United States Department of Agriculture

Natural Resources Conservation Service

CONSERVATION PRACTICE STANDARD

PUMPING PLANT

CODE 533

(no)

DEFINITION

A facility that delivers water or wastewater at a designed pressure and flow rate.

PURPOSE

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

- Deliver water for improved plant condition, livestock, or wetlands.
- Remove excessive subsurface or surface water.
- Provide efficient use of water on irrigated land.
- Transfer of livestock waste or liquid byporducts as part of a wastewater transfer system.
- Reduce energy use.

CONDITIONS WHERE PRACTICE APPLIES

This practice applies where conservation objectives require the addition of energy to—

- Pressurize and transfer water from a surface or underground source to irrigated land, wetlands, livestock watering facility, or reservoirs.
- Transfer water for fire protection, or transfer of wastewater or liquid by-products.
- Remove surface runoff or excess subsurface water.

The pumping plant includes one or more pumps and associated power units, plumbing, and appurtenances, and may include pressure tanks, onsite fuel or energy source, and protective structures.

For a combustion system replacement, repowering, or retrofit associated with a pumping plant (e.g., pumping plant power unit) for an air quality or energy purpose, use NRCS Conservation Practice Standard (CPS) Combustion System Improvement (Code 372).

CRITERIA

General Criteria Applicable to All Purposes

Plan, design, and construct all pumping plants to comply with all Federal, Tribal, State, and local laws and regulations.

Pump requirements

Meet design flow rate, range of operating pressures, and pump-type requirements of the application. Document how the proposed pump meets the requirements using manufacturer-supplied pump curves and other technical data.

Select pump materials based on the physical and chemical qualities of the material being pumped, the operating environment, and manufacturer's recommendations.

Power (drive) units
Select pump drive units based on the availability and cost of power, operating conditions, need for automation, and other site-specific objectives. Match drive units to the pump requirements so that the pumping plant can operate efficiently and effectively within the planned range of conditions. Size the pump drive unit to meet the horsepower requirements of the pump, including efficiency, service factor, and environmental conditions.

Electric drive units may include line power, photovoltaic panels, and wind- or water-powered turbines. Install electrical system to meet the requirements of the National Electrical Code (NEC). Other drive units may include power take-off (PTO), diesel, gasoline or distillate, or propane running engines.

Meet applicable design criteria in NRCS or industry standards for renewable energy power units and install units in accordance with manufacturer's recommendations.

Photovoltaic panels
Size the photovoltaic array based on average data for the location and the time of year pumping occurs, according to manufacturer's recommendations. Ensure that the photovoltaic array provides the power necessary to operate the pump at the design flow rate, with the appropriate service factor considering a minimum panel degradation of 10 years. Typically, panels are expected to degrade not more than about one percent each year. Orient fixed arrays to meet maximum efficiency. Base panel tilt angle on the location latitude and time of year for power requirements. Mount panels securely to resist movement by environmental factors.

Windmills
Size pumping units according to pumping lifts and capacities, as specified by the manufacturer. Base the diameter of the mill on the stroke length and the average wind speed. Size towers to the mill diameter, and to provide proper wind exposure, with adequate height for efficient and safe operation. Locate towers away from obstructions that will block wind movement.

Water-powered pumps (hydraulic rams)
Size pumping units according to flow rate, lift, fall, and efficiency. Return bypass water to the stream or storage facility, without erosion or impairment to water quality.

PTO-driven pumps
Size pump according to delivery rate required at outlet. Match pump size to the available operating equipment in addition to the pump demand.

Variable frequency drives (VFD)
Prior to installation, it is landowner's responsibility to inform the electric power provider of the proposed VFD installation. Ensure that the power provider's standards are met regarding potential harmonics (i.e., the Institute of Electrical and Electronics Engineers (IEEE) Std 519) and other interference issues. For proper application of a VFD and enhanced energy efficiency, ensure the following technical standards are met:

- Separation between VFD frequency (Hz) at differing flow conditions is greater than one hertz (>1 Hz).

- VFD frequency (Hz) at any of the defined flow conditions neither exceeds the base frequency (60Hz) by more than 10 percent (≤10%) nor drops below 50 percent (≥50%) of the base frequency, (i.e., VFD frequency must be maintained between 30Hz and 66Hz).

- Ideally, pump efficiency is to be maintained at or above 80 percent (≥80%) but must not drop below 70 percent (≥70%) at any of the defined flow conditions.

- Energy use reduction is to be at a minimum 10 percent (≥10%) as defined by the estimated post-VFD average annual or seasonal energy use compared to pre-VFD operating conditions.

Use invertor-duty electric motors that generally withstand higher voltage spikes through VFDs without overheating at slow speeds.

Protect VFD against overheating. Provide a VFD control panel that has a read-out display of flow rate or pressure.

Suction and discharge pipes
Design suction and discharge pipes to prevent cavitation. Account for suction lift, net positive suction head, pipe diameter and length, minor losses, temperature, and altitude. Base the size of suction and discharge pipes on hydraulic analysis, operating costs, and compatibility with other system components.

Include appurtenances such as gate valves, check valves, relief valves, pressure-reducing valves, pressure gages, pressure tanks, pipe connections, and other protective devices to meet the requirements of the application.

Install screens, filters, trash racks, or other devices as needed to prevent the intake of sand, gravel, debris, or other objectionable material into the pump. Design intake screens according to applicable Federal and State guidelines to avoid entrainment or trapping of aquatic organisms.

If chemicals or fertilizers are included in a delivery system using a water source, include backflow prevention devices according to Federal, State, and local laws to prevent contamination of water sources connected to the pumping plant.

Buildings and accessories
Mount floating pumps on floating structures as designed by the manufacturer. Support submersible pumps by a column pipe sufficient to support the pump and static and dynamic loads or provide additional support by stainless steel cable. For all other pumps securely mount on a solid foundation such as pilings or concrete. Design the foundation to safely support the loads imposed by the pumping plant and appurtenances. Use sheet piling or other measures as required, to prevent piping beneath the structure foundation.

Where enclosures, shelters, covers, or other structures are necessary to protect the pumping plant, include provisions for adequate ventilation and accessibility for equipment maintenance, repairs, or removal.

Design suction bays or sumps to prevent the introduction of air into the intake pipe and to eliminate rotating currents.

Design the discharge bay or the connection to the distribution system to meet all hydraulic and structural requirements.

Safety
Design structures and equipment to provide adequate safety features to protect operators, workers, and the public from potential injury. Require drive shaft covers on all exposed rotating shafts.

Construct barriers if needed to protect humans and livestock from the pump or drive unit.

If the project includes excavation, the landowner or contractor is responsible for locating all buried utilities in the project area, including drainage tile and other structural measures.

Additional Criteria for Providing the Efficient Use of Water on Irrigated Land
Include provisions for the connection of flow and pressure measurement devices in the pumping plant system design.

Additional Criteria for the Reduction of Energy Use

Meet or exceed the Nebraska Pumping Plant Performance Criteria for fossil fuel or electrical grid power sources and pumping plant installations, if applicable. Refer to NRCS National Engineering Handbook (NEH) (Title 210), Part 652, Chapter 12, Table 12-2.

Alternatively, estimate reduced energy use that results directly from the application of this practice. Calculate the estimated annual difference in energy use on an after-practice minus before-practice basis under the same operating conditions. Use a documented assessment methodology as approved by NRCS.

Additional Criteria for Pumping Waste and Waste By-products

Size pumps utilized for the transfer of wastewater or manure based on the required system pressure and flow rate determined by the waste management plan. Select the pump type based on the consistency of the material being pumped and the manufacturer's recommendations. See NRCS CPS Waste Transfer (Code 634) for additional criteria.

CONSIDERATIONS

When planning this practice, the following considerations are recommended:

- The removal of surface water by a pumping plant can affect downstream flows or aquifer recharge volumes. Consider potential long-term impacts downstream of the pumping plant.
- If using a pumping plant to remove surface water or ground water flowing into a wetland, consider the potential impacts on existing wetland hydrology.
- The operation and maintenance of a pumping plant can involve the use of fuels and lubricants that when spilled may adversely affect surface or ground water quality. Consider measures to protect the environment from potential spills. In some cases, secondary containment of spilled fuel may be required by Federal and State laws or regulations.
- Pumping plants are often constructed in flood-prone areas or can be subject to other unexpected natural events. Consider how the pumping plant may be protected from extreme natural events and the consequences of damage or failure.
- Consider having the visual appearance of pumping plant enclosures or housing compatible with the surrounding environment.
- Consider including protective sensors to detect low or stopped flow, or pressures that are too high or too low.
- Powered pumps can create noise that reaches nuisance levels to the surrounding environment. Consider selecting energy sources compatible with sensitive areas.
- Consider mobile photovoltaic panels for livestock watering facility to facilitate use in rotational grazing systems.
- Consider photovoltaic panels that tracks the sun.

PLANS AND SPECIFICATIONS

Prepare plans and specifications for constructing a pumping plant which describe the requirements for properly installing the practice to achieve its intended purpose. As a minimum, the plans and specifications must include—

- A plan view showing the location of the pumping plant in relationship to other structures, water source, pressure tank, pipeline, end use, or natural features.
- Detail drawings of the pumping plant and appurtenances, such as piping, inlet and outlet connections, mounting, foundations, and other structural components.
- Proposed pump manufacturer-supplied pump curves and data.

- Written specifications that describe the site-specific details of installation.

OPERATION AND MAINTENANCE

Prepare an operation and maintenance plan specific to the pumping plant being installed for use by the owner and responsible operator with specific instructions for operating and maintaining facilities to ensure the pumping plant functions properly as designed. As a minimum, address the following in the plan:

- Inspection of the pumping plant annually and after significant storm events to identify repair and maintenance needs.
- Inspection or testing of all pumping plant components and appurtenances.
- Proper start-up and shut-down procedures for the operation of the pumping plant.
- Routine maintenance of all mechanical components (power unit, pump, drive train, etc.) in accordance with the manufacturer's recommendations, including lubrication of parts.
- Procedures to protect the system from damage due to freezing temperatures.
- Prior to running tractors driving PTO pumps, ensure they are secured or blocked as necessary to prevent movement.
- When applicable, procedures to frequently check the power unit, fuel storage facilities, hydraulic lines, and fuel lines, for leaks and repair as needed.
- Periodic checks and removal of debris as necessary from trash racks and structures, to assure adequate flow capacity reaching the pumping plant intake.
- Periodic removal of sediment in suction bays, to maintain design capacity and efficiency.
- Inspection and maintenance of anti-siphon and blowback devices, if applicable.
- In photovoltaic panels, change tilt angle seasonally if used year-round.
- Routine test and inspection of all automated components of the pumping plant, to assure the proper functioning as designed.
- Inspection and maintenance of secondary containment facilities, if applicable.
- Periodic inspection of all safety features, to ensure proper placement and function.
- Prior to retrofitting any electrically powered equipment, disconnect electrical service and verify the absence of stray electrical current.
- Maintain records, including manufacturer installation and operation and maintenance guide along with records of when equipment is serviced, work performed, and by whom.
- When applicable, periodically clean the solar array of snow, ice, dust, and film to maintain efficiency.

REFERENCES

Iowa State University. 1993. MidWest Plan Service (MWPS-18), Livestock Waste Facilities Handbook, Chapter 8, Pumps . Ames, IA.

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