1. *Introduction :*

These specifications cover the technical and mechanical requirements for a heavy duty Photovoltaic Solar Systems with the operating voltage of (- 48V D.C) and to provide necessary D.C. power supplies to telecommunications equipment as BTS or DBS at various sites in republic of Yemen.

So the Tenders shall introduce total design for the solar power system including Battery Capacity, but the batteries will be provided by Yemen Mobile Company .

2. System Components:

The Photovoltaic solar system consists of the following:

- **PV Solar Modules.**
- **Solar Charge Controller.**
- **Installation materials and accessories.**
- **All interconnections**
- **All devices of Protection.**

All specifications for system components are shown in attached tables.

3. Basic System Requirements:

- **Type of system:**

The PV system is a stand-alone system, to meet the operating power requirement of the Telecommunication equipments.

- **Load :**

The solar power system has to deliver power continuously to telecommunications equipment.

The load rated power is (300) watt and terminal voltage of -48V DC .

- **Weather Data :**

For designing the system, weather data of our sites should be taken as representative data for Republic of Yemen.

- **Operating Environment :**

The Photovoltaic solar system should be suitable for locations and sites at various remote places. The entire system should be designed and built to withstand the environmental conditions found in Yemen.

So for design purposes, the solar power system should be able to work with the following environmental conditions.

i) Ambient Temperature: from ($-10C^{o}$ up to $+ 60C^{o}$).

ii) Relative Humidity : up to 98%

iii) The PV array and support structures must be able to withstand wind velocities up to 150km/hour without damage.

So that all wiring, enclosures, and fixtures that are mounted indoors or outdoors must be resistant to high humidity, and corrosion resistant terminals are required.

- **PV system capacity :-**

- The bidder shall indicate his calculations of the capacity of the module, no. of PV modules in array, battery capacity, and charge controller of the system recommended by him, giving the values of various factors adopted, depending on the required capacity and the autonomy days.

- The solar system capacity shall cover the following aspects-:

1- The power achieved by the solar modules, or batteries shall be able to meet the load current requirements during the whole time.
2- The power developed by the solar modules should be sufficient to keep the batteries fully charged at the end of a normal solar day.
3- The capacity of the individual solar module is chosen to ensure optimum efficiency and cell junction temperature.
4- Minimum autonomy days for various stations may be taken as 5 days .

4. Protection and interconnect the parts of the system:

- Protection for all system from reverse current follow.
- Protection for all system from lightning, any power sparks and earth leakage.
- Earth terminals for all devices of the system.
- Fuse or MCB terminal boxes for arrays input to the controller, the batteries input and output, and for the load terminals.

5. Scope of supply ".Bill of Materials "BOM"

- The bidder shall supply complete solar power system which consist of:

1. Solar PV modules and racks.
2. Array Junction boxes, main junction boxes and C.B boxes for merge more than one system (at least 3 systems) to feed the same load by using only one C.B in case of load capacity extended.
3. Array mounting structures.
4. Solar charge controllers and protection devices.
5. Weather proof cables, connectors, conduits and ground materials.
6. Spares test instruments and tools necessary for the installation, up to the load points, commissioning, operation and maintenance of all systems at all sites.

The items not listed in BOM but required for successful installation/commissioning of power systems shall also be added, as required at no extra cost.

- The Bidder shall give following information-:
  1. Power supply system drawings for all the above categories.
  2. Calculation formulas of capacity of solar array, and Batteries Capacity.
  3. Solar cell characteristics.
  4. Composition of solar array.
  5. Size and weight of solar array.
  6. All other technical information, catalogs and data for all devices of the system.
  7. Detailed information and drawings of civil works required.
- The Bidder shall provide the following tools without extra cost:
  - Two sunlight density meters.
  - Two latitude angle meters and compass.
  - Two longitude and latitude lines indicators.

6. Documentations supplied with offer:

HANDBOOKS/INFORMATION

The Bidder shall supply the following documents and information:

- Three sets of all documents and handbooks which contains complete information and illustrations for installation, commissioning, testing, operation and maintenance including the circuit diagrams of the elements of the equipments.
- The manual shall include complete system details such as array layout, schematic of the system, charger details, working principle etc.
- Step by step maintenance and troubleshooting procedures shall be given in the manuals.
- A complete component catalogue including information of re-ordering will be provided.
- A list of test equipments and tools will be included with the system.

Note: Any provided offer without complete technical data for all units and parts will be ignored.

7. Warranty Statements:

All Photovoltaic solar systems shall be under two years on-site comprehensive warranty support from the date of installation.

8. Spares:

The Bidder shall provide spares which required for operation and maintenance for three years at least.

9. Factory test:

The factory test must be by testing company in the original country and with attending two engineers from Yemen mobile company and should be one week at least.

Technical Specifications for Solar Photovoltaic Modules		
No	**Item**	**Required Specifications**
1	***Cells type" Crystalline modules"***	The modules shall be made of mono -crystalline / poly - crystalline silicon solar cells, and with high efficiency.
2	***Standard***	The Solar Photovoltaic module should have the best standards or shall conform to IEC 61215-2 and IEC 61730-2 qualification certification for PV modules At least.
3	***Module requirements***	• The Bidder shall indicate the performance data, under standard test conditions, of the module chosen by him. He shall also give the expected performance of the module under varying solar radiation conditions and corresponding cell junction temperatures. • The Bidder shall indicate the cell crystal structure, its estimated life cycle and annual rate of performance deterioration, depending on various conditions of the environment. • The solar cell and module shall be mechanically well protected within an Aluminum frame for a long term use over the entire life cycle against natural hazards such as rain, hail, storm, blowing sand, and small particles. The entire module casing should be impervious to moisture and rain water. • Each module shall be provided with water – proof connector box for suitable wiring.

Technical Specifications for Photovoltaic Solar Array and Mechanical Components		
No	**Item**	**Required Specifications**
1	***Output Array voltage***	The Output Array voltage should be -48V DC positive ground.
2	***Protection***	The Bidder shall indicate the methods employed specially details of arrangements of blocking or by-pass diodes to prevent partial loss of array output in case of any module of array is shaded or broken in parallel or series condition respectively.
3	***Solar Array Support Structure "*** **Mechanical Components** ***"***	**The mounting structures should be providing the following requirements:** • The support structure, mountings and fixing bolts/nuts should be weather proof and corrosion resistant." of galvanized steel" • The materials used in the array and support structure should be light weight but strong enough to withstand Wind speeds of 150 km/hr laden with salt, hydrogen sulphide and similar other elements obtained in coastal areas. • The supports shall allow free air to access through the area of array. • It shall allow tilt angle range adjustable by given steps. • The height of the lowest side of the solar support should be 0.5 m above the ground. • The installation method of structures should be very easy for replacing any module and cleaning solar panels. • The structure shall be designed to be simple in mechanical and electrical installations. • The array structure shall be designed to occupy as minimum of space as possible without sacrificing the output from the SPV panels. • The supplier / manufacture shall specify installation details of the PV modules and the support structure with appropriate design and drawing. • The support structure should match fully the size of the module frames so as to form a strong and rigid mechanical structure. It shall be easily assembled. The Bidder shall give complete details of the framework, the materials used and the foundations required to be provided at the site. • At some of the locations dust storms frequently occur and it is likely that dust accumulates on the panel surface. Provision shall be made for likely deterioration in performance, if any, on account. • In case of steel products (other than stainless steel) the metal surfaces shall be hot dipped galvanized (with 450 mg/m^2 or more for high level degree of galvanizing). • The mounting structure shall be such that solar system can be expanded with increase of the load up to 30%. **Orientation and Tilt of PV system** Modules alignment and tilt angle shall be calculated to provide the maximum annual energy output; this shall be decided based on the location of array installation. • The Bidder shall give his recommendations for the array, frame and support structure tilt angle for the optimum performance.

Technical Specifications for Solar Charge Control Unit		
No	**Item**	**Required Specifications**
1	***General***	The charge controller shall be designed for industrial and heavy duty use and shall be provided to monitor, protect and control the charging & discharging current and voltage. The Solar Charge controller must deliver the maximum available current for charging batteries and regulate battery voltage and output current based on the amount of energy available from the PV array and state-of-charge of the battery and feeding the load during the day light at the same time.
2	***Type***	Maximum Power Point Traker (MPPT) Charge controller
3	***Charge controller rating***	Solar Charger controller capacity should be at least 30% more than total short circuit current of PV array.
4	***Nominal Voltage:***	Adjustable output voltage of (12V,24V, 48V D.C).
5	***Charge Requirements***	The offered Charge Controller shall fulfill all system requirements as followed: • The Charge Controller should have temperature compensation for proper charging of the battery. • The controller should have high reliability and high efficiency. • A suitable Charge/Discharge controller is offered to manage the batteries charging process, disconnect the battery on a preset low voltage battery as well as affect interfacing functions with the solar panels, Batteries and Load. • All protection system offered by the controller. • All voltage, current and capacity measures of all sides of the system. • All remote and telemetry observing and controlling offered by the controller and also the parameters can be modified at site, the methods to do that. • Remote Signal Terminal.

Technical Specifications for Solar Charge Control Unit		
No	**Item**	**Required Specifications**
6	***Solar charge controller functions***	***<u>Programmable functions</u>*** The charge controller shall have at least the following functions-: • ON and OFF control for overcharging of battery • Indication of above status. • Protection from excessive current. • On and OFF control for over discharge of battery. • Indication of above status. • Alarm for low & high battery voltage. • Indication for battery voltage. • Indication of solar array open voltage. • Indications of solar output current. • Indication of load current, and charging or discharging current. • Fully local indications and alarms of the system conditions and retransmit them to the telecommunication network. ***<u>Digital instruments(measuring and display):</u>*** It should have LCD display which indicates at least the following parameters : • Battery Display: Battery Voltage, Battery Charging Current and Battery Ah. • PV Solar Display: PV panel Voltage, current and Ah which input to the system. • Load Display: Load voltage, current and Ah. • Accurate clock show.

Technical Specifications for Solar Charge Control Unit		
No	**Item**	**Required Specifications**
7	***Solar charge Controller alarm and protection***	1. The solar charge controller shall be provided fully protected against : • Discharge of battery to solar module during night". • Overcharging and deep discharging of the battery" disconnects". • Over-load Protection and short circuit conditions. • Battery Reverse polarity protection, overcurrent, overvoltage and reverse current flow at any of the controller terminals • Over Temperature Protection "Temperature compensation ". 2. Provision shall exist for the re-transmission of all alarms to a remote location by means of voltage-free loops. 3. The following protections shall be provided-: • Battery low voltage:- for Alarm (Adjustable between 42V – 46.0V) for auto-cutoff (Adjustable between 40V – 44.0V) • Battery High Voltages-: for Alarm (Adjustable between 56.0V - 60.0V) for auto-cutoff (Adjustable between 58.0V - 64.0V) • D.C. Output (Load Point) Voltages-: Regulation of D.C. output voltage Alarm if the voltage is outside range of -46 and -54 v Load auto cut off if the voltage is outside range 41.6 and 54.4 (adjustable) • Load Current Limiting-: • Provision shall be made to limit the load current to within 110% of nominal value.

Technical Specifications for Other requirements		
No	**Item**	**Required Specifications**
1	***Cables***	• All cables and wiring between array interconnections, array to junction boxes, and junction boxes to solar charger must be sized to keep the voltage drop and losses to the minimum. This drop shall not exceed 2.5% in each sub-circuit and to allow the circuit to operate within the capacity rating of the wire. • The cables and wires shall be insulated and made of pure copper conductors. • All wiring shall be color coded and/or labeled.