

**GOVERNMENT OF INDIA
MINISTRY OF RAILWAYS**



सत्यमेव जयते

**SPECIFICATION FOR
SOLAR BASED WATER HEATING SYSTEM**

Specification No. RDSO/PE/SPEC/PS/0094-2008 (Rev. 0), Amdt. 1

ISSUED BY

**ELECTRICAL ENERGY MANAGEMENT DIRECTORATE
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S N	Amendment		Revision		Reason
	No.	Date	No.	Date	
1.	1	15.10.2010	-	-	Clause Nos. 9.0 (Eligibility Criteria for Bidding), 12.0 (After Sales Service) and 13.0 (Guarantee/Warranty) deleted as per Railway Board's letter No. 2006/Elect.(G)/150/9/Pt. dated 10.09.2010

Approved by

Asht
25.10.2010

Executive Director / EEM

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I N D E X

S. No.	Description	Page No.
1.	FORWARD	3
2.	SCOPE	3
3.	REFERENCE STANDARDS	3
4.	SYSTEM DESCRIPTION	3
5.	GENERAL REQUIREMENT	4
6.	TECHNICAL REQUIREMENT	5
7.	TESTING	7
8.	INSTALLATION & COMMISSIONING	8
9.	ELIGIBILITY CRITERIA (Deleted)	9
10.	OPERATING & MAINTENANCE MANUAL	9
11.	FIELD TRAINING	9
12.	AFTER SALES SERVICE (Deleted)	9
13.	GUARANTEE/WARRANTY (Deleted)	9
14.	ANNEXURE 'A'	10
15.	ANNEXURE 'B'	12

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SPECIFICATION FOR SOLAR BASED WATER HEATING SYSTEM

1.0 FORWARD

Energy conservation can be achieved through promoting use of solar water heating system in place of conventional methods of water heating. With this objective, it has been decided to install solar based water heating system at all railway stations, rest houses, running rooms, hospitals, base-kitchens & other railway premises. It does not create pollution or harmful emissions and hence environment friendly. It is also economical in long run.

2.0 SCOPE

This specification covers the general and technical requirements for design, manufacture, supply, installation & commissioning of the solar based water heating system to be provided at the above railway premises.

3.0 REFERENCE STANDARDS

IS:12933 : Part 1-2003	Solar flat plate collector – Specification Part 1: Requirements
IS:12933 : Part 2-2003	Solar flat plate collector – Specification Part 2 Components.
IS:1570-Part5 –1985 (Reaffirmed 1998)	Schedules for Wrought Steels-Part 5 :Stainless & heat Resisting Steel.
IS: 12934-1990	Solar energy – Thermal applications - Vocabulary
IS:1239 : 1990 Part 2 (Reaffirmed 2002)	Mild steel Tubulars & other wrought steel pipe fittings.

Note: Latest version of the specification shall be referred to.

4.0 SYSTEM DESCRIPTION:

Solar water heating system shall comprise of the following:

- solar flat plate collector
- collector stand assembly/collector array support
- stainless steel insulated hot water storage tank
- Heat transfer medium (.e. Water)
- Inter connecting plumbing
- an auxiliary heater

The Solar Water Heating System (SWHS) shall operate on the principle of “Effective Theromsyphon”. The storage tank shall be positioned higher than the collector panel & no auxiliary energy shall be required to circulate water

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through it. Circulation will occur through natural convection or thermosyphoning.

The collector will intercept the sun rays, converting into heat which shall be used to heat up the water in the collector. Due to decrease in density, the heated water will rise up the collector, through a pipe & into the top of the storage tank. This will force cooler water at the bottom of the tank out another pipe leading to the bottom of the collector. This water after heating will again rise up into the tank. As long as sun shines, the water will quietly circulate, making the insulated storage tank full with hot water. An auxiliary/back up heating system shall be provided to take care of hot water requirement during cloudy or rainy days.

5.0 GENERAL REQUIREMENTS

- 5.1 The solar water heating system shall be safe, reliable & require no operator intervention for normal operation.
- 5.2 Heating system shall be designed and installed in accordance with relevant safety regulation.
- 5.3 The system shall be suitable for inlet water with chlorine & fluorine contents upto 100 ppm.
- 5.4 The system shall not require frequent internal cleaning
- 5.5 The system shall withstand & operate under lowest-record-low & highest-record-high temperature for the location.
- 5.6 The tank shall be close to the collector so as to minimize the length of piping & joints & bends are kept smooth & to a minimum.
- 5.7 The piping from the collector to the storage tank shall be well insulated in order to reduce thermal losses & shall present minimal interference with circulation.
- 5.8 Flat plate collector shall be long lasting, easy to disassemble without cutting or unsolder.
- 5.9 Valves provided in the system shall be compatible with the piping.
- 5.10 In coastal areas where hurricane force winds are possible extra care shall be observed while mounting the collectors on the roof of the premises.
- 5.11 Glazing shall be self-cleaning. Dirt accumulation on the glass cover will be washed away by the rain.

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- 5.12 Glazing shall be chemically inert to most chemical solvents and resistant to surface weathering, ultra violet and thermal degradation and moisture damage.
- 5.13 Neoprene or EPDM washers shall be used at dissimilar metal joints.
- 5.14 All service and repair shall be readily available from the manufacturer or distributor.

6.0 TECHNICAL REQUIREMENT

- 6.1 The Solar Water Heating System (SWHS) shall be "passive" working on thermo syphon action.
- 6.2 WHS shall be completely automatic and shall be left in operation year round.
- 6.3 System capacity shall be 500/1000 LPD or multiple of it depending upon the load requirement at site.
- 6.4 The equipment shall able to deliver hot water at 60°C for 24 hours a day.
- 6.5 Design shall be independent of ambient temperature and ideal even during winter.
- 6.6 When the solar system is providing full temperature water, the auxiliary shall remain OFF.
- 6.7 The design shall incorporate both freeze-protection and over heat protection (Freeze protection, however, may not be require, if climate is non-freezing)
- 6.8 The system shall practically require no maintenance and shall have a useful life of about 20 years.
- 6.9 Indicator shall be provided to indicate the temperature of hot water in the tank.

6.10 Storage Tank :

- 6.10.1 The storage tank shall be well insulated and large enough to hold about two days supply of hot water.
- 6.10.2 The hot water outlet to the user shall be from the top of the tank & the cold water refill shall be at the bottom.
- 6.10.3 The thickness of the water storage tank shall be uniform
- 6.10.4 The bottom of the storage tank shall be at least a foot higher than the top of the collector.

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- 6.10.5 Insulation of the tank shall be such that water can remain hot without significant drop in temperature for around 24 hours.
- 6.10.6 Other parameters and requirements are given **Annexure A & B**
- 6.11 Flat Plate Collector**
- 6.11.1 Flat plate collector shall be designed to maximize the absorption and retention of solar radiation.
- 6.11.2 Flat plate collector shall conform to IS: 12933
- 6.11.3 Flat plate collector shall be durable, low maintenance and last for 20 years or more.
- 6.11.4 The frame shall be of durable sea water resistant Aluminium frame.
- 6.11.5 Collector shall be designed to prevent condensate build-up.
- 6.11.6 The collector structure and performance shall not be degraded by moisture penetration. There shall be no cracking, warping or buckling of the cover plate.
- 6.11.7 Collector shall have corrosion resistant, extruded aluminium section with stainless steel fasteners.
- 6.11.8 Tempered glass with low iron content shall be used as outer cover sheet on collector because of its super resistance to environment.
- 6.11.9 The cover glazing shall be completely replaceable from the front of the collector without disturbing the piping or adjacent collectors. .
- 6.11.10 Collector array shall be oriented so that all collectors face the same direction.
- 6.11.11. The fin (absorber sheet) shall be made of material with high thermal conductivity.
- 6.11.12 Tube shall be thin walled and of a high thermal conductivity material.
- 6.11.13 The tube shall be brazed or welded to the absorber sheet to minimize thermal contact resistance.
- 6.11.14 The tube and the absorber sheet shall be of similar material to prevent galvanic corrosion between them.
- 6.11.15 Sealants and gaskets shall not corrode other collector materials.
- 6.11.16 Other parameters and requirements are given **Annexure A & B**.

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6.12 Supporting Structure for collector array.

- 6.12.1 The supporting structure shall be able to withstand the static weight of filled collectors and piping, wind, seismic and other anticipated loads without damage.
- 6.12.2 The supporting structure shall be able withstand wind speed upto 200 kmph.
- 6.12.3 Support structure shall allow access the all equipments for maintenance, repair and replacement.
- 6.12.4 Depending upon the system type, supports for solar array shall preferably terminate in ballast blocks to avoid roof penetrations.

6.13 Inter connecting plumbing.

- 6.13.1 The piping from the collector to storage tank shall be well insulated and shall present minimal interference with circulation. Joints and bends shall be kept smooth and to a minimum.
- 6.13.2 Other parameters and requirements are given **Annexure A & B**

6.14 The minimum general and technical requirements for solar water heating system setout in this specification are for general guidance only. The supplier/manufacturer shall submit the detail design of the complete SWHS, considering the specific location, insolation and nature of load etc.

7.0 TESTING :

Following tests shall be conducted on the fully assembled unit of solar collector as per IS: 12933 (Part 1): 2003

7.1 Type Tests :

- Outdoor No Flow Exposure Test – as per clause 7.2.1 of IS
- External Thermal Shock Test – as per clause 7.2.2 of IS
- Internal Thermal Shock Test – as per clause 7.2.3 of IS
- Rain Penetration Test – as per clause 7.2.4 of IS
- Impact Resistance Test – as per clause 7.2.5 of IS
- Thermal efficiency test – as per clause 7.2.6 of IS

7.2 Routine Test :

- Static pressure leakage test as per clause 7.1.1 of IS

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7.3 Test on Components :

- 7.3.1 Thermal shock test on Grommets and Gaskets – as per Clause 12.1.1 of IS 12933 Part 2 :2003 (type test)
- 7.3.2 Temperature test on absorber as per clause 9.1.4 of IS 12933 Part 2 2003 (type test)
- 7.3.3 Static pressure leakage test on 'Riser and Header' as per clause 9.2.1 of IS 12933 Part 2 :2003 (routine test)

Above tests shall be conducted at the works of the manufacturer. The test for which no facilities are available at the works, the same shall be carried out at Government Approved Laboratory and complete & satisfactory test report shall be submitted.

8.0 INSTALLATION & COMMISSIONING:

- 8.1 The installation shall be done by the supplier/manufacturer who is responsible for satisfactory performance of the Solar Water Heating System.
- 8.2 The collector, mounted on the roof, shall have proper exposure to sun throughout the day.
- 8.3 The solar collector array shall be installed at the proper tilt angle, orientation and the elevation above roof. This collector shall be installed with the ability to be removed for maintenance, repair or replacement.
- 8.4 Air vents, provided with threaded plugs or caps, shall be installed in high points of collector array piping.
- 8.5 Piping system shall be kept clean during installation by means of plugs or other approved methods
- 8.6 Any multiple pipe shall be installed in an order which does not require them to cross or interfere with each other or other building systems.
- 8.7 All control and sensor wiring shall be housed in conduit.
- 8.8 It is very important to identify all power lines in the working area. It shall be very dangerous to be handling collector near electrical lines.

9.0 **ELIGIBILITY CRITERIA FOR BIDDING:** Deleted

10.0 OPERATING & MAINTENANCE MANUAL:

- 10.1 The supplier shall supply two sets of O&M manual in English & Local Language to the consignee.

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10.2 O&M manual shall contain the details of step-by-step procedures required for system filling, start-up, operation and shutdown along with the condensed operating instructions explaining preventive maintenance procedures, method of checking the system for normal safe operation etc.

10.3 The manual shall also give the following details:-

- Routine maintenance procedures
- Possible breakdowns and repairs
- Recommended spare parts
- Trouble shooting guide containing causes for common failures such as dust ingress on glass cover, peeling of paint, scaling, damaged sealant, gaskets and grommets and their remedies.
- Piping and equipment layout
- Balanced fluid flow rates and
- Simplified wiring and control diagram of the system as installed.

11.0 FIELD TRAINING

11.1 Training shall be imparted to operating and maintenance staff after functionally completion of the system. The training shall include a discussion on system design and layout and demonstration on routine operation, maintenance and trouble shooting procedure.

11.2 Operating and Maintenance staff shall be trained what to do incase of any emergency with the solar water heating system.

12.0 **AFTER SALES SERVICE:** Deleted

13.0 **GUARANTEE / WARRANTY :** Deleted

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Annexure - A**1.1 DETAILS OF SYSTEM & SYSTEM COMPONENTS FOR 500 LPD SWHS**

System Capacity	500 LPD
System output temperature	60 deg.C
No. of Collectors	4 Nos for warm region (>5.0 Kw/sq.m. winter) and 5 Nos for cold region (<4.0 KW /sq.m. winter)
Tank Capacity	500 ltrs
Circulation	Thermosyphon

1.2 COLLECTOR SPECIFICATION: AS per IS - 12933

Type	Cu-Cu
Size	2080 mm x 1070 mm x 100 mm
Absorber area	2 Sq Mtrs
Weight	46 Kgs (Dry)
Absorber Coating	Selective - NALSUN
Absorptivity	> 0.95
Emissivity	< 0.2
Frame material	Extruded aluminium, 16 SWG
Insulation	Rock Wool
Glazing	Toughened Glass with 91%transmissivity
Grommet	EPDM
Glass beeding	EPDM
Hardware	Stainless Steel 304
Finish (Spray painting)	Golden Yellow - for frame Matt Black - for glass retaining angle

1.3 INSULATED HOT WATER TANK

Tank type	Cylindrical - Horizontal
Material	Stainless Steel - 304
Working Pressure	1.0 Kg/sq.cm
Insulation	PUF -40 mm thick.
Water proofing	Hessian cloth.
Cladding material	Pre-coated steel

1.4 SYSTEM INTERNAL PIPING

Material	EPDM Hose
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1.5 INSTRUMENT & CONTROLS

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1.5.1 Water Meter

Specification	IS: 779 & IS: 6784
Material	Brass
End connection	Screwed ends
Vane type	Metallic form designed
Purpose	Water usage measurement

1.5.2 Strainer

Type	"Y" TYPE
Material	Cast iron
Purpose	Filtration of suspended material

1.5.3 Temperature Gauge

Type	Dial Type, Mercury filled in SS stem
Range	0 to 150 deg.C.

1.5.4 Non Return Valve

Type	Horizontal
Material	Gun Metal
Specification	IS:778

1.5.5 Gate Valve

Type	Screwed Ends
Material	Gun Metal
Specification	IS: 778 :

1.5.6 Angle Wheel Valve

Type	'L' Type connection with 1/2" BSP 3/8" Bush.
Material	Gun Metal

1.6 Electrical Back up

Capacity	6 KW
Specification	As per IS: 4159

1.7 Anti scale device:

Type	online and maintenance free
Crystals	Ellestadite crystals

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Annexure – B**1.1 DETAILS OF SYSTEM & SYSTEM COMPONENTS FOR 1000 LPD SWHS**

System Capacity	1000 LPD
System output temperature	60 deg.C
No. of Collectors	8 Nos for warm region (>5.0 Kw/sq.m. winter) and 10 Nos for cold region (<4.0 KW /sq. m. winter)
Tank Capacity	1000 ltrs
Circulation	Thermosyphon

1.2 COLLECTOR SPECIFICATION AS PER IS12933:

Type	Cu-Cu
Size	2080 mm x 1070 mm x 100 mm
Absorber area	2 Sq Mtrs
Weight	46 Kgs (Dry)
Absorber Coating	Selective - NALSUN
Absorptivity	> 0.96
Emissivity	< 0.2
Frame material	Extruded aluminium, 16 SWG
Insulation	Rock Wool
Glazing	Toughened Glass textured with 91%transmissivity
Grommet	EPDM
Glass beeding	EPDM
Hardware	Stainless Steel 304
Finish (Spray painting)	Golden Yellow - for frame Matt Black - for glass retaining angle

1.3 INSULATED HOT WATER TANK

Tank type	Cylindrical - Vertical
Material	Stainless Steel - 304
Working Pressure	0.5 Kg/sq.cm
Design Pressure	1.0 Kg / Sq.cm.
Sheet thickness	16 swg.
Insulation	Rockwool - 48 kgs/cub.mtr.
Water proofing	Hessian cloth.
Thickness of insulation	100 mm
Cladding material	22 swg Aluminium

1.4 SYSTEM INTERNAL PIPING

Material	1" Class'B' GI as per IS 1239
Pipe fitting	Leader / ISI make
Valves	Gun metal
Insulation	Rockwool, 48kgs/cub.mtr. density
Thickness	50 mm
Cladding	26 swg Aluminium

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1.5 INSTRUMENT & CONTROLS

1.5.1 Water Meter

Specification	IS: 779 & IS: 6784
Material	Brass
End connection	Screwed ends
Vane type	Metallic form designed
Purpose	Water usage measurement

1.5.2 Strainer

Type	"Y" TYPE
Material	Cast iron
Purpose	Filtration of suspended material

1.5.3 Temperature Gauge

Type	Dial Type, Mercury filled in SS stem
Range	0 to 150 deg.C.

1.5.4 Non Return Valve

Type	Horizontal
Material	Gun Metal
Specification	IS: 778

1.5.5 Gate Valve

Type	Screwed Ends
Material	Gun Metal
Specification	IS: 778

1.6 Electrical Back up

Capacity	9 KW
Make	IS: 4159
Control panel	Indoor mounting type
Control switches	TPN MCB – 20 A
Cable	Finolex/ equivalent make
Thermostat (15A)	Conforming to IS: 3017

1.7 Anti scale device:

Type	online and maintenance free
Crystals	Ellestadite crystals

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