Livestock Pipeline (Ft.) 516

DEFINITION

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

PURPOSES

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 practices 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

Pipelines shall be planned, designed, and installed to meet all federal, state, local, and tribal laws and regulations.

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.

Capacity. *Capacity shall be sufficient to convey the design delivery flow rate for the planned watering facility.*

For livestock water, the installation shall have a capacity to provide seasonal high daily water requirements for the number and species of animals to be supplied. Animal water requirements can be obtained from the NRCS conservation practice standard Watering Facility (614).

Additional water capacity will be provided for wildlife when applicable.

Backflow Protection. If water from the pipeline is likely to be used for human consumption, applicable state and local regulations shall be met.

When a pipeline serving livestock is supplied from a well, an approved method for eliminating backflow shall be incorporated into the pipeline design. *Backflow prevention devices must have an American Society of Sanitary Engineers (ASSE) seal. Four types of backflow prevention components are acceptable, livestock pipeline designs must incorporate one of the following:*

- *Air Gap*
- *Pressure Vacuum Breaker (ASSE std 1020)*
- *Double Check Valve Assembly (consisting of two check valves, test cocks, and shut off valves in an assembly unit)(ASSE std 1012, 1015, 1024, 1048)*
- *Reduced Pressure Principle Backflow Preventer (RPZ valve)(ASSE std 1013)*

When the livestock pipeline outlet is below the water surface in a livestock watering tank, ASSE 1013 or 1020 must be used as a backflow prevention device.

If a freeze-proof yard hydrant that drains the riser into the ground will be installed on the pipeline, a backflow prevention device (ASSE 1012, 1013, 1015, 1020, 1024, or 1048) must be installed. Also, each freeze-proof yard hydrant that drains the riser into the ground must be permanently identified as non-potable outlets by approved signage stating: "Caution, Non-potable Water. Do Not Drink." Words on the signage shall be indelibly printed on a tag or sign constructed of corrosion-resistant waterproof material or shall be indelibly printed on the fixture. The letters of the words shall be not less than 0.5 inches in height and color in contrast to the background, on which they are applied. The sign shall be visible on both sides of the hydrant.

Water Conservation. *Flowing wells are to be constructed, equipped and operated in such a way to prevent unnecessary discharges. When an artesian well is going to be used to supply water for a pipeline*

system a deviation from the local Health Department is required.

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. All pipe must withstand the pressure it will be subjected to, including external loads (burial and wheel loads), hydraulic transients, *and static pressure at any point must be 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. When operating at design capacity, the full-pipe 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 (*surge or water hammer), the working pressure (maximum static pressure, psi) *at any point* should not exceed 72% of the pressure rating of the pipe. If either of these limits is exceeded, special *design* consideration must be given to flow conditions and measures must be taken to adequately protect the pipeline against transient pressures.

In lieu of a detailed transient pressure analysis, the minimum size of a pressure relief valve shall be ¼ inch nominal valve size per inch of the minimal pipeline diameter.

Plastic pipe installed above ground shall be resistant to ultraviolet light throughout the intended life of the pipe using materials with at least 2 percent carbon black.

Pressure ratings for pipes are normally based on a pipe temperature of 73.4°F. When operating temperatures are higher, the effective pressure rating of the pipe shall be reduced accordingly. Thermal effects must be properly factored into the system design where appropriate. Values and procedures for pressure rating reduction shall follow information described in NEH, Part 636, Chapter 52.

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.

Steel 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 coats.

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 (maximum static pressure, psi) 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 manufacture 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 valves.

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 wherever possible. If dissimilar materials are used, the joints or connections shall be protected against galvanic corrosion.

Pipe Protection. Above ground pipelines shall be suitable for seasonal use. Protect above ground pipe by placing along perimeter fencing and under cross fences, by shallow burial, or rolling up for the winter months. Shallow buried pipelines shall have at least 1.5 feet of cover unless shallower cover is specified. If shallower cover is specified, there shall be provisions to protect the pipeline from damage by livestock, vehicular traffic, excessive pipe movement, and other hazards.

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

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.

Water shall not be allowed to freeze in pipelines or appurtenances. If cold weather operation is planned, bury the pipe below frost depth (4 feet minimum), *or implement special design and operational measure to maintain flow to prevent freezing in the pipeline.* However, parts of the pipeline, such as float valves, connectors, reduced pressure zone (RPZ) valves, other backflow devices, etc., may not be freeze-proof.

Winterizing of pipeline systems shall be done prior to freezing temperatures. This can be done by blowing out the system to remove any water within the pipeline or equivalent method.

Install shut off valves in various locations along the pipeline to allow easy repair of broken appurtenances and damaged pipe.

Pipe Size. The pipeline shall be sized to accommodate potential future expansion of the system. Minimum pipe size shall be 1.25 inch nominal diameter, unless justification for a smaller diameter is documented by an engineering analysis or allowed under low pressurized systems.

Overflow pipes for watering facilities shall be a minimum diameter of 0.5 inch larger than the delivery pipe or 2 inch diameter, whichever is larger.

In areas where mineral or biological deposition in pipelines has proven to be a problem, the pipe shall be a minimum of 0.5 inch larger than otherwise required.

Low Pressure Systems. These systems are gravity flow or pumping systems where operating pressure does not exceed 15 psi and length of the pipe is less than 1,500-feet. The minimum pipe size shall be 0.75 inch diameter.

Flow from spring development may need a larger pipe size. Refer to the Engineering Field Handbook (EFH), chapter 12 for gravity system pipe capacities. Pipe capacity is based on Manning's equation. Low-pressure systems may also be designed based on the Hazen-Williams equation. Low pressure pumping systems such as nose pumps, solar pumps, etc. shall be considered if operating pressure does not exceed 15 psi.

Pump Pressure System. Pump pressure system is any system that has working pressures greater than 15 psi. Pump pressure systems shall be designed by an engineer, or approved engineering procedure. The design shall meet site conditions. For design purposes, head loss for hydraulic grade line computations shall be computed using the Hazen-Williams or Darcy-Weisbach equation. Equation selection shall be based on the given flow conditions and the pipe materials used.

Pressure Reduction. *Pressure Reducing Valves or Breaker Tanks (float valve box or drinking trough) 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. Pipeline design shall include details for all needed air release valves, air-and-vacuum valves, pressure relief valves, pressure reducer valves, check valves, vents, drain valves, hydrants, surge chambers, pressure tanks, drains, access enclosures, water source hookups, and other appurtenances.

Maximum pressure shall not exceed the pressure rating of pipe and appurtenances at any point in the pipeline.

When lever operated valves are used, an analysis shall be performed to evaluate potential transient pressures, assuming rapid valve closure.

Drainage. Valves or unions shall be installed at low points in the pipeline so that the line can be drained as needed. Check valves shall be installed as needed to protect groundwater quality or maintain a full pipeline.

Drainage shall be provided on above ground installations.

Where the pipeline is buried below probable frost depth (4 feet minimum), drains may be omitted.

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

***Air* Vents.** Design shall provide for entry and removal of air along the pipeline, as needed, to prevent air locking or pipe collapse.

Vents are typically used on low pressure systems. Vent pipes shall extend above the hydraulic grade line at design capacity.

If parts of the pipeline are above the hydraulic gradient, periodic use of an air pump may be required.

Provisions shall be made for pressure relief, air relief, and vacuum relief, as needed, to protect the pipeline.

Air Valves - Pipelines Operating Pressures Greater Than 10 psi. Pipelines where static or operating pressures exceed 10 psi shall have a combination air valve (a continuous acting air release valve, a vacuum-relief valve, and an air release and vacuum relief valve all in one body), or manually operated air vents at all significant high points in the pipeline. A significant high point is defined as a high point in the pipeline more than 10 feet above an adjacent low point.

In addition, a combination air valve or manually operated valve shall be located at changes of grade in downward direction of flow in excess of 10 degrees *(17.6ft V per 100 ft H change),* to ensure adequate air release during filling.

Combination air valves shall be used as needed to permit air to escape while the line is at working pressure. Small orifices of this valve type shall be sized according to the design working pressure and venting requirements recommended by the valve manufacture.

If needed to provide positive means for air escape during filling and air entry while emptying, a combination air valve or manually operated valve shall be installed at all high points, upstream and downstream of all inline valves as needed, at the entrance, and at the end(s) of the pipelines. Proper use of the combination air valve or manually operated valve must be identified in the Operation and Maintenance Plan.

Air Valves and Vent - Pipelines Operating at 10 psi or Less. Pipe shall be laid to grade such that all high points are well defined and can be vented. An open vent or continuous action air-release valve shall be installed at all high points (greater than 10 feet in elevation above an adjacent low point) in the pipeline.

Air valves shall only be used where pressures are high enough at high points to operate a valve properly.

Backflow Prevention and Check Valves. *An approved ASSE backflow prevention device shall be used on all pipelines where backflow may contaminate the source water supply or groundwater.*

Check valves shall be installed between the pump discharge and the pipeline if detrimental backflow may occur.

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.*

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 psi 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 marking on the valve.

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 manufacture's recommendations for thrust control shall be followed. In absence of manufacture's data, thrust blocks shall be designed using NEH, Part 636, Chapter 52.*

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 provision 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 flushing 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.

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 the system operators, livestock, electrical equipment, or other control valves.*

- *Air valves, pressure relief valves, reduced pressure zone valves and other valves discharge water when operating properly, when being tested, and when jammed in the open position by sediment or debris in the water. Where these types of valves are to be installed in structures (residential basement, garage, barn, well house, etc) that would potentially sustain flood damage in the event of a valve discharge, provisions shall be included to prevent flood damage such as a drain system, automatic pump shut off switch, etc.*

Vegetation. Disturbed areas shall be established with vegetation or otherwise stabilized 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

Potential effects of installation and operation of the pipeline on cultural, historical, archeological, or scientific resources at or near the site need to be considered in planning.

Vegetation should be allowed to grow over the pipe to shade it from the sun. Where fire is to be used as a management tool, specific provisions must be made to protect the pipe from fire.

The impact of water available at remote sites is a factor in keeping livestock out of streams and lakes, with the resulting reduction in bank erosion, sediment yield, and the direct deposit of manure in water courses.

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:*

- *Address rare plant species and cultural resources during the installation of buried pipelines. Where 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

Plans and specifications for installing pipelines shall be in keeping with this standard and shall describe the requirements for applying the practice to achieve its intended purpose. If the pipeline is a component of a system that includes additional conservation practices, the information necessary to construct these additional practices will also be conveyed on the plans.

Support data documentation requirements are as follows:

- Inventory and evaluation records
  - CONS-6 notes or special report
- Survey notes, where applicable
  - Design survey
  - Construction layout survey
  - Construction check survey
- Design records
  - Physical data, functional requirements, and site constraints, where applicable
  - Soils/subsurface investigation report, where applicable
- Design and quantity calculations
- Construction drawings/specifications with:
  - Location map
  - "Designed by" and "Checked by" names or initials
  - Approval signature
  - Job class designation
  - Initials from pre-construction conference
  - As-built notes
- Construction inspection records
  - CONS-6 notes or separate inspection records
  - Construction approval signature
- Record of any variances approved, where applicable
- Record of approvals of in-field changes affecting function and/or job class, where applicable

OPERATION AND MAINTENANCE

An Operation and Maintenance (O&M) plan shall be developed for *each Livestock Pipeline system installed*. The O&M plan shall be consistent with the purposes of the practice, its intended life, safety requirements, and the criteria for the design.

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

USDA-NRCS, National Engineering Handbook, Part 650, Engineering Field Handbook, Chapter 5, Preparation of Engineering Plans, and Chapter 12, Springs and Wells.

USDA- NRCS - National Range and Pasture Handbook.