# OPEN TENDER TECHNICAL SPECIFICATION

# FOR

# THE PROJECT

# SOLAR MULTI-EFFECT DESALINATION SYSTEM

## SPONSORED BY

## MINISTRY OF EARTH SCIENCES, GOVERNMENT OF INDIA, NEW DELHI

# INDEX

# I. PROJECT INFORMATION

## a. LOCATION

The Solar based stand alone Sea Water Desalination System (Solar LTF – MED) shall be installed at Vivekananda Kendra, Kanyakumari district of Tamil Nadu. The nearest Railway station is Kanyakumari and Airport is Trivandrum located at a distance of approximately 2 km & 90 km respectively from Project site.

## b. INTENT OF THE PROJECT

The intent of Solar LTF-MED system is to produce Potable water from Sea Water. It is envisaged to be accomplished by utilizing the hot water produced by solar thermal collectors. Hot water shall be used to produce low pressure saturated steam which in turn, shall be used in Multi-Effect Desalination system to produce desalinated water from sea water.

## c. PLANT INPUT & OUTPUT DATA

| S. No | Description | | | Unit | Parameter |
|---|---|---|---|---|---|
| i | Capacity (8 hr Operation) | | | Tons/Day | 10 |
| ii | Quality of Output Water | Desalinated Water | TDS | ppm | 5 |
| | | Potable Water | TDS | ppm | 150 |
| | | | pH | - | 6.5 - 8.5 |
| iii | Quality of Inlet of Seawater | TDS | | ppm | 33,000 - 35,000 |
| | | pH | | - | 8.2 |
| | | Temperature | | °C | 30 |

## II. PROCESS DESCRIPTION

The solar LTF-MED is designed for a capacity of 10 m3/day and is intended to operate for 8 hours a day. Initially hot water is produced from solar flat plate collectors utilizing solar energy. The inlet water for the solar flat plate collectors is taken from the bottom of the hot water storage tank. The outlet hot water at temperature 65-70 °C from solar flat plate collectors is fed at the top of the hot water storage tank.

The proposed concept of desalination involves both flashing and evaporation. The vapour is produced by flashing the hot water in the flash chamber from the storage tank and this vapour becomes the heat input to the multi-effect desalination unit to produce steam by evaporating sea water. The pre-heated sea water from the condenser is sprayed onto the tube bundles in the evaporator. The flashed vapour is passed through the tube bundles which condense by exchanging its latent heat with the falling sea water. Thus vapour is produced outside the tubes due to evaporation and this vapour enters the second effect of the evaporator. This vapour produced in the first effect is in turn condensed in the second effect, again evaporating a portion of the seawater feed. This process is repeated up to the fourth effect. The fourth effect vapour is condensed in a condenser by transferring latent heat to the incoming seawater. The heated raw seawater coming from the condenser becomes feed water to the evaporators. Pressure difference between the effects is maintained by orifice/ venturi meter on the vapour side and barometric head on the liquid side.

The distillate produced and remaining brine in each effect is transferred to the successive effects and finally pumped out by distillate and brine pumps respectively.

The brine is partially re-circulated to the process as feed water and the remaining is rejected by proper seawater drain system to the sea. The distillate from the condenser is re-mineralised for drinking purpose as per World Health Organisation (WHO) standards and stored in a storage tank. Typical process diagram of the system is mentioned in the pdf file.

This plant is a standalone system, the electrical power required to drive the pump and accessories of the plant is harnessed by using Solar Photo Voltaic System. Schematic layout of the plant is shown in the Fig.1.

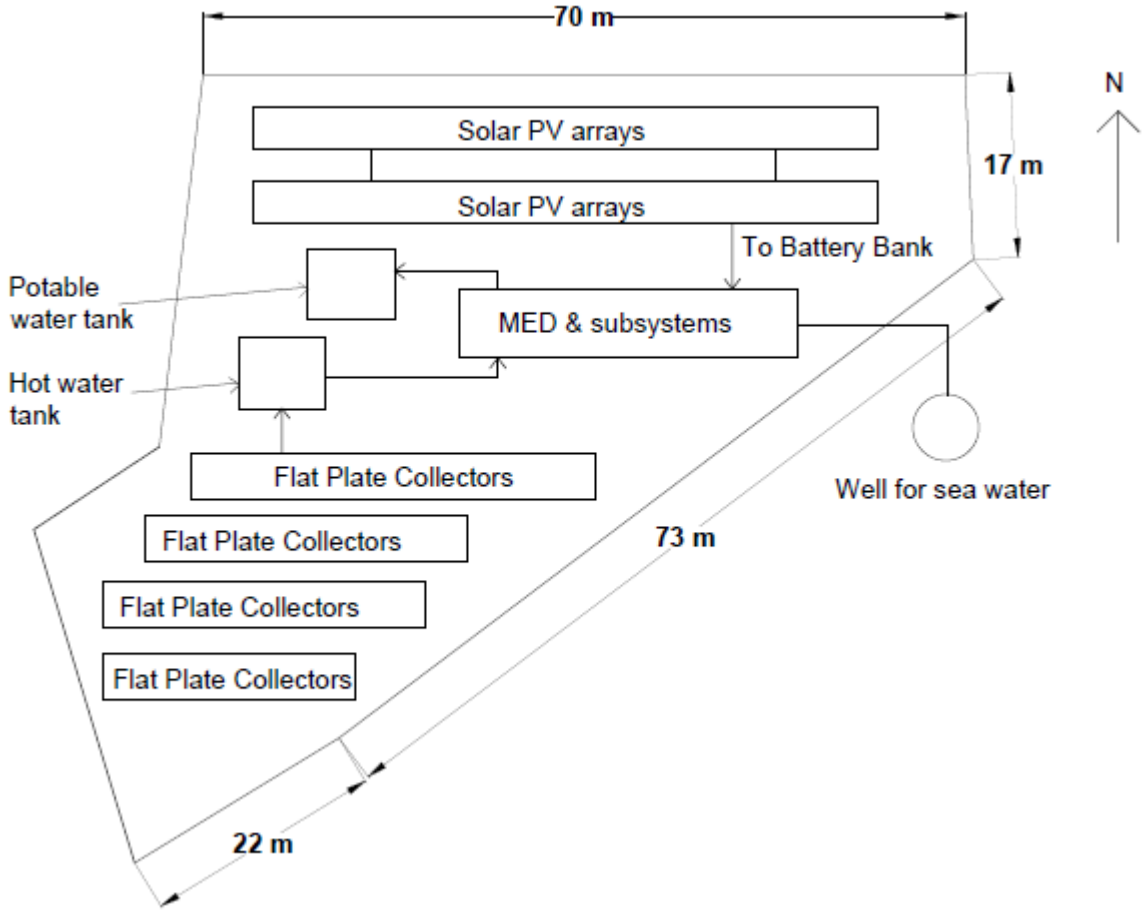


**Fig.1 Schematic Layout of the MED plant at site**

# A. MULTI-EFFECT DESALINATION(MED) SYSTEM

## 1. SCOPE OF WORK

- The Scope of Work includes Design, Fabrication, Manufacturing, Supply, Installation, and Testing & Commissioning of Evaporators, Flash Chamber, Condenser and sub systems at Vivekananda Kendra, Kanyakumari district of Tamil Nadu.
- Submission of all fabrication drawings of the installed system.
- Submission of training and maintenance documents.

## 2. SCOPE OF SUPPLY

Scope of supply includes all manufactured items like Flash chamber, evaporator, condenser and piping, instruments etc., as required.

## 3. MAIN COMPONENTS OF MED UNIT

The major plant components/equipments comprise mainly the following

| S. No | Main Components / Equipments | Unit | Quantity |
|---|---|---|---|
| 1. | Flash Chamber | No. | 1 |
| 2. | Evaporator | No. | 1 |
| 3. | Condenser | No. | 1 |
| 4. | Vacuum Systems | No. | 1 |
| 5. | Piping and Instruments | Lot | 1 |

### 3.1. FLASH CHAMBER

The hot water from the solar thermal collectors enters the flash chamber which is at a pressure lower than the saturated vapor pressure of the hot water. A portion of the hot water vaporizes and the water cools by giving away the heat for vaporization. The decrease in temperature after flashing is compensated by the heat source.

## 3.2. EVAPORATOR

The evaporator is a simple shell and tube heat exchanger where the vapour from the flash chamber is fed into the tubes and the saline water is sprayed over the tubes. The sprayed seawater is heated and evaporation begins when the temperature corresponding to saturation pressure maintained in the evaporator is reached. The vapour production in the effect is slightly lesser than the quantity of vapour produced in the flash chamber. The quantity of spraying is based on the experience and optimization of scaling factor.

The heat transfer tubes used are of aluminum alloy and fixed using Ethylene Propylene Diene Monomer (EPDM) rubber grommets Food Grade (FG) for simple and easy maintenance. The vapour generated in the last effect of the evaporator is condensed in a condenser.

The evaporator consists of four effects. Each effect will be individual with interconnecting pipes. As all the effects are operating at vacuum conditions reinforcements and stiffeners should be provided on the evaporator shell in order to endure the load during pneumatic tests and during operation. The evaporator shells of all effects should be made of Duplex Steel Material.

The bottom of each effect should be provided with a manhole for maintenance and inspection. The Manhole covers on evaporator shell should be hinged for easy opening and should be accessible from platforms and ladders around the unit. The cover should be kept in easily accessible locations. Observation windows/ sight glass with lighting should be provided in each effect to observe spray pattern inside the shell. The seawater feed spray nozzles shall be constructed of SS 316L material and will be designed for ease of removal in case of blockage. The nozzle design and their location on distribution header should ensure uniform flow distribution over the tube bundles to avoid areas of low flow or drying out and consequential scale formation on the tube surfaces. Demisters required for maintaining purity of the product water should be made by SS 316 L mesh mats with minimum 75mm thickness. They shall be arranged in conveniently sized inter changeable sections to permit ease of handling, maintenance, and replacement through access door. Access platform, walkways, handrails, and

access stairs shall be permanently installed for access to all important sections of the plant for maintenance and inspection wherever necessary. The design shall be in accordance with ASME / HEI / TEMA standard.

### 3.3. EVAPORATOR TUBE BUNDLE

The evaporator tube bundles shall be as per TEMA standards or design approved by the engineer user's department. The tube bundle in each effect shall be horizontal and fixed to Duplex tube plates by grommet. Mock testing of rubber grommets for arriving at the leak rate should be conducted before installation in the evaporators. Such testing will be witnessed by engineers from user department. Suitable support plates of compatible material are to be provided. Provisions for easy removal and replacement of tubes through bolted and manhole covers without any cutting should be planned. Evaporator tube shall be of Al alloy. Suitable fouling factors should be considered in the design of the heat transfer surface in the MED plant. Some of the tubes shall be used for cooling the non condensable gases. All interconnecting ducts and pipe work should have sufficient flexibility to allow thermal expansion without imposing excessive loading on associated plant equipments and pumps. Flexible bellow / couplings should be used wherever applicable and shall be designed to withstand both pressure and vacuum condition.

Tubes inside the shell can be arranged either in central tube or side tube arrangement. The actual tube arrangement can be chosen depending upon the ease of fabrication, accessibility of tubes and demisters and manhole placing. Mechanical design should be based on the arrangement chosen. For similarity all the effects shall be of same dimension and arrangement. The detailed engineering drawings of all the evaporators and equipments with all the dimensions are to be made by the supplier. The drawings are to be approved by the user’s executive engineer before taking up for the fabrication job by the supplier. Tentative dimensions & specifications of evaporator shell and tube bundle (Al alloy) are given in Technical specifications.

Each evaporator should have adequate heat exchanging surfaces. The requested heat surface shall be accommodated in shells with required diameter and total length not exceeding the comfortable access to the tube sheets. In this size, comfortable

access to the internals should be considered for inspection and maintenance.

### 3.4. INTERCONNECTION BETWEEN STAGES

All effects will be placed in a common shell. Vapour in the every effect should be transferred to the next effect through vapour box. Condensate collected at the end of tube bundle is transferred to the successive effects via U pipe. Concentrated seawater (brine) is also transferred to the successive effects via U pipe.

### 3.5. CONDENSER

Condenser is a simple heat exchanger with condensing steam on the shell side and cooling seawater on the tube side. The condenser is made of stainless steel shell and titanium tubes fixed with tube expansion. The cooling water enters the tubes of the condenser and the exit water is split into two streams one feeding the evaporator and the other is rejected back to the sea. The total product water is collected out from the condenser as distillate.

Tubes for condenser will be of Ti Gr.2 with required wall thickness as per the process. The water boxes, tube plates and tube support plates shall made of Duplex. Shell shall be made of Duplex. The design of condenser should be done in accordance of TEMA C. Galvanic coupling between dissimilar metal should be avoided. The tube side design flow rate of seawater should be in line with the process requirement. Shell side condensing vapor design load should compensate the working condition. Condenser coolant sea water flow rate should be designed as per the process requirement. The condenser should have an adequate heat exchanging surface and size of tubes corresponds to the same. The number of passes shall be as necessary to ensure the acceptable process water flow velocity.

### 3.6. VACUUM SYSTEM

A single stage water jet ejector forms the vacuum system for the entire system. This shall be capable of extracting all the non-condensable gases (NCG) from feed water, air in-leakage and carbon dioxide released in evaporation, together with associated vapour and discharging to atmosphere. Non-condensable gases will be transferred by cascade venting to the lowest pressure part (up to the condenser) and then extracted by the

ejector. The ejector is driven by seawater at required pressure which is the motive water flow for the ejectors and the NCG are sucked through the ejector secondary stream and discharged along with reject.

### 3.7. PIPING / INSTRUMENTS

Supply of necessary pipes and valves and laying them are under the scope of the supplier. Suitable sensors insertion points are to be kept on the piping for sensing the required parameters like flow, pressure and temperature. Suitable valves are to be provided wherever needed. Suitable Non Return Valves are to be provided wherever necessary. Adequate flanged connections shall be provided for hot water inlet and outlet piping from solar water heating system, sea water intake and drain piping and distillate pumping system.

## 4. INSPECTION / TESTING / ACCEPTANCE TESTS

i. IIT reserves the right to inspect, or to have their authorized representative inspect the Solar LTF-MED at any time during their fabrication to ensure their compliance with the specification.

ii. The supplier shall conduct the following tests at the factory.

Visual Inspection
Overall dimensional inspection
Leak test
Pressure test
Weight of each piece of the equipment

iii. The necessary tapping to be provided on the tube side as well as on the shell side for fixing gauges (Pressure, Temperature and Flow).

## 5. DRAWINGS & DOCUMENTS

The following Set of documents shall be supplied along with equipment:

- Bought out items Data Sheet
- Raw material test certificate for metallic components (shell, dish ends, tubes, tube sheets, baffle plates etc) under section 3

- Factory Acceptance Test Certificate Operation / Maintenance Manual Parts Catalog.
- As-Built Drawings for the entire Assembly and non-assembly procedure.
- Handling procedure.

## 6. PERFORMANCE GUARANTEE

The Solar LTF-MED shall be guaranteed for material, workmanship and satisfactory performance at site, online for a minimum period of Twelve (12) months from the date of commissioning.

## 7. OVERALL PROCESS SPECIFICATION

| S.NO | OVERALL DESIGN PARAMETERS | UNIT | DATA |
|---|---|---|---|
| 1 | Plant Capacity / Production | $m^3$/day | 10 |
| 2 | Operating Hours / Day | hrs. | 8 |
| 3 | Gain Output Ratio (GOR) | | 3.5 (min) |
| 4 | No. Effects (Minimum) | nos. | 4 |
| 5 | First effect temperature | ˚C | 55.4 |
| 6 | Last effect temperature | ˚C | 46.7 |
| 7 | Sea water flow rate to Condenser | kg/h | 27,000 |
| 8 | Sea water inlet temperature | ˚C | 25 to 30 |
| 9 | Feed Seawater spray flow rate in each effect | kg/h | 6,800 |
| 10 | Feed sea water temperature | ˚C | 32 |
| 11 | Product Salinity (TDS) | ppm | 5 |
| 12 | Sea water Salinity | ppm | 33,000 – 35,000 |
| 13 | Brine Discharge Flow Rate | kg/h | 1800 |

**Note:** *All the technical parameters are indicative value, Bidder has to design and specify in their offer*.

## 8. TECHNICAL SPECIFICATIONS

| S. NO | DESCRIPTION | REMARKS |
|---|---|---|
| **A** | **FLASH CHAMBER** | |
| 1 | Material of Construction | SS 316L |
| 2 | Design Pressure | Vacuum |
| 3 | Design Temperature | 65 °C |
| 4 | Shell Size (mm) – OD x Thick x Length | 1400 (minimum) x ** x ** |
| **B** | **EVAPORATOR** | |
| 1 | Material of Construction (Sea Water side/ Steam side ) | Duplex / SS 316L |
| 2 | Design Pressure | Vacuum |
| 3 | Design Temperature | 55.4 °C |
| 4 | Shell Size (mm) – OD x Thk x Length | 1400 (minimum) x ** x ** |
| 5 | Tube Material | Aluminum Alloy |
| 6 | Tube Size (mm) – OD x Thk x Length – For 1 Effect | 25.4 x ** x 1400(minimum) |
| 7 | No. of Effects (minimum) | 4 nos. |
| 8 | Tube to Tube Sheet Connection | Grommet |
| 9 | Grommet – Material / Size | EPDM (F.G) / ** |
| 10 | Tube arrangements | Triangular Pitch |
| 11 | Heat transfer area in $m^2$ | 380 |
| 12 | Sight glass with lighting | 4 nos |

** - Bidder to specify in their offer

**Note:** *All the technical parameters are indicative value, Bidder has to design and specify in their offer*.

| | | |
|---|---|---|
| **C** | **CONDENSER** | |
| 1 | Material of Construction (Sea Water side/ Steam side ) | Duplex/ SS 316 L |
| 2 | Design Pressure | Vacuum – 0.09 bar(a) |
| 3 | Design Temperature | ** |
| 4 | Size (mm) –ID x Thk x Length | 800 (min) x ** x 1800 (min) |
| 5 | Tube Material | Ti Grade 2 |
| 6 | Heat Transfer Area | 90 $m^2$ |
| 7 | Tube Size (mm) – OD x Thk x Length | 17.4 x ** x 1400 (min) |
| 8 | Type of Pass | Double Pass |
| 9 | Tube to Tube Sheet Connection | Expansion |
| 10 | Tube arrangement | Triangular Pitch |
| **D** | **Mounting structures** | Suitable mounting structures made of GI metallic frames shall be provided for MED and its subsystems to ensure proper positive suction head for the distillate pump. |
| **E** | **Piping and Instruments** | All the interconnecting pipes and valves shall be provided as per IBR standards.<br><br>Suitable sensor insertion points shall be provided for sensing the parameters (Flow, temperature, pressure).<br><br>Adequate flanged connections shall be provided for facilitating the process piping as specified in section 5.5. |

** - Bidder to specify in their offer

**Note:** *All the technical parameters are indicative value, Bidder has to design and specify in their offer.*

## 9. EXPERIENCE OF THE BIDDER

The bidder should have designed/engineered, manufactured/ erected and commissioned at least one multi-effect distillation coupled with 5 TPH steam generation system.

## 10. TECHNICAL DATA-SHEETS – BIDDER TO FILL

| S. NO | DESCRIPTION | REMARKS |
|---|---|---|
| **A** | **FLASH CHAMBER** | |
| 1 | Material of Construction | SS 316L |
| 2 | Design Pressure | ** |
| 3 | Design Temperature | ** |
| 4 | Shell Size (mm) – OD x Thick x Length | ** x ** x ** |
| **B** | **EVAPORATOR** | |
| 1 | Material of Construction (Sea Water side/ Steam side ) | Duplex/ SS 316 L |
| 2 | Design Pressure | ** |
| 3 | Design Temperature | ** |
| | | |
| 4 | Shell Size (mm) – OD x Thk x Length | ** x ** x ** |
| 5 | Tube Material | Aluminum Alloy |
| 6 | No. of Tubes | ** |
| 7 | Tube Size (mm) – OD x Thk x Length – For 1 Effect | ** x ** x ** |
| 8 | No. of Effects (minimum) | ** no |
| 9 | Tube to Tube Sheet Connection | Grommet |
| 10 | Grommet – Material / Size | EPDM (F.G) / ** |
| 11 | Tube arrangements | Triangular Pitch |
| 12 | Heat transfer area in Sq. m | ** |

** - Bidder to specify in their offer

| | | |
|---|---|---|
| **C** | **CONDENSER** | |
| 1 | Material of Construction (Sea Water side/<br>Steam side ) | Duplex/ SS 316 L |
| 2 | Design Pressure | ** |
| 3 | Design Temperature | ** |
| 4 | Size (mm) –ID x Thk x Length | ** x ** x ** |
| 5 | Tube Material | Ti Grade 2 |
| 6 | Heat Transfer Area | ** |
| 7 | No. of Tubes | ** |
| 8 | Tube Size (mm) – OD x Thk x Length | ** x ** x ** |
| 9 | Type of Pass | Double Pass |
| 10 | Tube to Tube Sheet Connection | Expansion |
| 11 | Tube arrangement | Triangular Pitch |
| **D** | **Mounting structures** | |
| **E** | **Piping and Instruments** | |

** - Bidder to specify in their offer

# B. SOLAR WATER HEATING SYSTEM

## 1. SCOPE OF WORK

- The Scope of Work includes Design, Supply, Installation, Testing & Commissioning of Solar flat plate collector water heating system with adequate storage at Vivekananda Kendra, Kanyakumari district of Tamil Nadu.
- Submission of training and maintenance documents.
- Submission of all details of the installed systems like component details and manuals, test reports, etc.

## 2. SCOPE OF SUPPLY

Scope of supply includes supply of all the Flat plate collectors, Thermal energy storage, support structures, piping and instruments, recirculation pump, as per the applicable standards given in the subsequent section.

## 3. SOLAR WATER HEATING SYSTEM

The plant being driven by thermal energy, the design/capacity of the entire plant is dictated by the availability of solar heat as hot water from solar panels in the day hours. The advantage of the technology is mainly from the use of renewable energy. Motive steam for the MED System is flashed from the hot water in the Flash chamber under Vacuum condition. This hot water is produced from the solar flat plate collectors utilizing the solar energy. The initial inlet water for solar collector is from a DM Tank. Once the system starts circulation the water is circulated continuously between solar thermal collectors and flash chamber. The required flashing temperature of 62 ºC for flash chamber is attained in the solar thermal collectors and there will be a temperature drop in the flash chamber. This water at lower temperature of 55 ºC is again circulated to solar thermal collectors for raise in temperature. The approximate flash range will be from 55 ºC to 62 ºC

### 3.1. PROCESS PARAMETERS

| S. NO | DESCRIPTION | SPECIFICATIONS |
|---|---|---|
| 1. | System Capacity | 30.6 TPH @ solar insolation of 800 $W/m^2$ |
| 2. | Plant operating hours | 8 hours / day |
| 3. | Working fluid | Distilled Water (<10 ppm) |
| 4. | Inlet Temperature | 55 deg C |
| 5. | Inlet Pressure | 2.9 bar |
| 6. | Outlet Temperature | 62 deg C |
| 7. | Outlet Pressure | 2.5 bar |

## 4. MAJOR COMPONENTS OF SOLAR WATER HEATING SYSTEM

The major components of the solar water heating system comprise the following

| S. NO | DESCRIPTION |
|---|---|
| A. | Flat plate collectors |
| B. | Thermal energy storage |
| C. | Recirculation pump |
| D. | Mounting / Support structures |
| E. | Piping and Instruments |

## 5. INSPECTION / TESTING / ACCEPTANCE TESTS

IIT reserves the right to inspect and /or to test the goods to confirm their quality in compliance with the specification.

## 6. DRAWINGS & DOCUMENTS

The following set of documents shall be supplied along with equipment:

- Bought out items Data Sheets and Test certificates
- Operation manuals with drawing, parts list (with part codes) P&I drawings with list ratings of components and list of do's and don'ts for the main equipment as well as the subsystems
- As-built drawing of the solar water heating system

## 7. STANDARDS

The goods supplied and works executed shall confirm to the standards mentioned in the technical specification and where no applicable standard is mentioned, the latest version of Indian Standard Institution or Bureau of Indian Specification shall be applicable.

## 8. PERFORMANCE GUARANTEE

The Solar water heating system shall be guaranteed for material, workmanship and satisfactory performance at site, on line for a minimum period of Twelve (12) months from the date of commissioning.

## 9. TECHNICAL SPECIFICATIONS

| S. NO | DESCRIPTION | SPECIFICATIONS |
|---|---|---|
| 1. | Type of solar thermal collectors | Flat plate collector |
| 2. | System capacity @ 800 $W/m^2$ | 30.6 TPH |
| 3. | Collector dimensions (Length × Height × Width) | 1860 mm (minimum)×** ×** |
| 4. | Absorber area | 1.8 $m^2$ |
| 5. | Absorber material | Copper sheet and copper tubes |
| 6. | Absorber coating | Selectively Coated Continuous |

| | | |
|---|---|---|
| | | Electroplating of Black Chrome over Nickel substrate Absorptivity >95%, Emissivity < 18% |
| 7. | Fin & Tube Bonding | Brazing/Welding |
| 8. | Header & Raiser Bonding | Brazing/Welding |
| 9. | Collector Box | Collector box shall be made of Aluminium section only |
| 10. | Cover plate | Single piece tempered / toughened glass of minimum thickness 4 mm. The solar transmission of the cover plate shall be >82% at near normal incidence |
| 11. | Insulation | Insulation of rock wool/ glass wool/ mineral wool of suitable thickness shall be provided at back and sides of the absorber. |
| 12. | Reflector | Aluminium foil of thickness >0.1 mm shall be provided |
| 13. | Gaskets and Grommets material | Neoprene / High quality EPDM |
| 14. | Flanges | SS 304 , Class 150 |
| 15. | Mounting structures | Galvanized iron or mild steel support structures to withstand wind load. Provide suitable grouting for installation on the ground |
| 16. | Piping | Piping as per IBR standards |
| 16. | Insulation for piping | Insulation of rock wool/ glass wool/ mineral wool of suitable thickness shall be provided with Aluminium cladding for hot water lines. |
| 17. | Thermal Energy storage | Suitable thermal energy storage shall be provided for continuous hot water supply |
| 18. | Recirculation pump | 1 no. as per specification given below. |

| S.no | Description | Recirculation pump |
|---|---|---|
| **1** | **General** | |
| | Make | Grundfos / equivalent |
| | Type | Centrifugal |
| | Duty (%) | 110 |
| | Suction pressure [bar(a)] | 0.16 |
| | Discharge pressure [bar(a)] | 6 |
| **2** | **Process parameters** | |
| | Fluid | Distilled water |
| | Flow ($m^3$/h) | 30.6 |
| | Temperature (˚c) | 55-62 |
| **3** | **Material of construction** | |
| | Casing | Ss 316l |
| | Impeller | Ss 316l |
| **4** | **Motor** | |
| | Rated power (kw) | 7.5 |
| | Duty (%) | 110 |
| | Variable frequency drive | Abb/equivalent |

** - Bidder to specify in their offer

**Note:** *All the technical parameters are indicative value, Bidder has to design and specify in their offer*.

All the components must confirm BIS Standards and IBR standards as specified below:

- The Flat plate collector and its components must confirm BIS Standard IS12933
- Piping as per relevant IBR standards

## 10. EXPERIENCE OF THE BIDDER

MNRE/TEDA Approved Manufacturers/Suppliers/System Integrators with minimum 2 years of experience in the field of solar water heating with at least one successfully installed industrial water heating project.

## 11. TECHNICAL DATA-SHEETS – BIDDER TO FILL

** - Bidder to specify in their offer

| S. NO | DESCRIPTION | SPECIFICATIONS |
|---|---|---|
| 1. | Type of solar thermal collectors | Flat plate collector |
| 2. | System capacity @ 800 $W/m^2$ | 30.6 TPH / 250 $kW_{th}$ |
| 3. | Collector dimensions (Length × Height × Width) | ** ×** ×** |
| 4. | Absorber area | ** |
| 5. | Absorber material | ** |
| 6. | Absorber coating | ** |
| 7. | Fin & Tube Bonding | ** |
| 8. | Header & Raiser Bonding | ** |
| 9. | Collector Box | ** |
| 10. | Cover plate | ** |
| 11. | Insulation | ** |
| 12. | Reflector | ** |
| 13. | Gaskets and Grommets material | ** |
| 14. | Flanges | ** |
| 15. | Mounting structures | ** |
| 16. | Piping | ** |
| 16. | Insulation for piping | ** |
| 17. | Thermal Energy storage | ** |
| 18. | Recirculation pump | ** |

# C. 15 kWp OFF-GRID GROUND MOUNTED SOLAR PHOTOVOLTAIC (PV) SYSTEM

## 1. SCOPE OF WORK

- The Scope of Work includes Design, Supply, Installation, Testing &Commissioning of Solar PV Power Plant of 15 kWp Capacity with adequate storage at Vivekananda Kendra, Kanyakumari district of Tamil Nadu.
- Submission of training and maintenance documents.
- Submission of all details of the installed systems like component details and manuals, test reports, etc.

## 2. SCOPE OF SUPPLY

Scope of supply includes supply of all the PV modules, Power conditioning unit, Battery banks, support structures, DC Junction boxes, DC and AC distribution boxes, grounding systems, as per the applicable standards given in the subsequent section.

## 3. SOLAR PV POWER GENERATION SYSTEM

As the plant is operated in a standalone mode, the total power required for the plant is harnessed by using Solar Photo Voltaic System. The major power consumption of the plant is for Pumps and I&C Items. The maximum Power requirement will be 15 kWp

## 4. MAJOR COMPONENTS OF SOLAR PV POWER GENERATION SYSTEM

The major components of the solar PV power generation system comprise the following

| S. NO | DESCRIPTION |
|---|---|
| A. | Solar PV array |
| B. | Battery bank |
| C. | Power conditioning unit |
| D | Cables |
| E | Junction Box/Combiners |

| | |
|---|---|
| F | Module Mounting structure |
| G | DC distribution board (DCDB) |
| H | AC distribution board (ACDB) |
| F | Earthing system |

## 5. INSPECTION / TESTING / ACCEPTANCE TESTS

IIT reserves the right to inspect and /or to test, the goods to confirm their quality in compliance with the specification.

## 6. DRAWINGS & DOCUMENTS

The following Set of documents shall be supplied along with equipment:

- Bought out items Data Sheets and Test certificates
- Operation manuals with drawing, parts list (with part codes) circuit diagrams with list ratings of components and list of do's and don'ts for the main equipment as well as the subsystems
- Maintenance manuals

## 7. STANDARDS

The goods supplied and works executed shall confirm to the standards mentioned in the technical specification and where no applicable standard is mentioned, the latest version of Indian Standard Institution or Bureau of Indian Specification shall be applicable.

## 8. PERFORMANCE GUARANTEE

The Solar PV system shall be guaranteed for material, workmanship and satisfactory performance at site, online for a minimum period of Twelve (12) months from the date of commissioning.

## 9. TECHNICAL SPECIFICATIONS

| S. NO | DESCRIPTION | SPECIFICATIONS |
|---|---|---|
| **A.** | **Solar PV array capacity** | **15 kWp** |
| 1. | Type of PV module | Poly Crystalline |
| 2. | No. of modules | 75 |
| 3. | Module rating | 200 Watts |
| 4. | Module efficiency | ≥14% |
| 5. | Open circuit voltage | 44.78 V |
| 6. | Short circuit current | 5.78 A |
| 7. | Vmax | 37.67 V |
| 8. | Imax | 5.31 A |
| 9. | No. of cells | 72 |
| 10. | Module dimensions | 1323 mm ×982 mm × 36 mm |
| **B.** | **Battery bank** | **Battery backup for 1 hour** |
| 1. | Battery rating | 24 V, 150 Ah |
| 2. | Type of battery | Lead acid tubular battery |
| 3. | No. of batteries | ** |
| **C.** | **Power conditioning unit** | **Minimum 18.75 kVA Nominal output** |
| 1. | Inverter output voltage | 3 phase 415 Volts |
| 2. | Inverter output frequency | 50 Hz |
| 3. | Inverter efficiency | >80% |
| 4. | Waveform | Pure sine wave |
| **D** | **Cables** | Cables running between solar panels and array junction box should be 4 Sq mm copper flexible. Power cables of adequate voltage and current insulation rating shall be used. Cable trays shall be provided as per requirement. |
| **E** | **Junction Box/Combiners** | Dust and water proof junction boxes of |

| | | |
|---|---|---|
| | | adequate rating and adequate terminal facility made of fire resistant plastic (FRP) shall be provided. |
| **F** | **Module Mounting structure** | Modules shall be mounted on a non-corrosive support structures towards due south and at a suitable inclination to maximize annual energy output. Suitable grouting shall be provided for installing over the ground. |
| **G** | **DC distribution board (DCDB)** | It shall be provided in between PCU and Solar Array. |
| **H** | **AC distribution board (ACDB)** | It shall control the AC power from PCU, and should have necessary surge arrestors |

** - Bidder to specify in their offer

**Note:** *All the technical parameters are indicative value, Bidder has to design and specify in their offer*.

All the components must conform to the latest edition of IEC/ Equivalent BIS Standards/ MNRE specifications as specified below:

- The PV modules must confirm IEC / BIS equivalent IS Standards IEC 61215 / IS14286
- PCUs must comply with IEC 61683/IS61683 or equivalent BIS standards
- Batteries as per relevant BIS standards
- Cables IEC 60227 / IS 694
- Junction boxes, charge controllers IP 54(for outdoor)

## 10. EXPERIENCE OF THE BIDDER

MNRE approved or TEDA Approved manufacturer/supplier/system integrator with at least 2 years of experience in Solar Photovoltaic (PV) field.

## 11. TECHNICAL DATA-SHEETS – BIDDER TO FILL

** - Bidder to specify in their offer

| S. NO | DESCRIPTION | SPECIFICATIONS |
|---|---|---|
| **A.** | **Solar PV array capacity** | **15 kWp** |
| 1. | Type of PV module | ** |
| 2. | No. of modules | ** |
| 3. | Module rating | ** |
| 4. | Module efficiency | ** |
| 5. | Open circuit voltage | ** |
| 6. | Short circuit current | ** |
| 7. | Vmax | ** |
| 8. | Imax | ** |
| 9. | No. of cells | ** |
| 10. | Module dimensions | ** |
| **B.** | **Battery bank** | **Battery backup for minutes** |
| 1. | Battery rating | ** |
| 2. | Type of battery | ** |
| 3. | No. of batteries | ** |
| **C.** | **Power conditioning unit** | **Minimum 18.75 kVA Nominal output** |
| 1. | Inverter output voltage | 415 V |
| 2. | Inverter output frequency | 50 HZ |
| 3. | Inverter efficiency | ** |
| 4. | Waveform | ** |
| **D** | **Cables** | ** |
| **E** | **Junction Box/Combiners** | ** |
| **F** | **Module Mounting structure** | ** |
| **G** | **DC distribution board (DCDB)** | ** |
| **H** | **AC distribution board (ACDB)** | ** |

# D. SEA WATER INTAKE AND DRAIN SYSTEM, DISTILLATE RE-MINERALIZATION UNIT & INTEGRATION OF PLANT SUBSYSTEMS

## 1. SCOPE OF WORK

The Scope of Work includes

- Design, Engineering, Supply, Construction, Erection & Commissioning of sea water intake and drain systems, distillate re-mineralization unit at Vivekananda Kendra, Kanyakumari district of Tamil Nadu.
- Construction of new bore well / open well / utilizing existing well at the site for continuous supply of 27 TPH of sea water .
- Integration of various components of the plant with necessary piping and instruments.
- Submission of training and maintenance documents.
- Submission of all details of the installed systems like component details and manuals, test reports, etc.

## 2. SCOPE OF SUPPLY

Scope of supply includes supply of Sea water pump, Brine pump, Distillate pump, Re-mineralization plant, Distillate storage tank, Sea water intake and drain sub system, piping and instruments as per the technical specifications and applicable standards given in the subsequent section.

## 3. OVERALL PROCESS PARAMETERS

| S. NO | OVERALL DESIGN PARAMETERS | UNIT | DATA |
|---|---|---|---|
| 1 | Plant Capacity / Production | $m^3$/day | 10 |
| 2 | Operating Hours / Day | hrs. | 8 |
| 3 | Gain Output Ratio (GOR) | | 3.5 (min) |

| | | | |
|---|---|---|---|
| 4 | No. Effects (Minimum) | nos. | 4 |
| 5 | Fist effect temperature | ˚C | 55.4 |
| 6 | Last effect temperature | ˚C | 46.7 |
| 7 | Sea water flow rate to Condenser | kg/h | 27,000 |
| 8 | Sea water inlet temperature | ˚C | 25 to 30 |
| 9 | Feed Seawater spray flow rate in each effect | kg/h | 6,800 |
| 10 | Feed sea water temperature | ˚C | 32 |
| 11 | Product Salinity (TDS) | ppm | 5 |
| 12 | Sea water Salinity | ppm | 33,000 – 35,000 |
| 13 | Brine Discharge Flow Rate | kg/h | 1800 |

## 4. INSPECTION / TESTING / ACCEPTANCE TESTS

I. IIT reserves the right to inspect, or to have their authorized representative inspect the project at any time during their construction, erection and commissioning to ensure their compliance with the specification.

II. The necessary tapping to be provided on piping and tanks for fixing gauges (Pressure, Temperature and Flow).

## 5. DRAWINGS & DOCUMENTS

The following set of documents shall be supplied along with the equipments:

- Bought out items Data Sheets and Test certificates
- Raw material test certificate for metallic components
- As- built drawings
- Handling procedures

## 6. STANDARDS

The goods supplied and works executed shall confirm to the standards mentioned in the technical specification.

## 7. PERFORMANCE GUARANTEE

The system shall be guaranteed for material, workmanship and satisfactory performance at site, online for a minimum period of Twelve (12) months from the date of commissioning.

## 8. TECHNICAL SPECIFICATIONS

| S. NO | DESCRIPTION | SPECIFICATIONS |
|---|---|---|
| **A.** | **SEA WATER INTAKE SYSTEM** | |
| 1. | Construction of new bore well / open well or utilizing existing well at the site for continuous supply of 27 TPH of sea water at 25 - 30 deg C. | |
| 2. | Seawater pump | 1 no. * |
| 3. | Water pretreatment | Multimedia filter and Pre-chlorination system |
| **B.** | **SEA WATER DRAIN SYSTEM** | |
| 1. | The Brine reject of 1.8 TPH shall be pumped by brine pump to the disposal point embedded in the sea shore. From there the reject brine will be dispersed in to the sea water. | |
| 2. | Brine Pump | 1 no. * |
| **C.** | **DISTILLATE RE-MINERALIZATION UNIT** | |
| 1. | Distillate storage tank capacity | 20000 Litres (minimum) |
| 2. | Material of construction | Fiberglass Reinforced Plastics (Food grade) |
| 3. | Distillate Pump | 1 no. * |
| 4. | Soda Ash for pH Dosing System | As per requirement |
| 5. | Dosing pumps | As per requirement |
| **D.** | **Piping** | As per requirement |
| **E** | **Civil works** | As per requirement |

* - Detailed specification of the pumps is given in the table PUMP SPECIFICATIONS
** - Bidder to specify in their offer

**Note:** *All the technical parameters are indicative value, Bidder has to design and specify in their offer*.

**PUMP SPECIFICATIONS**

| S.No | DESCRIPTION | SEA WATER PUMP | BRINE PUMP | DISTILLATE PUMP |
|---|---|---|---|---|
| **1** | **GENERAL** | | | |
| | MAKE | Grundfos / Equivalent | Grundfos / Equivalent | Grundfos / Equivalent |
| | TYPE | Centrifugal | Centrifugal | Centrifugal |
| | DUTY (%) | 110 | 110 | 110 |
| | SUCTION PRESSURE [bar(a)] | 0.40 | 0.30 | 0.30 |
| | DISCHARGE PRESSURE [bar(a)] | 2.5 | 3 | 3 |
| **2** | **PROCESS PARAMETERS** | | | |
| | FLUID | Sea water | Sea water | Distilled water |
| | FLOW ($m^3$/h) | 27 | 5.5 | 1.6 |
| | TEMPERATURE (˚C) | 30-35 | 44-46 | 43 |
| **3** | **MATERIAL OF CONSTRUCTION** | | | |
| | CASING | SS 316L | SS 316L | SS 316L |
| | IMPELLER | SS 316L | SS 316L | SS 316L |
| **4** | **MOTOR** | | | |
| | RATED POWER (kW) | 4 | 1.1 | 0.55 |
| | DUTY (%) | 110 | 110 | 110 |
| | VARIABLE FREQUENCY DRIVE | ABB/Equivalent | ABB/Equivalent | ABB/Equivalent |

## 9. EXPERIENCE OF THE BIDDER

The bidder should have minimum 3 years experience in the field and must have designed / engineered, manufactured / erected and commissioned conveyance pipelines and construction of water treatment plants of minimum capacity 15$m^{3/}$day

## 10. TECHNICAL DATA-SHEETS – BIDDER TO FILL

| S. NO | DESCRIPTION | SPECIFICATIONS |
|---|---|---|
| **A.** | **SEA WATER INTAKE SYSTEM** | |
| 1. | ** | |
| 2. | Seawater pump | ** |
| 3. | Water pretreatment | ** |
| **B.** | **SEA WATER DRAIN SYSTEM** | |
| 1. | The Brine reject of 1.8 TPH shall be collected in a tank of suitable capacity that is embedded near the disposal point in the sea shore. The reject water will be pumped to this tank for percolation in to the sea water. | |
| 2. | Brine Pump | ** |
| 3. | Brine reject storage tank | ** |
| **C.** | **DISTILLATE RE-MINERALIZATION UNIT** | |
| 1. | Distillate storage tank capacity and quantity | ** |
| 2. | Material of construction | ** |
| 3. | Distillate Pump | ** |
| 4. | Soda Ash for pH Dosing System | ** |
| 5. | Dosing pumps | ** |
| **D.** | **Piping** | ** |
| **E** | **Civil works** | |

** - Bidder to specify in their offer

| S.No | DESCRIPTION | SEA WATER PUMP | BRINE PUMP | DISTILLATE PUMP |
|---|---|---|---|---|
| **1** | **GENERAL** | | | |
| | MAKE | ** | ** | ** |
| | TYPE | Centrifugal | Centrifugal | Centrifugal |
| | DUTY (%) | 110 | 110 | 110 |
| | SUCTION PRESSURE [bar(a)] | ** | ** | ** |
| | DISCHARGE PRESSURE [bar(a)] | ** | ** | ** |
| **2** | **PROCESS PARAMETERS** | | | |
| | FLUID | Sea water | Sea water | Distilled water |
| | FLOW (CuM/h) | 27 | 5.5 | 1.6 |
| | TEMPERATURE (˚C) | 30-35 | 44-46 | 43 |
| **3** | **MATERIAL OF CONSTRUCTION** | | | |
| | CASING | SS 316L | SS 316L | SS 316L |
| | IMPELLER | SS 316L | SS 316L | SS 316L |
| **4** | **MOTOR** | | | |
| | RATED POWER (kW) | ** | ** | ** |
| | DUTY (%) | ** | ** | ** |
| | VARIABLE FREQUENCY DRIVE | ** | ** | ** |

** - Bidder to specify in their offer