

# Material and Component Specifications Single Axis Tracked Parabolic Trough



Prepared by  
IT Power India

Under UNDP-GEF market development &  
promotion of solar concentrator based process  
heat application in India  
Ministry of New and Renewable Energy  
Government of India  
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# Preface

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This booklet outlines the material and component specifications of a Single Axis Tracked Parabolic Trough for process heat applications. The purpose of this booklet is to lay out the material and component specifications of key components of a Parabolic Trough system to serve as a reference document so as to maintain quality in the field by the manufacturers supplying and installing the system.

The booklet is intended to serve as a guide for stakeholders interested in Concentrated Solar Thermal (CST) system based on this technology for applications in process heat for industry and help them set up a durable system which meets the necessary safety and quality standards. It is one of a series of such booklets produced to cover the field of commercially available CST systems marketed for process heat applications in India.

The specifications for key components and subcomponents of the Parabolic Trough system and their relevant parameters are outlined in an easy to understand tabular format. Wherever applicable, images of the components and schematic diagrams have also been presented for easy identification of the components.

The booklet has been compiled with technical inputs from the developers and manufacturers of this technology. Inputs and suggestions of experts in the domain of concentrated solar thermal systems and users have also been taken in the compilation of this booklet.

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# Background

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India has a very good potential for solar energy, with average solar irradiation being around 4-7 kWh/m<sup>2</sup>/day. This abundant solar radiation can be used to meet the demand of low to medium process heat required by various industries and institutions. Concentration of solar radiation so as to produce temperature in the range of 100 to 450°C or more is called concentrated solar thermal (CST) technology. This technology offers sizable potential across the diverse range of industries and commercial establishments in India.

There are six CST technologies commercial available in India, namely,

- Fixed focus automatically tracked elliptical dish (Scheffler)
- Dual axis tracked paraboloid dish
- Fresnel reflector based dish (ARUN dish)
- Single axis tracked parabolic trough concentrator
- Non-imaging concentrators
- Linear Fresnel reflector

## **About the Parabolic Trough Technology**

Parabolic trough concentrator (PTC) comprises of a cylindrical concentrator, of parabolic cross-sectional shape, and a circular cylindrical receiver located along the focal line of the parabola. It reflects direct solar radiation onto a receiver tube located in the focal line of the parabola. Since the collector aperture area is bigger than the outer surface of the receiver tube, the direct solar radiation is thus concentrated.

### ***Underlying principle***

*The parabolic trough concentrator (PTC) converts solar beam radiation into thermal energy in its linear focus receiver. The focal line, onto which the beam radiation is reflected, is comprised of all focal points at each cross-sectional location of the concentrator. The receiver tube is selectively coated to increase its absorptivity. It is generally encased within a glass tube to reduce any convective heat losses. The trough assembly tracks the sun in a single axis so as to always keep the trough aperture towards the sun. The trough is generally mounted with its focal axis parallel towards either east- west direction or north-south direction.*

### ***Key components of Parabolic Trough***

Key components of Parabolic Trough based system can be classified on the basis of their individual functions:

#### **PARABOLIC TROUGH**

- Collector
- Receiver
- Trough stand
- Tracking System

#### **BALANCE OF SYSTEM**

- Piping
- Instrumentation and Safety Mechanism
- Storage System (optional)

### ***Key design variants***

Parabolic Trough is currently available in five different designs, as given below  
[In Bracket: Aperture Area]



*Large Aperture Parabolic Trough  
SharperSun (29.22m<sup>2</sup>) by Leveragenet*



*Optitrough300 (28.75m<sup>2</sup>) by Ultra  
Conserve*



*SolPac P60 (6.41m<sup>2</sup>) by Thermax*



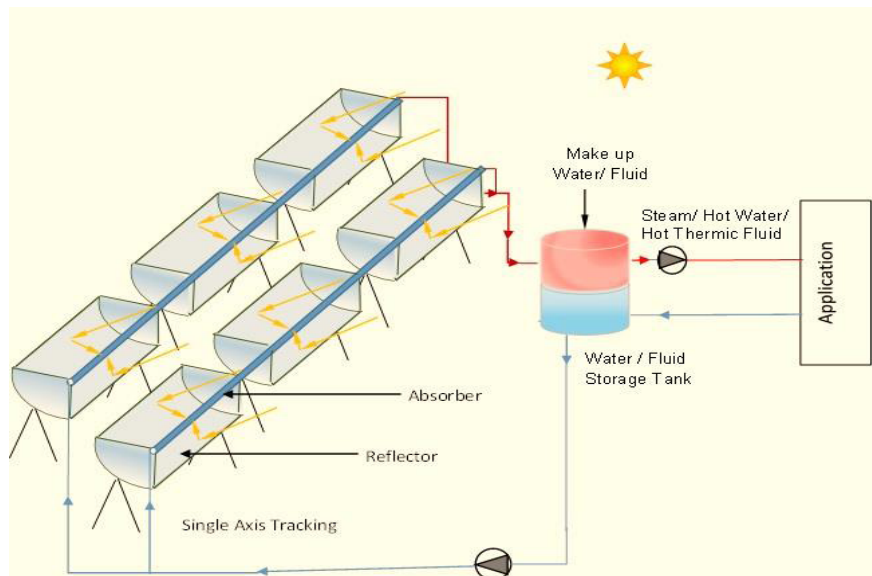
*SG1000 (2.06m<sup>2</sup>) by GreenEra*



*PTC (1.7m<sup>2</sup>) by Oorja Energy*

### ***End-use applications***

Parabolic Trough is used for any low to medium process heat applications. It can attain a maximum temperature up to 250°C as per requirement in industries, commercial & residential complexes, religious places, etc. A typical parabolic trough of 6 m<sup>2</sup> aperture area has a thermal output capacity of 2 kW on a clear sunny day. (Source: CSH India)



*Schematic Diagram of CST based System with Parabolic Trough (Courtesy: CSH India)*

Some of the typical application areas of Parabolic Trough are:

- Steam generation
- Hot water generation above 90°C
- Thermic Fluid or HTF Heating

The steam and high temp water find application in

- Community cooking
- Coal, Biomass or Gas based Hybrid Power Plants
- Enhanced Oil Recovery
- Solar-assisted comfort cooling
- Laundry
- Effluent treatment
- Food processing
- All processes where steam or hot water is used

The configuration of an industrial process heat solar system depends mainly on the specific application. It may consist of one or more number of Parabolic Troughs in a system. Parabolic Trough systems have already been installed in various thermal applications across industries including food processing in food parks, thermic fluid heating in scientific laboratories, ironing application amongst others. There are 5 manufacturers of this technology and around 16 case specific examples of Parabolic Trough systems installed across India. List of a few such installations is given as an **Annexure**.

Development of the Parabolic Trough in the country requires component and material standards to be followed for maintaining the quality in the field by the manufacturer and assurance of the quality by an end-user.

The following section covers detail specifications of various components and materials of a Parabolic Trough.

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# Material and Component Specifications

## PARABOLIC TROUGH

### Collector

The collector of a parabolic trough is an assembly of curved shaped reflectors arranged on a structural steel framework. The reflectors are arranged so as to give a parabolic shape and reflect the incident solar radiation onto a tubular receiver.



*Mirrors*



*Support Structure*

### Specifications

Reflector	
Type	Specification
Glass Mirror	Material – Tempered and toughened solar grade glass tested for scratches and durability
	Shape – Parabolic
	Thickness – 3-4 mm
	Reflective Coating – Silver back coating
	Specular Reflectivity – more than 93 %
	Protective Coating – Edge sealing coat on all sides of mirrors cut in different sizes after rubbing and cleaning them properly



Type	Specification
Glass Mirror	<p>Special weather protection coat to be made for mirrors to be used in coastal and colder regions</p> <p>Strength &amp; Durability – Applicable standards ISO<sup>1</sup> 6270-2:2005,ISO 9227:2012</p>
Silver reflective film backed by Aluminium	<p>Material – Painted (polyesters, acrylics, and epoxy/polyester paints) Aluminium substrate</p> <p>Substrate Thickness – 0.38 – 0.50 mm</p> <p>Shape – Parabolic</p> <p>Reflective Coating – Solar Grade silver film of 0.10 – 0.12 mm thickness</p> <p>Edge sealing – Use of Edge Tape/Caulk</p> <p>Reflectivity Specular– more than 94 %</p> <p>Strength &amp; Durability – EN<sup>2</sup> 485-2: 2008; ASTM<sup>3</sup> D882; ISO 9227:2012</p>
Solar grade anodized Aluminium reflector	<p>Material – Solar Grade Anodized Aluminium substrate</p> <p>Shape – Parabolic</p> <p>Thickness – 0.3 – 0.8mm</p> <p>Reflective Coating – PVD (Physical Vapor Deposition) coating</p> <p>Specular Reflectivity – at least 88 %</p> <p>Protective Coating – Solar lacquer/Teflon coating/Epoxy coating for corrosion protection</p> <p>Strength &amp; Durability – ISO 9227:2012, ISO 4623, EN 485-2: 2008; ASTM D882</p>
<b>Support Structure</b>	
Design	<p>Space frame or torque tube structure with arrangements to fix mirrors so as to have an accurate focus on line receiver</p>

<sup>1</sup>International Organization for Standardization

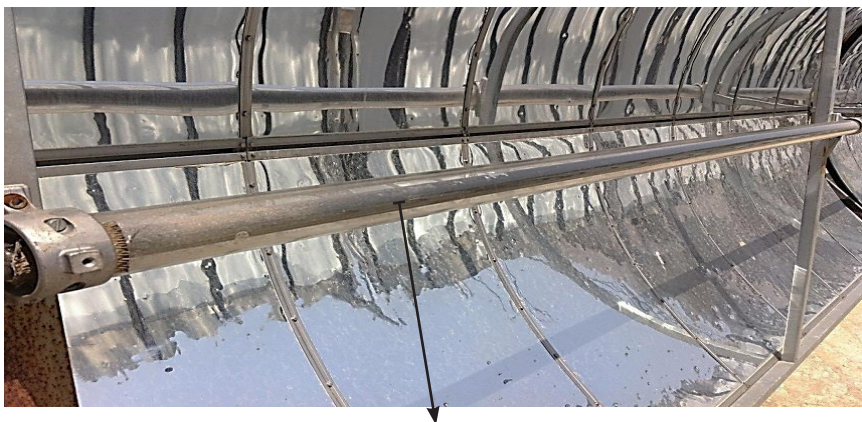
<sup>2</sup>European Standards

<sup>3</sup>American society for Testing and Materials

Parameter	Specification
Material	Standard Structural steel as per IS <sup>4</sup> 2062
Shape	Parabolic
Protection from corrosion	Cathode Electrode Deposition (CED) painting process or Galvanization as per relevant code or epoxy coating / PU (polyurethane) paints
Strength & Durability	Designed as per IS 800/IS 875 and allied/ applied codes considering a life span of 25 years
Fixing of mirrors	On the base structure with the help of Aluminium channels and standard fasteners

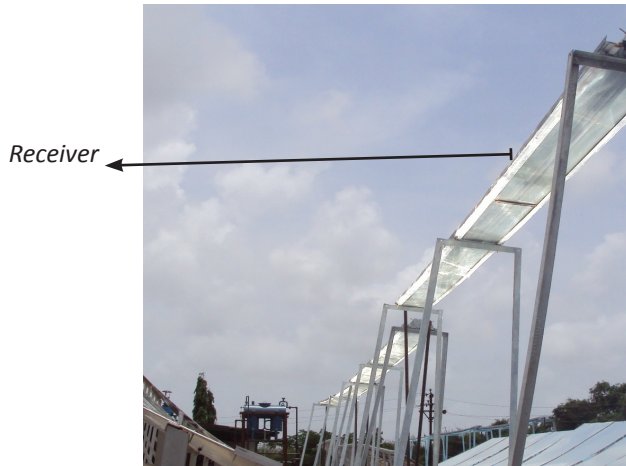
## Receiver

The receiver of parabolic trough is placed at the line focus of a trough so as to capture the solar radiation and transfer the same to the thermal medium used in the system. In India, the receiver being used is evacuated/non-evacuated type comprising of a linear absorber constructed of a metallic tube surrounded by a glass tube.



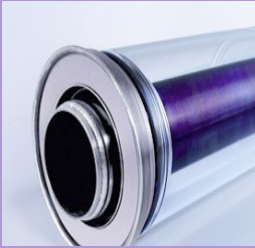
*Receiver*

<sup>4</sup> Indian Standard



### Specifications

Receiver	
Sub components	Specification
Absorber	Design – Linear round tube Material – Stainless Steel 304 grade Thickness – 1 - 2mm Diameter – 25 - 35 mm Durability – Minimum 10 years
Absorber Coating	Material – Black Chrome/ Solar grade absorber paint/Selective Coating (AS (C2-80)) Absorptivity – 0.90 – 0.95 Emissivity – 0.09 - 0.15
Glass Cover	Design - Linear round tube Material - Borosilicate glass Transmittivity – At least 95% Thickness – 2 - 3mm Diameter – 50 - 80 mm Durability – Minimum 10 years

<p>Absorber - Glass fixing</p>	<p>Glass to Metal sealing methods – Matched thermal expansion seal and unmatched thermal expansion seal</p>  <p>(Image source: SCHOTT)</p>
<p>Receiver Fixing</p>	<p>A receiver is fixed on to a mirror support structure with the help of standard steel sections/angles, die cast Aluminium clamps and fasteners and should have adequate expansion provision.</p>

### Trough stand

The basic framework of a trough stand is a steel structure. The structure is designed so as to withstand wind speed in an operating condition as well as in parked stage as per the existing structural design code. Overall system rests on a civil foundation made for the purpose



*Trough Stand*

## Specifications

Civil Foundation	
Parameter	Specification
Design	Designed to rest on soil of sufficient strength or to suit the prevalent soil condition
Material	Cement and concrete
Coating Protection	Coating of paint on exterior surface
Strength & Durability	Designed as per IS 456 and allied/applied codes considering a life span of 25 years
Structural Steel Foundation	
Design	Structural steel frame
Material	Standard structural steel as per IS 2062
Protection from corrosion	Cathode Electrode Deposition (CED) painting process or Galvanization as per relevant code or epoxy coating / PU paints
Strength & Durability	Designed as per IS 800/IS 875 and allied/applied codes considering a life span of 25 years

## Tracking System:

Tracking system enables the trough to remain focused towards the sun so as to capture the maximum possible direct radiation during the day. The single axis tracking system is provided with either north to south or east to west tracking. Tracking system may include the following few set of equipments – Electrical motor, Gearbox, Gear & Pinion, Shaft, Solar radiation sensor, Wind sensor and Timer



Gear Box

Shaft



Gear & Pinion



*Cradle like Tracking System*

### *Specifications*

Tracking System	
Parameter	Specification
Mechanism	Microprocessor/timer based single axis tracking system i.e. moves East-West
Control Logic	Sun position sensors based tracking with feedback mechanism or Solar algorithm (preprogrammed) based tracking
Accuracy	+/- 0.2°
Weather Protection of outdoor equipment	Cable channel for electric cables, Aluminium sheet cover on motors, Box casing for microprocessor based electronics
Subcomponents	
Sensors	Any sensor from Standard Sun position Sensor, Wind Sensor (anemometer), Feedback Sensor (Proximity Sensor) may be used to assist tracking.
Electrical components	Standard servo/ stepper/induction electric motor
Mechanical Components	Standard Gear and Pinions, Rotating shaft

## **BALANCE OF SYSTEM**

Balance of plant includes a number of components such as heat transfer pipes & support structure, instrumentation & safety mechanism and storage tank (optional) to control fluid flow and temperature. The heat transfer pipes carry fluid and thus transfer the heat received by it to an end use application. Fluid circulates in the system at a certain desired rate.

### *Specifications*

#### **Heat Transfer Pipe**



Parameter	Specification
Design	Electric Resistance Welded (ERW) pipe or seamless pipe
Material	Galvanized Iron/ Mild Steel/ Stainless Steel
Size	Diameter of pipe depends on the flow rate of fluid Thickness is based on the pressure required in the system
Working Fluid	Hot Water/Steam/ Pressurized Hot water/ Thermic Fluid
Strength & Durability	As per IBR <sup>5</sup> /ASME <sup>6</sup> and allied/ applied standards

#### **Insulation**



*Typical LRB Mattress*






*Aluminium Cladding*

<sup>5</sup> Indian Boiler Regulation

<sup>6</sup> American Society of Mechanical Engineers



Parameter	Specification
Type	Thick insulation layer with cladding over the pipe
Material	Insulation Material - Mineral wool or Glass wool or Light Resin Bonded (LRB) mattresses Cladding Material – Aluminium/Stainless Steel/ Galvanized Iron sheets
<b>Circulation Pump</b>	
Pump	As per API <sup>7</sup> 674/ISO 5199 / DIN <sup>8</sup> 24255 / EN 733 Standards
<b>Instrumentation</b>	
<div style="display: flex; justify-content: space-around; align-items: center;"> <div style="text-align: center;">  <p><i>Pressure Gauge</i></p> </div> <div style="text-align: center;">  <p><i>Typical Flow Meter</i></p> </div> <div style="text-align: center;">  <p><i>Typical Pressure Valve</i></p> </div> </div>	
Pressure Gauges	As per IS 13947 / IS 3624 Standards
Temperature sensors	As per DIN 43760 / EN 60751 / IEC <sup>9</sup> 751 Standards
Valves	As per API 598 / BS <sup>10</sup> 5352 Standards
Flow meters	Standard Positive displacement / Turbine / Electromagnetic / DP / Vortex flow meters as suitable for application flow rate
<b>Support Structure</b>	
Design	Structural Steel Structure fixed on to RCC column
Material	Standard structural steel as per IS 2062 Cement-concrete for civil structure
Coating Protection	Cathode Electrode Deposition (CED) painting process or Galvanization as per relevant code or epoxy coating / PU paints Coating of paint on exterior surface of Civil structure
Strength & Durability	Designed as per IS 800/ IS 875/ IS 456 and allied/ applied codes considering a life span of 25 years

<sup>7</sup> American Petroleum Institute

<sup>8</sup> Deutsches Institut für Normung i.e. German Institute for Standardization

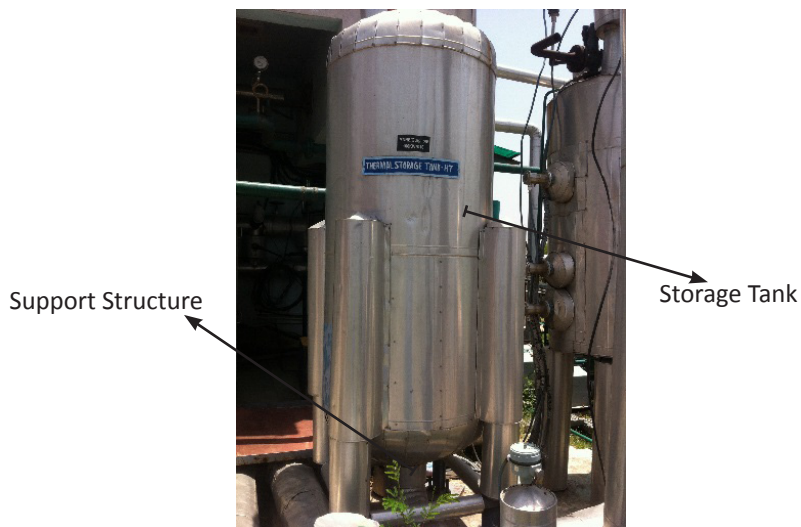
<sup>9</sup> International Electro technical Commission

<sup>10</sup> British Standards



### Storage System (optional)

The thermal storage subsystem is a part of the circulation system. It extracts heat from the circulating fluid when the temperature becomes too high. When the temperature is too low, it supplies the stored heat to the fluid. Insulation should be provided both on the tank and supporting structure.



### Specifications

Heat Storage Tank	
Parameter	Specification
Type	Cylindrical tank
Material	Generally MS, other material as per application.
Size	Depends on the application requirements
Storage medium	Hot water / Pressurized hot water / Hot oil
Strength and Durability	Designed as per ASME codes and allied/ applied codes

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## Annexure

### *List of a few Installations*

User	State	System Size (sq. m.)	Application
SKF Technologies (India) Pvt. Ltd., Bengaluru	Karnataka	256	Pressurized hot water at 120°C for metal phosphating
Honeywell Technology, Hyderabad	Telangana	820	Pressurized hot water at 180°C for cooling application
Sidharath Surgicals, Valsad	Gujrat	263	Pressurized hot water at 110°C for Cleaning & bleaching of cotton
NPCIL, Kota	Rajasthan	641	Pressurized hot water at 180°C for cooling application
NISE, Gurgaon	Haryana	308	Comfort Cooling
Alpine Fruit, Pune	Maharashtra	58	Process heat
PSG Hospitals, Coimbatore	Tamil Nadu	50	Laundry
ITC Hotel, Hyderabad	Telangana	128	Laundry
Maharishi Ayurveda, Noida	Uttar Pradesh	316	Steam Cooking
Almond House, Hyderabad	Telangana	255	Thermic Fluid heating for making khova for sweets
Wellproof Technologies, Thane	Maharashtra	115.20	Steam for polymer coating process

### *Manufacturers*

There are five Parabolic Trough manufacturers in India at present. Details of manufacturers can be found on MNRE website.



**Contact:**

For more details on the manufacturers/suppliers, government support, applications, technologies and successful installations please visit: [www.mnre.gov.in](http://www.mnre.gov.in) OR [www.cshindia.in](http://www.cshindia.in) OR contact Project Management Unit UNDP-GEF CSHP, Ministry of New and Renewable Energy, Block 3, CGO Complex, Lodi Road, New Delhi-110003. Telefax: 011-32314365/24363638, Email: [singhalak@nic.in](mailto:singhalak@nic.in)

Toll Free Helpline No. 1800 2 33 44 77 could be accessed Monday through Friday between 9:30am to 6:30pm and on Saturday 9:30am to 1:30pm

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