

SPECIFICATIONS
FOR
SUPPLY AND INSTALLATIONS OF SOLAR PANELS AND ALLIED
EQUIPMENTS



2019

APPROVED BY STANDARIZATION COMMITTEE OF
KHYBER PAKHTUNKHWA

NOTIFICATION:

NO.SO(B)/II-10/Solar Panels/PBC/2018-19/C&WD-Dated-30/01/2019: The recommendations of the Sub-Committee as arrived in its meeting held on 08/01/2019, the Standardization Committee notified vide Planning & Development Department letter No. Chief/INF/P&&D/601/03/2017/378-483 dated 21/02/2017 regarding standardization of Engineering products / Materials / Equipment's has approved the "**Revised Technical Specifications For Solar Panels And Allied Equipment (Rev 2019)**" in its meeting held on 11/01/2019 as per following details and notified with the direction that these specifications will be applicable for the works which would be tendered on or after 01/04/2019. These specifications will also be available on C&W Department official website i-e www.cwd.gkp.pk.

A - SPECIFICATIONS FOR SOLAR SYSTEMS-COMMON PART

1. SOLAR PANELS:

- a. The PV module(s) shall contain mono crystalline silicon Grade-A Solar cells. (N-Type Mono PV Cell Modules and Bifacial Double Glass Modules due to its better performance will be given preference).
- b. The PV module should Work well with high-voltage input Inverters/ charge controllers (1000 Vdc).
- c. The PV Panel must have clear anodized aluminium frame with Anti-reflective, hydrophobic, low-iron Tempered cover glass.
- d. The Solar Modules shall meet the following valid IEC Standards or latest:
 - IEC 61215-1, IEC 61215-1-1, IEC 61215-2 :2016 (Design Qualification)
 - IEC61730-1:2016 (Safety - Requirements for construction)
 - IEC61730-2:2016 (Safety - Requirements for testing)
 - IEC TS-62804-1. (i.e: TUV PPP-58042 or Equivalent) Anti-PID Certification.
 - IEC 61701 Salt Mist Corrosion Resistance Test (Latest)
 - IEC 62716 Ammonia Corrosion Resistance Test (Latest)
 - IEC 60068-2-68 Sand and Dust Erosion Resistance Test.
- e. Unique Serial number, Name / Logo of manufacturer and separate date of manufacturing (DD/MM/YYYY) should be laminated inside the module so as to be clearly visible from the front side.
- f. A properly laminated sticker containing the following details should be available at the back side of the module.
 - Name of the manufacturer / distinctive logo.
 - Model Name and Type of Cell Technology.
 - Peak Watt Rating (Wp) and Power Tolerance Range
 - Voltage (V_{mp}) and Current (I_{mp}) at STC
 - Open Circuit Voltage (V_{oc}) and Short Circuit Current (I_{sc})
 - Maximum System Voltage (V_{dc}) (i.e: This should not be less than 1000 V_{dc})
 - Dimensions of PV Module
 - Test Standard(s) to which the module has been tested and certified.
- g. Following essential technical parameters of solar panel/modules should be provided with each panel supplied as well as in the technical proposal.
 - I-V curve for the solar photovoltaic module/panel.

- Date and year of obtaining IEC PV module standardization qualification certificate.
 - Electrical Data (i.e: Pmax, Voc/Vmp, Isc/Imp at nominal Cell Operating Temperature (NOCT).
 - PV Module efficiency at STC.
 - Working temperature range of PV Module.
- h. Each panel should have factory equipped weather proof terminal junction box having at least IP67 protection with provision of opening for replacement of DC cables, blocking diodes and easy debugging if necessary.
 - i. Limited performance guarantee: panel power, in standard conditions, will not be less than 90% of nominal power by the end of 10 years of operation and at least 80% at the end of 25 years of operation with 25-year limited power warranty.
 - j. The PV Module should have at least 10-years warranty for any defects and efficiency as mentioned above. It should be provided On Stamp Paper Signed and Sealed by Contractor at the time of Handing/Taking Over.
 - k. The PV Module should have at-least 17.50 % Module efficiency with Positive Power Tolerance.
 - l. The PV modules offered should not be more than 12 months old from the date of issue of work order.
 - m. PV Module should have a Snow Load bearing of 5400 Pa and Wind Load Bearing of at least 2400 pa however if department deem appropriate may go for 3800 pa wind load depending upon their requirement.
 - n. The Solar Module should be free from visual and cosmetics defects.
 - o. The department/consultant on the expense of contractor/supplier shall verify Flash test reports with serial numbers from manufacturer for each panel (at the time of supply).
 - p. All information regarding solar panel with above mentioned featured data should be accessible and verifiable online on the manufacturer website.
 - q. IEC accredited lab test for solar panels is mandatory.
 - r. EL (Electro-luminous) test will be performed randomly for each individual project at the cost of contractor/supplier.

2. CABLE & WIRING:

- a. The AC / DC cables should be made of 99.9% copper strands and Flexible.
- b. From PV Panel to Junction Box, XLPE or XLPO insulated & XLPE/PVC Sheathed, UV stabilized single core, Double Insulated. Stranded /flexible cables (Conforming preferably to EN 50618 or IEC FDIS 62930) be used.
- c. From JB to Inverter, the DC cable must have Single Core, double insulated and suitable for minimum 1000 V_{DC} transmission.
- d. From Inverter to batteries, the DC cable can be single insulated, Single Core and suitable for minimum 300 V_{DC} transmission.
- e. DC circuit breakers (not fuse) of $\geq$ Voc of String Voltage and suitable ampere rating (1.25 to 1.50 Times of Rated Current of all strings connected) must be installed between PV modules and controller / inverter.
- f. AC Circuit Breaker (s) of suitable rating (1.25 to 1.50 Times of connected Load) must be installed between Controller / inverter to Load and Grid to Controller / Inverter.
- g. AC / DC breakers should be marked with the manufacturer model number, rated voltage, ampere rating and batch/serial number.
- h. DC / AC breakers rating should be approved from Engineer In-charge before installation at site.
- i. To prevent solar panels from damage an appropriate size of DC Breaker / Fuse should be installed for each PV string and Surge Protection should be installed for combined Array (before Main DC Breaker / Inverter).

- j. DC Breaker, AC Breaker & Change overs should be placed in an enclosure. All Enclosures / Junction boxes should be made from Hot Dipped Galvanized Sheets of minimum 16 SWG.
- k. Cables shall be clearly labelled with essential electrical parameters including manufacturer name, Voltage Range, standards etc.
- l. All DC Wiring shall be aesthetically neat and clean, over all wiring/connection losses shall not exceed 1% of the total rated output power.
- m. All connections/ socket outlet among array, controller, inverters, batteries, and pumping set etc must be made in junction boxes of adequate protection level.
- n. All wires/cables should be in standard flexible UV-Resistant conduits / HDPE of PN12, SDR 13.6, PE100 for outdoor installation & (2-3 feet deep) for underground wiring / Cabling and PVC ducts for indoor installation.
- o. The DC Combiner Junction Box should be properly earthed including earthing of door as well.
- p. The DC Combiner should contain proper bus bars of adequate size each for Positive, Negative and Earthing.
- q. The Inverter Junction Box should be properly earthed as well as per vetted design of the Engineer in charge.
- r. All wiring should be in proper conduit of capping casing. Wire should not be hanging loose.
- s. All wires should be terminated properly by using lugs / thimble connectors / sleeves.
- t. Distribution board must be installed with proper screws.
- u. Electrical Hazards Safety Labels should be pasted on DC Combiner /VFD Enclosure / Charge Controller /Battery Enclosures.
- v. Following lab tests are mandatory.

Conductor resistance test, Insulation resistance test, Pressure test, Spark test.

- w. DC Cable from PV Module to Junction Box / Inverter for each string should be minimum size 6 mm².
- x. DC Cable sizing (For Pumping Schemes) from Junction Box to Inverter as per details below;

S. No	Nos of Strings	Cable Size ((mm ²))	Remarks
1	1	6	If Cable length is >200 ft (One Sided) than cable size should also be increased accordingly.
2	2	10	
3	3	16	
4	4-5	25	
5	6-8	35	

3. **PANEL MOUNTING & STRUCTURE:**

- a. The panel mounting and structure should be made of hot dipped (80 microns Average) galvanized steel of minimum thickness of **12 SWG / 2.64 mm Channel / Pipe or 8 SWG / 4.06 mm Angle** (Profile of channel and Sketch Attached for Reference).
- b. A sketch of the mounting frame (As per Actual Site Requirements) showing dimensions of the frame parts should be provided at the time of supply.
- c. PV to ground clearance must not be less than 1.5 feet. The height of the upper edge of the structure should not exceed 10 feet above the ground and 6 Feet for Roof Top Installations.
- d. To avoid Shading, Distance between two rows of PV panels and from walls should be maintained at a minimum of 1.6 times the height of structure/walls.
- e. The pit size for concrete works should be minimum 1.5x1.5x2 feet for each individual leg or 1.5x2.5x2 for double leg and the concrete should be extended at least 1 foot above the ground. The concrete ratio should be 1:2:4.
- f. The Surface azimuth angle of PV Module 180° and the Tilt angle (slope) of PV Module should be 33°.

- g. The PV modules will 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.
- h. Due to land Non-availability or any other problem, Structure design can be modified as per site requirement. Pole Mounted or manual Tracker Structure can be provided with the approval of Engineer In-charge.
- i. Array fasteners (nut/bolts/washers) between PV Module and Structure shall be stainless steel. Washers should be installed on both sides of Module frame.
- j. The minimum space between two PV Modules should be 2.54 cm (1 inch), to avoid air push over PV Modules.
- k. Mechanism / arrangement for cleaning of PV Panels should be provided. i.e.: Space and ladder between panels or at the back side of structure, so that the operator can safely climb and clean the panels.
- l. All other array fasteners Structure shall be stainless steel or galvanized steel that provides the required mechanical strength.
- m. The PV modules will be mounted on metallic structures at the inner holes for cantilevered installation, which will evenly distribute the load of the panel around the support structure on both sides and in the middle.

4. EARTHING/ GROUNDING:

- a. The PV Panel frame and structure should be connected by the shortest practical route to an adequate earth contact (of Less than 5 Ohms Resistance) as per requirement of equipment manufacturer and site earth conditions, using an uninterrupted conductor. Grounding can reduce the risks of damage from lightning-induced surges.
- b. The Sizing of Earthing conductor will be done as per NEC Table 250.122
- c. The grounding conductor should be 99% Copper and PVC insulated / Bare Copper if installed underground along a defined path where size & Design shall be approved from Engineer In-charge before installation at site.
- d. Motor, inverter, Battery / Battery Box (if required), Main Distribution Board should be connected to an adequate earth contact / Grounding.
- e. Ground enhancement material (GEM) shall be used below and above the Earthing plate for proper grounding. Gravel or coarse sand shall be pour along with soil in the pit.
- f. Grounding / Earthing plate should be made of Copper plate of 4mm thickness & Size minimum 1.0 x 1.0 Ft.
- g. Grounding / Earthing conductor should be connected to the plate / Rode / GI Pipe by proper connector of minimum depth of 6 feet.
- h. Alternatively Earthing Rod of suitable size and length can be installed. (Instead of Plate). If given / mentioned in the BOQ/Design and Engineer In-Charge Approval.
- i. All nut / bolt and Earthing clamp shall be stainless steel or galvanized steel.

5. BATTERIES:

- a. The battery should be Deep Cycle, GEL, OPzV/OPzS, Lithium LiFePO4, Lead Carbon Type or equivalent. (Note: Battery type shall be specified in the bidding documents.)
- b. The battery must ensure safe and reliable operation in the whole range of ambient temperatures from -5° C to + 50° C.
- c. The maximum permissible self-discharge rate should not be more than 5 percent of rated capacity per month at 25° C.
- d. The battery shall have a certificate of compliances, issued by a recognized laboratory.
- e. The Batteries should have three years Comprehensive replacement warranty.
- f. The battery shall meet the requirements and recommendations given in IEC 61427, IEC 60896 21/22 (For VRLA) or equivalent. Lab Test Reports for battery cycle life should be provided.

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- g. The Battery must support parallel connection to increase capacity in case of future expansion. Each Battery should have following minimum information printed on battery:
- Model Number, Serial Number and Type of battery.
 - Rated Voltage and Capacity (AH) at discharge rate of 10 Hours.
 - Origin of made.
 - Manufacturer Name with distinct logo.
- h. The following information must be provided in the data sheet while submitting technical bid.
- Certification/Test Standard(s) of the battery.
 - Information regarding cycles & self-discharge rate.
- i. In case of rechargeable battery bank (having more than one battery), the interconnection shall be made using lead plated copper bus bars or properly insulated flexible copper conductors.
- j. Battery disconnect switch / breaker of suitable size should be installed between batteries and inverter / charge controller.
- k. The Battery must have Low self-discharge rate, No memory effect and No gassing.

5.1 GEL BATTERIES:

5.1.1 Cycle life of the GEL battery (12V) before 80% capacity of Initial Capacity must be minimum **1000** cycles @ 50% depth of discharge (DOD) at discharge rate of 10 Hours

5.1.2 Cycle life of the GEL battery (2V Cell) before 80% capacity of Initial Capacity must be minimum **1300** cycles @ 50% depth of discharge (DOD) at discharge rate of 10 Hours

5.2 LEAD CARBON:

5.2.1 Cycle life of the Lead Carbon battery (12V) before 80% capacity of Initial Capacity must be minimum **2000** cycles @ 50% depth of discharge (DOD) at discharge rate of 10 Hours.

5.2.2 Cycle life of the Lead Carbon battery (2V) before 80% capacity of Initial Capacity must be minimum **2500** cycles @ 50% depth of discharge (DOD) at discharge rate of 10 Hours.

5.3 OPzV / OPzS BATTERIES:

5.3.1 Cycle life of the OPzV / OPzS battery (12V) before 80% capacity of Initial Capacity must be minimum **2000** cycles @ 50% depth of discharge (DOD) at discharge rate of 10 Hours

5.3.2 Cycle life of the OPzV / OPzS battery (2V Cell) before 80% capacity of Initial Capacity must be minimum **2500** cycles @ 50% depth of discharge (DOD) at discharge rate of 10 Hours

5.4 LITHIUM BATTERIES (LiFePO4):

5.4.1 Cycle life of the Lithium LiFePO4 battery before 80% capacity of Initial Capacity must be minimum **5750** cycles @ 50% depth of discharge (DOD) at discharge rate of 10 Hours.

5.4.2 The battery must have Integrated Battery Management System (BMS) to ensure battery safety and reliability.

5.4.3 The BMS of the battery must have the following specifications:

- Temperature protection
- Over charge protection
- Low voltage disconnect
- High Voltage Disconnect
- Short circuit alarm function
- Self-balancing function

5.4.4 The LiFePO4 Battery must have LED status and alarm indication.

5.4.5 The charge and discharge rate of the battery must be designed at 0.2C minimum but capable of handling 0.5C charge and discharge currents.

Note:

- **Product brochure, catalogue and certificates must be attached with the Technical Bid.**

6. BOX / STAND FOR BATTERIES, SHS-INVERTER & CHARGE CONTROLLER:

- The batteries should be housed in a vented compartment/stand that prevents users from coming in contact with battery terminals. This compartment/stand should be strong enough to accommodate the weight of the battery.
- A mechanism to prevent opening and entry of the battery should be provided.
- This compartment should be manufactured of mild steel of at least **18 SWG**.
- The compartment should be powder coated paint.
- The entire enclosure/stand must be constructed to last at least twenty years without maintenance and should be protected against corrosion. The enclosure should have a clean and neat appearance. Battery Box /stand should be installed at a place in accordance with user's preference

7. LED FLOOD LIGHTS:

- Solar Based LEDs/Light fixtures shall conform to the latest IEC/ISO internationally recognized standards.
- LEDs/Light fixtures should not be Chip-on-board (COB) single chip type due to their poor heat dissipation.
- LEDs/Light fixtures shall be modular type with proper heat sinks.
- Solar based lights (LED fixtures etc) should provide at least 100 Lumen/watt.
- The Color rendering Index (CRI) must be equal or greater than 70
- LEDs/Light fixtures should be designed to deliver at least 10 years of service.
- Complete lightening unit shall be weather proof (Protection Class IP65).
- The output from the LEDs/Light fixtures should be constant throughout the duty cycle.

8. AC ENERGY EFFICIENT LED LIGHT BULBS:

Shape	Cap/Fitting/Base Type	Colour	Lumen s Per Watt	Colour Temperature	Colour rendering index (CRI)	Life Time of Lamp (Hours)	Power Factor & Rated Voltage
Globe	E27	Cool or Warm White	Min 100W	2700K / 6500K	70	10,000	≥ 0.70 & 220 Vac

Note:

- LED Light Bulbs should be marked with the manufacturer model number, rated voltage, Wattage.

9. AC ENERGY EFFICIENT CEILING FANS:

Sweep		Rated Power	Speed		
Inches	MM	Watts	Rpm		
56	1400	50 Max	≥ 320		

- 10% + in Power Consumption is Allowed as per PSQCA Standard
- Rated Voltage: 230 V~ (±10V)

- c. Rated Frequency: 50 Hz
- d. Insulation Class: 155 (F) or better
- e. Motor Core: Electrical Steel Sheet
- f. Winding Wire: 99.99% Super Enamelled Copper CA Wire or 99.99% Pure Copper Wire.

Note:

- Energy efficient fan should be marked with the manufacturer model number, rated voltage, and wattage.

10. DC ENERGY EFFICIENT LED LIGHT BULBS:

- a. The LED lamps must have luminous efficacy of at least 80 lm/W (at 25 °C ambient temperature).
- b. The LED lamp must be protected against reversed polarity of the operation voltage.
- c. Base shall be an E-27 thread type.
- d. The emitted light shall be cool or warm white.
- e. The wide angle shall be between 120° to 125°.
- f. Operating Voltage 12Vdc / 24Vdc
- g. Lamps should be marked with the manufacturer model number, rated voltage, wattage and date of manufacture or batch number.

11. DC CEILING FANS:

Sweep	Rated Power	Speed	Service Value	Operating Voltage
Inches	Watts	Rpm	Air Delivery/W	V
48 ((with Speed Control) Metal Blades	30-36	> =320 RPM	9.54	12 / 24

12. DC PEDISTAL FANS:

Sweep	Rated Power	Speed	Service Value	Operating Voltage
Inches	Watts	Rpm	Air Delivery/W	V
18 Inch (with Speed Control)	18-30 W	1250 RPM (Full Speed)	5.22	12 / 24

13. INVERTER BASED SPLIT AC

Inverter based AC with both heating and cooling option.

S.No	DESCRIPTION	UNIT	DETAILS
1	Compressor	Type	Multistage Rotary
2	Noise Level (Indoor)	Db (Max)	≤ 50
3	Voltage Range	Volts (Min & Max)	180 to 250 Vac

14. PVC CHANNEL DUCTS & PIPES

- a. A product of good quality standard material standardized by the provincial standardization committee with suitable size to be provided / used, as per direction/approval of Engineer In-charge.
- b. Ducting must be done with proper steel nails and clips.
- c. All ducting (wiring) must be align.

15. FLEXIBLE PVC PIPE

- a. The flexible PVC pipe should be of good quality material standardized by the provincial standardization committee with suitable size to be provided / used, as per direction/approval of Engineer In-charge.

16. CIVIL WORK:

The following Civil Works should be carried out for ground installation of SPV Modules/mounting structures.

- a. Minor Cutting and clearing of trees/plantation to avoid shadows.
b. Civil work for earthing system as per the statutory requirements.

17. REFLECTIVE / INSULATING PAINT

The Roof Paint should be ultra-white, high reflective, 100% acrylic elastomeric roof sealer designed for fixing leaks in roofs the paint should contain heat reflective pigments and additives that provide an excellent, highly protective barrier which reflects the sun's heat and destructive UV rays leaves a brilliant ultra-white finish, reducing surface heat absorption up 20°F.

The Reflective paint should comply with ASTM D6083, Fiber Reinforced for more protection, strength and durability which allows for contraction and expansion, Resists surface fungal growth.

18. WARRANTY/AFTER SALE SERVICE:

Three years Comprehensive Free Replacement, Repair and maintenance Warranty at site (Free of Cost) should be provided for all the components of Solar System. (if not mentioned separately otherwise).

B - SPECIFICATIONS FOR SOLAR PUMPING SYSTEMS

19. PUMP (SUBERSIBLE):

Pump should be supplied having standard ISO-9906 specifications. The pump must be submersible, made of stainless steel. The characteristic curves (Original from Manufacturer) showing the efficiency at duty point and performance of the pump should be provided in the technical proposal and also at the time of pre-supply testing. The quoted pump should be tested for its performance and certified as per ISO-9906 standard. The pump should be suitable for installation and operation in tube wells/dug wells/open well with clear water discharge. Pump shall comprise of bowl assembly and non-return valve as integral part of pump's parts. Pump and motor shall rigidly couple through NEMA standard coupling. The stage casings of pumps should be connected as per NEMA/ANSI/AWWA /ASTM/BSS standard. Each stage casing must have replaceable wear ring. The impellers shall be secured to the pump shaft with tapered conical sleeves pressed into the taper bore of impeller or impeller secured through chrome plated stainless steel hexagonal sleeves. Suction casing must be between pump and motor with suction strainer as protection of pump against coarse impurities of the liquid handled.

Specification for main components of the Pumps:

S.NO	Components	Specifications
1	Casing/Diffuser	The Casing/Diffuser should be in fabricated stainless steel AISI 304 / 316.
2	Impellers	Stainless steel AISI 304 / 316.
3	Driving Shaft	Stainless steel 304/420 / 316
4	Sleeves	Stainless steel AISI 329/ 304 / 316
5	Gaskets	Rubber Gaskets
6	Bearings	AISI 329 stainless steel

7	Coupling & Screen + Cable Guard	Stainless steel AISI 316/319/304/420
8	Non-Return Valve / Sluice Valve	As per British standard specifications (BSS), Minimum PN16 (16 Bar) or Above (As Per Site Requirements) PN Value / Bar Capacity of Valves must be more than Installed Pump Max/Shut-off Head Minus Static Water Level of Bore. (Leakages in Valves are NOT Acceptable).
9	Pressure Gauge	As per British standard specifications (BSS), having PSI or Bar scale (4 Inch Size), Liquid Filled, minimum 350 PSI Range, Looped Siphon tube Pipe, Stainless Steel/polypropylene Casing.
10	Clamps	Steel – Pressed
11	Pump Efficiency	Minimum efficiency of the pump (For discharge of 3000 GPH and more) should be 70% ensured at duty point. (Duty Point of the Pump be preferably selected at the peak efficiency point or (Within $\pm 10\%$ of discharge) of Pump Peak efficiency Point)

20. MOTOR:

The winding material should be 99.99% copper. The motor should have wet type, water cool rewind-able/repairable stator. The motor should have non-disposable/non-hermetically sealed winding. The insulation class of the winding material should be mentioned. For each model quoted, all the technical parameters such as rated voltage, power factor, efficiency, full load ampere, speed and other similar parameters should be provided at the time of pre-supply testing. The testing report with all basic parameters should also be provided at the time of pre-supply testing.

The motor shall be manufactured in compliance with National Electrical Manufacturer Association (NEMA) standards. The motor shall be three-phase submersible and shall be capable of operating at rated voltage of 380 Volts at 50 Hz. The motor should be capable of operating with variable speed through V/F control. Winding of the motor shall of rewind able type with class – IC40 insulation and IP68 protection. The synchronous speed should be 2850-2950 RPM. Motor shall be capable of operating in well water with temperature normally start from 40°C. Motor should be designed for continuous operation. Motor must be filled with water without any chemical additives hazards to health for cooling. The motor must be properly protected against the entry of well water sand etc by double mechanical seal one is rotating and other stationary and must be made of Silicon carbide/ Tungsten carbide and must be protected with sand protection guards. All supports shall be high grade cast iron and stator outer side jacket body should be in stainless steel in AISI 304. The excessive pressure due to heating up of the filled water must be compensated by a pressure equalizing rubber diaphragm in the lower part of the motor. The axial thrust of the pump shall be countered by oscillating sliding block type thrust bearing. The thrust bearing of the motor should be able to bear a download thrust force from the water pump and the upward thrust force produced while starting the water pump. Motor in open well / water tank should be installed with cooling jacket / shroud / sleeve and when motor is installed in bore then installing of cooling jacket is also required. Motor shall be capable of maximum of 20 starts in an hour. Motor efficiency of motors 7.5 HP and above should not be less than 75% at Full Load and Motor Rated Voltage.

Technical specification of rewind-able wet stators, three phase squirrel cage water filled submersible motor.

S.No	Components	Specification
1.	Winding	Made of pure electrolyte copper and the winding insulation should be suitable for > 1000 Volts and must full fill resistant tests range.
2.	Stator	Energy efficient low-losses electrical magnetic sheet should be fixed in stainless steel casing. M800 or M600 magnetic sheet are preferable to use.
3.	Rotor	Energy efficient low-losses electrical magnetic sheet fixed with high grade copper bars. M800 or M600 magnetic sheets are preferable to use.
4.	Spline Shaft	AISI 420 stainless steel, flange dimension according to NEMA standard, over size design to ensure stiffness in severs condition.
5.	Shaft bearing	Water lubricated guide/general bearings fixed in upper and lower brackets should be made of metal impregnated carbon.
6.	Lower thrust bearing	Thrust sliding block bearings, self-aligning Mitchell type, should be able withstand 20000N axial load.
7.	Mechanical Seal (Stationary & Rotary)	Silicon carbide or tungsten carbide mechanical seal.
8.	Cooling filling fluid	Water mixed with non-toxic anti-freeze provide cooling and lubrication also protect and prevent inside parts from corrosion.
9.	Degree of protection	IP68
10.	Insulation Class	Insulation Class B (130°C) NEMA Insulation Class F (155°C) NEMA or above Will be given Preference.
11.	Voltage Tolerance	+6% to -10%
12.	Mounting position	Capable of both Vertical or horizontal Installation
13.	Class	IC40
14.	Maximum Immersion	150 Meters
15.	Starting per hour	20

21. SUBMERSIBLE FLATE ELECTRIC CABLE (4-Core):

The Submersible cable (4-Core) should be made of 99.9% copper strands with double PVC insulation for **1000Vac**, should be adequately flexible and environment friendly. Stranded and flexible insulated copper wires and cables must be used for all outdoor and indoor installations. The wiring that leads into the building shall be protected in a conduit. The cable must have undergone quality tests as per BSS standards. Cable size should be selected so that the Voltage drop Losses in the drop cable should not be more than 2.5%.

Following lab tests are mandatory.

- Conductor resistance test.
- Insulation resistance test.
- Pressure test.
- Spark test.
- Note: The Supplier should provide the quality tests certificates at the time of pre-supply testing and inspection.

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22. COLUMN PIPE:

The column pipe shall be flanged ERW steel pipes confirming to ASTM designation A-53 with a minimum thickness of **3.6 / 4.0 mm (3.6 mm for pipes upto 2.5" dia and 4 mm for pipes above 2.5" dia)** and shall be painted with corrosion resistance paint of suitable thickness. Flanges thickness of 19-20 mm shall have grooves for cable passage. Each column pipe shall be complete with gaskets, bolts/studs, washers and nuts. All nuts, bolts, and washers shall be made of minimum A2 grade stainless steel.

The column pipe shall be supplied in interchangeable section having an approximate length of 10 feet column pipe shall be flanged perpendicular to the axis of pipe.

Column pipe size should be selected so that the Head Losses in the column pipe should not be more than 5%.

For Reference a table-1 is given below.

HDPE Pipe of ≥ 0.75 Inch diameter, SDR 13.6, PE100, conforming to ASTM F-2160 Standard without Joints to be installed/included along with and equal to Column pipe for confirming Water Level testing purpose.

FEATURES:

- Manufacturer's pipes should meet international standards like BSEN 10255 & ASTM A 53.
- Dimensional accuracy circularity and plan end cut should be observed,
- Weld strength of pipe and mechanical properties of raw material should be tested as per manufacturing standards.
- Pipes should be NDT tested (Non-destructive – Eddy current)
- Pipes should be hydrostatically pressure as per manufacturing standard.
- Pipes should be gone through straightening process to remove bendiness.

23. TOPSET:

Top set shall comprise of Bore covers plate, (covering bore hole completely and securely), installation/suspension clamps (2-Nos), sluice valve (BSS/ASTM), reflex valve (BSS/ASTM), Washout Valve approx. 3-4 feet above the ground (T-Connection For Testing Pump's discharge), connector and cable jointing material (Cable connection from motor to switching device shall be joint free), Liquid Filled Pressure gauge minimum 4 Inch diameter suitable / appropriate for the required head pressure and cable ties. Bore Cover Plate should have provision for water level testing facility (i.e: Hole for Sonic Water Level Meter / HDPE Pipe insertion)

For Cleaning of solar Panels, Plastic pressure pipe should be provided of suitable length to reach the furthest / last Solar Panel.

Every Water Supply Scheme should have a non-removable name plate fitted at suitable place / box having essential information and bearing the name of supplier, Consultant and client.

24. SOLAR PUMP INVERTER / CONTROLLER:

- a. The solar pump inverter/controller should have built-in advance version of Auto MPPT controller, over load protection, Soft start/Soft Stop Features and Variable Frequency Drive (VFD) with integrated Gate Bipolar Transistors (IGBTs) of European, USA or Japanese origin or atleast equivalent.
- b. The make and origin of the inverter/controller should be clearly mentioned in the catalog and submitted in the technical proposal.
- c. The inverter offered should comply to or Equivalent standards:

- i. CE/RoHS
 - ii. Low Voltage Directive 2014/35/EU
 - iii. EMC Directive 2014/30/EU
 - iv. IEC 62109-1 (Safety of Power Converters for use in PV Systems)
- d. The complete datasheet showing all the electrical parameters like input & output voltage ranges should be provided in the technical bid.
- e. All the electrical parameters like input & output voltage ranges, and efficiency should be provided at the time of pre-supply testing and inspection.
- f. Efficiency of inverter should be 96% and above at Rated Capacity.
- g. Efficiency of MPPT should be 98% and above.
- h. The inverter < 25kW ingress protection of inverter must be minimum IP 65 Rating or above and for inverter ≥ 25kW ingress protection of inverter / enclosure will be minimum IP 54 Rating or above.
- i. Inverter / Controller having the capability to run both on AC and DC Power would be given preference.
- j. Inverter should have at least three (3) years product and performance warranty.
- k. The Pump Controller/Inverter should have an ON/OFF Switch/Button to Start and Stop the Pump.
- l. Inverter should have active RS232/485 etc communication port available, the Data available through this port can be used for Remote Monitoring.
- m. Inverter circuit must include protection against:
 - i. Over or Low voltages and currents beyond critical level of the inverters circuits.
 - ii. Protection against accidental short circuits & reverse polarity connections.
 - iii. Protection against lightning induced transients.
 - iv. Over load protection.
 - v. Low RPM Protection (i.e: Frequency < 30 Hz or as per pump characteristic curve) Motor Should Stop.
 - vi. Dry run protection. (PF / Current Based).

25. dV/dT or Sine Filters With Inverter (VFD):

- a. The use of load reactors increases the reliability, performance, and efficiency of VFD systems, extends the life of both drives and motors, and reduces the amount of energy consumed by the motor/drive system.
- b. Output dV/dT or Sine Filters (between VFD and Motor) of appropriate size (for 3-phase ≥380Vac Motor of Class B Insulation) should be used where the cable length between motor and inverter is more than Fifty (50) Feet or as advised / recommended by the inverter manufacturer in their Technical Documentation. For Cable lengths of more than 150 meters sine filters should be used.
- c. Filter should be enclosed in a vented box.
- d. Filter Efficiency should be minimum 97%.
- e. Filter should have a current rating of equal or greater than Motor FLA Rated Current.
- f. Distance between filter and pumping inverter should not be more than 2 meters.
- g. Motors with Insulation Class F, H or above are exempted from the requirement of dV/dT Filter.

26. SYSTEM DESIGN FOR PUMPING SYSTEM:

- a. Suitable factor of safety should be applied while designing the system in order to have compensations for variations in irradiations.
- b. For Fix Structure and Auto Tracker, the PV panel **peak power at STC (Wp) should be 75% more** than the Motor basic input power (**PV Loss Compensation Factor = 1.75**).

- c. For Auto /Manual Tracker, the PV panel **peak power at STC (Wp) should be 50% more** than the Motor basic input power (**PV Loss Compensation Factor = 1.5**) as per direction of Engineer Incharge
- d. If Single Axis Auto Tracker Structure is installed on the above factor, then daily operational timings of pumping can be increased by 10-20%, as compared to fixed structure installation.
- e. Total PV Power (Wp) (Imperial Gallons) =
$$\frac{Q \text{ (iGPH)} * TDH \text{ (ft)} * 746 * PV \text{ Loss Factor}}{60 * 3300 * \eta_{\text{pump}} * \eta_{\text{motor}}}$$
- f. Total PV Power (Wp) (US-Gallons) =
$$\frac{Q \text{ (US-GPH)} * TDH \text{ (ft)} * 746 * PV \text{ Loss Factor}}{60 * 3960 * \eta_{\text{pump}} * \eta_{\text{motor}}}$$
- g. Total PV Power (Wp) (Metric Units) =
$$\frac{Q \text{ (m}^3\text{/hr)} * TDH \text{ (m)} * 9.81 * 1000 * PV \text{ Loss Factor}}{3600 * \eta_{\text{pump}} * \eta_{\text{motor}}}$$
- h. Voltage (V_{mp}) of Each String of PV Panels should be as per details given below and String Voltage (V_{mp}) should be within the MPPT range of Inverter.
 - i. For 380 Vac 3-Phase Motor = $380 * 1.414 * 1.06 = 570$ Vdc String, minimum
 - ii. For 220 Vac 3-Phase Motor = $220 * 1.414 = 310$ Vdc String.
 - iii. Small Inverters (i.e: 3-Phase, 220 Vac) with voltage boost function are exempted from the above string voltage requirements. String can made as per boost Inverter / Controller recommended String DC Voltage and should not be less than 230Vdc in any case.
- i. Details of each PV Panel string should be submitted in Technical proposal (i.e: Nos of total strings and Nos of PV panels in each string along with wattage and V_{mp} of each PV panel).
- j. Unjustified Oversizing in PV Panels Wattage is not allowed.
- k. To avoid any oversizing, all commercially available PV Panels should be considered.
- l. Solar Pump Inverter should have a kW capacity equal or greater than the Motor Rated Input Power.
- m. Solar Pump Inverter / Controller Size (kW) $\geq$ (Motor Rated Power in kW / Motor Efficiency).
- n. Solar Pump Inverter / Controller should have a current rating of 1.15 Times (minimum) of Motor FLA Rated Current.
- o. Motor should not be loaded more than 90%. (i.e: Design / Calculated BHP should not be more than 90% of Motor Rated Horse Power)
- p. Along with this specification, contractors should also follow manufacturer's recommendations for all major components of Solar Pumping System.
- q. Requirement of Efficiency for Motor i.e. 75% will not apply on Motors smaller than or equal to 5.5HP and the requirement of efficiency for pump i.e. 70% will not apply on pumps having discharge equal to or lower than 3000 GPH.

27. PRESSURE PUMPS (UPTO 5.5 HP):

- a. Submersible pump confirming to ISO-9906 Standard.
- b. Pump + AC Motor (3-Phase-220V/380V) or DC Motor and Pump with Display Unit.
- c. Solar pump inverter/controller should be MPPT based and Minimum Ingress Protection of IP65.
- d. In case, where the column pipe diameter is less than or equal to 1.5-inch (For discharge equal or less than 6000 LPH and/or for Motor 4 HP and below), HDPE pipe of at least PN12 / SDR 13.6 / PE100 (For TDH of equal or less than 300 ft) without joint may be used instead of MS pipe for better economics and to avoid hydraulic losses. However stainless steel rope of minimum diameter of 6 mm (28 mm²) for suspension of pump-set must be supplied with HDPE

pipe. (Note: For TDH of more than 300 ft, HDPE Pipe type / thickness may be increased/changed accordingly)

- e. Top set shall comprise of Suitable Galvanized stand (Design should be verified from Engineer In-Charge before start of work)
- f. For Pressure Pumps ≤ 5.5 HP schemes, Solar Module efficiency requirement is minimum 16%. (Only for Cut Cells PV Modules or Cell Size of 5 Inches PV Modules).
- g. Connection to overhead water storage tank. Top bend, S.S Fasteners & Erection clamps.
- h. Civil work to protect borehole i/e foundation.
- i. The pump should operate safely with Sand particles up to (50) gram/m³.

28. DC SOLAR WATER PUMP-SETS (UPTO 5.5 HP)

- a. DC Motor can also be provided for Equal or less than 5.5 HP.
- b. Motor should be capable of both AC and DC operation. There must be auto power source recognition feature.
- c. The motor should be brushless, permanent magnet type.
- d. The Controller must have a display Unit, showing all essential parameters (i.e: Current, Voltage etc).
- e. The Controller must be of MPPT type. MPPT efficiency should be equal or more than 98%
- f. Pump should have auto and soft start / stop feature.
- g. The pump-set should have following protections
 - 1. Dry Running Protection
 - 2. Reverse Polarity Protection
 - 3. Over phase protection
 - 4. Over Head Protection
 - 5. Lose Phase Protection
 - 6. Electronic Protection
 - 7. Over Current/ Overload Protection

29. SOLAR AUTO TRACKER:

- a. The solar tracker offered should be fully automatic and intelligent, and must be capable of Single axis tracking (from east to West) and should have its own power supply (PV Panel, Battery and Charge Controllers) other than PV Panel used for Pumping Setup.
- b. Individual Auto-Tracker should be ≥ 4 kW each and Tracking Accuracy should be within $\pm 5^\circ$.
- c. The auto Tracker should also have manual control mode to adjust the tracking angle manually. Structure Material Should be Hot Dipped Galvanized Steel (Minimum 80 Microns).
- d. All nuts, bolts, washers and other fasteners for mounting structure shall be made of minimum A2 grade stainless steel.
- e. Foundation and other details will be separately provided.
- f. Three years Comprehensive Free Replacement, Repair and maintenance Warranty (Free of Cost) should be provided for all the components of auto Tracker (including Batteries).

30. PV MOUNTING FRAME WITH MANUAL TRAKERING :

Suitable for 2.5 or 3.5 KW PV Panels easily movable in multi directions having flanges with bearing balls $\frac{1}{2}$ " and having angle adjustment. Base steel cage $\frac{3}{4}$ ", MS rod 3.5 feet length with nut-bolts system for strong anchoring. Pillar pipe 6 mm with 5.5" dia, base plate 15"x15"x $\frac{1}{2}$ " size with 04 numbers of supports. Support for PV, 5 mm thickness 4" dia pipe and 24"x12"x $\frac{1}{4}$ " side plates. MS Angle side bracing 2"x 2" x $\frac{1}{4}$ ". MS Angle frame 2"x 2" x $\frac{1}{4}$ " for panel mounting. Steel structures/frames shall be powder coated. Galvanized nuts, bolts and washers for tracker fitting.

Steel frame shall be properly designed and shall withstand wind speed/load of at least 130 km/hr and tough weather condition.

31. PRE-SUPPLY TESTING & INSPECTION:

The firm applying for the tender has to provide the recent test bed reports from the pump/motor manufacturer or any other third party as per ISO-9906 standard. Each of the offered pump set models must undergo these test prior to supply and installation, In order to ensure the quality and standard of the equipment contractor may be asked to provide test result conducted by third party for re-verification.

32. OPERATION AND MAINTENANCE MANUAL:

An Operation and Maintenance Manual, in English and Urdu language, should be prepared and provided by the contractor with the solar PV pumping system. The Manual should have information about solar energy, photovoltaic, modules, DC/AC motor pump set, tracking system (if any), 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.

C- SPECIFICATIONS FOR SOLAR HOMES & BUILDING SYSTEMS.

33. GRID TIE INVERTER (ON`-Grid without battery backup / Hybrid with battery backup)

1. UL-1741 Certified or IEC 62109-1 and IEC 62109-2 or Equivalent Certificates.
2. Minimum 95% Conversion Efficiency at Rated Capacity (High Frequency Inverters).
3. Minimum 87% Efficiency for Transformer based inverters (Low frequency Inverters).
4. The inverter should have built-in MPPT controller
5. The Priority of the inverter should be set that load will be running from the solar energy then Grid and in the end will be running from the Battery Backup.
6. Inverter (Hybrid Only) must be capable of configuring for Charging GEL, Lead Carbon, OPzV/OPzS Batteries and Lithium Iron Phosphate batteries (LiFePO4).
7. Hybrid Inverter (If Quoted along with Lithium Batteries) must be capable of communication with the BMS of Lithium Batteries.
8. Rated output voltage of inverter / Controller shall be pure sine wave AC.
9. Total harmonic distortion (THD) in AC output should not exceed 3% at rated capacity.
10. The degree of protection of the ON-Grid inverter Installation should be IP-65 rated and for indoor Hybrid Inverter installation, the IP rating should be IP-20 or above.
11. Wide input voltage range capability. (i.e: Voltage Range can be adjustable / selectable)
12. Natural convection cooling for maximum reliability
13. Outdoor enclosure for unrestricted use under any environmental conditions
14. Capability to connect external sensors for monitoring environmental conditions.
15. The output of the inverter must synchronize automatically its AC output to the exact AC voltage and frequency of the grid.
16. The Inverter should have the capability of Parallel operation upto three units. (Only For projects, where more than one inverter should be installed).
17. Inverter should have active RS232/485 etc communication port, the Data available through this port can be used for Remote Monitoring.
18. Liquid crystal display should at least be provided on the inverters front panel or on separate data logging/display device to display following

- a. DC Input Voltage
- b. DC Input current
- c. AC Power output (kW)
- d. Current time and date
- e. Temperatures (C)
- f. Converter status

19. Inverter circuit must include protection against:

- Over or Low voltages and currents beyond critical level of the inverters circuits.
- Protection against accidental short circuits.
- Protection against lightning induced transients.
- Over load protection.

34. OFF-GRID / HYBRID INVERTER:

1. The Inverter must be pure sine wave output suitable for 220 Volt, 50 Hz.
2. Inverter must be capable of configuring for Charging GEL, Lead Carbon, OPzV/OPzS Batteries and Lithium Iron Phosphate batteries (LiFePO4).
3. The Inverter / system must have a MPPT Solar Charge Controller.
4. Minimum 92% Conversion Efficiency at Rated Capacity (High Frequency Inverters).
5. Minimum 87% Efficiency for Transformer based inverters (Low frequency Inverters).
6. Total harmonic distortion (THD) in AC output should not exceed 3% at rated capacity.
7. The inverter must be user programmable for selecting PV, Grid and Battery Priority as well as Built-in programmed and user defined voltage and current settings of the charge controller for GEL, Lead Carbon, OPzV/OPzS batteries and Lithium Iron Phosphate batteries (LiFePO4).
8. The Inverter must have Protective function limits for:
 - a. AC under voltage protection
 - b. AC over voltage protection
 - c. Battery under voltage Alarm
 - d. Low Voltage Disconnect
 - e. High Voltage Disconnect
 - f. Overload and Short Circuit Protection
 - g. Over Temperature Protection
9. The inverter must be ISO 9001, ISO 14001 and CE Certified.
10. The inverter must have IEC 62109-1 and IEC 62109-2, or Equivalent Certificates.
11. The degree of protection of the outdoor inverter Installation should be IP-55 rated and for indoor Inverter installation, the IP rating should be IP-20 or above.
12. Wide input voltage range capability.
13. Inverter should have active RS232/485 etc communication port, the Data available through this port can be used for Remote Monitoring.
14. Inverter (If Quoted along with Lithium Batteries) must be capable of communication with the BMS of Lithium Batteries.

Note:

- Product Brochure, Catalogue and certificates must be attached with the Technical Bid.

PS

D - SPECIFICATIONS FOR SOLAR STREET LIGHTS

35. SOLAR STREET / ROAD LIGHT SYSTEM DESIGN:

- a. Assessment of Wattage of the LED Luminaire, Pole Height, Pole thickness, Pole top diameter, Pole base diameter, Base plate size, Base Plate thickness, Stiffener size, Stiffener thickness, Pole arm design, Pole Arm Length, Pole arm thickness, Pole arm diameter, Pole arm Placement / Fixing position, RCC foundation size, Anchor / J-bolt size, Steel Rebars cage (Mesh) and Number of Poles (Pole to Pole distance) should be according to the design provided / approved by the Engineer In-charge.
- b. Round Conical or Octagonal Hot Dipped Galvanized Pole of average 80 Microns should be installed.
- c. All Nuts, Bolts and Washers should be stainless steel.
- d. Pole base plate should be tightened in between two stainless steel nuts and washers (one nut and washer at upper and one nut and washer at lower side of the base plate).
- e. All Anchor / J-bolt shall be in level and align to each other.
- f. All Anchor / J-bolt shall be galvanized.
- g. All Anchor / J-bolt shall have at least 150 mm minimum threads.
- h. All poles shall be installed on levelling nuts secured to the anchor bolts and with locking nuts on the top of the base flange.
- i. The concrete ratio should be 1:2:4 for RCC foundation.
- j. Proper sketches of Pole, base plate, RCC Foundation and Steel Rebars cage (Mesh) should be provided and approved from Engineer In-charge.
- k. In order to focus on winter sun availability and Easy cleaning of Solar panel from dust etc with Rain water, Solar Panels should be installed at 180° Azimuth Angle and the Tilt angle (slope) of PV Module should be between 45° ±5° (Only for Solar Street Lights).

36. LED SOLAR ROAD/STREET LIGHT FIXTURE:

1. LED Efficacy must be greater than or equal to 130 Lumens/Watt.
2. The fixture must be IP-66 Rated or above.
3. The Color temperature of the LED should be Pure white in the range of 5000-6000 K.
4. The LED Light distribution must be IESNA Type-II
5. The LED must be suitable for working Temperature from -40 ~ + 60°C with relative humidity of 15% ~ 90%
6. The Color rendering Index (CRI) must be equal or greater than 70.
7. The LED Light Fixture must be LM79 and LM80 Tested.
8. LEDs/Light fixtures should not be Chip-on-board (COB) single chip type due to their poor heat dissipation.
9. LEDs/Light fixtures shall be modular type with proper heat sinks.
10. The output from the LEDs/Light fixtures should be constant throughout the duty cycle
11. LED Life should be greater or equal to than 50,000 Hours.
12. The LED Light Fixture must have the following certification:
 - ISO 9001
 - ISO 14001
 - CE (EMC and LVD) Certified or equivalent.
 - International standard Certifications

Note: Product Brochure, catalogue and certificates must be attached with the Technical Bid

37. SOLAR CHARGE CONTROLLER (FOR STREET / ROAD LIGHTS):

- a. The charge controller must be suitable for the required battery voltage, auto voltage recognition feature and capable of charging OPzV & Lithium Ferrous Phosphate (LiFePO4) Batteries
- b. The charge controller must be IP-67 rated or above for outdoor installation
- c. The charge controller must be Remote Controlled for parameter setting. The system must have the following feature:
 - *Remote Parameter Setting and Monitoring*
 - *Remote control of the Lights (on/off, timer setting etc)*
- d. The charge controller must have MPPT Technology
- e. The charge controller must have at-least three stage Flexible dimming function (0-100%).
- f. The Maximum power point tracking (MPPT) efficiency should be minimum 97%.
- g. It must have temperature compensation for charging batteries in higher temperatures.
- h. Charge controller must have the following protections:
 - PV Short circuit
 - PV reverse polarity
 - PV over voltage
 - PV over current
 - Battery over charging
 - Battery over discharging
 - Battery reverse polarity protection
 - Load short circuit
 - Load overload protections
- i. It must have proper heat sink to dissipate excessive heat
- j. The charge controller must have protection for reverse flow of current through the PV modules
- k. Controller should have active port for GSM based communication for Remote Monitoring.
- l. Mid Night based timing controller will be preferred.
- m. The Solar Charge controller must have the following certification:
 - ISO 9001
 - CE Certified

Note: Product Brochure, catalogue & certificates must be attached with the Technical Bid

38. Battery and Controller Box:

- a. The battery box should be made of Hot Dipped Galvanized Sheet of average 80 Microns.
- b. The battery box must have vented compartment having inverted louvers.
- c. For Pole Mounted batteries Battery boxes must be made of minimum 16 SWG sheet and must have proper locking arrangement for protection against theft.
- d. For underground battery installation, the battery box should be made of minimum 16 SWG sheet and should be properly sealed to ensure protection against water. Proper cable glands and packing material should be used to ensure water proofing of the box.
- e. The battery and Controller Box should be at least IP65 ingress protection.

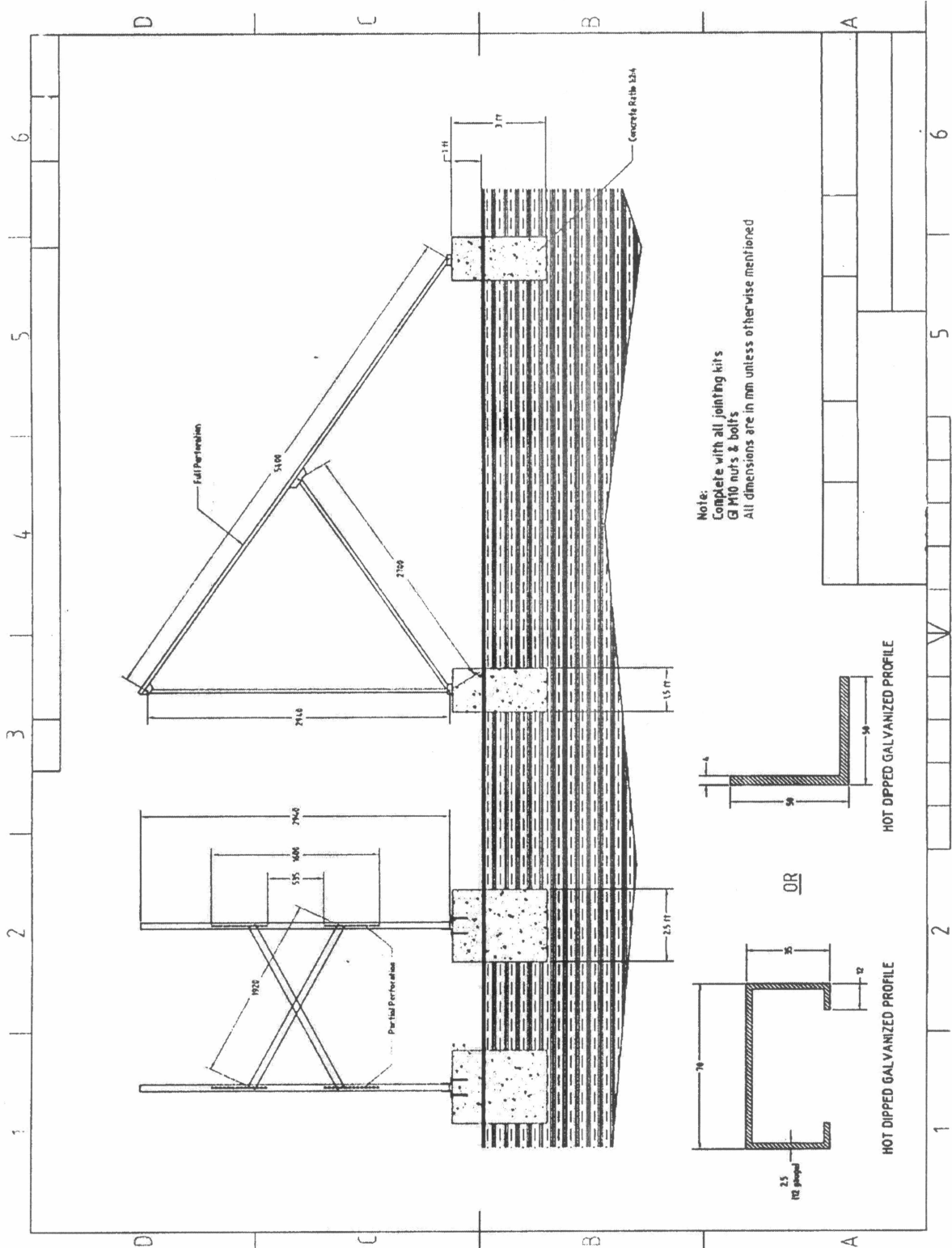
39. Electric Cable:

The specifications of Electric cables are as under:

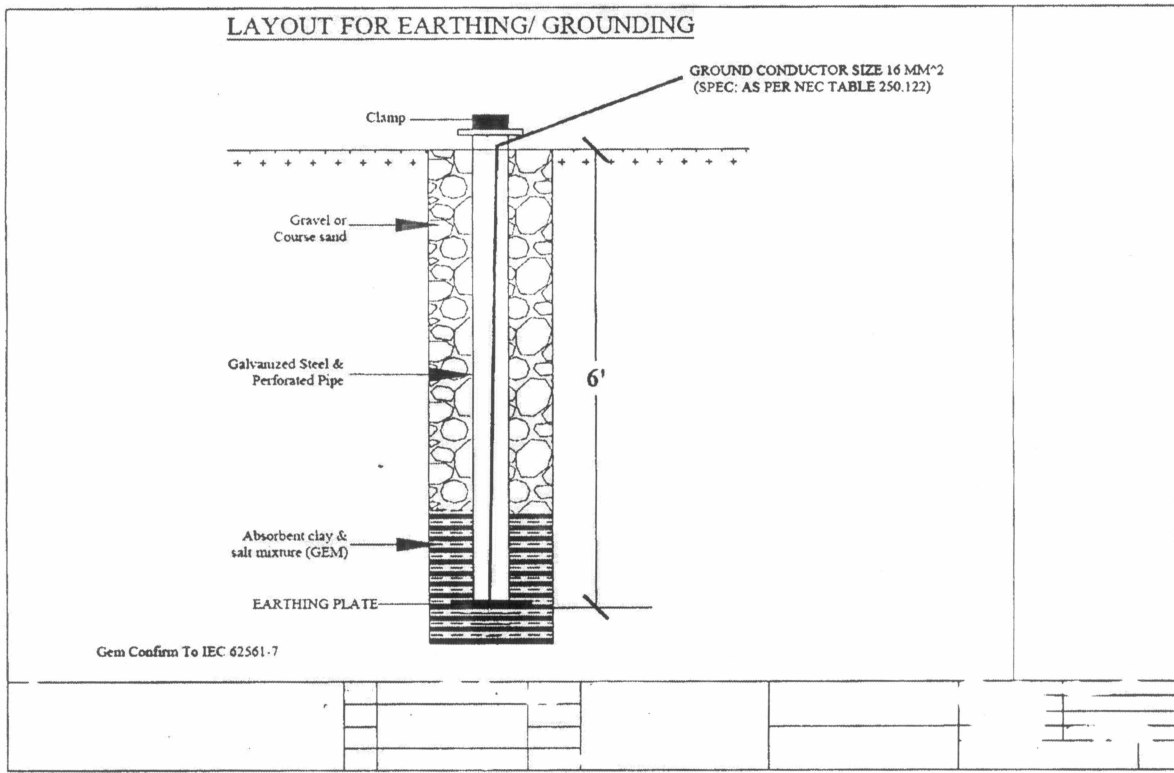
- a. Flexible copper cable of proper size along with MC-4 connectors (TUV Approved) from solar panel to charge controller and charge controller to battery as well as to light fixtures.
- b. The cables should be made of minimum 99.9% Pure copper cable

Yes

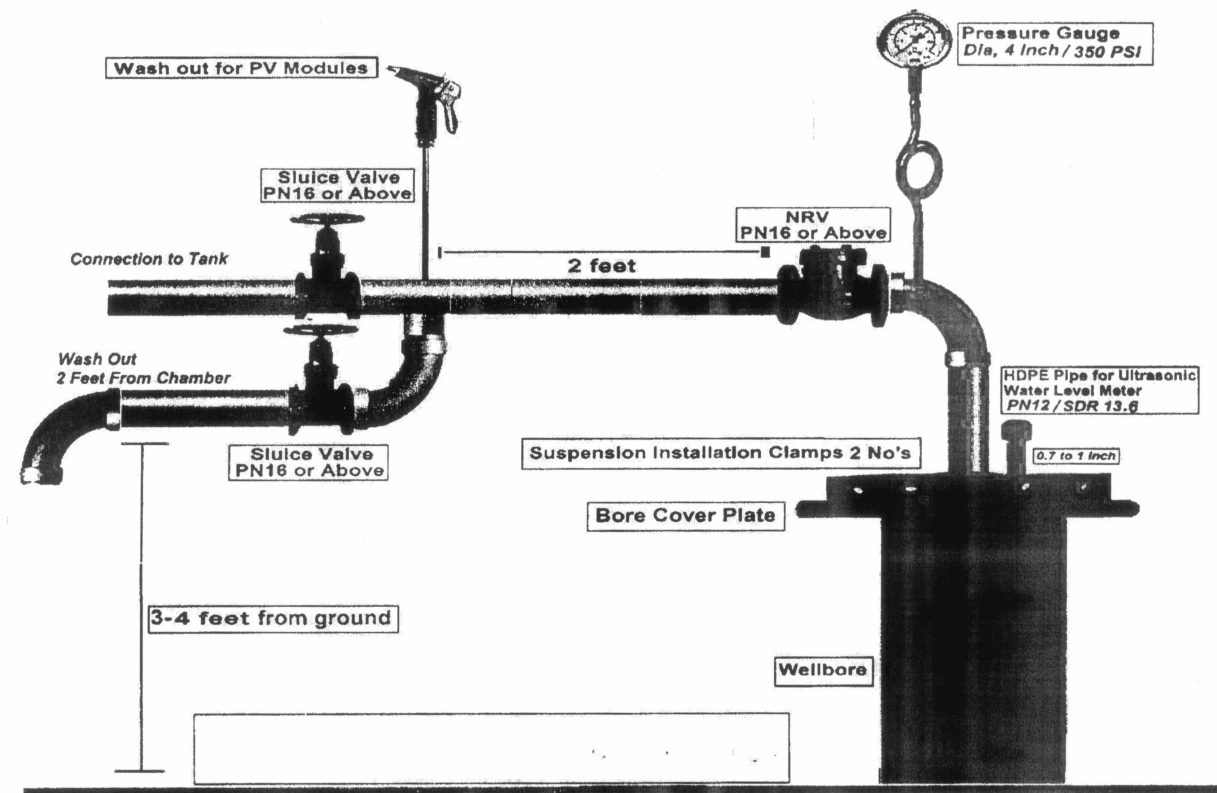
ANNEXURE-1 (STRUCTURE DRAWING)



ANNEXURE-2 (EARTHING / GROUNDING DRAWING)

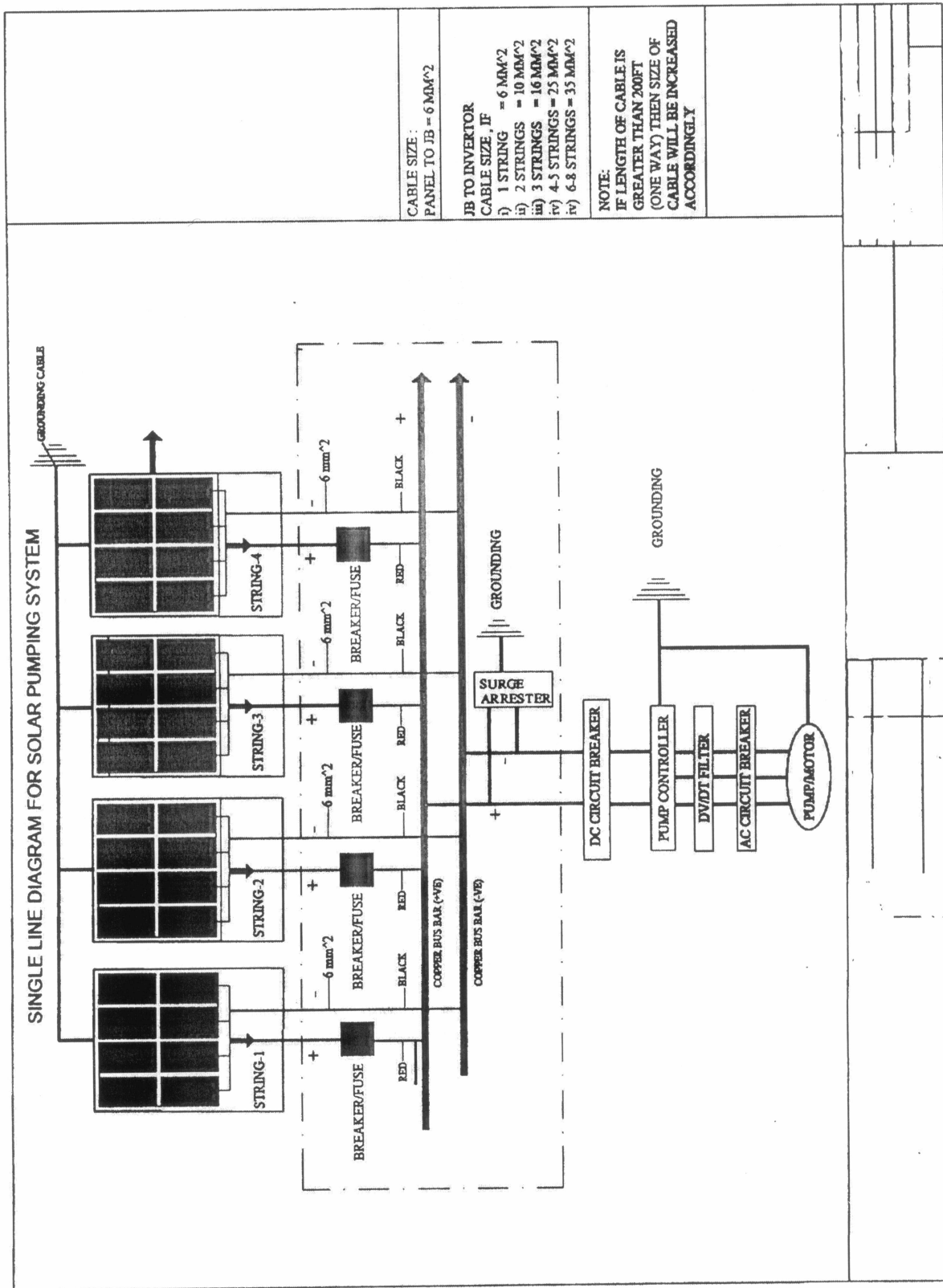


ANNEXURE-3 TOPSET LAYOUT:



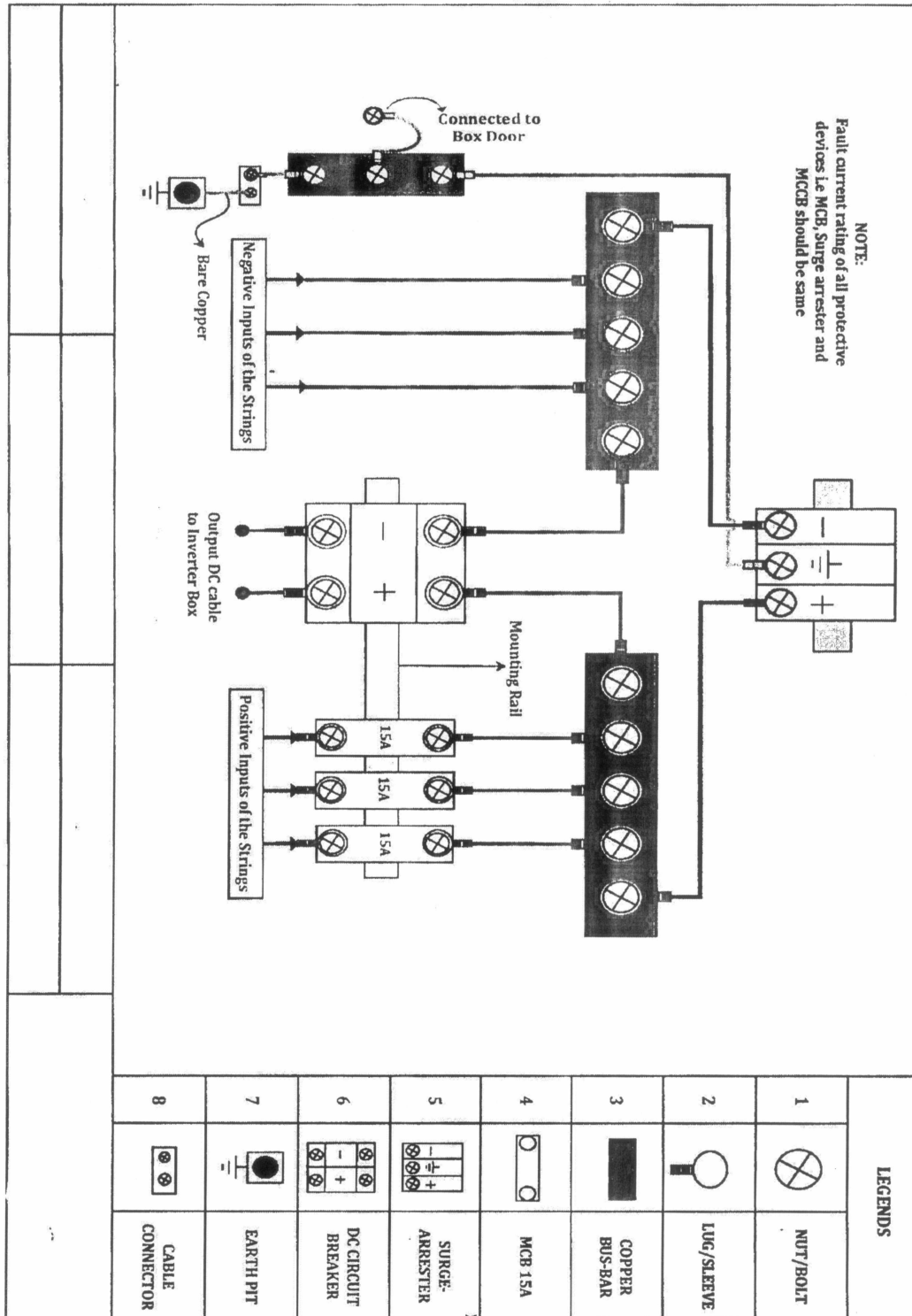
IPS

ANNEXURE-4 (SYSTEM SINGLE LINE DIAGRAM-PUMPING)



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ANNEXURE-5 **(JUNCTION/COMBINER BOX SCHEMATICS DIAGRAM)**



NO.SO(B)/II-10/Solar Panels/PBC/2018-19/C&WD-Dated-30/01/2019

Copy forwarded to: -

1. Additional Chief Secretary Planning and Development Department Government of Khyber Pakhtunkhwa.
2. The Secretary Finance Department Government of Khyber Pakhtunkhwa.
3. The Secretary P&D Department Government of Khyber Pakhtunkhwa.
4. The Secretary Higher Education Department Government of Khyber Pakhtunkhwa.
5. The Secretary Elementary & Secondary Education Department Government of Khyber Pakhtunkhwa.
6. The Secretary Health Department Government of Khyber Pakhtunkhwa.
7. The Secretary Energy & Power Department Government of Khyber Pakhtunkhwa.
8. The Secretary Local Government Department Government of Khyber Pakhtunkhwa.
9. The Secretary Irrigation Department Government of Khyber Pakhtunkhwa.
10. The Secretary Public Health Engineering Department Government of Khyber Pakhtunkhwa.
11. The Secretary Housing Department Government of Khyber Pakhtunkhwa.
12. The Secretary Sports, Culture, Youth Affairs, Tourism, Archaeology & Museums Department Government of Khyber Pakhtunkhwa.
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14. The Secretary Law Department Government of Khyber Pakhtunkhwa.
15. The Registrar Peshawar High Court.
16. The Secretary Industries Department Government of Khyber Pakhtunkhwa.
17. The Secretary Food Department Government of Khyber Pakhtunkhwa.
18. The Secretary Environment Department Government of Khyber Pakhtunkhwa.
19. The Secretary Mines & Minerals Department Government of Khyber Pakhtunkhwa.
20. The Secretary (Admn. Ifra & Coord) Fata Secretariat, Warsak Road Peshawar.
21. The Secretary Excise & Taxation Department Government of Khyber Pakhtunkhwa.
22. The Secretary Administration Department Government of Khyber Pakhtunkhwa.
23. The Secretary Establishment Department Government of Khyber Pakhtunkhwa.
24. The Director General M&E P&D Department, Peshawar.
25. The Director Agriculture Engineering Tarnab Farm Peshawar.
26. The Superintending Engineer, PHE Division Mardan, PHE Department.
27. The Superintending Engineer PBC, C&W Department, Peshawar.
28. The Director General PDA, Hayatabad, Peshawar.
29. The Chairman Electrical Engineering Department, University of Engineering & Technology Peshawar.
30. The Executive Engineer Warsak Canal Division Peshawar, Irrigation Department.
31. The Executive Engineer, Peshawar Division, PHE Department.
32. The Deputy Director (PHA), ATI Campus Jamrod road Peshawar.
33. The Executive Engineer PBC-II C&W Department.

34. The Planning Officer, LG&RD Department.
35. The Assistant Engr. CSR / MRS (Cell) C&W Department.
36. The Manager Energy & Power Department Peshawar.
37. The Deputy Secretary (Technical), Public Health Engineering Department, Peshawar.
38. The Chief Engineer (Centre), C&W Department, Peshawar.
39. The Chief Engineer (North), C&W Department, Peshawar.
40. The Chief Engineer (East) C&W Department, Abbottabad.
41. The Chief Engineer (CDO), C&W Department, Peshawar.
42. The Chief Engineer (Merged Area) C&W Department, Peshawar.

Sd/
Secretary C&W



(Engr: Muhammad Imran)
Section Officer (Buildings)