F. No. 32/651/2017-SPV Division
Government of India
Ministry of New & Renewable Energy
*****

Atal Akshay Urja Bhawan
Near CGO Complex
Lodhi Road, New Delhi
Dated: 1st October, 2024

NOTICE

Subject: Updation in the standards/specification of the SPV water pumping system under PM KUSUM

The Ministry has issued standards and specifications of Solar Water Pumping System and Universal Serial Pump Controller under PM KUSUM during March 2023. These standards and specifications are being updated by the Ministry from time-to time to incorporate innovations and technological improvements in the equipment.

2. In this regard, it is proposed to update following standards and specifications covered under PM KUSUM Scheme:

a) Specifications of Solar Water Pumping Systems with Positive Displacement Pump (Annexure- A)
b) Specification for SPV water pumping system with micropumps (Annexure- B)

3. All stakeholders are requested to provide their suggestions for updation of these standards and specifications in the following format using word document:

Suggestions for the Specification/Testing procedure of .....

S. No.	Annexure	Present Clause	Modification Proposed	Justification

4. The suggestions may please be sent through email to pmkusum-mnre@gov.in by 31 October 2024.

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(Dr Nikhil Gakkhar)
Scientist D

To:

All concern

Annexure A

Solar Water Pumping Systems with Positive Displacement Pump

1 SCOPE

This document is primarily intended to introduce performance, safety features and testing requirements for Solar Photo Voltaic Water Pumping Systems utilizing Positive Displacement Technology. The specification covers the technical requirements for Solar Photo Voltaic Water Pumping Systems using positive displacement technology for handling clear cold water covering design qualification s and performance specifications. These pump sets can be installed on a suitable bore-well.

2 REFERENCES

In the formulation of these guidelines' assistance has been derived from the following Standards:

- IS 17018 (Part 1): 2022: Solar Photovoltaic Water Pumping Systems - Specification Part 1 Centrifugal Pumps.
- IS 17429: 2020 : Solar Photovoltaic Water Pumping Systems — Testing Procedure — Guidelines
- IS 5120:1977: Technical requirements for roto-dynamic special purpose pumps.
- IS 10069: 2023: Hydraulic fluid Power-Positive displacement pumps, motors & integral transmissions
- IEC 62253: 2011 Photovoltaic pumping system — Design qualification and performance measurements
- IEC 61730-1: 2016 Photovoltaic (PV) module safety qualification — Part 1: Requirements for construction
- IEC 61730-2: 2016 Photovoltaic (PV) module safety qualification — Part 2: Requirements for testing
- IEC 60068-2-6: 2007 Environmental testing — Part 2-6: Tests — Test Fc: Vibration (sinusoidal)
- IS 16221 Part 2: 2015: Safety of Power Converters for Use in Photovoltaic Power Systems Part 2 Particular Requirements for Inverters

*For the purpose of this document, the latest version of Indian standards (IS) and International Standards (IEC or ISO) including the amendments issued thereof, as published and notified from time to time, shall be applicable from the date as notified.

3 TERMINOLOGY

In addition to the terminology specified in Clause 3 of IS 17018-1, IS 5120 and IEC 62253, the following shall also apply.

3.1 Static Water Depth — It is the depth of water level below the ground level when the pump is not in operation.

3.2 Draw-Down — It is the elevation difference between the depth of static water level and the consistent standing water level in tube well during operation of pump set.

3.3 Shut-off Head (m) – The Shut off head of Positive Displacement pump set cannot be closed off under any circumstance. This may endanger the pump and the piping connected to it. A Positive Displacement pump set can guarantee performance per depth up to the maximum depth allowed.

3.4 Not to exceed Head (m) – The absolute depth that the pump can be installed and operated without causing damage to the pump mechanism.

3.5 Submergence — It is the minimum height of water level after drawdown above the pump suction casing.

3.6 Daily Water Output — It is the total water output on a clear sunny day with three times tracking Solar Photo Voltaic (PV) panel, under the "Average Daily Solar Radiation" condition of 7.15 kWh / m^2 on the surface of Photo Voltaic (PV) array (i.e. coplanar with the SPV Modules).

3.7 Wire to Water Efficiency — It is the combined efficiency of controller (excluding the MPPT efficiency), pump set and piping. It can also be stated below:

Water to Wire Efficiency

$$\eta = \frac{Flow\left(\frac{m^3}{s}\right) * Head(m) * Gravity\left(\frac{m}{s^2}\right) * Density\left(\frac{Kg}{m^3}\right)}{V * I}$$

3.8 Clear Cold Water — Clear cold water shall mean, water having the characteristics specified below:

Sl. No.	**Characteristics**	**Specified Value**
(1)	(2)	(3)
i)	Turbidity	50 ppm (silica scale), *Max*
ii)	Chlorides	500 ppm, *Max*
iii)	Total solids	3000 ppm, *Max*
iv)	pH value	6.5 to 8.5
v)	Temperature	33°C, *Max*
vi)	Specific gravity	1.004, *Max*

vii)	Hardness (as CaC03) (drinking water)	300 mg, *Max*

Note:
1. If any characteristics of the water differ from those specified above, the pump details shall have to be agreed between the manufacturer / supplier & user and shall be specified in the order.

3.9 Pump Controller

The PV controller converts the DC voltage of the PV Array into a suitable DC voltage or Three phase AC. The Driver portion of the unit receives commands from a built-in control algorithm and uses the single or multiphase AC voltage to generate motor movements to match the desired stroke profile and speed.
Note:
1. The PV controller may also include equipment for MPPT, monitoring, metering and for protection purposes.

3.9.1 Maximum Power Point Tracker (MPPT)

MPPT is an algorithm used for extracting maximum available power from Photo Voltaic (PV) module under certain conditions. The voltage at which PV module can produce maximum power is called 'maximum power point'.

4. CONSTRUCTION FEATURES

4.1 General

Positive Displacement SPV water pumping system uses the irradiance available through SPV array. The SPV array produces power, which can be utilized to drive a dc pump set using pump controller.

4.2 A SPV Positive Displacement water pumping system typically consists of:

1.Motor

2. Pump Set

3. PV Array

4. SPV Pump Controller (*see* **3.9**)

NOTE — Some controllers can be inbuilt in the motors.

4.2.1 Provision for remote monitoring unit for the pumps shall be made in the pump controller using GSM/GPRS Gateway with Geo tagging and through an integral/external arrangement having following basic functions:

a) Controller shall be assigned with a unique serial number and its live status shall be observed remotely on online portal through login credentials;

b) Live status shall indicate whether controller is ON/OFF;

c) The parameter that is, the water output, water flow rate, fault condition; array input voltage/current and power shall be logged at an interval of 10 minutes; and

d) Controller shall have a back up to store the data locally (at least for 1 year).

4.3 Solar Photo Voltaic (SPV) Array

4.3.1 SPV arrays contain specified number of same capacity, type and specification modules connected in series or parallel to obtain the required voltage or current output. The SPV water pumping system shall be operated with a PV array minimum capacity in the range of 900 Watt peak to 5500 Watt peak, measured under Standard Test Conditions (STC). Sufficient number of modules in series and parallel could be used to obtain the required voltage or current output. The power output of individual PV modules used in the PV array, under STC, shall be a minimum of 300 Watts peak, with adequate provision for measurement tolerances. Use of PV modules with higher power output is preferred.

4.3.2 Modules supplied with the SPV water pumping systems shall have certificate as per IS 14286/ IEC 61215 specifications or equivalent National or International/Standards. STC performance data supplied with the modules shall not be more than one-year-old.

4.3.3 Modules must qualify to IS/IEC 61730 Part 1 and Part 2 for safety qualification testing.

4.3.4 The module efficiency shall be minimum 19 percent and fill factor shall be more than 75 percent.

4.3.5 Modules must qualify to IS 17210 (Part 1) for the detection of potential-induced degradation Part 1 Crystalline silicon (mandatory in case the SPV array voltage is more than 600 V DC).

4.3.6 In case the SPV water pumping systems are intended for use in coastal areas the solar modules must qualify to IS/IEC 61701 for salt mist corrosion test.

4.3.7 The name plate of PV Module shall conform to IS 14286/IEC 61215.

4.3.8 Module to Module wattage mismatch in the SPV array mismatch shall be within ± 3 percent.

4.3.9 Any SPV array capacity above the specified array wattage for various models of solar pumping systems is allowed.

4.3.10 The PV modules must be warranted for output wattage, which shall not be less than 90 percent of the rated wattage at the end of 10 years and 80 percent of the rated wattage at the end of 25 years.

4.3.11: The Solar PV Modules have to be registered with Bureau of Indian Standard under MNRE's Quality Control Order (QCO).

4.4 Motor-pump Set

4.4.1 The SPV Positive displacement water pumping systems may use the following type of motor pump sets:

Submersible motor-pump set with motor of the motor-pump set may be of the following type:

1. DC motor (brushless), PMSM/BLDC/SRM

4.4.2 The "motor-pump set "shall have the following features:

a) The dc motor capacity ranging from 3.5 kW to 5.5 kW shall be dc.
b) Submersible pumps could be used according to the dynamic head of the site at which the pump is to be used.

4.4.3 The pump and all external parts of motor used in submersible pump which are in contact with water shall conform to the requirement of relevant IS specification mentioned in IS 5120 and IS 14602 – All the parts which are in contact with water should be of stainless steel grade (SS 304, 316, 316L) or higher as per IS 6911 and IS 3444 or brass or engg. plastic or elastomers

The motor pump set shall have 60 months guarantee and therefore, it is essential that the construction of the motor and pump shall be made using parts which have a much higher durability and do not need replacement or corrode for at least 60 months of operation after installation.

4.4.4 The suction/delivery pipe shall be of HDPE or uPVC column pipes of appropriate size. In case of HDPE pipes, the minimum pressure rating of 8 kg/cm^2 PE100 grade for pumps up to 3 HP, 10kg/cm^2 PE100 grade for 5 HP pumps as per IS 10804 and further higher minimum pressure rating for above 5 HP as appropriate shall be used.

4.5 Module Mounting Structures (MMS) and Tracking System

4.5.1 The PV modules shall be mounted on metallic structures of adequate strength and appropriate design, which can withstand load of modules and high wind velocities up to 150 km per hour. The raw material used and process for manufacturing of module mounting structure including welding of joints shall conform to applicable IS 822. The module mounting structure shall be hot dip galvanized according to IS 4759. Zinc content in working area of the hot dip galvanizing bath shall not be less than 99.5% by mass.

4.5.2 To enhance the performance of SPV water pumping systems arrangement for seasonal tilt angle adjustment and three times manual tracking in a day shall be provided. In order to make structure rigid, the gap between telescopic pattern supports shall be minimal, further, for bearing of center load of whole structure only pins shall be used instead of threaded bolts.

4.5.3 The general hardware for structure fitment shall be either SS 304 or 8.8 Grade as per IS 6911. Modules shall be locked with antitheft bolts of SS 304 Grade. Foundation shall be as per the site condition, based on the properties of soil. Foundation can be done either with the help of 'J Bolt' (*see* IS 5624 for foundation hardware) or direct pilling, it shall be decided asper the site and relevant IS that is, IS 6403/IS 456/IS 4091/IS 875 shall be referred for foundation design.

4.5.4 Typical design of Module Mounting Structure (MMS) for different capacity of SPV pumps are already notified by the Ministry. The standards mentioned therein are to be followed however any other proven designs may also be used.

4.6 SPV Pump Controller

4.6.1 Maximum Power Point Tracking (MPPT) shall be included to optimally use the power available from the SPV array so as to maximize the water discharge.

4.6.2 The SPV pump controller must have IP (67) protection or shall be housed in a cabinet having at least IP (67) protection in case of submergence.

4.6.3 Adequate protections shall be provided in the SPV pump controller to protect the solar powered pump set against the following:

a) Dry running; with/without sensor
b) Open circuit
c) Accidental output short circuit
d) Under voltage
e) Reverse polarity
f) Surge protection to arrest high current surge.
g) Over Temperature

The system will have a minimum protection of reverse polarity and lightning. It is desirable to have additional overvoltage and over current protection either through the system software or directly by the hardware.

4.6.4 A dc. Switch as per IS/IEC 60947-3 or dc. circuit breaker as per IS/IEC 60947-2 suitable for switching dc power ON and OFF shall be provided in the SPV Positive displacement pump controller.

4.6.5 All cables used shall be as per IS 694 or IS 9968 (Part 1). Suitable size of cable shall be used in sufficient length for inter-connection between the SPV array to SPV pump controller and the SPV pump controller to solar powered pump set. Selection of the cable shall be as per IS 14536.

4.6.6 Power Inverters (if any) for Use in Photovoltaic Power Systems have to be registered with Bureau of Indian Standards (BIS) after testing as per IS 16221 (part 2) or as per applicable Standards mentioned in MNRE's QCO.

4.7 Earthing Arrangement

4.7.1 Earthing of the motor shall be done in accordance with the relevant provisions of IS 3043. Adequate Earthing shall be provided for controller, pump and SPV array and earthings should be equipotential.

4.7.2 For safety purposes, it shall be ensured during installation that the earthing is capable of taking care of leakage current.

4.7.3 In case of PVC/HDPE pipes used as discharge pipe, a separate non-corrosive, lower resistance conductor from motor earth terminal to control panel earth terminal shall be provided for earthing.

4.7.4 A lightening arrestor shall be provided with every SPV water pumping system.

5. PERFORMANCE REQUIREMENTS

TEST PROCEDURE FOR PERFORMANCE EVALUATION OF SPV PUMPING SYSTEM: should be as per clause 5, 5.1 & 5.2 of MNRE guidelines 2023.

5.1 Under the "Average Daily Solar Radiation" condition of 7.15 KWh/m^2 on the surface of PV array (i.e. coplanar with the PV Modules), the minimum water output from a Solar PV Water Pumping System at different

"Total Dynamic Heads" should be as specified in Table 2.1.

5.2 Material of Construction (MOC)

It is recognized that a number of materials of construction are available to meet the needs for pump set handling clear, cold water. A few typical materials are indicated in Table 1 - for Bore well submersible pump set.

Notes:

1. This is merely for the guidance of the manufacturers and the users.

2. The materials listed are to be considered as only typical and indicative of minimum requirements of the material properties. The use of materials having better properties is not prejudiced by the details above provided materials for components in bearing contact with each other do not entail galling, corrosion, magnetic induction, etc.

6 TESTS FOR HYDRAULIC AND ELECTRICAL PERFORMANCE OF PUMPSET

6.1 The pumping set shall be tested independently for hydraulic and electrical performance to be tested as per IS 17429

Note:

1. Temperature effect (Temperature coefficients) of the solar modules must be considered while performing the testing with simulator (see cl. 5 MNRE guidelines)

7. GUARANTEES AND TOLERANCES ON SOLAR PHOTO VOLTAIC POSITIVE DISPLACEMENT WATER PUMPING SYSTEMS PERFORMANCE

7.1 Guarantee of Workmanship and Material

The pumps shall be guaranteed by the manufacturer against the defects in material and workmanship under normal use and service for a period of at least 60 months from the date of commissioning.

7.2 Guarantee of Performance

The pump set shall be tested as per IS 17429 and guaranteed for their performance of the daily water output (Liters Per Day) at the guaranteed dynamic head as specified in **5.1** under the

"Average Daily Solar Radiation" condition of 7.15 KWh/m^2 on the surface of Photo Voltaic (PV) array (i.e. coplanar with the PV Modules). The actual duration of pumping of water on a particular day and the quantity of water pumped could vary depending on the solar intensity, location, season, etc.

7.3 Pump sets used in the manufacture of Solar Photovoltaic Water Pumping systems shall be as per relevant Indian Standard Specification as applicable.

8. MARKING AND PARAMETERS TO BE DECLARED BY THE MANUFACTURER

The Solar Powered Pump set and Solar Photo Voltaic (PV) Controller shall be marked with the following parameters declared by the manufacturer:

8.1 Solar Photovoltaic Positive Displacement Pumping system

a) Manufacturer's name, logo or trade-mark;
b) Type, Model, size and SI No of pump set;
c) Motor Rating (kW / HP);
d) Recommended PV array power range
e) Head Range (m), Discharge Range (lpm) TDH;
f) Capacity (LPD) at guaranteed head;
g) Operating head range, m;
h) Capacity range (LPD);
i) Maximum Current (A);
j) Maximum Voltage Range (V) and;
k) Photo Voltaic (PV) Array Rating in Watts peak (Wp) range
l) Overall Efficiency of the pump set

Note: Since the PD Pump has a wider range of TDH, most of the performance parameters are also in range and will depend on the specific configuration chosen.

8.2 Solar Photo Voltaic Pump Controller

a) Manufacturer's name, logo or trade-mark;
b) Model Number;
c) Serial Number;
d) Voltage Range;
e) Power Range in kW for Controller; and
f) Current rating (A)

9. BIS CERTIFICATION MARKING

This Indian Standard is amenable for conformity assessment under the provisions of the *Bureau of Indian Standards Act*, 2016.

TABLE 1

Material of Construction of Submersible Positive Displacement pump sets as per Relevant Indian Standard Specification

Components	**Bore well submersible Positive Displacement pump sets (Parts made of Casted / Molded / Sheet Metal fabricated process)**
Bearing inner sleeve	Bronze grade LTB 2, 3,4 or 5 of IS 318 or 12 percent chromium steel grade X 04 Cr 12, X 12 Cr 12 and X 20 Cr 13, X04Cr19Ni-9/10, SAE 4140/4340 conforming to IS 6911 or IS 6603
Connecting Rod	AISI 4140 Hard Chrome plated
Bearing Lock nut	SAE 4340, Stainless steel X12 Cr 12 of IS 6911, X04Cr19Ni-9/10 of IS 6911
Non return valve	Stainless steel X12 Cr 12 of IS 6911, SAE 304/316 or Plastic/technopolymer or X04Cr19Ni-9/10 of IS 6911
Piston	Stainless steel grade X 12 Cr 12 or X04Cr19Ni-9/10 of IS 6911 or IS 6603 or Plastic/techno polymer or Aluminum, SAE 304/316
Pump shaft	Stainless steel grade X 04 Cr 12, X 12 Cr 12 or X 20 Cr 13, X15Cr16Ni2 of IS 6603 or Mild steel EN19
Angular contact/Deep Groove Ball Bearing	Stainless steel versus Carbon polymer Composite or Stainless steel versus carbon or bronze-fiber or fiber-stainless steel
Suction	Stainless steel grade X 12 Cr 12 or X04Cr19Ni-9/10 of IS 6911 or IS 6603, SAE 304/316 or Plastic/techno polymer
Stator Casing	Stainless steel grade X 12 Cr 12 or X04Cr19Ni-9/10 of IS 6911 or IS 6603 or Bronze grade), SAE 304l
Stator lamination	Electrical sheet steel as per IS 648
Winding Wire	Insulation:
	For water filled motors - Photo Voltaic (PV)C or poly wrap copper conductor as per IS 8783

	For dry or encapsulated or oil filled or resin filled motor - Super enameled, Insulation details as per IS 13730 (Part 34), VPI with resin/varnish
Motor Shaft	Grade X 04 Cr 12, X 12 Cr 12, ISO-41cr4 or X 20 Cr 13 as per IS 1570 (Part 5)
Cable	Electro grade copper insulating with Photo Voltaic (PV)C or with polymer and/or sheathing as per IS 694
Cable gland	Nitrile rubber/Silicon Rubber/EPDM/Neoprene
Bearing Bush/inner ring	Leaded tin bronze Grade LTB3, LTB4 or LTB5 of IS 318 or resin bonded carbon metal-clad or rubber or rubber-lined, PTFE bonded carbon, SAE 4340
Rotor Lamination	Electrical sheet steel as per IS 648
Rotor conductor	Electro grade copper rods as per IS 613: 1984 or Die cast aluminum as per IS 4026
PCB's	Conformal Coating (SKR-70/ Humiseal 1B31)
Controller PCB's Mounting Plate	Brass, Aluminum

Table 2.1
Minimum Requirement for Daily Flow

Indicative Technical Specifications of Solar Deep well (submersible) Positive Displacement Pumping Systems with D.C. Motor Pump Set

Description	Model-1	Model-2	Model-3	Model-4	Model-5	Model-6	Model-7	Model-8	Model-9	Model-10	Model-11	Model-12	Model-13	Model-14
PV array (Wp)							**3300**	**3300**		4500	4500			
Motor Pump-set capacity (HP)							**5**	**5**		7.5	7.5			
Total Dynamic Head (meters)							**70**	**100**		70	100			
Water output * (Liters per day)	45600	68400	114000	69000	45000	110400	**70000**	**50000**	155250	98000	70000	207000	135000	94500

Water output figures are on a clear sunny day with three times tracking of SPV panel, under the "Average Daily Solar Radiation" condition of 7.15 kWh/ sq.m. on the surface of PV array (i.e. coplanar with the PV Modules).

10. PULSATION & VIBRATION CONTROL REQUIREMENTS:

Refer 7.7, Doc. ISO 13710

11. OPERATION & MAINTENANCE MANUAL

An operation & Maintenance Manual in English & the local language shall be provided with the solar PV pumping system. The manual shall have information about solar energy, photovoltaic modules, DC motors pump set, tracking system, mounting structures, electronics & switches. It shall also have clear information about mounting of PV module, Do's & Don'ts & on regular maintenance & trouble shooting of the pumping system. Helpline number & name & address of the service center & contact number of authorized representative to be contacted in case of failure or complaint shall also be provided. A guarantee card for the modules & the motor pump set shall also be provided to the beneficiary.

LIST OF REFERRED INDIAN STANDARDS	
210:2009	Grey iron castings — Specification (fourth revision)
304:1981	High tensile brass ingots and castings (second revision)
318:1981	Specification for leaded tin bronze ingots and castings (second revision)
613:2000	Copper rods and bars for electrical purposes (second revision)
617:1994	Aluminum and aluminum alloy ingots and castings for general engineering
	purposes (Third Revision) (Under print)
694:2010	694 Polyvinyl Chloride Insulated Unsheathed--And Sheathed Cables/cords
	With Rigid And-Flexible Conductor For Rated Voltages-Up To And Including
	450/750 V
1570(Part 2/Sec 1): 1979	Part 2 Carbon steels (unalloyed steels), Section 1 Wrought products (other than wire) with specified chemical composition and related properties (first revision)
3043:1987	Code of Practice for Earthing
3073:1967	Assessment of Surface Roughness
3444:1999	Corrosion resistant High Alloy Steel and Nickel base castings for general applications(second revision)
4026:2007	Aluminum ingots billets and wire bars (EC grade)
5120:1977	Technical requirements for rotodynamic special purpose pumps (First revision)
6603:2001	Stainless Steel Bars and Flats
6911:2017	Stainless steel plate, sheet and strip Stainless steel plate, sheet and strip
8034:2002	Submersible pump sets - Specification (second revision)
8783 (Part 4): 1995	Winding Wires for Submersible Motors - Part 4 : Individual Wires – Section 1 : HR Photo Voltaic (PV)C Insulated Wires
9079:2002	Electric monoset pumps for clear, cold water for agricultural and water
	supply purposes - Specification (second revision)
9283:2013	Motors for submersible pump sets
10572:1983	Methods of sampling for pumps
11346:2002	Code of acceptance tests for agricultural and water supply pumps (first revision)
13730 (Part 6):1994	Specifications for Particular Types of Winding Wires - Part 6 : Oleo-Resinous Enameled Round Aluminum Wire, Class 180
13730 (Part 34):2000/IEC 60317:1997	Specifications for Particular Types of Winding Wires - Part 34 : Polyester Enameled Round Copper Wire, Class 130 L
IS/ISO 1940-1:2003	Mechanical Vibration ─ Balance Quality Requirements For Rotors in a Constant (Rigid) State Part 1-Specifications And Verification Of Balance Tolerances

IS/IEC 60034-1:2004	Rotating Electrical Machines ─ Part 1 Rating and Performance
IS/IEC 61683:1999	Photovoltaic System-Power Conditioners — Procedure for Measuring Efficiency
IEC 62253:2011	Photovoltaic Pumping Systems – Design qualification and performance measurements
IS 14286 : 2010 /IEC 61215 : 2005	Crystalline Silicon Terrestrial Photovoltaic (Photo Voltaic (PV)) modules - Design Qualification And Type Approval (First Revision)
IS/IEC 61730-1 2004	:Photovoltaic (Photo Voltaic (PV)) Module Safety Qualification Part 1 Requirements for Construction
IS/IEC 61730-2 2004	:Photovoltaic (Photo Voltaic (PV)) Module Safety Qualification Part 2 Requirements for Testing
IEC 60068-2-6:2007	Environmental testing – Part 2-6: Tests – Test Fc: Vibration (sinusoidal)
IEC 60068-2-30:2005	Environmental testing – Part 2-30: Tests – Test Db: Damp heat, cyclic (12 + 12h cycle)

ANNEXURE B

SOLAR PHOTOVOLTAIC WATER PUMPING SYSTEMS FOR MICRO PUMPING APPLICATIONS

I. INTRODUCTION:

A Solar Photovoltaic (SPV) Water Pumping System consists of:

- PV Array:
  PV Array should be mounted on a suitable structure with a provision for manual tracking.

- Motor Pump Set (Surface or submersible) :
  It could be installed on a suitable bore-well, open well, Water Reservoir, Water stream, etc. It could be:

  - D.C. Motor Pump Set (with Brushes or Brush less D.C.)

    OR

  - A.C. Induction Motor Pump Set with a suitable Inverter

- Electronics :

  - Inverter for A.C. Motors (Appropriate Electronic Controller in case of B.L.D.C. motors)
  - Electronic Protections.

- Interconnect Cables and
- "On-Off" switch.

II. PERFORMANCE SPECIFICATIONS AND REQUIREMENTS

Solar PV Water Pumps with PV Panel capacity in the range of 200 Wp to 500 Wp may be installed on a suitable bore-well / open well / Water Reservoir / Water stream etc.

FOR 0.25 hp Motor Pump Set and 300 Wp Solar Panel:

Under the "Average Daily Solar Radiation" condition of 7.15 KWh / sq.m. on the surface of PV array (i.e. coplanar with the PV Modules), the minimum water output from a Solar PV Water Pumping System at different "Total Dynamic Heads" should be as specified below:

(i) Minimum 15, 000 liters of water per day from a Total Dynamic Head of 10 metres and the shut off head being at least 12 metres.

(ii) Minimum 8,000 liters of water per day from a Total Dynamic Head of 20 metres and the shut off head being at least 30 metres.

(iii) Minimum 5,000 liters of water per day from a Total Dynamic Head of 30 metres and the shut off head being at least 45 metres.

FOR 0.5 hp Motor Pump Set and 500 Wp Solar Panel:

Under the "Average Daily Solar Radiation" condition of 7.15 KWh / sq.m.on the surface of PV array (i.e. coplanar with the PV Modules), the minimum water output from a Solar PV Water Pumping System at different "Total Dynamic Heads" should be as specified below:

(i) Minimum 35, 000 liters of water per day from a Total Dynamic Head of 10 metres and the shut off head being at least 12 metres.

(ii) Minimum 20, 000 liters of water per day from a Total Dynamic Head of 20 metres and the shut off head being at least 30 metres.

(iii) Minimum 15,000 liters of water per day from a Total Dynamic Head of 30 metres and the shut off head being at least 45 metres.

The actual duration of pumping of water on a particular day and the quantity of water pumped could vary depending on the solar intensity, location, season, etc.

Indicative performance specifications for the Shallow and Deep well SPV Water Pumping Systems are given in the Annexure.

III. PV ARRAY

The SPV water pumping system should be operated with a PV array capacity in the range of ***200 Wp to 500 Wp,*** measured under Standard Test Conditions (STC). Sufficient number of modules in series and parallel could be used to obtain the required PV array power output. The power output of individual PV modules used in the PV array, under STC, should be a minimum of 75 Watts peak, with adequate provision for measurement tolerances. Use of PV modules with higher power output is preferred.

Indigenously produced PV module (s) containing mono/ multi crystalline siliconsolar cells should be used in the PV array for the SPV Water Pumping systems.

- Modules supplied with the SPV water pumping systems should have certificate as per IEC 61215 specifications or equivalent National or International/ Standards.
- Modules must qualify to IEC 61730 Part I and II for safety qualification testing.
- The efficiency of the PV modules should be minimum 14% and fill factor should be more than 70%.
- The terminal box on the module should have a provision for "Opening" for replacing the cable, if required.
- There should be a Name Plate fixed inside the module which will give:
    a. Name of the Manufacturer or Distinctive Logo.
    b. Model Number
    c. Serial Number
    d. Year of manufacture
    e. Made in India (Subscribe in words)

IV MOTOR PUMP-SET

- The SPV water pumping systems may use any of the following types of motor pump sets:
    a. Surface mounted motor pump-set
    b. Submersible motor pump set
    c. Floating motor pump set
    d. Pressure booster pumps
    e. Any other type of motor pump set after approval from Test Centers of the Ministry.

- The "Motor Pump Set" should have a capacity in the range of ***0.2 hp to 0.5 hp and*** should have the following features:

    - The mono block DC/ AC centrifugal motor pump set with the impeller mounted directly on the motor shaft and with appropriate mechanical seals which ensures zero leakage.
    - The motor of the capacity ranging from 0.2 hp to 0.5 hp should be AC, DC or BLDC type. The suction and delivery head will depend on the site-specific condition of the field.

- Submersible pumps or Surface pumps could also be used according to the dynamic head of the site at which the pump is to be used.

- It is recommended that all parts of the pump and the motor of the submersible pumps should be made of stainless steel or suitable grade of plastic. The impellers and other internal parts can be of suitable grade of modified PPE resins (example Noryl) or Polycarbonate or equivalent.

- The manufacturers of pumps should self-certify that, the pump and all ***external parts of motor used in submersible pump which are in contact with water, are of stainless steel or suitable grade of plastic.*** The pumps used for solar application should have a 5 years warranty so it is essential that the construction of the pump be made using parts which have a much higher durability and do not need replacement or corrode for at least 5 years.

- The following details should be marked indelibly on the motor pump set
  a) Name of the Manufacturer or Distinctive Logo.
  b) Model Number.
  c) Serial Number.

- The suction/ delivery pipe (GI/HDPE), electric cables, floating assembly, civil work and other fittings required to install the Motor Pump set.

V. MOUNTING STRUCTURES.

The PV modules should be mounted on metallic structures of adequate strength and appropriate design, which can withstand load of modules and high wind velocities up to 150 km per hour. The support structure used in the pumping system should be hot dip galvanized iron with minimum 80 micron thickness.

To enhance the performance of SPV water pumping systems, manual or passive or auto tracking system **must** be used**.** For manual tracking, arrangement for seasonal tilt angle adjustment and three times manual tracking in a day should be provided.

VI. ELECTRONICS AND PROTECTIONS

- Inverter could be used, if required, to operate an A.C. Pump. The inverter must have IP 65 protection or must be housed in a cabinet having at least ***IP65*** protection.

- Controller for BLDC motor driven pumps, if required may be used. The controller must have ***IP 65*** protection or must be housed in a cabinet having at least IP 65 protection.
- Adequate protections should be incorporated against dry operation of motor pump set, lightning, hails and storms.
- Full protection against open circuit, accidental short circuit and reverse polarity should be provided.

VII. **ON/OFF SWITCH**

A good reliable switch suitable for DC use is to be provided. Sufficient length of cable should be provided for inter-connection of the PV array, Controller / Inverter and the motor pump set.

VIII.**WARRANTY**

The PV Modules must be warranted for output wattage, which should not be less than 90% at the end of 10 years and 80% at the end of 25 years. The whole system including submersible/ surface pumps shall be warranted for 5 years. Required Spares for trouble free operation during the Warrantee period should be provided along with the system.

IX. **OPERATION AND MAINTENANCE MANUAL**

An Operation and Maintenance Manual, in English and the local language, should be provided with the solar PV pumping system. The Manual should have information about solar energy, photovoltaic, modules, DC/AC motor pump set, tracking system, mounting structures, electronics and switches. It should also have clear instructions about mounting of PV module, DO's and DONT's and on regular maintenance and Trouble Shooting of the pumping system. Name and address of the person or Centre to be contacted in case of failure or complaint should also be provided. A warranty card for the modules and the motor pump set should also be provided to the beneficiary.

X. MISC

- The type of pump set used must match the total dynamic head requirement of the site (i.e. the location at which it is installed).
- There should not be any compulsion to use only one or the other type of Motor-pump set. The beneficiary may select an appropriate Model (i.e. Capacity of PV Array and Type of Motor Pump Set) as per site requirement.
- Solar Photovoltaic Water Pumping Systems should be tested and certified by an authorized test centre of the Ministry to meet the performance and water discharge norms specified in section II above.
- Variation in the modules wattage in the PV Array should be within +3% or - 3 % so as to minimize the mismatch losses in the PV Array.
- Any array capacity above the minimum array wattage requirement as specified in these specifications for various models of solar pumping systems is allowed.

ANNEXURE

Indicative Technical Specifications of Solar 'MICRO' Pumping Systems:

	Model-I	Model-II	Model-III	Model-IV	Model-V	Model-VI
PV array	**300 Wp**	**300 Wp**	**300 Wp**	**500 Wp**	**500 Wp**	**500 Wp**
Motor capacity	**0.25 hp**	**0.25 hp**	**0.25 hp**	**0.5 hp**	**0.5 hp**	**0.5 hp**
Shut Off Dynamic Head	**12 metres**	**30 metres**	**45 metres**	**12 metres**	**30 metres**	**45 metres**
Water output *	**15,000 litres per day from a total head of 10 metres**	**8,000 litres per day from a total head of 20 metres**	**5,000 litres per day from a total head of 30 metres**	**35,000 litres per day from a total head of 10 metres**	**20,000 litres per day from a total head of 20 metres**	**15,000 litres per day from a total head of 30 metres**

* Water output figures are on a clear sunny day with three times tracking of SPV panel, under the "Average Daily Solar Radiation" condition of **7.15 KWh/ sq.m. on the** surface **of PV array (i.e. coplanar with the PV Modules)**.

Notes:

1. For higher or lower head / PV capacity, or in between various models; water output could be decided as per the clause II. (i.e. performance specifications and requirements) specified earlier.
2. In case of a surface pump, the suction head to be maintained at minimum 6 metres static suction lift corrected for atmospheric pressure and water temperature