Schedule 23
Standards and Labelling of Solar Water Heaters

Date- 14th December 2019

1. SCOPE

This schedule specifies the energy labelling requirement for Solar Water Heaters (SWH) imported or sold in India for water heating and similar use. The schedule covers all types of thermosyphon based solar water heaters up to 500Liters storage capacity.

For this schedule, the star rating shall be based on the efficiency of the system averaged over the day-test period ($\overline{\eta_{sys}}$) as per '*IS 16368:2015 Test procedure for thermosyphon type domestic solar hot water heating systems'*.

This schedule does not apply to SWHs where:

- Concentrating collectors are used
- Heat transfer fluid changes phase
- Water temperature is ≥100°C
- Unglazed flat-plate collectors are used

2. NORMATIVE REFERENCES

This schedule shall be read in conjunction with the following standards with all amendments, for the purpose of star labelling

Number	Standard
1.	*IS 16368:2015 Test procedure for thermosyphon type domestic solar hot water heating systems*
2.	IS 12933 part-1:2003 Solar Flat Plate Collector- specifications; Part 1 Requirements
3.	IS 12933 part-2:2003 Solar Flat Plate Collector- specifications; Part 2 Components
4.	IS 12933 part-3:2003 Solar Flat Plate Collector- specifications; Part 3 Measuring Instruments
5.	IS 12933 part-5:2003 Solar Flat Plate Collector- specifications; Part 5 Test Methods
6.	IS 16544: 2015 All Glass Evacuated Solar Water Heating System
7.	IS 16543: 2016 All Glass Evacuated Solar Collector Tubes – Specification

3. TERMINOLOGY

For this schedule, the following definitions shall apply. However, in case of dispute, the definitions given in '*IS/ISO 9488:1999 Solar Energy- Vocabulary*' can be referred.

3.1. Solar Water Heater (SWH)

The system normally consisting of a collector and a container which may be integral, close coupled or remote, and which heats water by means of radiant energy from the sun. It is normal for solar water heaters to be either fitted with or connected to a supplementary heating source.

3.2. Solar Collector

A device designed to absorb solar radiation and to transfer the thermal energy so produced to a fluid passing through it.

3.2.1. Flat Plate Collector (FPC)

A non-concentrating solar collector in which the absorbing surface is essentially planar.

3.2.2. Evacuated Collector

A collector in which the space between the absorber and the cover is evacuated.

3.2.3. Evacuated Tube Collector (ETC)

Evacuated collector employing transparent tubing (usually glass) with an evacuated space between the tube wall and the absorber.

3.2.4. Concentrating Collector

The Solar Collector that uses reflectors, lenses or other optical elements to redirect and concentrate the solar radiation passing through an aperture onto an absorber.

3.3. Storage tank

The storage tank is a thermal store for the energy transferred from the collector. It is a container used for storing thermal energy. The heat transfer fluid and the accessories such as heat exchangers, flow switching devices, valves and baffles which are firmly fixed to the thermal storage container are considered part of the storage device.

4. TESTING GUIDELINES AND REQUIREMENTS

The schedule is only limited to thermosyphon based solar water heaters. Hence the testing methodology mentioned in 'IS 16368:2015 *Test procedure for thermosyphon type domestic solar hot water heating systems'* must be followed to determine the maximum efficiency of the system.

4.1. Standard Rating Conditions

Solar hot water systems must be tested for its thermal performance as per clause 7.0 of IS 16368:2015 Test procedure for thermosyphon type domestic solar hot water heating systems.

4.1.1. Test report

The results of the test shall be reported in the prescribed format as given in Annexure B of this schedule. Only BIS recognized lab/NABL/ILAC/APAC accredited lab test reports are acceptable.

4.2. Tolerance limit

There is no negative tolerance for star rating band; the system efficiency $\overline{\eta_{sys}}$ products tested must be at par or better than the star rating band threshold. The system efficiency of the SWH system will be rounded off to the nearest two decimal places as per IS 2:1960.

5. STAR RATING / LABELLING PLAN

Star rating will be given based on system efficiency $\overline{\eta_{sys}}$. Mathematically expressed in equation (1), (2), (3), (4) at standards test conditions mentioned in the clause 9.6.5 of IS16368:2015, reproduced in clause 5.1 below:

$$\begin{bmatrix} Rate\ of\ Change \\ in\ Energy \\ contents\ of\ water \\ in\ the\ storage\ tank \end{bmatrix} = \begin{bmatrix} Rate\ at\ which \\ useful\ energy \\ is\ supplied\ to \\ water\ in\ the \\ storage\ tank \\ by\ solar\ collector \end{bmatrix} - \begin{bmatrix} Rate\ at\ which \\ energy\ is\ lost \\ rom\ water\ in \\ the\ storage \\ tank\ to\ the \\ ambient\ air \end{bmatrix} \ldots (1)$$

$$(MC)_s \frac{dT_s}{dt} = A_a F' \left[G_T(\tau\alpha)_{eff} - U_L(T_s - T_a)\right] - (A_s U_s + A_P U_P)(T_s - T_a) \ldots (2)$$

$$(MC)_s \left(T_{sfd} - T_{sid}\right) = A_a F' \int_{t_{1d}}^{t_{2d}} G_T(\tau\alpha)_{eff} \cdot dt - \begin{pmatrix} A_a F' U_L + \\ A_s U_s + A_P U_P \end{pmatrix} \int_{t_{1d}}^{t_{2d}} (T_s - T_a) \cdot dt \ldots (3)$$

$$\overline{\eta_{sys}} = \overline{\eta_{sys.o}} - \overline{U_{sys,d}} \cdot \bar{X} \ldots (4)$$

Where,

$$\overline{\eta_{sys}} = \frac{(MC)_S \left(T_{sfd} - T_{sid}\right)}{A_c \int_{t_{1d}}^{t_{2d}} G_T \cdot dt}$$

$$\overline{\eta_{sys,o}} = \frac{A_a F' \int_{t_{1d}}^{t_{2d}} G_T(\tau\alpha)_{eff} \cdot dt}{A_c \int_{t_{1d}}^{t_{2d}} G_T \cdot dt}$$

$$\overline{U_{sys,d}} = \frac{A_a F' U_L + A_s U_s + A_P U_P}{A_c}$$

$$\bar{X} = \frac{\int_{t_{1d}}^{t_{2d}} (T_s - T_a) \cdot dt}{\int_{t_{1d}}^{t_{2d}} G_T \cdot dt}$$

where

A_c = Gross area of solar collector, in m^2

A_a= Absorber area of solar collector, in m^2

A_s= Outside surface area of the storage tank, in m^2

A_P= Total outside area of connecting pipes, in m^2

F' = Collector efficiency factor

G_T = Solar irradiance on the inclined plane of the solar collector, in W/m^2

$(MC)_S$= Thermal capacitance of the water in the storage tank only, in J/K

t = time, in s

T_S= Temperature of water in storage tank, in ^{o}C

T_a = Ambient air temperature, in ^{o}C

T_{Sfd}= Final storage tank water temperature at the end of the day-test, in ^{o}C

T_{Sid}= = Initial storage tank water temperature at the start of the day-test, in ^{o}C

$\overline{U_{sys,d}}$= Average overall heat loss coefficient of the system during day-test, in W/m^{2}K

U_L= Overall heat loss coefficient of solar collector, in W/m^{2}K

U_P= Overall heat loss coefficient of piping, in W/m^{2}K

U_S= Overall heat loss coefficient of the storage tank, in W/m^{2}K

$\overline{\eta_{sys,o}}$= Maximum efficiency of the system averaged over the day-test period

$\overline{\eta_{sys}}$= Efficiency of the solar hot water system averaged over the day-test period

$(\tau\alpha)_{eff}$= Effective transmittance-absorptance product of the solar collector for solar radiation

5.1. Standards test conditions as mentioned in the clause 9.6.5 of IS16368:2015 is as reproduced below:

i. Average storage temperature = 50 ^{o}C
ii. Average ambient air temperature during test period = 25 ^{o}C
iii. Average of total solar radiation incident on the plane of solar collector = 700 W/m^2

The star rating levels are given in Table 1.

5.2. Qualification criteria for star labelling:

In an FPC based SWH, the collector must meet all the requirements as per *'IS 12933 part-1:2003, Solar Flat Plate Collector- specifications*'. Similarly, for ETC based SWH, the system must meet all the requirements as per 'IS 16544: 2015 All Glass *Evacuated Solar Water Heating system'*.

In addition, the hot water storage tanks in FPC based SWH system must comply with MNRE's '*Minimum Technical Requirements laid down for ensuring quality aspects of Solar Water Heating Systems being installed in field*' released on 24.08.2012. The specifications are mentioned in Appendix A.

Table 1 Star Labelling scheme for Solar Water Heaters (from 14th Dec. 2019 to 31st Dec. 2021)

Star level	**System Efficiency (%$\overline{\eta_{sys}}$)**	
	Minimum	Maximum
1 Star	40.00	45.00
2 Star	>45.00	50.00
3 Star	>50.00	55.00

4 Star	>55.00	65.00
5 Star	>65.00	

6. CHECK TESTING

BEE registered Solar Water Heater samples would be picked up at random from the market and tested at a BEE empanelled Lab. If the first sample fails, then a second check testing would be carried out. Under second check testing, two similar SWH system with same rated efficiency would be picked up again from the market randomly and both samples would have to meet the declared system efficiency. Even if one sample fails to meet the declared system efficiency during second check testing, the SWH will be treated as being in non-compliance with the prescribed BEE standards.

7. FEES

With regards to the S&L scheme for Solar Water Heaters, the manufacturer has to first register his company under BEE scheme by making one-time payment of Rs. 25,000/- for MSME and Rs.1,00,000/- for rest of the manufacturers. **This amount is refundable.**

7.1. The application for registration should be submitted with all applicable pre-requisite certificate and a test report from a BIS recognized, NABL accredited or ILAC/APLAC/APAC signatories test labs recognized by BIS.

7.2. The application fees for each model is Rs. 2,000/-(Rupees two thousand only) and fees for renewal/degradation for each model will be Rs.1,000/- (Rupees One thousand only).

7.3. Labelling fee for affixation of the label on each unit of SWH is INR 0.02 per LPD /- (2 paise per Liters Per Day only)- shall be charged by BEE.

7.4. However, the Labelling fees for 5 star rated models would be waived off (for voluntary phase only) to promote higher efficiency SWH.

7.5. The label validity period would be effective from the date of launch till 31st December 2021.

8. LABEL DESIGN AND MANNER OF DISPLAY

8.1. **Placement:** All SWH must display the label on the storage tank.

8.2. **Material, Dimension, and Shape:** The label shall be of durable material and be printed as per the size given below.

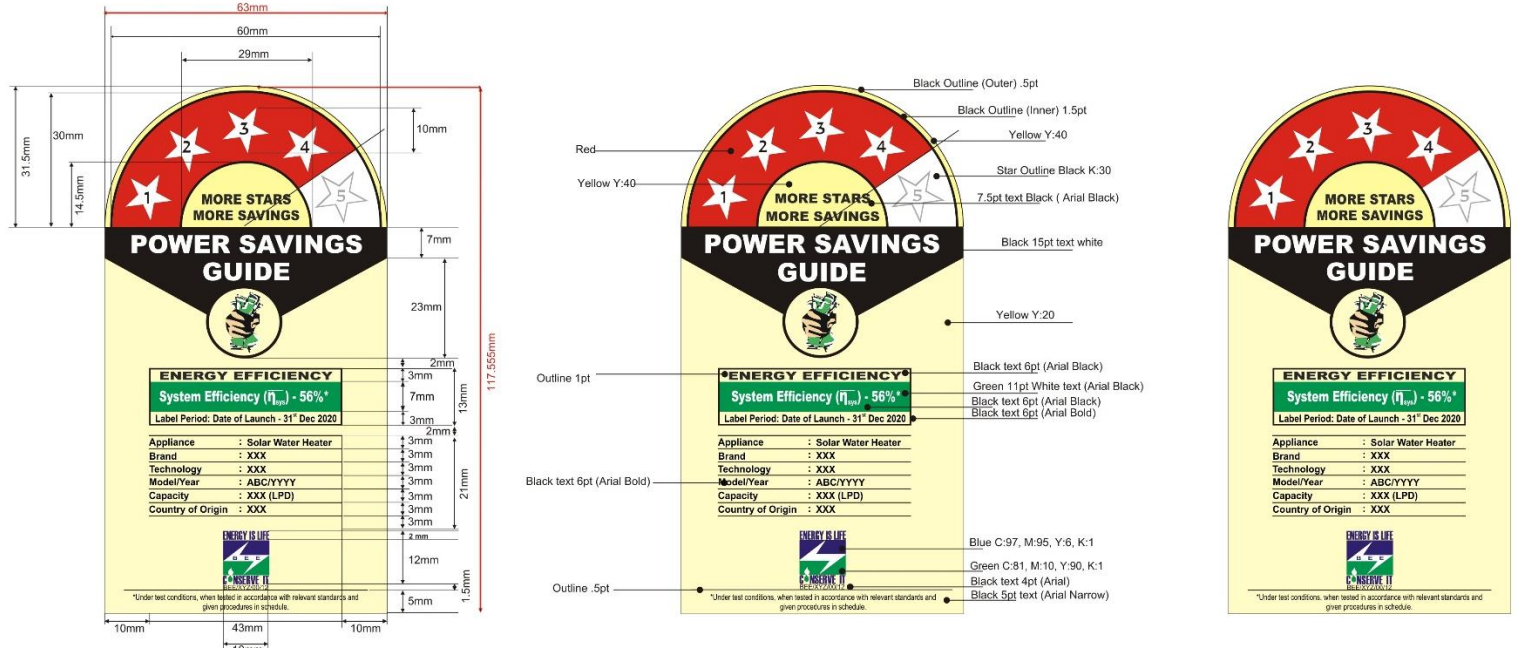

Figure 1 Label for SWH system

APPENDIX -A

Table 2 Minimum Technical Requirements laid down for ensuring quality aspects of Solar Water Heating Systems being installed in field (MNRE)

Components of Storage Tank	**Specification as mentioned by MNRE**
Inner tank material	SS 304 or 316 grade min/ MS or any other material with anticorrosive coating for hard water with chlorine contents.
Inner tank thickness	For SS minimum thickness will be 0.5 mm when using argon arc or metal inert gas for welding & 0.8 mm when using other type of welding. For MS it will be 1.5 mm. No leakage under any kind of negative or positive pressure of water will be ensured.
Inner tank welding	TIG / Seam/ pressurized weld (Open arc weld not permitted)
Storage tank capacity	Not less than system capacity. In case of ETC based system, volume of tubes & manifold not to be included in tank capacity.
Thermal insulation of storage tanks	Minimum 50 mm thick CFC free PUF having density of 28-32 kg/ cu.m for domestic systems and 100mm thick Rockwool of 48 kg per cu. m for other systems. For colder regions, it will be 1 ½ times at least. In case of higher density insulations, the thickness may reduce proportionately.
Thermal insulation of hot water pipes	Minimum 50 mm thick rockwool or 25 mm thick PUF on GI pipes. For colder regions, it will be 1 ½ times at least. In case of composite pipes, it will depend on region to region. For higher density insulations, the thickness may reduce proportionately
Out cladding and frames	Al/ FRP or GI powder coated. MS may also be used with special anti-corrosive protective coatings. Thickness of sheets will be strong enough to avoid any deformation of the cladding.
Valves, cold water tank, vent pipe, heat exchanger, make up tank & instruments	Of ISI mark or standard make
Support structure for collectors, piping tanks etc.	Of non-corrosive material or have corrosion resistant protective coating. They will be strong enough to sustain their pressure during the lifetime of system.

APPENDIX-B

Table 3 General Information and specifications to be reported

Manufacturer/Laboratory name	Values
Address	
Date of receipt	
Test report No.	
Tested by	
Date of testing	
Reviewed by	
System efficiency $(\%\overline{\eta_{sys}})$	
$F_R(\tau\alpha)$ (for flat plate collector)	
$F_R U_L$ (for flat plate collector)	
U_{LT} (for evacuated tube collectors)	
Absorptivity of selective coating (for evacuated tube collectors)	
Emissivity of Selective Coating (for evacuated tube collectors)	

Table 4 Compliance metric for storage tank (only for FPC)

Components of Storage Tank	Specification of the material used in the system.	Is the material/component meeting the MNRE specifications? (Yes or No) stated in Annex-A
1. Inner tank material		
2. Inner tank thickness		
3. Inner tank welding		
4. Storage tank capacity		
5. Thermal insulation of storage tanks		
6. Thermal insulation of hot water pipes		
7. Out cladding and frames		
8. Valves, cold water tank, vent pipe, heat exchanger, make up tank & instruments		
9. Support structure for collectors, piping tanks etc.		

In addition to the above-mentioned information, all the specifications of the product and results of testing must be reported as per the Annex D of '*IS* 16368*:2015 test procedure for thermosyphon type domestic solar water heating systems*.'