

**NATURAL RESOURCES CONSERVATION SERVICE
CONSTRUCTION SPECIFICATIONS**

PUMPING PLANT (SOLAR PHOTOVOLTAIC-POWERED)

1. Scope

These construction specifications cover the components and installation of solar photovoltaic (PV)-powered pumping plants.

2. Location

Location of the PV-powered pumping plant and accessories shall be as specified on the construction plan or as staked in the field.

3. Materials

The PV system shall conform to the most recent or currently adopted provisions of the National Electrical Code (NEC). All major components shall be warranted by the manufacturer to be free from material or workmanship defects for a minimum of 1 year.

PV array. The array shall be tested and listed by Underwriters Laboratories Inc. (UL) to meet UL 1703 or tested and certified to withstand the impact of 1-inch diameter hail at a minimum velocity of 51 miles per hour (mph) without major visual defects by another nationally recognized testing lab in accordance with International Electrotechnical Committee (IEC) 612512 or IEC 61646. Arrays must also be certified to withstand winds of 81 mph or greater. Each array shall be labeled by the manufacturer with rated open-circuit voltage, operating voltage, maximum permissible system voltage, operating current, short-circuit current, and maximum power. Arrays shall be assembled with seals capable of remaining watertight over a temperature range of -20°F to +120°F. The manufacturer shall warrant each array for a minimum period of 10 years against power degradation in excess of 10% of the rated power.

Array junction boxes shall be moisture-resistant and shall have sufficient space for addition of bypass diodes. Boxes that accept conduit are preferred. Junction boxes should be mounted to the PV array frame and not to the PV array surface.

Mounting structure. The PV array mount shall be constructed from materials protected from corrosion as suitable for the environment at the site. A mounting structure that tracks the sun is recommended but not required. As a minimum, the structure shall have a tilt angle from horizontal that ensures optimum utilization of the solar energy. As a minimum, the tilt angle shall be adjustable from the local latitude plus 15° in the winter to local latitude minus 15° from horizontal. The mounting structure must be capable of supporting the array under loads caused by 81 mph winds and ice loading of a minimum 1-inch thickness over all exposed surfaces and should be certified as such.

Electronics. When available, electronic components shall be UL listed (or equivalent). PV systems shall be fused as required by NEC. A controller of the type recommended by the pump manufacturer that is capable of protecting the pump from common faults--including low water (dry running), overload, and electrical short circuits--shall be provided. The controller should be capable of providing flow or level control with the addition of a remote pressure or level control switch.

Wiring. All wire material shall be copper. Array to array wiring shall be in conduit or be rated sunlight- and weather-resistant (underground service entrance [USE], type tray cable [TC], or equivalent). In-line splices are not permitted in the module wiring. Module wiring connectors must be crimp ring lugs and wiring terminals or compression terminal blocks. Wire nuts shall not be used. Each wire termination shall be adequately marked to identify the circuit conductor. The marking shall be consistent with the identification included on the wiring diagram.

A direct current (DC)-rated switch or circuit breaker shall be provided as a means for disconnecting the array from the system (per NEC requirements). The disconnecting device shall be located near the system controls and housed in a grounded, weatherproof enclosure.

The electrical cable for submersible pumps shall be double-insulated and shall be rated for submersible pump service. Portable systems shall employ a mechanical, weatherproof splice to connect the electrical drop cable to the pump motor. The drop cable for permanent systems shall employ a weatherproof splice made with crimp-style butt connectors. In either case, the lead connected to the motor shall be factory-installed, and the lead connected to the drop cable shall be field-installed. The splice shall be located above the static water level or made waterproof.

Pump. Pumps, connectors, and fittings shall conform to all requirements of the design and manufacturer's specifications.

Protective structures. Fencing or other protective structures for the PV system shall be as shown on the construction plan. The enclosure must exclude livestock and allow access to all system components for service and maintenance.

4. Installation

All manufacturer's and testing lab installation instructions shall be followed during installation of the PV system and pump. All equipment shall be installed so as not to void manufacturer's warranties. All fasteners and hardware shall be torqued to the manufacturer's specifications. All electrical work shall conform to requirements in the current edition of the NEC. All plumbing work shall conform to the requirements of appropriate state and local regulations and be performed in a workmanlike manner.

PV array. The array shall be located as needed to receive the maximum amount of sunlight with its orientation and tilt angle set as specified in the design. The array shall be covered with opaque material until all electrical work has been completed.

Mounting structure. The PV array mounting structure shall be installed and anchored in accordance with the manufacturer's instructions. When the mounting structure is to be set in concrete, the concrete shall be placed at least 24 hours before the array is attached.

Pumps. Pumps, screens, valves, etc., shall be assembled in accordance with the manufacturer's recommendations. Where flexible tubing is used for the discharge pipe inside a well, the pump should be attached to the top of the casing with a rope or cable of adequate strength to pull the pump from the well. Appropriate measures shall be provided to prevent the rope or cable from falling into the well casing.

Electronic components and wiring. Electronic components shall be installed in accordance with NEC requirements and manufacturer's recommendations. The negative PV conductor, the array mounting structure, and all other metal components of the system shall be grounded directly to earth. Where pumps are placed inside a well, the electrical drop cable should be fastened to the discharge pipe by wrapping with tape on intervals of 10 feet. Other electronic components specified in the design shall be installed in accordance with the manufacturer's recommendations and NEC requirements. Electronic components shall be located in a weatherproof enclosure with strain relief entrances and mounted at a level for convenient access on the PV array mounting structure.

5. Measurement

Measurement of the completed installation will be each PV pumping plant installed. The PV array and pumping plant shall be tested for proper operation. The test shall document water output in gallons per minute.

6. Construction Details