GOVERNMENT OF INDIA
MINISTRY OF RAILWAYS

सत्यमेव जयते

Technical Specification for

Manufacture & Supply of

Solar Cooker

Specification No. RDSO/2009/EM/SPEC/0003, Rev. '0' Amdt. 1

S N	Amendment		Revision		Reason
	No.	Date	No.	Date	
1.	1	20.10.2010	'0'	July 2009	Clause Nos. 11.00 (After Sales Service) and 12.0 (Guarantee/ Warranty) deleted as per Railway Board's letter No. 2006/Elect. (G)/150/9/Pt. dated 10.09.2010

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1.0 FORWARD:

Energy conservation can be achieved through promoting use of solar energy in place of conventional methods of cooking. With this objective, Indian Railway has decided to make use of solar cookers in railway institutes/training schools, rest houses, running rooms, base-kitchens & other railway premises. At present above premises on Indian Railways are using conventional methods for cooking of food. This not only increases the burden on the already fast depleting fossil fuels but also add to the ever increasing global warming. Solar cookers are intended to be used in Indian Railways with a view to save on LPG and electricity and in turn save on fast depleting fossil fuel and make positive contribution towards preventing global warming.

2.0 SCOPE:

This specification covers the general and technical requirements for design, manufacture, supply, installation & commissioning of the solar cookers to be provided at the above railway premises. Within the scope of this Standard a solar cooker shall be understood to include heat transfer and heat retention surfaces, heat storage and transfer media and associated controls, light transmitting and reflecting surfaces, and all associated adjustments, supports, and solar locating and tracking mechanisms as may be integral parts of a particular solar cooker.

3.0 REFERENCE STANDARDS:

Components and parts used in solar cooker should confirm to the Bureau of Indian Specification (BIS) wherever such specifications are available and applicable. Following IS standards, wherever applicable, may be used:

S. N.	Specification No.	Description
1.	IS 12933 (Part 1):2003	Solar flat plate collector – Specification, Part 1– Requirements.
2.	IS 12933 (Part 2):2003	Solar flat plate collector – Specification, Part 2 – Components.
3.	IS 12933 (Part 3):2003	Solar flat plate collector – Specification, Part 3–Measuring instruments.
4.	IS 12933 (Part 5):2003	Solar flat plate collector – Specification, Part 5 – Test methods.
5.	IS 13429 (Part 1):2000	Solar Cooker Box type - Specification, Part 1 – Requirements.

S. N.	Specification No.	Description
6.	IS 13429 (Part 2):2000	Solar cooker – Box type - Specification, Part 2 – Components
7.	IS 13429 (Part 3):2000	Solar cooker – Box type - Specification, Part 3 – Test methods.

4.0 SYSTEM DESCRIPTION:

In the typical operation of a solar cooker, solar radiation arrives at the cooker location, where it is often reflected off a reflecting surface and directed through a transparent cover where some radiation is absorbed and reflected away but most is transmitted through, where it is absorbed by a surface, which gets hot and transfers heat to the food. Simultaneously, heat is lost to the surrounding atmosphere. However, the heat loss may be minimized by thermal insulation. Many solar collector devices, including solar cookers, often have a transparent cover which transmits solar radiation into the device to become absorbed at a surface. The purpose of the cover is to lessen the heat loss from the cooker by enclosing hot air and preventing the escape of thermal radiation from inside the cooker, yet still allow a solar radiation input to the cooker. Not every cooker needs a cover, as for example a concentrator cooker could direct a sufficiently high flux directly to a pot without an intervening cover material.

There are a variety of types of solar cookers. In fact, there are over 65 major designs and hundreds of variations of them. The basic principles of all solar cookers are:

a) **Concentrating sunlight:** Some device, usually a mirror or some type of reflective metal, is used to concentrate light and heat from the sun into a small cooking area, making the energy more concentrated and therefore more potent.

b) **Converting light to heat**: Any black on the inside of a solar cooker, as well as certain materials for pots, will improve the effectiveness of turning light into heat. A black pan will absorb almost all of the sun's light and turn it into heat, substantially improving the effectiveness of the cooker. Also, the better a pan conducts heat, the faster the oven will work.

Alone, each of these strategies for heating something with the sun is fairly ineffective, but most solar cookers use these

strategies in combination to get temperatures sufficient for cooking.

Following types of solar cookers are relevant for use in Indian Railways in rest houses, institute hostels, running rooms, base kitchens etc.

i) Dish Type Solar Cooker:

Dish solar cooker is used for faster outdoor cooking. A dish cooker with reflector shape as round bowl or square or rectangular or double rectangular popularly known as butterfly cooker is designed for short focal length less than 500mm so that intermediate adjustment of focus is not required for cooking one meal. Reflecting surface is strips of anodized aluminum sheets of 0.3 to 0.4 mm thickness or glass mirror pieces of 2 to 3 mm thickness tied with SS wire or fitted with sealant to a rigid reflector frame. Normally focus is adjusted manually and a little focus indicator device is essentially fitted by manufacturer so that cooking person has not to watch at the focus to avoid glaring effect on eyes. This cooker is useful for large families or institutions where food is cooked for 10-15 persons every day.

ii Community Solar Cookers:

The community solar cooker is parabolic solar cooker with reflector surface from 2.5 sq mt. to 8 sq mt. useful for cooking for 20 persons to 100 persons. It consists of reflector shape as round bowl or square or rectangular or double rectangular and it is designed for short focal length less from 500mm to 800mm so that intermediate adjustment of focus is not required for cooking one meal. Reflecting surface is strips of anodized aluminum sheets of 0.3 to 0.4 mm thickness or glass mirror pieces of 2 to 3 mm thickness tied with SS wire or fitted with sealant to a rigid reflector frame. Normally focus is adjusted manually and a little focus indicator device is essentially fitted by manufacturer on both sides of reflector ends so that cooking person has not to watch at the focus to avoid glaring effect on eyes. As this cooker has no automatic sun tracking device, it is simpler, cheaper and easy to use by any layman. It is useful for small institute hostels and

small communities. For increasing the capacity multiple units of such cookers can be used.

5.0 GENERAL REQUIREMENTS

5.1 The solar cooker 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 cooking food for 10 to 100 persons, for which suitable type of solar cooker shall be offered as per requirements.

5.4 The system shall not require frequent internal cleaning

5.5 The collector shall be long lasting, easy to disassemble without cutting or unsolder.

5.6 In coastal areas where hurricane force winds are possible extra care shall be observed while mounting the collectors on the roof of the premises.

5.7 Glazing shall be self-cleaning. Dirt accumulation on the glass cover will be washed away by the rain.

5.8 Glazing shall be chemically inert to most chemical solvents and resistant to surface weathering, ultra violet and thermal degradation and moisture damage.

5.9 All service and repair shall be readily available from the manufacturer or distributor.

6.0 TECHNICAL REQUIREMENTS

The tenderer shall comply to the following requirement. Deviation to these requirements or alternative superior design may also be offered supported with technical reasons for review.

I) Reflecting Bowl :

a) Dish type Solar Cooker :

1. Dish made of single/multiple reflectors fixed firmly to a rigid frame. The size and the shape of the reflectors shall be suitably designed.

2. Dish diameter is 1.2m (minimum).

3. Reflector:
   i) Materials: Bright anodized aluminum sheets/glass mirrors or any other suitable material with positive layers of back surface to minimize the weathering effects.
   ii) Useful Life: 10 years Minimum:
   iii) Focal Length: 0.25m (minimum).
   iv) Focal Spot: It will be of size that all the reflected rays are exactly focused at the bottom of the vessel. For larger cookers it may proportionately be larger.

4. Suitable for cooking food for 10-15 persons.

b) Community type Solar Cooker :

1. Dish made of single/multiple reflectors fixed firmly to a rigid frame. The size and the shape of the reflectors shall be suitably designed.

2. Aperture area of primary reflector: Minimum 2.5 sq meter (may be more as per capacity)

3. Reflector:

i) Materials: Bright anodized aluminum sheets/glass mirrors or any other suitable material with positive layers of back surface to minimize the weathering effects.
ii) Useful Life: 10 years Minimum:
iii) Focal Length: 0.5m minimum.
iv) Focal Spot: It will be of size that all the reflected rays are exactly focused at the bottom of the vessel. For larger cookers it may proportionately be larger.

4. Suitable for cooking food for 20-100 persons.

II) Bowl Supporting Frame:

The supporting frame for the reflecting bowl will be made of MS ring supported by MS strip of FRP material thick MS wire mesh structure. It will be rigid enough to avoid any deformation of the bowl shape during manual handling or under wind pressure. The MS structure will have epoxy anti rust coating.

III) Bowl Stand:

a) Of mild steel epoxy/ powder coated.
b) With arrangement to hold cooing vessels of different sizes.
c) With suitable position for securing the cooker to the ground.

IV) Tracking Mechanism :

a) Manual or Automatic (DC motor run by a photovoltaic power panel).

b) Design to enable unrestricted 360 degree of dish around its horizontal axis passing through its focal point and the centre of gravity and also around its vertical axis for adjustment of the cooker in the direction of sun.

c) With simple locking arrangement to hold/fix the bowl at a particular position.

d) With pointer/other arrangements to facilitate users positioning of the bowl exactly in the direction of the sun.

V) Mounting Structure:

a) The Mounting Structure must have a provision for at least three times manual tracking in a day & also a provision for altering the angle of inclination with respect to the horizontal.

b) The supporting frame of the paraboloid dish shall be made either of MS rings supported by MS strips, FRP material, or thick MS wire mesh structure. The frame shall be rigid enough to resist any deformation of the dish shape due to wind pressure or manual handling. The MS structure will have epoxy/anti-rust coating.

c) The stand for the dish shall be made up of MS having epoxy/powder coating. The stand shall be equipped with an arrangement to hold the cooking pot firmly and also to secure itself to the ground to inhibit any undesired movement.

VI) Cooking Pot:

a) The cooking pot shall be a pressure cooker with ISI-mark. It needs to be coated at the bottom with a high temperature resistant black powder coating.

b) Pot-holder shall be of adequate strength to be able to hold the cooking pot with full load without any bending. It shall be made of mild steel with high temperature resistant coating to avoid degradation.

VII) Other Requirement:

a) The entire structure will be able to withstand wind speed of 60kmph without any damage.

b) All parts/components should be of weather resistant design specifications to withstand natural weathering outdoor under the climatic conditions, for a minimum period of 15 years. (Except for reflecting mirror, which may require replacement every 5 years).

c) The cooker will be supplied with accessories like cap, hand gloves, goggles, manual for its installation and proper use and tool kit for installation. The supplier will give one-year warranty of the cooker wherein he will provide free services for repair/replacement of parts.

7.0 TESTING :

The successful tenderer shall submit complete type test results to the purchaser. If the manufacturer does not have the test facilities, the tests can be conducted at any government recognized laboratory. The purchaser reserves the right to witness all or part of the type tests at his sole discretion. Regular supplies shall commence only after successful completion of the type tests. All the units shall be routine tested before supply. Routine tests shall comprise of tests at sl. nos. 1, 2, 4, 5, 6, 7 & 8.
The following type tests/measurements shall be carried out on the first solar cookers before supply.

7.1 Diameter of the dish:

It shall be measured at the aperture at two positions, which are about normal to each other. Average of two readings shall be reported for diameter of the dish.

7.2 Material of the reflector and its thickness:

The measurement for thickness of the reflector material shall be made at least at three positions, and average of these values shall be reported. In case, disruption/distortion of the dish is anticipated, the measurement may be made after completing thermal performance tests.

7.3 Reflectivity of the dish:

This measurement shall be done on a separate sample of the same material obtained from the manufacturer.

7.4 Focal length of the dish:

This is equal to the linear distance from centre of the pot-holder to the vertex of dish, presuming that the cooking pot is kept at the focus of the paraboloid.

7.5 Rim angle of the dish:

This is the angle subtended by the line joining a point on the aperture of the dish to the focal point with the axis of the paraboloid, measured with respect to focal plane.

7.6 Size of focal spot:

It shall be measured with solar cooker in normal incidence position.

7.7 Cooking Pot:

The following details regarding its physical measurements shall be measured/observed and recorded in the test report:

a) Material of construction
b) Height and inner/outer diameter
c) Capacity in litres
d) Bottom area
e) Total surface area (sides+top+bottom)
f) Mass (kg)
g) Coating on the outer bottom surface

7.8 Tracking Mechanism:

Tracking mechanism may be manual or automatic, allowing unrestricted rotation of the dish along its horizontal and vertical axes enabling its adjustment in the normal direction to the sun's rays. It shall be equipped with a locking arrangement to hold/fix itself at the desired position.

7.9 Thermal Performance Test:

Heating and cooling tests shall be conducted to evaluate characteristic performance parameters of the solar cooker. These parameters are :

a) Heat Loss Factor
b) Optical Efficiency Factor, and
c) Standardized Cooking Power

The values of each of these parameters shall be reported based on an arithmetic mean of at least five (5) test values which shall not have variation of more than ±5%.

The thermal performance tests shall be carried out under the following conditions:

i) Wind

Tests shall be conducted when wind is less than 1.0 m/s, measured at the elevation of the cooker being tested and within ten meters of it. Should wind exceed 2.5 m/s for more than ten minutes, discard that test data. If a wind shelter is required, 1) it shall be designed so as to not interfere with incoming total radiation and 2) the wind instrumentation shall be co-located with the cooker in the same wind shadow.

ii) Ambient temperature

Tests should be conducted when ambient temperatures are between 20 and 35 °C.

iii) Water temperature

Test data shall be recorded while cooking vessel contents (water) are at temperatures between 5 °C above ambient and 5 °C below local boiling temperature.

iv) Insolation

Available solar energy shall be measured in the plane perpendicular to direct beam radiation (the maximum reading) using a radiation pyranometer. Variation in measured insolation greater than 100 W/m2 during a ten-minute interval or readings below 450 W/m2 or above 1100 W/m2 during the test shall render the test invalid. For convenience, the pyranometer may be fixed on the cooker at the average beam radiation zenith angle as calculated for the entire test period.

v) Solar zenith and azimuth angle.

Tests should be conducted between 10:00 and 14:00 solar time. Exceptions necessitated by solar variability or ambient temperature shall be specially noted.

The tenderer shall submit complete test procedure for the above tests.

8.0 INSTALLATION & COMMISSIONING:

i) The installation shall be done by the supplier/ manufacturer who is responsible for satisfactory performance of the Solar cooker.

ii) The solar cooker shall have proper exposure to sun throughout the day.

iii) The solar cooker shall be installed at the proper tilt angle, orientation and the elevation. This collector shall be installed with the ability to be removed for maintenance, repair or replacement.

iv) All control and sensor wiring, if any, shall be housed in conduit.

9.0 OPERATING & MAINTENANCE MANUAL:

i) The supplier shall supply two sets of O&M manual in English & Local language to the consignee.

ii) O & M manual shall contain the details of step-by-step procedures required for 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.

iii) The manual shall also give the following details:-

a) Routine maintenance procedures
b) Possible breakdowns and repairs
c) Recommended spare parts
d) 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.

10.0 FIELD TRAINING

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 and safety precautions.

11.0 AFTER SALES SERVICE: Deleted

12.0 GUARANTEE/WARRANTY : Deleted

13.0 INFRINGEMENT OF PATENT RIGHTS:

Indian Railways shall not be responsible for infringement of patent rights arising due to similarity in design, manufacturing process, use of the components, used in design, development and manufacturing of solar cooker and any other factor which may cause such dispute. The responsibility to settle any issue lies with the Contractor.
