भारतीय मानक
Indian Standard

IS 17018 (Part 1) : 2022

सोलर फोटोवोल्टेइक वॉटर पम्पिंग सिस्टम — विशिष्टि

भाग 1 केन्द्राप्रसारक पंप

(पहला पुनरीक्षण)

Solar Photovoltaic Water Pumping Systems — Specification

Part 1 Centrifugal Pumps

(First Revision)

ICS 23.100.10

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FOREWORD

This Indian Standard (Part 1) (First Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Pumps Sectional Committee had been approved by the Mechanical Engineering Divisional Council.

This standard was first published in 2018. Substantial changes in the industrial practices, requirements and updation of testing procedures necessitate this revision.

This standard is primarily intended to introduce constructional, design, performance and safety features for solar photovoltaic water pumping systems and also prescribes the methods of measurement of performance and energy efficiency ratings.

Testing of solar photovoltaic water pumping systems is covered in a separate standard and this part shall cover only the specification and requirements of different parts of SPV pumping system. Due to change in the average daily solar radiation from 6.5 kWh/m^2 to 7.15 kWh/m^2 (as per recommendations of regulatory authorities), the hot and cold profile have been changed accordingly. There is no additional test setup required due to this revision, however, minimum requirement of measuring instruments shall be maintained for testing.

Following important changes are made in this revision:

a) Range of the SPV pumps has been specified in the scope;
b) Typical module mounting structures and tracking systems have been illustrated in this revision;
c) Average daily solar radiation has been changed from 6.5 kWh/m^2 to 7.15 kWh/m^2;
d) Reference to a separate standard for testing has been mentioned in this revision; and
e) Material for manufacture of SPV pumps has been modified.

The manufacturers of solar powered water pump set offer an array of equipment to meet the diverse applications of markets. The complexity of the product offering precludes the testing of each and every model. However, to promote consistency in the representation of Solar powered water pump set performance by all manufacturers; this standard establishes uniform rating and testing methods. It is intended that equipment testing shall be done in laboratory where the instrumentation and load stability as defined in the standard are provided.

While formulating this Standard, assistance has been drawn from the following International Standards:

IEC 62253 : 2011	Photovoltaic pumping systems — Design qualification and performance measurements
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)

The composition of the committee responsible for the formulation of this standard is given in Annex E.

For the purpose of deciding whether a particular requirement of this standard is complied with the final value, observed or calculated, expressing the result of a test or analysis shall be rounded off in accordance with IS 2 : 2022 ‘Rules for rounding off numerical values (*second revision*)’. The number of significant places retained in the rounded off value shall be the same as that of the specified value in this standard.

Indian Standard

SOLAR PHOTOVOLTAIC WATER PUMPING SYSTEMS — SPECIFICATION

PART 1 CENTRIFUGUAL PUMPS

(First Revision)

1 SCOPE

This specification (Part 1) covers design qualifications and performance specifications for Centrifugal Solar Photovoltaic (SPV) Water Pumping Systems from 0.75 kW up to 7.5 kW to be installed on a suitable bore-well, open well, water reservoir, water stream, etc.

2 REFERENCES

The Indian Standards listed in Annex A contain provisions which, through reference in this text, constitute provision of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards.

3 TERMINOLOGY

In addition to the terminology specified in 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 Submergence — It is the minimum height of water level after drawdown above the pump suction casing.

3.4 Manometric Suction Lift — Manometric suction lift is the vacuum gauge/suction manometer reading in meter of water column when pump operates at suction lift.

3.5 Static Suction Lift — Static suction lift/head is the vertical distance between sump water level and centre of pump inlet.

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

3.7 Wire to Water Efficiency — It is the combined system efficiency of SPV converter/controller with inbuilt MPPT mechanism, pump set and piping.

3.8 SPV Pump Controller — Pump controller converts the d.c. voltage of the SPV array into asuitable d.c. or a.c. single or multi-phase power and may also include equipment for MPPT,remote monitoring, and protection devices.

3.9 Maximum Power Point Tracker (MPPT) — MPPT is an algorithm that is included in the pump controller used for extracting maximum available power from SPV array under agiven condition. The voltage at which SPV array can produce maximum power is calledmaximum power point' voltage (or peak power voltage).

4 CONSTRUCTIONAL FEATURES

4.1 General

SPV water pumping system set uses the irradiance available through SPV array. The SPV array produces d.c. power, which can be utilized to drive a d.c. or an a.c. pump set using pump controller.

4.2 A SPV water pumping system typically consists of:

4.2.1 *Motor Pump Set* (*see* **3.4**)

4.2.2 *SPV Pump Controller* (*see* **3.8**)

NOTE — Some controllers can be inbuilt in the motors.

4.2.3 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(calculated based on parameters), in fault condition; array input voltage/current and power shall be logged at an interval of 10 min; 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 9000 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 200 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 16 percent and fill factor shall be more than 70 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 d.c.).

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 61701for salt mist corrosion test.

4.3.7 The name plate of PV Module shall conform the 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 Variation in overall SPV array wattage from the specified wattages shall be within zero percent to + 10 percent.

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.

4.4 Motor-pump Set

4.4.1 The SPV water pumping systems may use any of the following types of motor pump sets:

a) Surface mounted motor-pump set; and

b) Submersible motor-pump set.

The motor of the motor-pump set may be of the following types:

1) a.c. induction motor; and

2) d.c. motor (with brush or brushless), PMSM/BLDC/SRM.

4.4.2 The "motor-pump set" shall have a range from 0.75 kW upto7.5 kW and shall have the following features:

a) The close-coupled or mono block d.c./a.c. centrifugal motor pump set with appropriate mechanical seal(s) which ensures zero leakage;

b) The motor of the capacity ranging from 0.75 kW to 7.5 kW shall be a.c./d.c. The suction and delivery head will depend on the site-specific condition of the field; and

c) Submersible pumps could also be used according to the dynamic head of the site atwhich 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 be of stainless steel of grade 304 or higher as per IS 6911 and IS 3444. 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, electric cables, floating assembly, civil work and other fittings required to install the motor pump set. 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 percent 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 centre 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 attached at Annex B. The standards mentioned therein are to be followed however any other proven designs may be used.

4.6 SPV Pump Controller

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

4.6.2 The SPV pump controller must have IP (65) protection or shall be housed in a cabinet having at least IP (65) protection.

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;
b) Open circuit;
c) Accidental output short circuit;
d) Under voltage;
e) Reverse polarity; and
f) Surge protection to arrest high current surge.

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

4.7 Earthing Arrangement

4.7.1 Earthing of the motor shall be done as per IS 9283 in accordance with the relevant provisions of IS 3043. Separate earthing shall be provided for controller, pump and SPV array.

4.7.2 For safety purpose, 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

5.1 Under the "average daily solar radiation" condition of 7.15 KWh/m^2 on the surface of PV array (that is, coplanar with the PV modules), the minimum water output from a solar PV water pumping system at different "total dynamic heads" shall be as specified below:

5.2 For d.c. Motor Pump Set

a) 110 litres of water per watt peak of PV array, from a total dynamic head of 10 meter (suction head, if applicable, minimum of 7meter static suction lift corrected for atmospheric pressure and water temperature) and with the shut off head being at least 12 meter;
b) 55 litres of water per watt peak of PV array, from a total dynamic head of 20 meter (suction head, if applicable, minimum of 7 meters static suction lift corrected for atmospheric pressure and water temperature) and with the shut off head being at least 25 meter;
c) 38 litres of water per watt peak of PV array, from a total dynamic head of 30 meters and the shut off head being at least 45 meter;
d) 23 litres of water per watt peak of PV array, from a total dynamic head of 50 meter and the shut off head being at least 70 meter;
e) 15 litres of water per watt peak of PV array, from a total dynamic head of 70 meters and the shut off head being at least 100 meter; and
f) 10.5 litres of water per watt peak of PV array, from a total dynamic head of 100 meters and the shut off head being at least 150 meter.

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 Annex C.

5.3 For a.c. Induction Motor Pump Set

a) 99 litres of water per watt peak of PV array, from a total dynamic head of 10 meter (suction head, if applicable, minimumof 7 metersstatic suction lift corrected for atmospheric pressure and water temperature and with the shut off head beingat least 12 meter);

b) 49 litres of water per watt peak of PV array, from a total dynamic head of 20 meter (suction head, if applicable, minimum 7 metersstatic suction liftcorrected for atmospheric pressure and water temperature and with the shut off headbeing at least 25 meter);

c) 35 litres of water per watt peak of PV array, from a total dynamic head of 30 meter and the shut off head being at least 45 meter;

d) 21 litres of water per watt peak of PV array, from a total dynamic head of 50 meter and the shut off head being at least 70 meter;

e) 14 litres of water per watt peak of PV array, from a total dynamic head of 70 meter and the shut off head being at least 100 meter; and

f) 9 litres of water per watt peak of PV array, from a total dynamic head of 100 meter and the shut off head being at least 150 meter.

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 Annex D.

6 TESTS FOR HYDRAULIC AND ELECTRICAL PERFORMANCE OF PUMPSET

6.1 The motor-pump set shall be tested independently for hydraulic and electrical performance as per the relevant Indian Standard specification including following test:

a) Constructional requirements/features (for a.c. induction pump sets);

b) General requirements (for a.c. induction pump sets);

c) Design features (for a.c. induction pump sets);

d) Insulation resistance test;

e) High voltage test; and

f) Leakage current test.

6.2 Testing of SPV water pumping systems shall be done as per IS 17429.

7 GUARANTEE OF PERFORMANCE

7.1 The SPV water pumping systems shall be guaranteed for their performance of the nominalvolume rate of flow and the nominal head at the guaranteed duty point as specified in **5.1** under the "average daily solar radiation" condition of 7.15 KWh/m^2 on the surface of SPV array [that is, coplanar with the Photo Voltaic (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.

7.2 Solar photovoltaic water pumping systems 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.

7.3 Sufficient spares for trouble free operation during the guarantee period shall be made available as and when required.

8 MARKING AND PARAMETERS TO BE DECLARED BY THEMANUFACTURER

8.1 The motor pump-set and controller used in SPV water pumping systems shall be securely marked with the following parameters declared by the manufacturer:

8.1.1 *Motor Pump-set*

a) Manufacturer's name, logo or trade-mark;

b) Model, size and SI No. of pump set (to be engraved/laser marked on the motor frame);

c) Motor rating (kW/HP);

d) Total head, m, at the guaranteed duty point;

e) Capacity (LPD) at guaranteed head;

f) Operating head range, m;

g) Maximum current (A);

h) Voltage range (V) and;

j) Type a.c. or d.c. pump set;

k) Photo voltaic (PV) array rating in Watts peak (Wp); and

m) Country of origin.

NOTE — In addition, a metal name plate containing the above details shall be fixed on the module mounting structure for the information of the user.

8.1.2 *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;

f) current rating (A); and

g) Country of origin.

9 OPERATION AND MAINTENANCE MANUAL

An operation and maintenance manual, in English and the local language, shall be provided with the solar PV pumping system. The manual shall have information about solar energy, photovoltaic, modules, d.c./a.c. motor pump set, tracking system, mounting structures, electronics and switches. It shall also have clear instructions about mounting of PV module, DO's and DONT's and on regular maintenance and troubleshooting of the pumping system. Helpline number and name and address of the service centre and contact number of authorized representative to be contacted in case of failure or complaint shall also be provided. A guarantee card for the modules and the motor pump set shall also be provided to the beneficiary.

10 BIS CERTIFICATION MARKING

The product(s) conforming to the requirements of this Standard may be certified as per the conformity assessment schemes under the provisions of the *Bureau of Indian Standards Act*, 2016 and the Rules and Regulations framed thereunder, and the product(s) may be marked with the Standard Mark.

ANNEX A

(*Clause* 2)

LIST OF REFERRED INDIAN STANDARDS

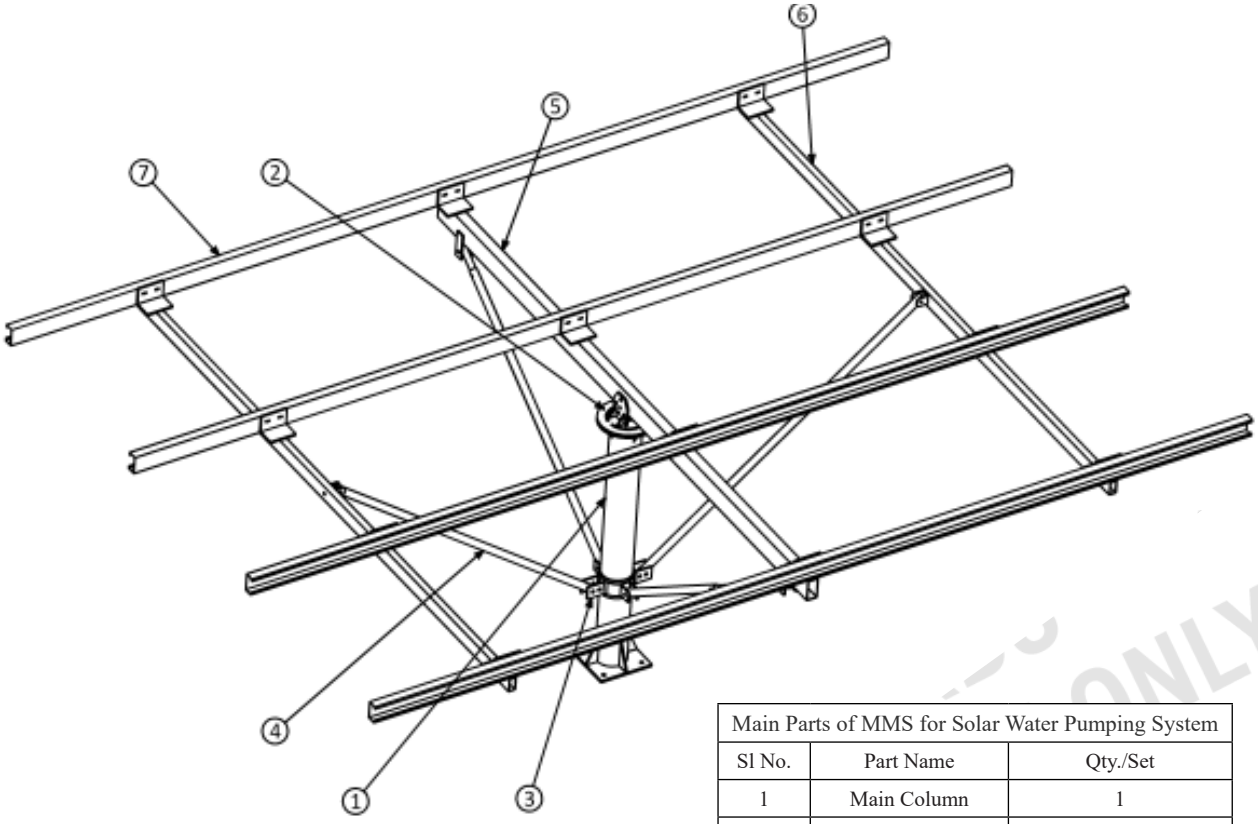
IS No./Other Standards	*Title*
456 : 2000	Plain and reinforced concrete — Code of practice (*fourth revision*)
811 : 1987	Specification for cold formed light gauge structural steel sections (*second revision*)
822 : 1970	Code of procedure for inspection of welds
875 (Part 1) : 1987	Code of practice for design loads (other than earthquake) for buildings and structures: Part 1 Dead loads — Unit weights of building materials and stored materials (*second revision*)
694 : 2010	Polyvinyl chloride insulated unsheathed and sheathed cables/cords with rigid and flexible conductor for rated voltages up to and including 450/750 v (*fourth revision*)
1079 : 2017	Hot rolled carbon steel sheet, plate and strip — Specification (*seventh revision*)
1161 : 2014	Steel tubes for structural purposes — Specification (*fifth revision*)
1239 (Part 1) : 2004	Steel tubes, tubulars and other wrought steel fittings — Specification: Part 1 Steel tubes (*sixth revision*)
2062 : 2011	Hot rolled medium and high tensile structural steel —Specification (*seventh revision*)
2629 : 1985	Recommended practice for hot-dip galvanizing of iron and steel (*first revision*)
2633 : 1986	Method for testing uniformity of coating on zinc coated articles (*second revision*)
3043 : 2018	Code of practice for earthing (*second revision*)
3444 : 1999	Corrosion resistant high alloy steel and nickel base castings for general applications — Specification (*third revision*)
4091 : 1979	Code of practice for design and construction of foundations for transmission line towers and poles (*first revision*)
4759 : 1996	Hot-dip zinc coatings on structural steel and other allied products — Specification (*third revision*)
5120 : 1977	Technical requirements for rotodynamic special purpose pumps (*first revision*)
5624 : 2021	Foundation bolts — Specification (*second revision*)
6403 : 1981	Code of practice for determination of bearing capacity of shallow foundations
6745 : 1972	Methods for determination of mass of zinc coating on zinc coated iron and steel articles
6911 : 2017	Stainless steel plate, sheet and strip — Specification (*second revision*)
7215 : 1974	Tolerances for fabrication of steel structures
8034 : 2018	Submersible pump sets — Specification (*third revision*)
9079 : 2018	Monoset pumps for clear, cold water for agricultural and water supply purposes— Specification (*third revision*)
9283 : 2013	Motors for submersible pump sets — Specification (*second revision*)
9968 (Part 1) : 1988	Specification for elastomer insulated cables: Part 1 For working voltages up to and including 1100 volts (*first revision*)
10804 (Part 1) : 2018	Recommended pumping systems for agricultural purposes: Part 1 Surface pumps (*third revision*)
10804 (Part 2) : 2018	Recommended pumping systems for agricultural purposes: Part 2 Submersible pump sets (*third revision*)

IS No./Other Standards	*Title*
14220 : 2018	Open well submersible pump sets — Specification (*first revision*)
14536 : 2018	Selection, installation, operation and maintenance of submersible pump set — Code of practice (*first revision*)
IS/IEC 61701 : 2011	Salt mist corrosion testing of photovoltaic (PV) modules (*first revision*)
17210 (Part 1) : 2019	Photovoltaic (PV) modules — Test methods for the detection of potential — Induced degradation: Part 1 Crystalline silicon
IS/IEC 61683 : 1999	Photovoltaic system-power conditioners — Procedure for measuring efficiency
IEC 62253 : 2011	Photovoltaic pumping systems — Design qualification and performance measurements
14286 : 2010/ IEC 61215 : 2005	Crystalline silicon terrestrial photovoltaic [photo voltaic (PV)] modules — Design qualification and type approval (*first revision*)
17429 : 2020	Solar photovoltaic water pumping systems — Testing procedure — Guidelines
IS/IEC 61730-1 : 2016	Photovoltaic (PV) module safety qualification: Part 1 Requirements for construction (*first revision*)
IS/IEC 61730-2 : 2019	Photovoltaic (PV) module safety qualification: Part 2 Requirements for testing (*first revision*)
IS/IEC 60947-1 : 2007	Low-voltage switchgear and controlgear: Part 1 General rules (*first revision*)

ANNEX B

(*Clause* 4.5.4)

SPECIFICATIONS FOR DUAL AXIS MANUAL TRACKING TYPE MODULE MOUNTING STRUCTURE (MMS) FOR SOLAR WATER PUMPING SYSTEM



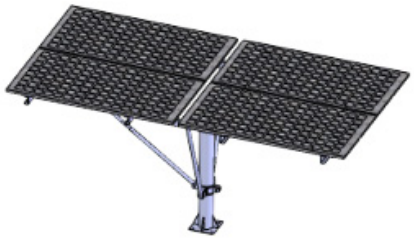
Main Parts of MMS for Solar Water Pumping System		
Sl No.	Part Name	Qty./Set
1	Main Column	1
2	Top Plate	1
3	Clamp with blade	2
4	Supporting pipe	6/8
5	Main tube	1
6	Side tube	2
7	Mounting purlin	4

For hot dip galvanizing of fabricated structure following shall be referred:

a) Minimum coating required shall be as per IS 4759;
b) Preece test ($CuSO_4$ Dip test) as per IS 2633;
c) Mass of zinc (IS 6745 or IS 4759); and
d) Adhesion test (IS 2629).

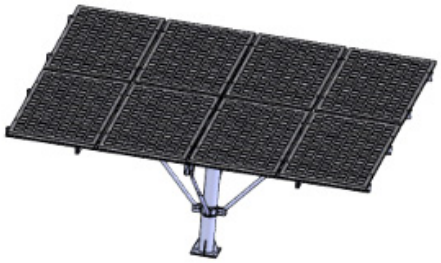
B-1 STANDARD MMS FOR 4, 6, 8 AND 10 SOLAR MODULES HAVE BEEN SPECIFIED. THESE STANDARD MMS MAY BE USED IN COMBINATIONS FOR DIFFERENT CAPACITIES OF SOLAR WATER PUMPING SYSTEMS AS FOLLOWS

a) Standard MMS of 4 modules for 1 HP;
b) Standard MMS of 6 modules for 2 HP;
c) Standard MMS of 10modules or combination of standard MMS of 4 Modules and standard MMS 6 Modules for 3 HP;
d) Combination of two standard MMS of 8 modules or combination of standard MMS of 10 modules and standard MMS 6 modules for 5 HP; and

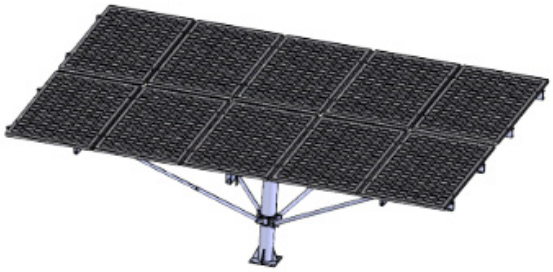


4 Module MMS

6 Module MMS



8 Module MMS



10 Module MMS

e) Combination of three standard MMS of 8 modules or combination of twostandard MMS of 10 Modules and one standard MMS 6 modules for 7.5 HP and so on.

B-2 SPECIFICATIONS OF MAIN PARTS USED IN MMS ARE GIVEN BELOW

B-2.1 Centre Shaft

Centre shaft used in structure shall be of:

a) *For 4, 6 and 8 Modules Structure* — Minimum 139 OD with minimum thickness of 4 mm with base plate minimum 10 mm thickness if used and foundation hardware shall be as per IS 5624.

b) *For 10 Modules Structure* — Minimum 165 OD with minimum thickness of 4 mm with base plate minimum 20 mm thickness if used and foundation hardware shall be as per IS 5624.

For system without base plate that is, direct pilling is shall be as per the site condition based on the properties of soil and refer (IS 6403/456/4091/875) for foundation design.

B-2.2 Rafters

The main and secondary rafter used in structure shall be of either SHS and RHS pipe sections.

B-2.3 Purlin

Mounting purlins used in the structure shall be made of cold form steel section as per IS 1079 with minimum thickness of 2 mm.

B-2.4 Provision for Seasonal Tilt

In one structure at least four telescopic supports (three may be used in MMS for 4 modules) either round hollow sections or square hollow section to be provided to support the mounting structure.

B-2.5 Provision for Daily Tracking

Provision for daily tracking shall be provided by the way of providing minimum 8 mm thick metal sheet with precision cut grooves.

B-2.6 Module Locking System

Modules shall be locked with antitheft bolts of SS 304 Grade.

B-2.7 General Hardware for Structure Fitment

Either SS 304 or 8.8 grade hardware shall be used for fitment.

B-2.8 Hot Dip Galvanizing

All structure parts shall be hot dip galvanized according to IS 4759.

B-2.9 Tolerance for Fabrication

Tolerance for fabrication of steel structure shall as per IS 7215.

B-2.10 Welding

Welding shall be done as per IS 822 and grade of welding wire shall be (ER70S-6).

B-2.11 Raw Material Test Certificates (MTC)

MTC of all types of raw material used in dual axis manual tracking type MMS as per appropriate Indian Standard shall be submitted along with dispatch documents.

B-2.12 Tests to be performed on dual axis manual tracking type MMS for solar water pumping system.

B-2.12.1 For ascertaining proper welding of structure part following shall be referred:

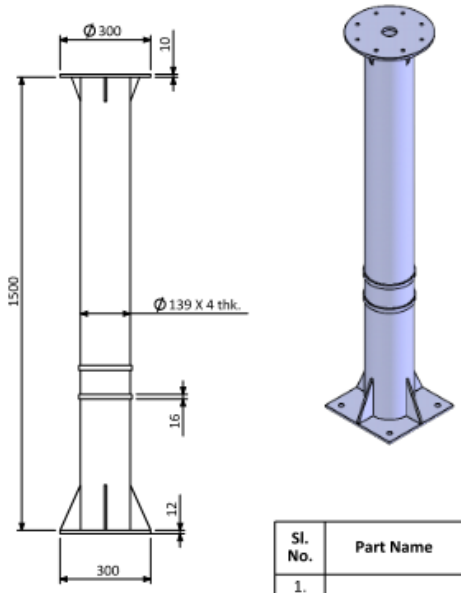
a) Weld wire grade shall be of grade (ER 70 S - 6); and
b) D.P. test (pin hole/crack) (IS 822).

B-2.12.2 For ascertaining hot dip galvanizing of fabricated structure following shall be referred:

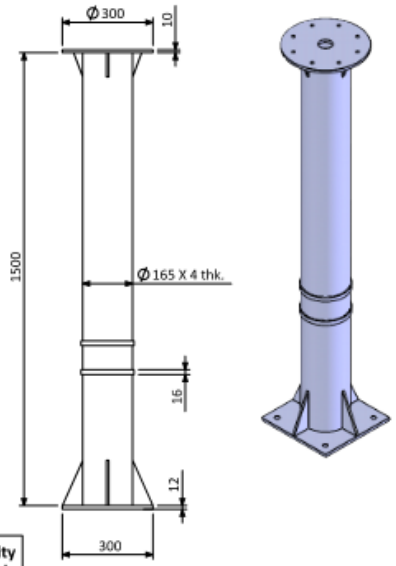
a) *Min* coating required shall be as per IS 4759;
b) Testing of galvanized material;
c) Preece test (CuSO4 dip test) (IS 2633);
d) Mass of zinc (IS 6745 or IS 4759); and
e) Adhesion test (IS 2629).

Part 1 Main Column

Common for 4, 6 & 8 MMS



For 10 MMS

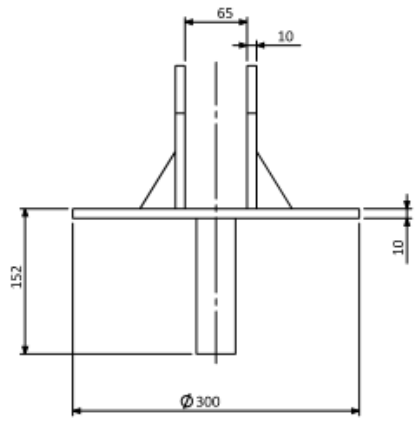


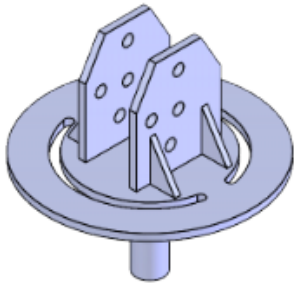
Sl. No.	Part Name	Cross Section Detail	Length (mm)	Quantity Per Set
1.	MAIN POLE			
	4,6 and 8 Modules	139 OD	1500	1
	10 Modules	165 OD	1500	1

Notes :
1. All dimensions are in mm.

Part 2 Top Plate

Common for 4, 6, 8 & 10 MMS



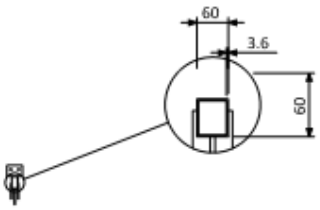


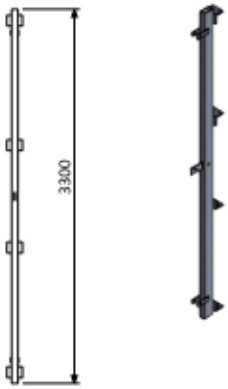
Sl. No.	Part Name	Cross Section Detail	Length (mm)	Quantity Per Set
2.	TOP PLATE (Common for all)	300 OD	--	1

Notes :
1. All dimensions are in mm.

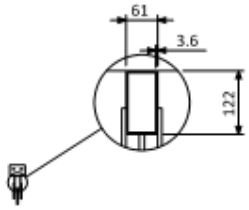
Part 3 Main Tube

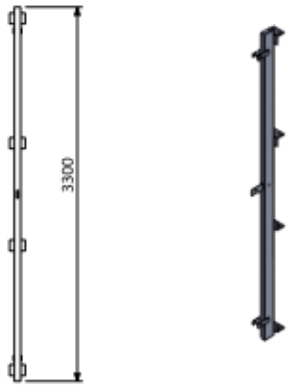
Common for 4 & 6 MMS





Common for 8 & 10 MMS



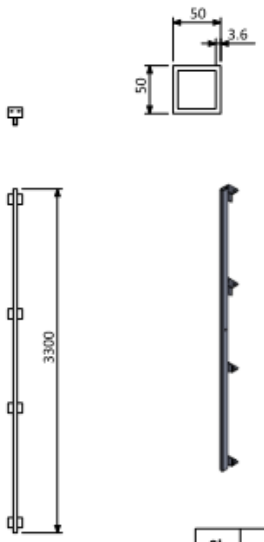


Sl. No.	Part Name	Cross Section Detail	Length (mm)	Quantity Per Set
5.	MAIN TUBE			
	4 and 6 Modules	60X60X3.6	3300	1
	8 and 10 Modules	112X61X3.6	3300	1

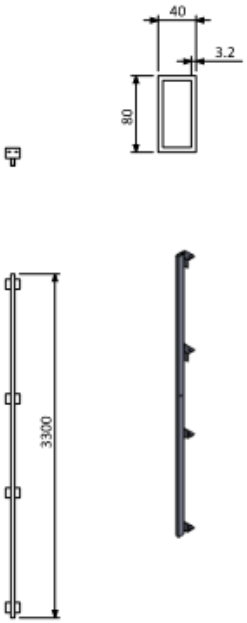
Notes :
1. All dimensions are in mm.

Part 4 Side Tube

Common for 4 & 6 MMS



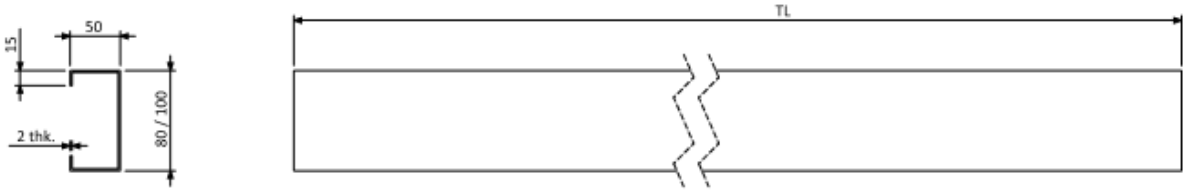
Common for 8 & 10 MMS



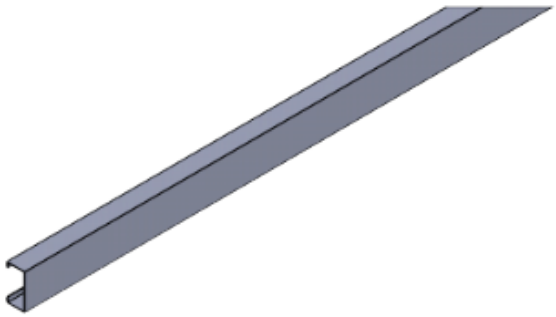
Sl. No.	Part Name	Cross Section Detail	Length (mm)	Quantity Per Set
6.	SIDE TUBE			
	4 and 6 Modules	50X50X3.6	3300	2
	8 and 10 Modules	80X40X3.2	3300	2

Notes :
1. All dimensions are in mm.

Part 5 Purlin



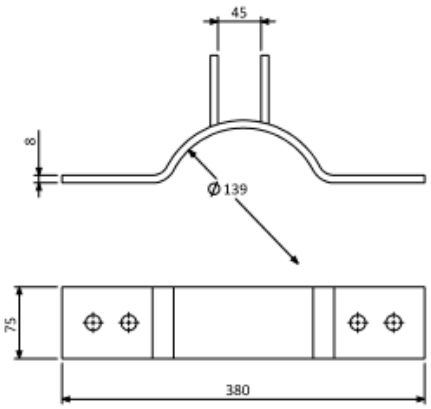
Sl. No.	Part Name	Cross Section Detail	Length (mm)	Quantity Per Set
7.	MOUNTING PURLIN			
	4 Modules	80X50X15X2	2050	4
	6 Modules	80X50X15X2	3100	4
	8 Modules	80X50X15X2	4150	4
	10 Modules	100X50X15X2	5200	4



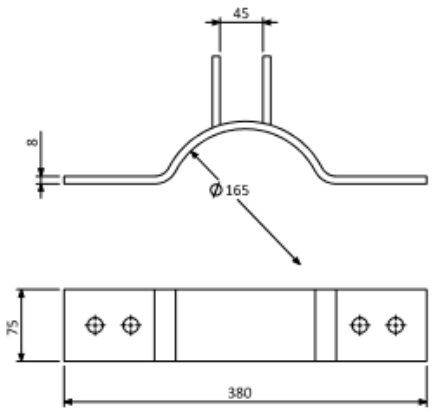
Notes :
1. All dimensions are in mm.

Part 6 Clamp with Blade

Common for 4, 6 & 8 MMS



For 10 MMS

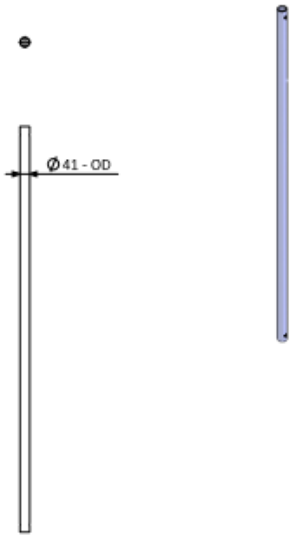


Sl. No.	Part Name	Cross Section Detail	Length (mm)	Quantity Per Set
3.	CLAMP WITH BLADE			
	4,6 and 8 Modules (For 139 OD pole)	75x8	380	2
	10 Modules For 165 OD pole)	75x8	380	2

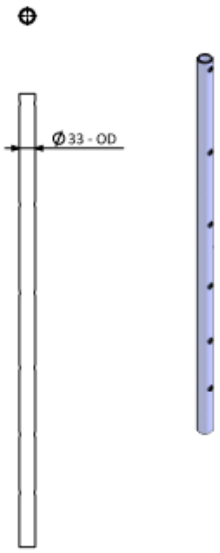
Notes :
1. All dimensions are in mm.

Part 7 Supporting Pipes

4A) Spporting Pipe - 4 nos / set
Common for 4, 6, 8 & 10 MMS



4B) Supporting Pipe - 2 nos / set
Common for 4, 6, 8 & 10 MMS



Notes :
1. All dimensions are in mm.

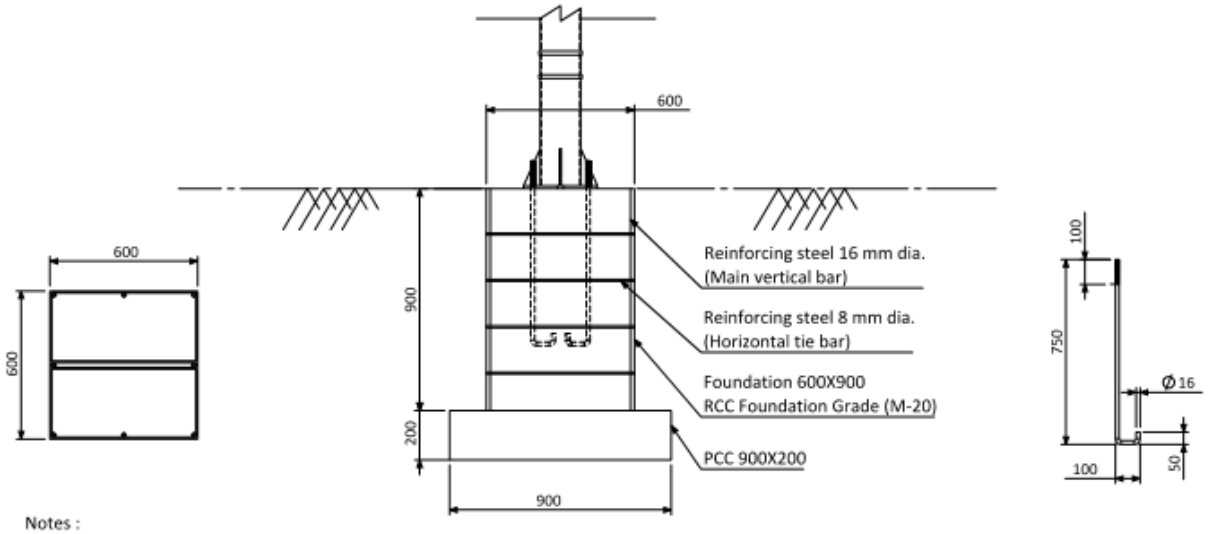
Main Parts of MMS for Solar Water Pumping System

Sl No.	Part Name	Cross Section Detail	Length (mm)	Quantity Per Set	Material Grade
1.	**MAIN COLOUMN**				
	4, 6 and 8 Modules	139 OD	1500	1	YST – 240 as per IS 1161/IS 1239 and E 250 as per IS 1079/IS 2062
	10 Modules	165 OD	1500	1	
2.	**TOP PLATE (Common for all)**				
		300 OD	–	1	YST – 240 as per IS 1161/IS 1239 and E 250 as per IS 1079/IS 2062
3.	**MAIN TUBE**				
	4 and 6 Modules	60 × 60 × 3.6	3300	1	YST – 240 as per IS 1161/IS 1239 and E 250 as per IS 1079/IS 2062
	8 and 10 Modules	122 × 61 × 3.6	3300	1	
4.	**SIDE TUBE**				
	4 and 6 Modules	50 × 50 × 3.6	3300	2	YST – 240 as per IS 1161/IS 1239 and E 250 as per IS 1079/IS 2062
	8 and Modules	80 × 40 × 3.2	3300	2	
5.	**MOUNTING PURLIN**				
	4 Modules	80 × 50 × 15 × 2	2050	4	E 250 as per IS 1079/ IS 2062 and IS 811
	6 Modules	80 × 50 × 15 × 2	3100	4	
	8 Modules	80 × 50 × 15 × 2	4150	4	
	10 Modules	100 × 50 × 15 × 2	5200	4	
6.	**CLAMP WITH BLADE**				
	4, 6 and 8 Modules (for 139 OD pole)	75 × 8	380	2	As per IS 1079 and E 250 as per IS 2062
	10 Modules (for 165 OD pole)	75 × 8	380	2	
7.	**SUPPORTING PIPES**				
	4, 6 and 8 Modules	41 OD and 33 OD	–	6	YST – 240 as per IS 1161/IS 1239 and E 250 as per IS 1079/IS 2062
	10 Modules	41 OD and 33 OD	–	8	

Foundation Design for 4 /6 MMS

BOM for steel				
TMT Bar	Length	Unit Weight	Quantity	Total weight
16 mm	1000 mm	1.578 kg	8 pcs	12.6 kg
8 mm	2400 mm	0.950 kg	4 pcs	3.8 kg
8 mm	1250 mm	0.500 kg	4 pcs	2 kg

BOM for RCC and PCC				
Block	Width	Length	Height	Volume
RCC Column	0.600 M	0.600 M	0.900 M	0.324 CU.M
PCC	0.900 M	0.900 M	0.200 M	0.162 CU. M

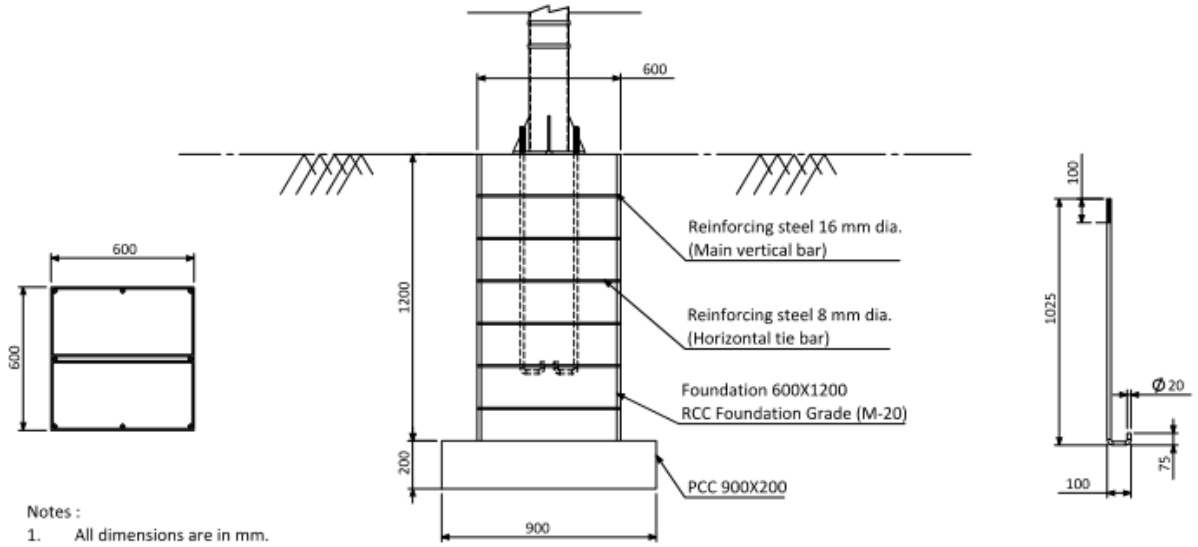


Notes :
1. All dimensions are in mm.

Foundation Design for 8 MMS

BOM for steel				
TMT Bar	Length	Unit Weight	Quantity	Total weight
16 mm	1300 mm	2.050 kg	8 pcs	16.4 kg
8 mm	2400 mm	0.950 kg	6 pcs	5.7 kg
8 mm	1250 mm	0.500 kg	6 pcs	3 kg

BOM for RCC and PCC				
Block	Width	Length	Height	Volume
RCC Column	0.600 M	0.600 M	1.20 M	0.432 CU.M
PCC	0.900 M	0.900 M	0.200 M	0.162 CU. M

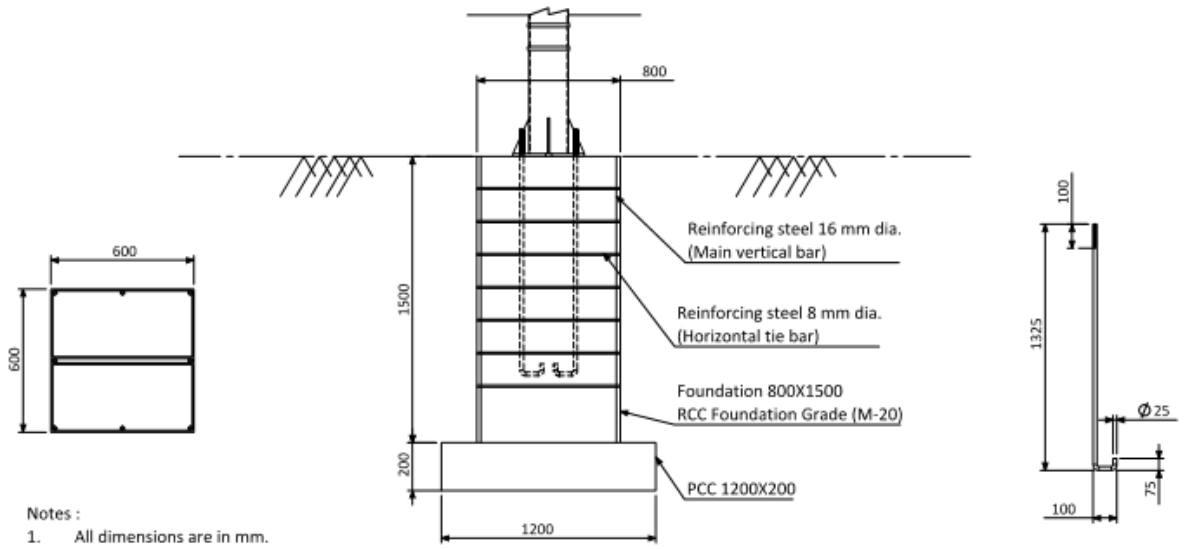


Notes :
1. All dimensions are in mm.

Foundation Design for 10 MMS

BOM for steel				
TMT Bar	Length	Unit Weight	Quantity	Total weight
16 mm	1800 mm	2.50 kg	8 pcs	20.0 kg
8 mm	3200 mm	1.25 kg	7 pcs	8.75 kg
8 mm	1650 mm	0.650 kg	7 pcs	4.55 kg

BOM for RCC and PCC				
Block	Width	Length	Height	Volume
RCC Column	0.800 M	0.800 M	1.50 M	0.960 CU.M
PCC	1.20 M	1.20 M	0.200 M	0.288 CU. M



Notes :
1. All dimensions are in mm.

ANNEX C

(*Clause* 5.2)

INDICATIVE TECHNICAL SPECIFICATIONS OF SHALLOW WELL (SURFACE) SOLAR PUMPING SYSTEMS WITH D.C. MOTOR PUMP SET WITH BRUSHES OR BRUSHLESS D.C. (B.L.D.C.)

Description	Model-I	Model-II	Model-III	Model-IV	Model-V	Model-VI	Model-VII	Model-VIII	Model-IX	Model-X	Model-XI	Model-XII	Model-XIII
PV array (Wp)	900	1800	2700	2700	4800	4800	4800	6750	6750	6750	9000	9000	9000
Motor pump-set capacity (HP)	1	2	3	3	5	5	5	7.5	7.5	7.5	10	10	10
Shut off dynamic head (meters)	12	12	12	25	12	25	45	12	25	45	12	25	45
Water output * (liters per day)	99000 (from a total head of 10 meters)	198000 (from a total head of 10 meters)	297000 (from a total head of 10 meters)	148500 (from a total head of 20 meters)	528000 (from a total head of 10 meters)	264000 (from a total head of 20 meters)	182400 (from a total head of 30 meters)	742500 (from a total head of 10 meters)	371250 (from a total head of 20 meters)	256500 (from a total head of 30 meters)	990000 (from a total head of 10 meters)	495000 (from a total head of 20 meters)	342000 (from a total head of 30 meters)

* 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/ m^2 on the surface of PV array (that is, coplanar with the PV modules).

NOTES

1 Suction head, if applicable, minimum of 7 meters static suction lift corrected for atmospheric pressure and water temperature).

2 For higher or lower head/PV capacity, or in between various models; water output could be decided as per the clause **4** (that is, performance requirements) specified earlier.

3 If submersible pumps are used in lieu of surface pumps, the water output must match that of the surface pumps as specified in this table.

ANNEX C (*Concluded*)

INDICATIVE TECHNICAL SPECIFICATIONS OF SOLAR DEEP WELL (SUBMERSIBLE) PUMPING SYSTEMS WITH D.C. MOTOR PUMP SET WITH BRUSHES OR BRUSHLESS D.C. (B.L.D.C.)

Description	Model-I	Model-II	Model-III	Model-IV	Model-V	Model-VI	Model-VII	Model-VIII	Model-IX	Model-X	Model-XI	Model-XII	Model-XIII	Model-XIV
PV array (Wp)	1200	1800	3000	3000	3000	4800	4800	4800	6750	6750	6750	9000	9000	9000
Motor pump-set capacity (HP)	1	2	3	3	3	5	5	5	7.5	7.5	7.5	10	10	10
Shut off dynamic head (meters)	45	45	45	70	100	70	100	150	70	100	150	70	100	150
Water output * (Liters per day)	45600 (from a total head of 30 meters)	68400 (from a total head of 30 meters)	114000 (from a total head of 30 meters)	69000 (from a total head of 50 meters)	45000 (from a total head of 70 meters)	110400 (from a total head of 50 meters)	72000 (from a total head of 70 meters)	50400 (from a total head of 100 meters)	155250 (from a total head of 50 meters)	101250 (from a total head of 70 meters)	70875 (from a total head of 100 meters)	207000 (from a total head of 50 meters)	135000 (from a total head of 70 meters)	94500 (from a total head of 100 meters)

* 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/ m^2 on the surface of PV array (that is, 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 **4** (that is performance requirements) specified earlier.

2 If surface pumps are used in lieu of submersible pumps, the water output must match that of the submersible pumps as specified in this table.

ANNEX D

(*Clause* 5.3)

INDICATIVE TECHNICAL SPECIFICATIONS OF SHALLOW WELL (SURFACE) SOLAR PUMPING SYSTEMS WITH A.C. INDUCTION MOTOR PUMP SET

Description	Model-I	Model-II	Model-III	Model-IV	Model-V	Model-VI	Model-VII	Model-VIII	Model-IX	Model-X	Model-XI	Model-XII	Model-XIII
PV array (Wp)	900	1800	2700	2700	4800	4800	4800	6750	6750	6750	9000	9000	9000
Motor pump-set capacity (HP)	1	2	3	3	5	5	5	7.5	7.5	7.5	10	10	10
Shut off dynamic head (meters)	12	12	12	25	12	25	45	12	25	45	12	25	45
Water output * (Liters per day)	89100 (from a total head of 10 meters)	178200 (from a total head of 10 meters)	267300 (from a total head of 10 meters)	132300 (from a total head of 20 meters)	475200 (from a total head of 10 meters)	235200 (from a total head of 20 meters)	168000 (from a total head of 30 meters)	668250 (from a total head of 10 meters)	330750 (from a total head of 20 meters)	236250 (from a total head of 30 meters)	891000 (from a total head of 10 meters)	441000 (from a total head of 20 meters)	315000 (from a total head of 30 meters)

* 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/m^2 on the surface of PV array (i.e. coplanar with the SPVModules).

NOTES

1 Suction head, if applicable, minimum of 7 meters static suction lift corrected for atmospheric pressure and water temperature).

2 For higher or lower head / PV capacity, or in between various models; water output could be decided as per the clause **4** (that is performance requirements) specified earlier.

3 If submersible pumps are used in lieu of surface pumps, the water output must match that of the surface pumps as specified in this table.

ANNEX D (*Concluded*)

INDICATIVE TECHNICAL SPECIFICATIONS OF SOLAR DEEP WELL (SUBMERSIBLE) PUMPING SYSTEMS WITH A.C. INDUCTION MOTOR PUMP SET

Description	Model-I	Model-II	Model-III	Model-IV	Model-V	Model-VI	Model-VII	Model-VIII	Model-IX	Model-X	Model-XI	Model-XII	Model-XIII	Model-XIV
PV array (Wp)	1200	1800	3000	3000	3000	4800	4800	4800	6750	6750	6750	9000	9000	9000
Motor pump-set capacity (HP)	1	2	3	3	3	5	5	5	7.5	7.5	7.5	10	10	10
Shut off dynamic head (meters)	45	45	45	70	100	70	100	150	70	100	150	70	100	150
Water output * (Liters per day)	42000 (from a total head of 30 meters)	63000 (from a total head of 30 meters)	105000 (from a total head of 30 meters)	63000 (from a total head of 50 meters)	42000 (from a total head of 70 meters)	100800 (from a total head of 50 meters)	67200 (from a total head of 70 meters)	43200 (from a total head of 100 meters)	141750 (from a total head of 50 meters)	94500 (from a total head of 70 meters)	60750 (from a total head of 100 meters)	189000 (from a total head of 50 meters)	126000 (from a total head of 70 meters)	81000 (from a total head of 100 meters)

* 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/ m^2 on the surface of PV array (that is, 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 **4** (that is, performance requirements) specified earlier.

2 If surface pumps are used in lieu of submersible pumps, the water output must match that of the submersible pumps as specified in this table.

ANNEX E

(*Foreword*)

COMMITTEE COMPOSITION

Pumps Sectional Committee, MED 20

Organization	*Representative(s)*
Fertilizers and Chemicals Travancore (FACT), New Delhi	Shri A. K. Nijhawan (***Chairman***)
Aquasub Engineering, Coimbatore	Dr C. Muthu Shri C. Murugesan (*Alternate*)
Best Engineers Pumps Pvt Limited, Coimbatore	Shri S. Thangapandi Shri N. Ranadhive (*Alternate*)
Bharat Petroleum Corporation Limited, Mumbai	Shri D. P. Chandramore Shri Santosh N. Kale (*Alternate*)
Bureau of Energy Efficiency, New Delhi	Shri Sameer Pandita Shri Kamran Shaikh (*Alternate*) Shri Rajeev (*Young Professional*) Ms Neha Kumari (*Young Professional*)
Central Water and Power Research Station (CWPRS), Pune	Shri Pramod Kumar Goel Shri Abdul Rahiman (*Alternate*)
Crompton Greaves Consumer Electricals Limited, Ahmednagar	Shri Pandhari Susar Shri Parvin Garje (*Alternate*) Shri Karan Kamble (*Young Professional*)
Delhi Jal Board, New Delhi	Shri P. K. Gupta Shri Bhupesh Kumar (*Alternate*)
Electrical Research and Development Association (ERDA), Vadodra, Gujrat	Shri Ravi Prakash Singh Shri Gautam Brahmbhatt (*Alternate*)
Engineers India Limited, New Delhi	Shri Ankul Mandal Shri Abhay Kumar (*Alternate*)
International Copper Association	Shri Abhishek Dhupar Shri Debdas Goswami (*Alternate*)
Mangalore Refinery and Petrochemicals Limited, Mangalore	Shri Adarsh G. A. Shri P. Rajendran (*Alternate*)
Mecon Limited, Ranchi	Shri P. S. Rao Shri A. Gangal (*Alternate*)
Ministry of Defence (CQAE), New Delhi	Joint Controller (Jag/Nfsg) Lt Col R. D. Mishra, (*Alternate*)
National Bank For Agriculture and Rural Development, Mumbai	Shri D. Elangovan Shri A. K. Sinha (*Alternate*)
Petroleum Conservation Research Association, New Delhi	Shri A. K. Goel Dr Abhay Sharma (*Alternate*)
Projects and Development India Limited, Vadodara	Shri A. K. Gupta Shri D. K.Vohra (*Alternate*)

Solar Photo Voltaic Water Pumping Systemssubcommittee, MED 20 : 7

Organization	*Representative(s)*
Ministry of New and Renewable Energy (MNRE), Govt of India, New Delhi	Shri J. K. Jethani (***Convener***)
Agricultural Engineering Department, Chennai	Dr R. Murugesan Ms Shanthi Sundar Ram (*Alternate*)
Electrical Research and Development Association (ERDA), Vadodara	Shri Ravi Prakash Singh Shri Vinod Gupta (*Alternate*)
Flowmore Limited, Gurugram, Haryana	Shri I. C. Jain
Department of Electrical Engineering, IIT, Delhi	Prof Amit Kumar Jain
Grundfos Pumps India Private Limited, Gurugram	Shri Bibek Saha Shri Rangarajan Ramaswamy (*Alternate*)
Indian Pump Manufacturers Association (IPMA), Ahmedabad	Shri Yogesh Mistri Shri Utkarsh A. Chhaya (*Alternate*)
Jain Irrigation Systems Ltd, Jalgaon	Shri Sanjeev Phadnis Shri Pradip Bhosale (*Alternate*)
Kinetica Solar Pvt Ltd, Jaipur	Shri Nimesh Sheth Shri Mihir Patel (*Alternate*)
National Institute of Solar Energy (NISE), Gwalpahari, Gurugram	Er Sanjay Kumar Ms Richa Parmar/Shri Gopal Kumar (*Alternate*)
North India Pump Manufacturers Association, (NIPMA), Ludhiana	Shri C. L. Garg Shri Puneet Kalsi (*Alternate*)
Punjab Agricultural University, Ludhiana	Prof Rakesh Sharda Shri Rajan Aggarwal (*Alternate*)
Rajkot Engineering Association, Rajkot	Shri Anand Savaliya Shri Vinod Asodariya (*Alternate*)
Rotomag Motors and Controls Pvt Ltd, Gujarat	Shri Umesh Balani Shri Sanjay Mahagaokar (*Alternate*)
Scientific and Industrial Testing and Research Centre (SITARC), Coimbatore	Shri A. M. Selvaraj
Shakti Pumps (India) Limited, Pithampur, Indore	Shri Dinesh Patidar Shri Amit Mukherjee (*Alternate*)
The Southern India Engineering Manufacturers Association, (SIEMA) Coimbatore	Shri K. V. Karthik Shri P. Ramesh (*Alternate*)
Tata Power Solar Systems Limited, Noida	Shri Ramakrishna Sataluri Shri Arpit Srivastava (*Alternate*)
Voda Private Limited, Mysuru	Shri Padmakar Pratapure Shri Avinash Kumar (*Alternate*)
Maxop Research and Testing Institute Pvt Ltd, New Delhi	Dr O. S. Sastry

Member Secretary

Shri Aman Dhanawat
Scientist 'B' (MED), BIS

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Amendments Issued Since Publication

Amend No.	Date of Issue	Text Affected

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