valves shall be installed downstream of Pressure Reducing Valves.

Pressure Relief Valves shall be set 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. 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.

In lieu of a detailed transient pressure analysis, the minimum size of Pressure Relief Valve shall be ¼ 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 shall 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 shall 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. Outlets shall be designed 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. The pipe manufacturer's recommendations for thrust control shall be followed. In absence of manufacturer's data, thrust blocks shall be designed using NEH, Part 636, Chapter 52.

Thermal Effects. For plastic pipe, thermal effects must be properly factored into system design. Values and procedures for pressure rating reduction shall follow information described in the NEH, Part 636, Chapter 52.

Physical Protection. Steel pipe installed above ground shall be galvanized or shall be protected with a suitable protective paint coating.

HDPE pipe installed above ground shall be resistant to ultraviolet light deterioration. Pipe may be laid along the ground surface or supported on saddles. Pipe laid on the ground shall be bedded along its entire length. The ground surface shall be free of rocks, crevices or other irregularities that can create a point load or an abrasion situation on the pipe as movement from thermal expansion and contraction occurs. The allowable design pressure for HDPE pipe shall be adjusted for the expected maximum operating temperature of the pipeline per the manufacturer's recommendations. Aboveground pipe shall be anchored as needed to control movement and maintain general alignment of the pipe. The pipe shall be restrained at tees, wyes and connections to troughs, storage tanks, pumps, etc. On sloping ground the pipe shall be adequately anchored to avoid pipe wall stresses due to continual downhill creep of the pipe associated with movement from expansion and contraction associated with expected temperature changes that exceed the allowable stress for the specific pipe materials. Design will be in accordance with Idaho Engineering Technical Note 17.All pipes shall be protected from hazards presented by traffic loads, farm operations, freezing temperatures, fire, thermal expansion and contraction. Reasonable measures shall be taken to protect the pipe from potential vandalism.

Filling. The pipeline system shall have a means of controlling the filling of the pipeline to 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, the system shall be open to the atmosphere (outlets open) prior to pressurizing. The system shall be designed for air removal and excessive transient pressures that may develop at higher filling rates.

Flushing. If the sediment load in the water is significant, the pipeline shall have 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, a suitable valve shall be installed at the distant end or low point of the pipeline.

Draining. Provisions shall be made 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 shall not cause water quality, soil erosion, or safety problems upon release.

Safe Discharge of Water. Provisions shall be made for water being discharged from valves, especially air valves and pressure relief valves. These valves shall be located 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 shall meet applicable criteria in NRCS Conservation Practice Standard, Critical Area Planting (342).

Additional Criteria Applicable to Reduce 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.

Additional Criteria Applicable to Develop Renewable Energy Systems

Renewable energy systems shall meet applicable design criteria in NRCS and/or industry standards, and shall be in accordance with manufacturer's recommendations. Hydropower systems shall be designed, operated, and maintained in accordance with the Microhydropower Handbook, Sections 4 and 5, as appropriate.

CONSIDERATIONS

Safety. Pipeline systems may present a hazard to the safety of people, during installation and operation. Consider safety as follows:

- Address trench safety in design and during construction.
- Provide protection for people from high pressure water blowing from Pressure Relief, Air Release, and other valves.
- Determine the existence or non-existence of underground utilities prior to construction.

Economics. Consider economics in pipeline design, as follows:

- Select pipe sizes based on lifetime energy requirements, versus initial costs of materials.
- Select pipe material based upon the expected service life of practice.
- Consider 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 as follows:

- Address rare plant species and cultural resources during the installation of buried pipelines. When possible, avoid these resources, as well as wetlands and other habitats that are highly sensitive to

disturbance, or include measures to minimize impacts.

- Consider 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 shall include:

- A plan view of the layout of the pipeline.
- Profile view of the pipeline.
- Pipe sizes and materials.
- Pipe joint requirements.
- 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.
- Vegetative establishment requirements.

OPERATION AND MAINTENANCE

An Operation and Maintenance (O&M) Plan shall be developed for each Livestock Pipeline system installed. The plan should document needed actions to ensure that practices perform adequately throughout their expected life.

O&M requirements shall be included as an identifiable part of the design. Depending on the scope of the project, this may be accomplished by written statements in the plans and specifications, the conservation plan narrative, or as a separate O&M Plan.

Other aspects of O&M, such as draining procedures, marking crossing locations, valve operation to prevent pipe or appurtenant damage, appurtenance or pipe maintenance, and recommended operating procedures, should be described as needed within the O&M Plan.

Monitoring of any cathodic protection systems shall be performed as specified in the O&M Plan.

A filling procedure shall be developed, which details allowable flow rates and appurtenance operation at the various phases of the filling process, required 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. This information shall be provided to the operator, and shall be incorporated into the O&M Plan as appropriate.

REFERENCES

McKinney, J.D., et al. Microhydropower Handbook, IDO-10107, Volumes 1 & 2. U.S. Department of Energy, Idaho Operations Office.

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

Plastic Pipe:

D 1527 Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe, Schedules 40 and 80
D 1785 PolyVinyl Chloride (PVC) Plastic Pipe, Schedules 40, 80 and 120
D 2104 Polyethylene (PE) Plastic Pipe, Schedule 40
D 2239 Polyethylene (PE) Plastic Pipe (SIDR-PR) Based on Controlled Inside Diameter
D 2241 PolyVinyl Chloride (PVC), Pressure-Rated Pipe (SDR)

D 2282 Acrylonitrile-Butadiene-Styrene

(ABS) Plastic Pipe (SDR-PR)
D 2447 Polyethylene (PE) Plastic Pipe, Schedules 40 and 80, Based on Outside Diameter
D 2513 Thermoplastic Gas Pressure Pipe, Tubing and Fittings
D 2737 Polyethylene (PE) Plastic Tubing
D 2672 Joints for IPS PVC Using Solvent Cement
D 3035 Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Controlled Outside Diameter
AWWA C900 Polyvinyl Chloride (PVC) Pressure Pipe, 4 inches through 12 inches
AWWA C901 Polyethylene (PE) Pressure Pipe and Tubing, 1/2 inch through 3 inches
ASTM D 3350 and D 2837 for HDPE pipe (material shall be PE 3408 as per ASTM D 3350)

Plastic pressure pipe fittings:

D 2464 Threaded PolyVinyl Chloride (PVC) Plastic Pipe Fittings, Schedule 80
D 2466 PolyVinyl Chloride (PVC) Plastic Pipe Fittings, Schedule 40
D 2467 PolyVinyl Chloride (PVC) Plastic Pipe Fittings, Schedule 80
D 2468 Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe Fittings, Schedule 40
D 2609 Plastic Insert Fittings for Polyethylene (PE) Plastic Pipe
D 2683 Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe and Tubing
D 3139 Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals
D 3261 Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing

Solvents for solvent-weld plastic pipe joints

D 2235 Solvent Cement for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe and Fittings
D 2564 Solvent Cements for PolyVinyl Chloride (PVC) Plastic Pipe and Fittings
D 2855 Making Solvent-Cemented Joints with PolyVinyl Chloride (PVC) Pipe and Fittings

Rubber Gaskets

ASTM F477, Elastomeric Seals (Gaskets) for Joining Plastic Pipe

Steel Pipe:

AWWA Specification C-200 or ASTM A 53