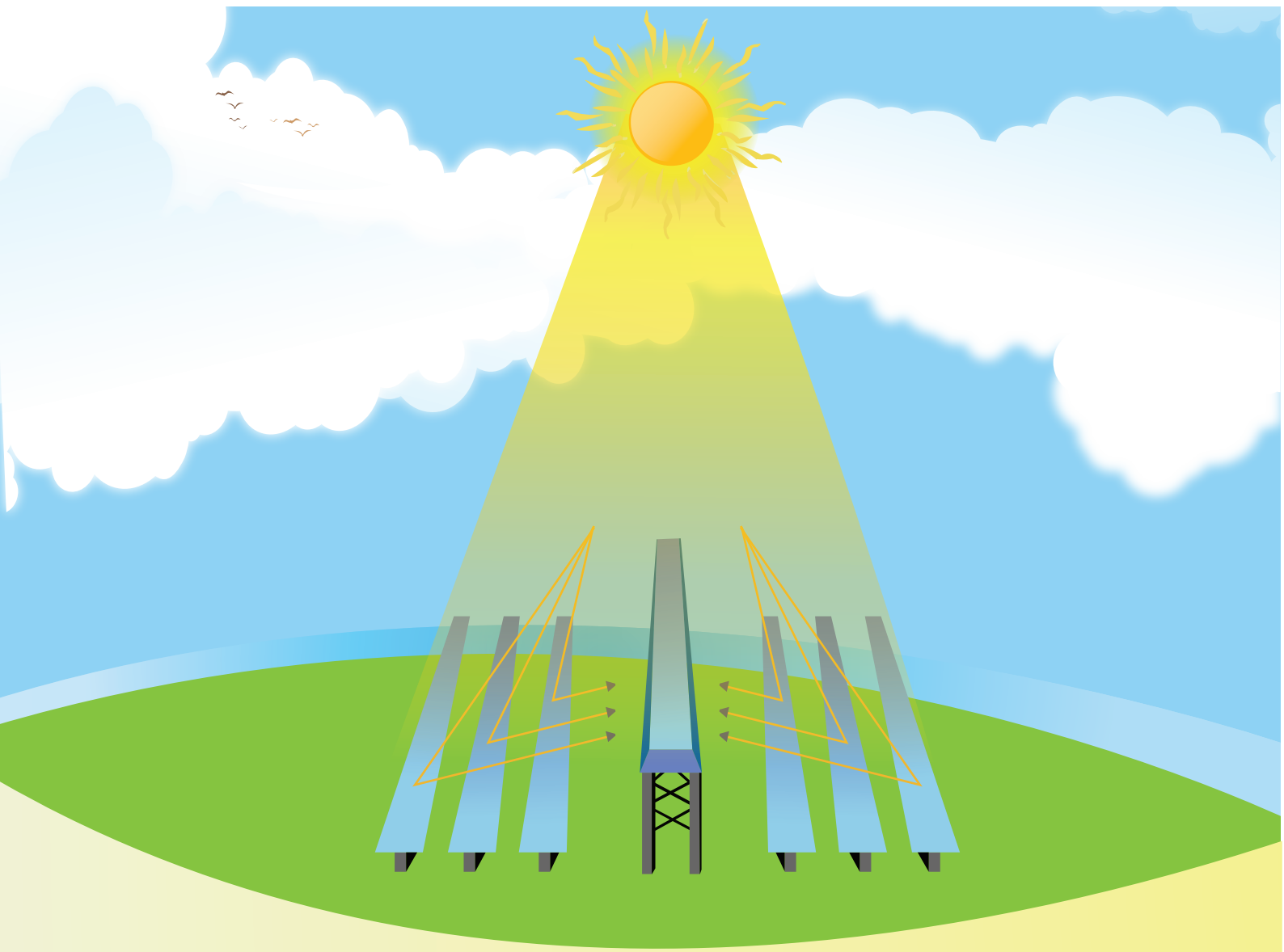


Linear Fresnel Reflector

based Solar System

Operations & Maintenance Manual

UNDP-GEF Project on Concentrated Solar Heat

Ministry of New & Renewable Energy

Government of India

November, 2014

gef

सत्यमेव जयते
MNRE

UNDP
Empowered lives.
Resilient nations.

Prepared By:

AnthroPower

MSA RENEWTECH FOUNDATION

Index

Acknowledgement

This manual is a simplified version of the operation and maintenance manual provided by KGDS Renewable Energy Private Limited (KGDS) for concentrating solar systems.

A special note of thanks owes to the employees of KGDS Renewable Energy Private Limited (KGDS), manufacturer of LFR system, who briefed us on the working principles, operation, maintenance and troubleshooting.

We deeply appreciate Mr. Suresh for giving us a chance to visit their center. We would also like to appreciate his co-operation and arrangement during the visit. We would also show our gratitude to Dr. S.P. Viswanathan (President of KGDS) for his benevolence. We highly appreciate the enthusiasm and commitment displayed by Mr. Prabhakaran and Mr. Ashwin, who accompanied us to the R&D sites and shared their knowledge and experience with us. Their practical experience and co-operation is of great value to our work. We also express our thanks to Er. S.K. Singh, Scientist F of MNRE, who directed us for technical content and presentation of manual.

We collected all their field experiences regarding this LFR system. We also assimilated the content and pictures of their existing operation manual into this manual.

About This Manual

This document describes a typical LFR solar thermal dish and the procedures needed to operate and maintain it successfully. The document is intended primarily for instructors, supervisors and engineers to train the site level technicians. This manual is to be used in conjunction with the ‘Solar Scheffler Dish Operation and Maintenance Manual’

The document maintains a focus on the practical day-to-day tasks of operating a LFR dish. The design of the system and the engineering considerations behind its operation are not covered unless they have a direct bearing on operational decisions.

1. Plant Specification

Table 1. Plant Specification

Sr. no	System Description	Rating
1	Nominal Rating (MW)	2
2	Basic Module	Linear Fresnel Reflector
3	No. of Bay	2
4	No. of Rows	4 pair/bay (4x2=8)
5	No. of Array	5 array/row
6	No. of Module	4 module/array
7	Area of Module	(1.8X12) 21.6 m^2
8	Total Collector Area	6912 m^2
9	Tracking	Single axis (East-West)
10	Heat carrier	Water
11	Nominal Temperature (˚C)	350
12	Circulation Flow Rate (m^3/hr.)	100 - 400 m^3/hr
13	Thermal Storage	Pressurised hot water
14	System Heat Exchanger	Nil.
15	Backup System	Nil.
16	Temperature Protection	Emergency Alarm
17	Pressure protection	Safety relief valve at receiver pipe and steam drum
18	Fluid Makeup	Steam drum water level makeup with **deaerator** water

1.1. Reflector Specification

Table 2. Reflector Specification

Sr. no	Module Description	Rating
1	Surface Area of Reflector (m^2)	(1.8X12) 21.6
2	Aperture Area of Reflector (m^2)	11.65
3	Shape	Fresnel Lenses
4	Reflectivity	96%

1.2. Receiver Specification

Table 3. Receiver Specification

Sr. no	Receiver Description	Specification
1	Type	Linear Cavity Receiver
2	Height	12 m
3	Unit Size	12 m x 0.6 m x 0.35 m
4	Aperture Width	500 mm

5	Aperture Cover	Anti-reflective Coated Low-Iron Glass
6	Maximum Temperature for Glass	200 °C
7	Operating Temperature	180 °C
8	Cavity Sealing	Silicone Rubber Beading
9	Insulation	Ceramic Wool
10	Quantity	42 nos.
11	Maximum Flow Possible	13 ton/h
12	Minimum Flow Possible	5 ton/h
13	Operating Pressure	45 bar
14	Design Pressure	65 bar

1.3. Absorber Tube Description

Table 4. Absorber Tube Specification

Sr. no	Absorber tube Description	Rating
1	No. of Absorber Tubes/Bay	8 (4 tubes for each inlet and outlet)
2	Absorber Tube Material	SS 304 Seamless tube
3	Diameter	Outer Diameter- 33.4mm Inner diameter- 26.7 mm
4	Coating	Black chrome Solar Absorption Cermet
5	Absorptivity	92%
6	Transmissivity	95%
7	Reflectivity	92%
8	Emissivity	25%
9	Maximum Temp	550 °C
10	Operating Temp	350 °C

2. Safety Aspects

General Aspects

- Pressurized steam or high temperature (above 180 °C) steam is explosive and hence should be avoided. Pressure of the fluid increases with the increase in temperature.
- Avoid looking at reflector mirror with naked eyes. Always use sunglasses.
- Regularly monitor pressure and temperature of steam drum or boiler. It should be under safe operating limit (Normal Limit[1]: 45 Kg/cm^2). If pressure exceeds this limit open the safety valve immediately.
- Only technician with thorough knowledge of the system specifications should adjust the Pressure Reducing Valve and Safety Relief Valve.
- In steam drum, two Safety Relief Valves (manual and automatic) are attached for additional safety.
- Pressure Relief Valve has to be set and tuned only by trained personnel.
- Adjust Safety Relief Valve.
- Always perform receiver maintenance when the temperature of receiver is at ambient temperature. Also make sure that the plant is shut down.
- The system is pressurized, with fluid/steam at a pressure much higher than atmospheric pressure.

[1] See steam table for normal pressure according to operating temp.

Thus, on any opening/breakage/crack the fluid/steam can come out as a jet and may come in contact with the human body. This might result in burns.

- Pipes and other metal parts carrying the heated fluid/steam should be insulated. As any exposed area can pose burn hazards. Cover it with some temporary insulator (cotton, cloth etc.) for the time being and flag it as danger.

3. Precautions during Maintenance

3.1. Pipeline and Equipment

- Flexible hose pipes are generally susceptible to leakages due to high pressure in the system. Therefore, maintain safe distance from it.
- Wear gloves while removing insulation to avoid skin contact with hot surfaces.
- Ensure isolating valves are closed before working on any equipment.
- Remove steam[2] completely through the vents before opening any equipment.
- If fluid is to be flushed out by opening the pipe flanges or coupling, ensure that majority of your body part is above the pipeline.
- Stand away from the pipe while opening drainage valves to avoid fluid spill over the body.

3.2. Steam Drum/Boiler

Historically, boilers were a source of many serious injuries and property destruction due to poorly understood engineering principles. Thin and brittle metal shells can rupture, while poorly welded or riveted seams could open up, leading to a violent eruption of the pressurized steam. When water is converted to steam it expands to over 1,000 times its original volume and travels down the steam pipes at over 100 kmph.
Some of the key points from safety's point of view are as follows:

- Boiler temperature and pressure shouldn't go up beyond the allowed limit. (See steam table for applicable pressure.)
- Regular checkup of boiler body is mandatory.

3.3. Receiver

- Always use winch for receiver maintenance or repair.
- Always perform receiver maintenance or repairing in presence of supervisor/manufacturer/engineer
- Reflectors should be defocused completely before any maintenance work
- Receiver temperature should be near ambient temperature before repair/maintenance work
- Drain the entire heat carrier (water or thermic fluid) before repairing absorber tube
- Don't start receiver maintenance without gloves, helmet and shoes
- When working on the receiver at a height, ensure that winch is working properly and a support for feet is available to avoid fall

3.4. Reflector

- Always use sunglasses whilst in solar collector area
- Don't forget to use gloves in addition to sunglasses while changing the reflector mirror

3.5. Precautions during Operation

- Keep an eye on the temperature and pressure at every TT and PT[3]. It shouldn't increase from the normal[4] range.
- Header pipe stores steam at high pressure, hence one should avoid going near it.
- Don't allow children / unauthorized person / animals in the solar field.
- Keep distance from Safety Relief Valve when releasing steam.

[2] In case of thermic fluid, drain it out in some container.
[3] TT- Temperature Transmitter. PT – Pressure Transmitter
[4] It is system specific / see steam table.

3.6. Human Protective Equipment

- Hand Gloves
- Industrial Safety Shoes
- Protective Sunglasses

While working on receiver always use winch and make sure that the hands remain free from oil and grease.

3.7. Chemical Related Precautions

- Use only DM water or a branded thermic fluid as heat carrier. Never use normal water in pipes.

4. Operating Principle

A Fresnel lens is a type of compact lens. The principle of this lens is the chopping of the continuous surface of a standard lens into a set of surfaces with discontinuities between them. This allows a substantial reduction in thickness (and thus weight and volume) of the lens, at the expense of reducing the imaging quality of the lens.

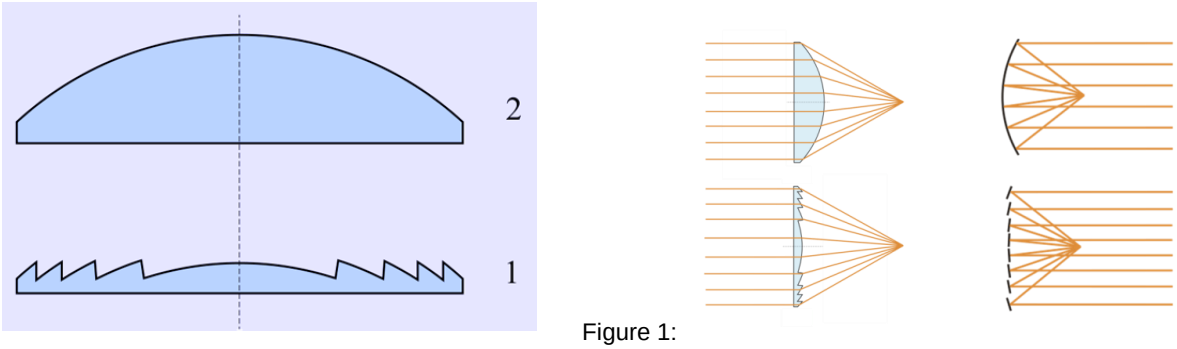


Figure 1:
Operating Principle of a Linear Fresnel Reflector

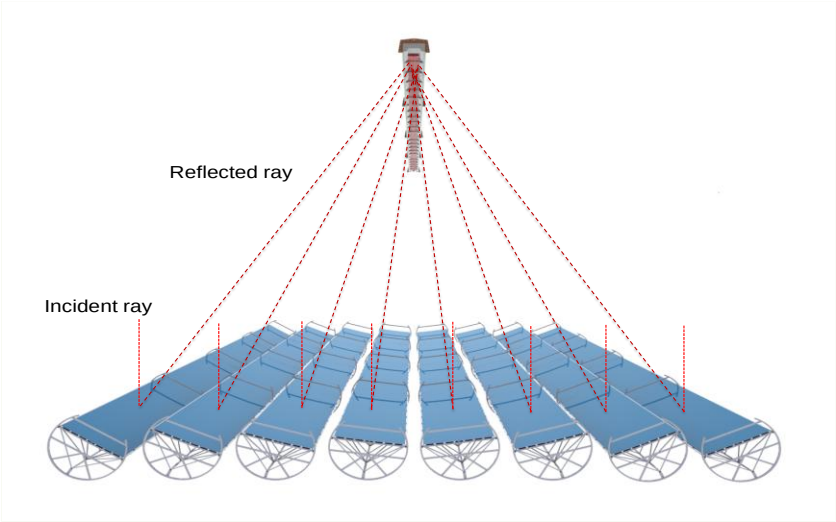


Figure 2: Schematic of a LFR system

4.1. Explanation of System Components

The LFR system consists of parallel rows of linearly coupled reflector units, single axis tracking system, and linear cavity receiver at appropriate height above the reflectors, to receive solar radiation reflected and subsequently focused by the reflectors. Figure 2 shows the schematic of a LFR system.

Linear Fresnel Reflector system comprises of the following components:

- Reflectors
- Receiver
- Tracking System
- Process and Instrumentation System

4.2. Reflector

Main components of reflector are:

1. **Mirror:** High reflective mirror is used as the reflector. It reflects sun rays to the receiver.
2. **Corrugated Sheet:** It is a wavy structure made up of GI or any other equivalent metal. Mirror is pasted on this sheet. It gives a good support to the mirror and also protects reflective paint of mirror from corrosion.
3. **Support Structure:** Reflector (mirror) tracks sun with the help of mirror support structure.
4. **Elastically Curved Low Iron Glass Mirrors:** They are adhered to the corrugated sheets. The mirrors along with the corrugated sheet are supported by the **Mirror Support Structure (MSS),** fabricated with GI hollow sections (See figure 3).

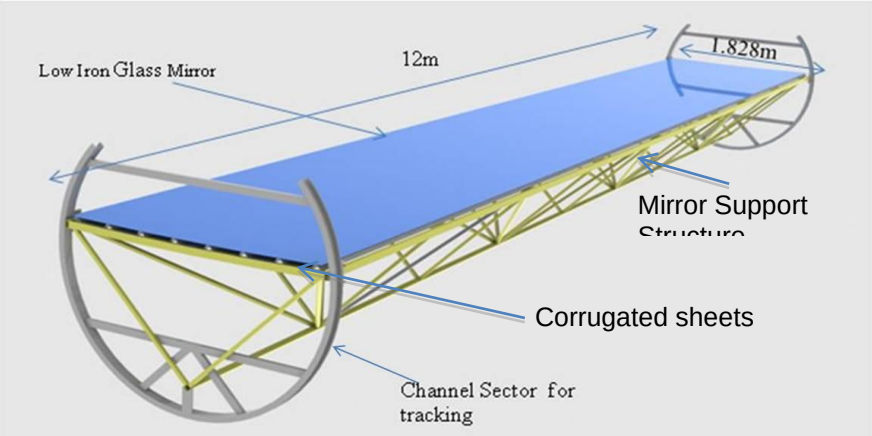


Figure 3: Components of a Reflector

4.3. Receiver

Linear Cavity Receiver (LCR) is used in this system. Main components of the receiver are as follows:

- **Absorber Tube:** It is made up of stainless steel with solar selective absorber coating (high absorbance and low transmittance). Number of absorber tubes depends upon the concentration ratio[5]. Inner diameter and wall thickness of the tube depends on the operating pressure and flow velocity.
- **Insulated Casing:** This is low iron casing filled with heat insulator and its inner side has anti-reflective coating. Absorber tube is mounted in the cavity of the casing and this cavity is further sealed with a glass sheet (window glass) cover and silicon beading.
- **Support Structure:** The receiver is supported by steel **A-Frame** structure that in turn is grouted to concrete foundation. Wind arrestor (metal wire) reduces the wind load and provides support to A-frame structure.

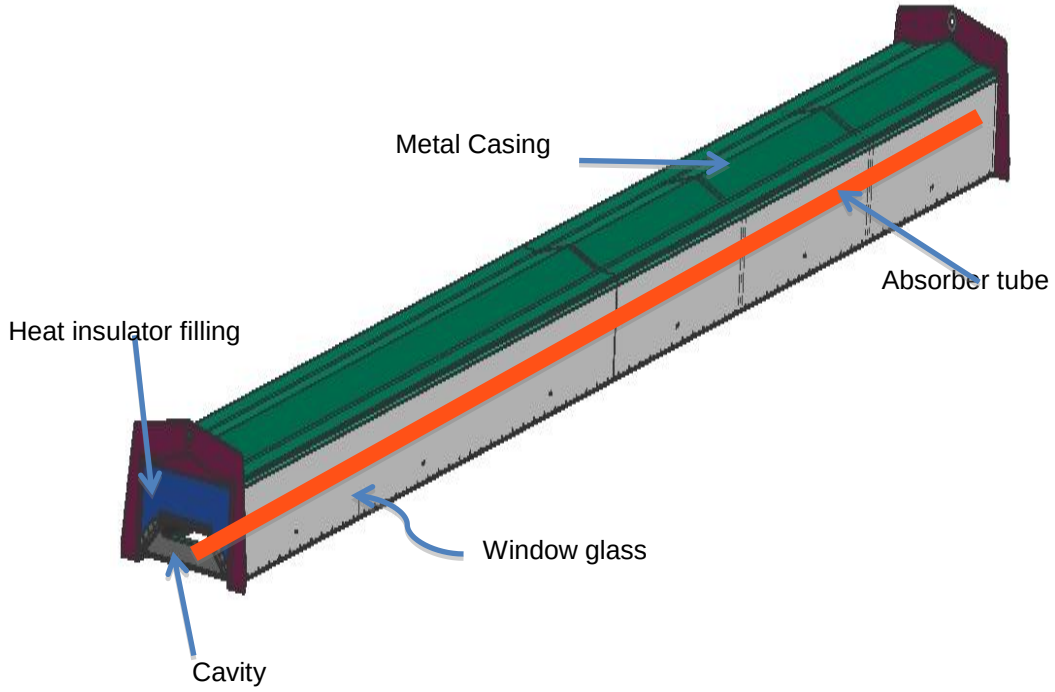


Figure 4: Receiver of a LFR system

4.4. Tracking System

Since the sun moves from east to west therefore reflector should also move along with the sun to receive maximum energy. Reflector needs a tracking system to track the sun. GPS is used to synchronize the reflector with the sun. The mechanical component of the tracking system comprises of Sprocket & Chain Drive Transmission Mechanism driven by a stepper motor (Fig 5).

[5] The term "*concentration ratio*" is used to describe the amount of light energy concentration achieved by a given collector. Concentration ratio = Reflector area / receiver area

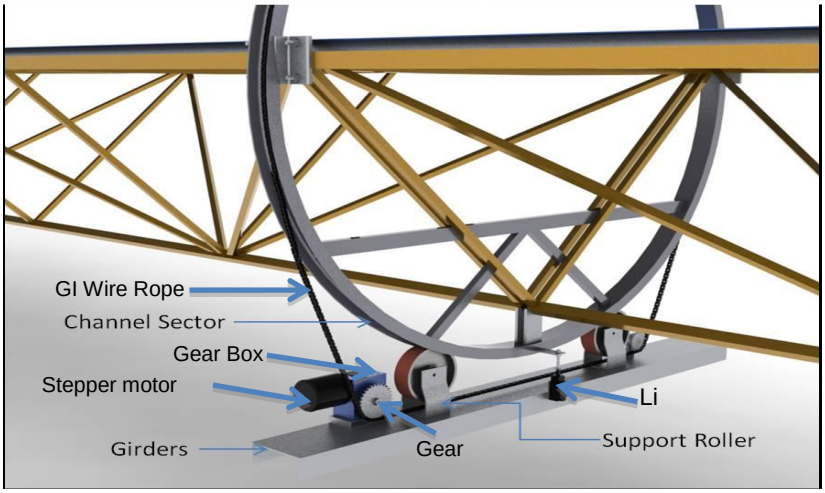


Figure 5: Tracking System of a LFR system

The inclination of the reflector is sensed using encoders and limit switches. An algorithm (GPS[6]) that determines the Azimuth and Elevation of the sun based on date, time, and longitudes and latitudes of the location, is implemented in the PLC. Each tracking system is connected to the PLC, which will get inputs from the Encoder / Limit Switch and determine the rotational position of the solar reflector. It then provide the output instructions to the motor drive that rotates the motor, which in turn rotates the solar reflector to the desired position & direction. Flow cart of tracking logic are given below.

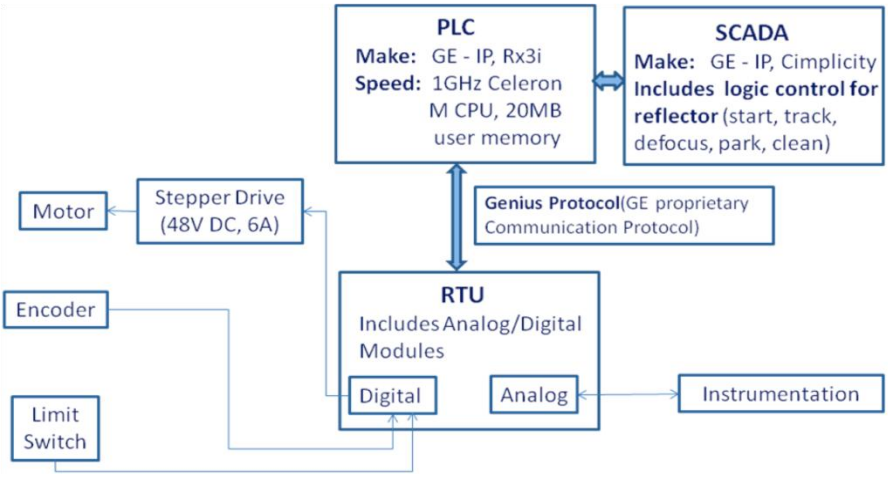


Figure 6: Flow Chart of Tracking Logic in a LFR system

Sub component of tracking system

- **Mechanical system:** Gear box, Stepper Motor , Chain, Sprocket, Support Roller
- **Logical system:** Limit Switch, PLC, Controlling Software (SCADA), Encoder

[6] Global positioning system (GPS), it's a satellite based system.

5. P&I Diagram

Figure 7 shows the process flow of the system. The water from the deaerator (A) is pumped into the steam drum (C) by means of a boiler feed pump (B). The recirculation pump (D) pumps the saturated or sub-cooled water from the steam drum through the down comer into the bay (E&F) (absorber housed inside the Linear Cavity Receiver). The saturated steam water mixture generated by the absorber tubes of desired dryness fraction enters the steam drum (G). The steam separated by the steam drum is taken out through the outlet provided at the top of the steam drum (G) and subsequently delivered to the process (H) through the pressure control valve.

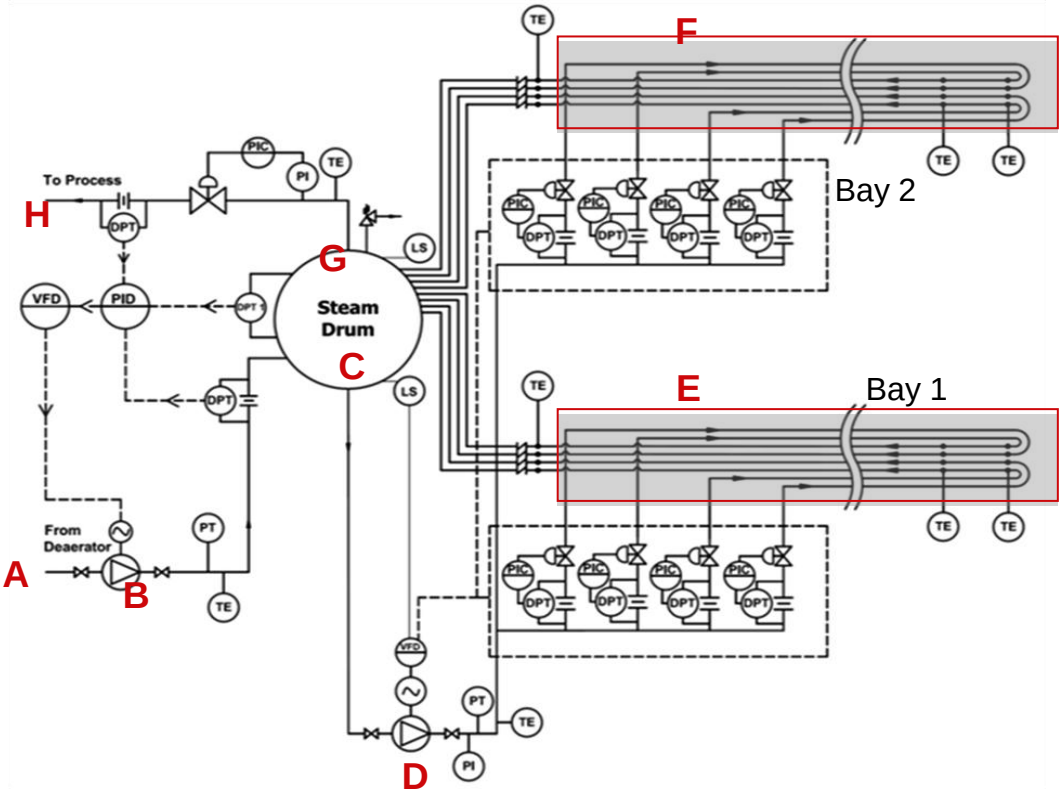


Figure 7: P&I Diagram depicting the Process Flow of a LFR system

The Process line & Instrumentation system comprises of the following components:

- Pressure Indicator (PI)
- Temperature Element (TE)
- Pressure Transmitter (PT)
- Differential Pressure Transmitter (DPT)
- Level Switch Sensors (LS)
- Control Valves
- Solar Boiler
- Steam Drum
- Re-circulation Pumps
- Boiler Feed Pumps
- Blow down Tank

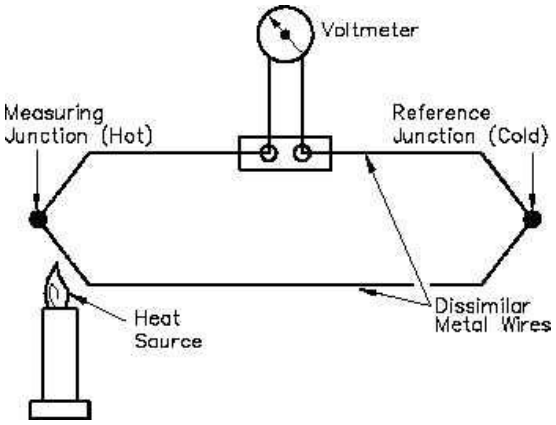
Pressure Indicator (PI)

Pressure indicator is an instrument for measuring the condition of a fluid (liquid or gas) that is specified by the force the fluid would apply, when at rest, per unit area, such as **pounds per square inch (psi) or Pascal (Pa)**.

The reading on the gauge, called the **gauge pressure,** is always a difference between two pressures. When the lower of the pressures is that of the atmosphere, the total (or absolute) pressure is the sum of the gauge and atmospheric pressures.

Temperature Element (TE)

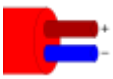
A **thermocouple** is a device consisting of two different conductors (usually metal alloys) that produce a voltage, proportional to the temperature difference, between either ends of the two conductors. Thermocouples are a widely used type of temperature sensor for measurement and control and can also be used to convert a temperature gradient into electricity.



They are inexpensive, interchangeable, are supplied with standard connectors, and can measure a wide range of temperatures. In contrast to most other methods of temperature measurement, thermocouples are self powered and require no external form of excitation. The **main limitation** with thermocouples is accuracy and system errors of less than one degree Celsius (°C) can be difficult to achieve.

Table below describes the specification of thermocouple:

Table 5. Thermocouple Specifications

Type	Temperature range °C (continuous)	Temperature range °C (short term)	Tolerance class one (°C)	Tolerance class two (°C)	BS what is BS Color code
	0 to +1100	−180 to +1300	±1.5 between −40 °C and 375 °C ±0.004×T between 375 °C and 1000 °C	±2.5 between −40 °C and 333 °C ±0.0075×T between 333 °C and 1200 °C	

Pressure Transmitter (PT)

The pressure transmitter is used to sense the pressure and transmit the signal to the control system.

Differential Pressure Transmitter (DPT)

The Flow and Level Transmitters are Differential Pressure Transmitter assembled with an integral orifice and are excellent for very low flow measurement.

Control Valves

Control valves are valves used to control the flow, pressure, and liquid level in the steam drum by fully or partially opening or closing in response to signals received from controllers that compare a "set point" to a "process variable", whose value is provided by sensors that monitor changes in such conditions.

Boiler

Boiler is closed vessel in which water gets heated. In this system boiler is a receiver tube. Receiver tube absorbs heat from the mirror reflector and transfers it to the water (working fluid).

The boiler units are of the balanced draught single drum radiant type solar boiler that includes a series of absorber tubes. The water circuit is of controlled circulation design incorporating boiler circulating pumps in unheated down comer at the front of the boiler. Boiler units comprise a steam generator, steam drum, boiler feed pump and recirculation pump.

Steam Drum

The function of the steam drum internals is to separate the water from the steam generated in the solar steam generators and to reduce the dissolved solids contents of the steam to below the prescribed limit. The separated water from the steam-water mixture sweeps down along both sides of the drum through the narrow annulus formed by a baffle extending over the length of the drum. The **baffle** is concentric with the drum shell and effects adequate velocity and uniform heat transfer, thereby maintaining the entire drum surface at a uniform temperature. Separation is generally performed in two stages, the first stages of separation is done with the baffle, the final stage takes place at the top of the drum with the chevron separator, just before the steam enters the connecting tubes. The secondary separation system consists of rows of corrugated plate dryers extending the length of the drum with a drain. The steam flows with relatively low velocity through the tortuous path formed by the closely spaced layers of corrugated plates, the remaining entertained water is deposited on the corrugated plates, the water is not picked up again but runs down the plates into the drain through suitably located drain pipes return this water to the water side of the drum.

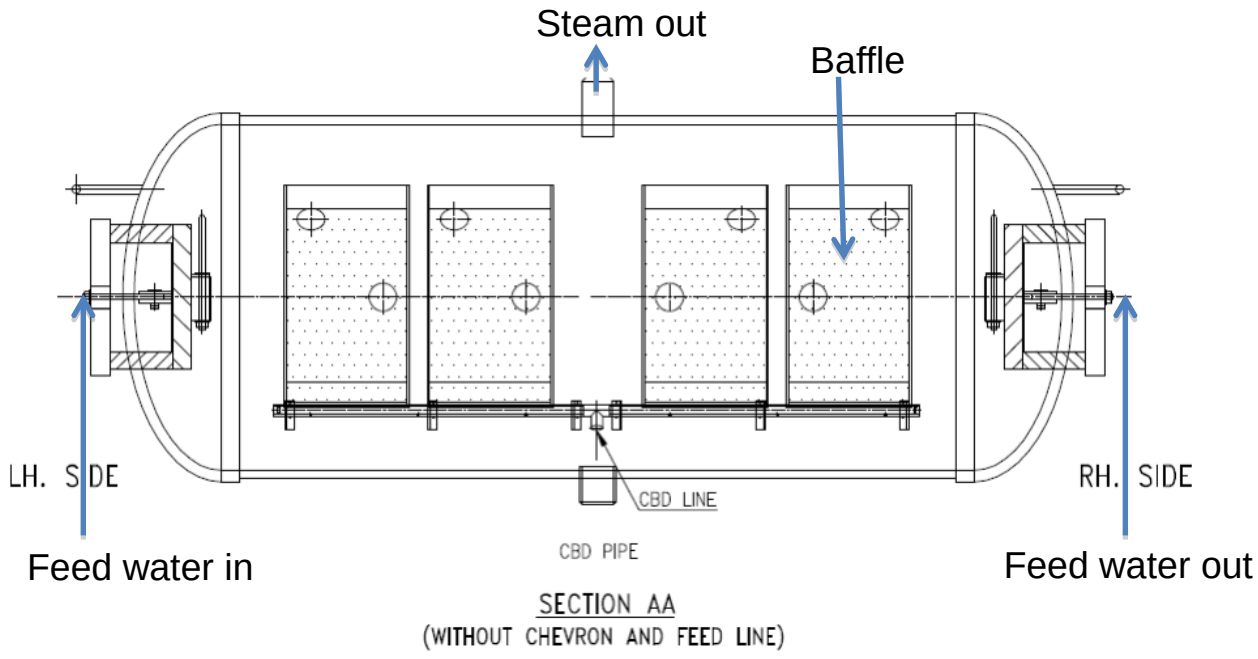


Figure 8: Steam Drum of a LFR system

Boiler Feed Pumps

A **boiler feed water pump** is a pump used to pump feed water into the boiler steam drum. To control the amount of water inflow to the boiler steam drum, the pump motor is equipped with a variable frequency drive (VFD) (P&I dig) which in turn controls the amount of water sent to the steam drum. It can be of the centrifugal pump type or positive displacement[7] type.
Feed water pumps sometimes run intermittently and are controlled level-sensing device energizing the pump when it detects a lowered liquid level in the steam drum. The pump then runs until the level of liquid in the boiler drum is substantially increased. In any case if the deaerator level is very less than the normal value, then deaerator level sensor will raise alarm and subsequently the boiler feed pump will be switched off. As soon as the deaerator water level reaches normal value, the boiler feed pump will be switched ON.

Re-Circulation Pumps

A **Re-circulation Pump** is a specific type of pump used to pump water from the steam drum into receiver tube. Once the water level in the steam drum reaches the optimum level, the recirculation pump will get automatically switched on and pump the water in to the receiver coils. To control the amount of water inflow in to the receiver coils, the pump motor is equipped with a variable **frequency drive** what is it which in turn controls the amount of water sent to the receiver coil. Since the steam pressure and the temperature are high, we have selected high temperature canned motor pumps.
High temperature pumps differ in construction from basic centrifugal pumps, as pump and motor are separated thermally by an adaptor which prevents heat transfer from the pump to motor area. In these pumps, an independent circulating system using same liquid being pumped with cooling jacket and heat exchanger is provided. The circulation is achieved with the aid of an auxiliary impeller mounted at the fore end of the motor chamber. The cooling arrangement permits the motor and bearings to operate at temperatures much lower than the processed fluid.

Blow Down Tank

Boiler blow down is the removal of water from a boiler. Its purpose is to control boiler water parameters within prescribed limits to minimize scale, corrosion, carryover, and other specific problems. Blow down is also used to remove suspended solids present in the system. These solids are caused by feed water contamination, by internal chemical treatment precipitates, or by exceeding the solubility limits of otherwise soluble salts.
In effect, some of the boiler water is removed (blow down) and replaced with feed water. The percentage of boiler blow down is as follow.

$$\frac{\text{Quantity of blow down water}}{\text{Quantity of feed water}} \times 100 = \%\ \text{blow down}$$

The blow down can range from less than 1% when extremely high-quality feed water is available to greater than 20% in a critical system with poor-quality feed water.

[7] Positive Displacement Pumps has an expanding cavity on the suction side and a decreasing cavity on the discharge side.

6. Start Up Procedure

Table 6. Pre-operational Checklist

S.N0	Equipment	Condition	Location
1	Reflector	Cleaned	Field
2	Reflector	Obstacle free	Field
3	**BFP** full form suction valve	Open	Field/ pump house
4	BFP discharge valve	Open	Field/ pump house
5	BFP isolation valve	Open	Field/ steam drum
6	**RCP full** suction valve	Open	Field/ pump house
7	Blow down Isolation valve	Open	Field/Steam drum
8	Manifold Isolation valves	Open	Field
9	Manifold Equalizer valves	Closed	Field
10	Vent valves	Closed	Field
11	Drain valves	Closed	Field
12	Instrument air	> 4 bar	Field
13	Cooling water pump		ON
14	Deaerator level		Normal
15	UPS		ON
16	CPU panel RTU-0		ON
17	Remote terminal unit	RTU	ON
18	VFD Panel		ON
19	VFD drive main		ON
20	Distribution box (DB)		ON
21	MOV power supply		ON
22	MCB to FIELD		ON
23	Analytical panel		ON
24	Recirculation pump	VFD	AUTO
25	Feed pump	VFD	AUTO
26	Flow control valves	FCV	AUTO
27	Level indicating controller	LIC	AUTO

6.1. Emergency Alarm

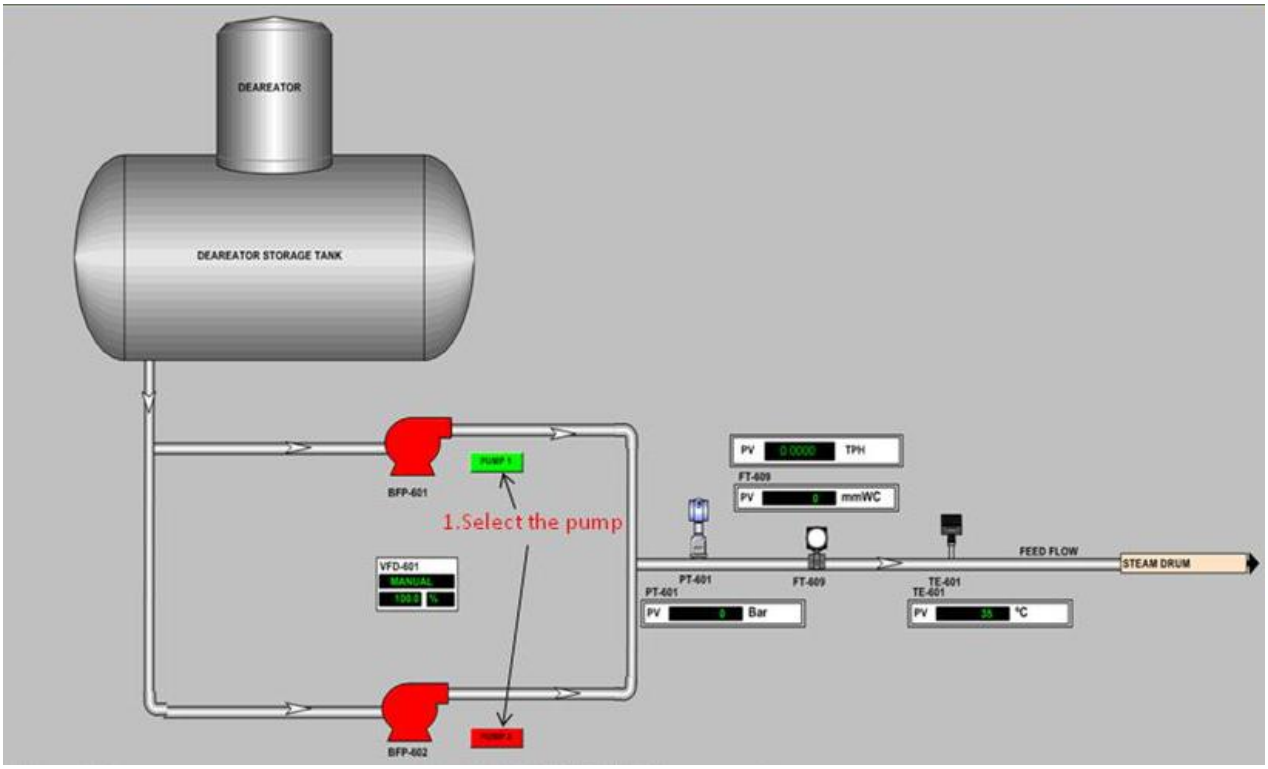
All the emergency alarm should be OK. List of alarms are given below:

Table 7. Alarms v/s Risk Level

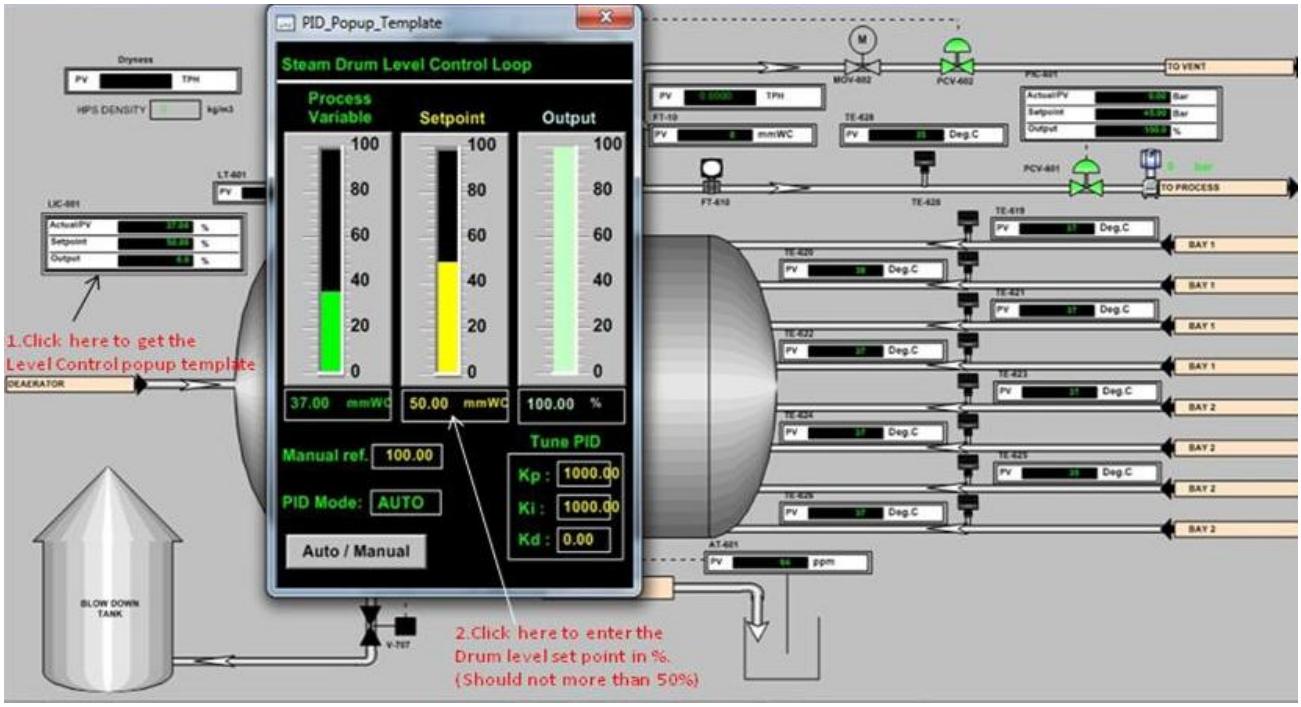
S.NO	Alarms	Risk level
1	Receiver tube surface temperature - High	High
2	Steam temperature - High	High
3	Steam drum pressure - High	High
4	Steam drum Level - Low	Low
5	Boiler Feed pump - Fail to start	Low
6	Boiler feed pump- NO flow	Low
7	Recirculation Pump - Fail to Start	Low
8	Recirculation Pump - NO flow	Low
9	TDS - High	High

6.2. LFR Plant Start Up

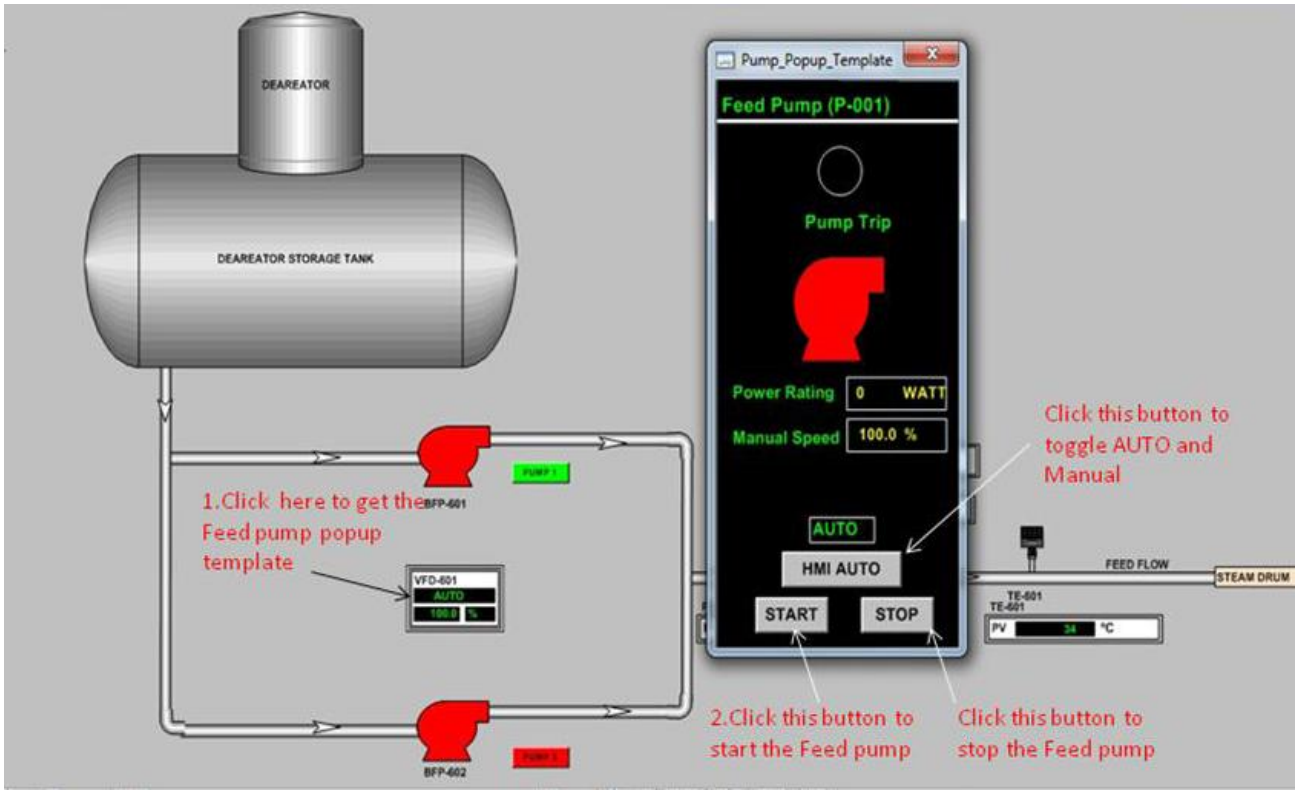
1. Select the Pump



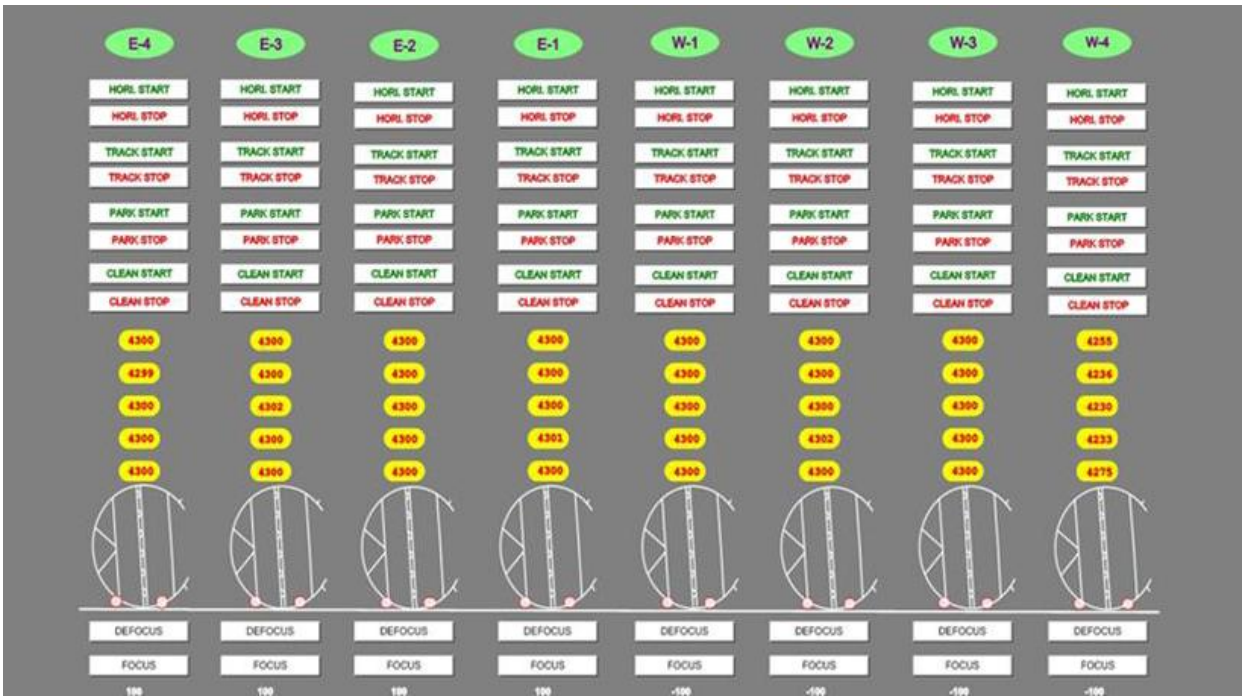
2. Keep the Steam Drum Level at 50%



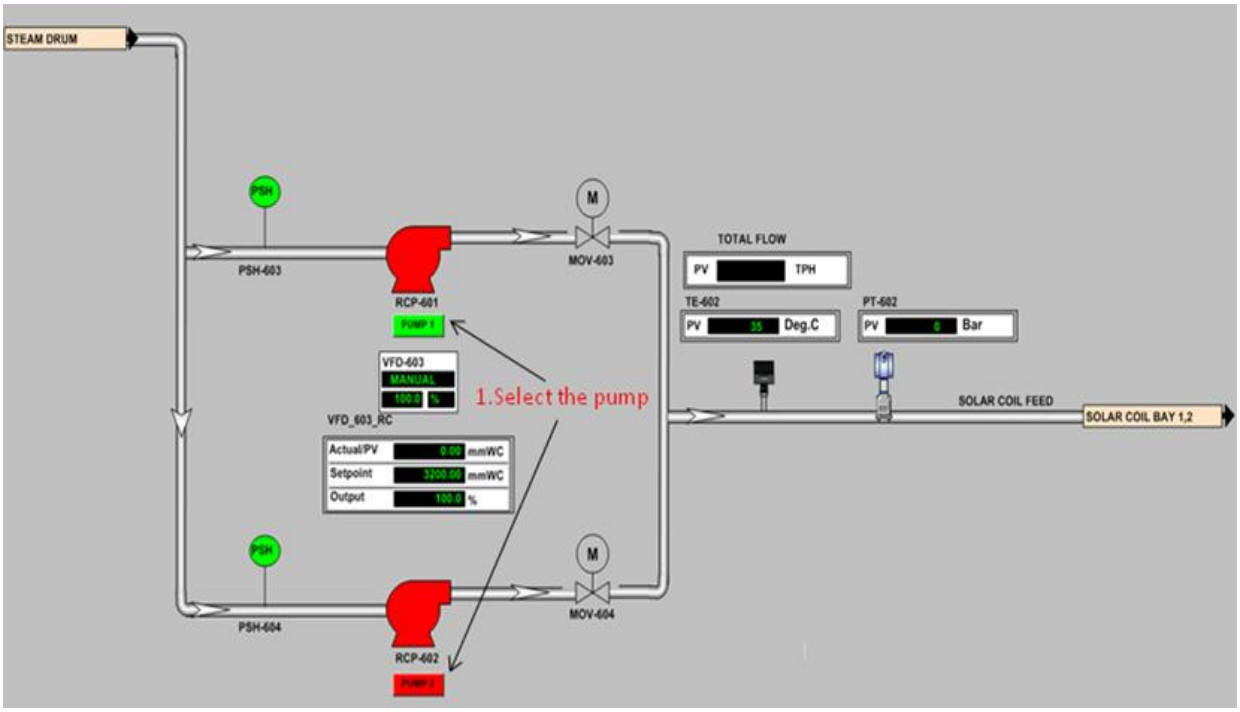
3. Select the Boiler Feed Pump



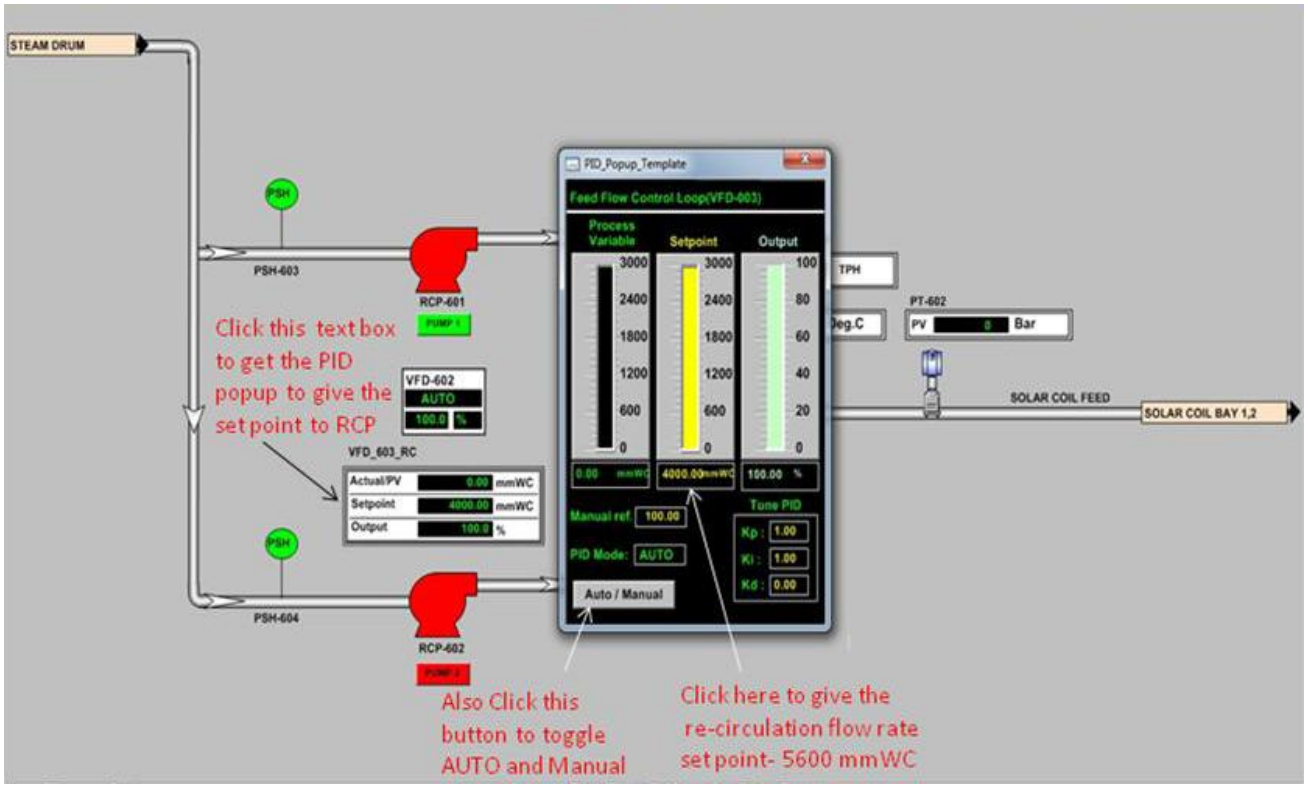
4. Bring all the Reflectors at Vertical Position



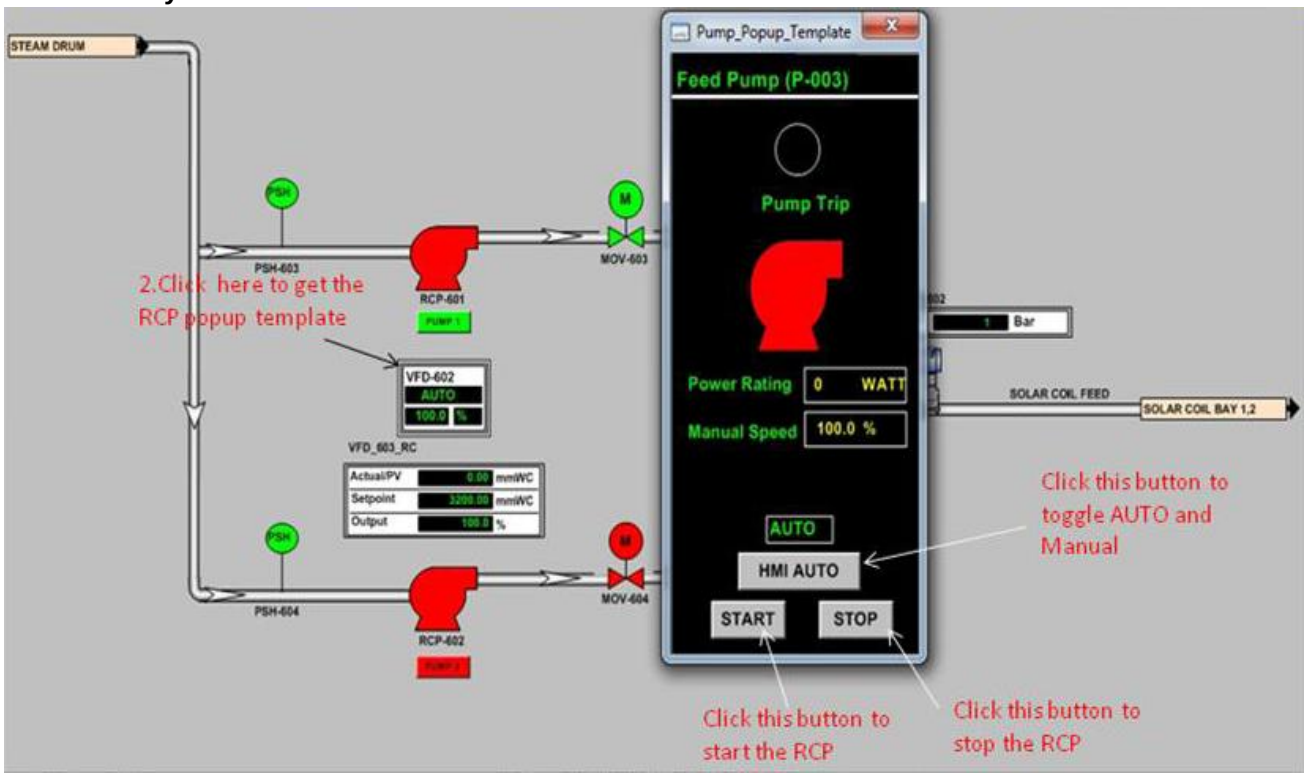
5. Select the Re-Circulating Pump



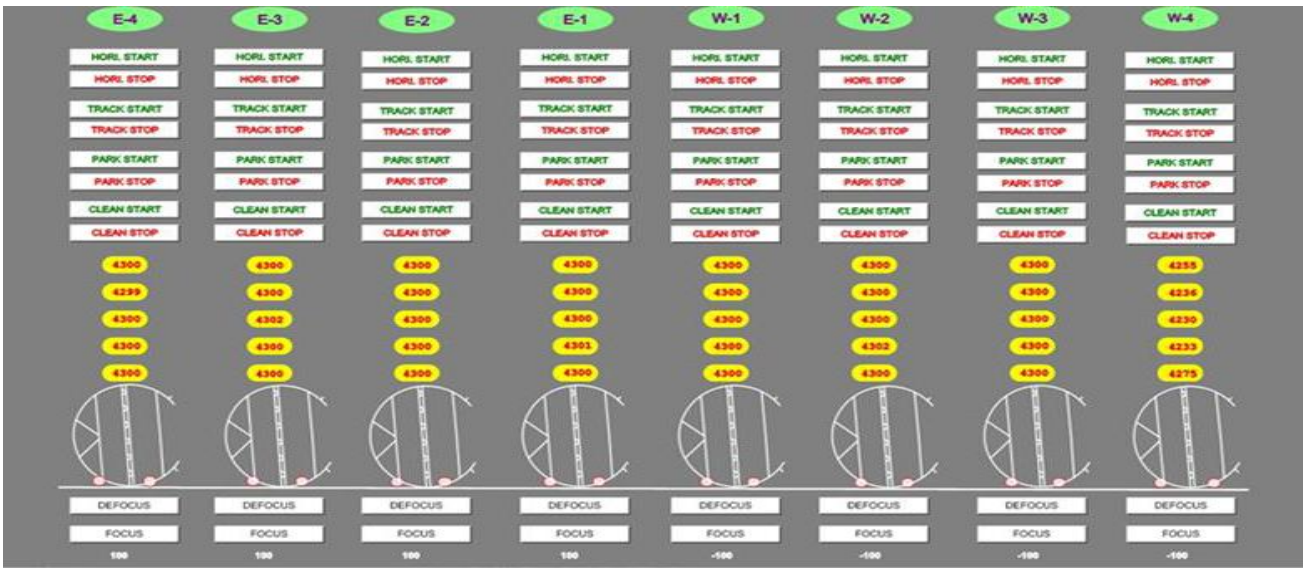
6. Set the RCP Flow Rate



7. Once the Steam Drum Level Reaches Normal Limit (System Specific) RCP will Start Automatically



8. After 15 Min of RCP Starts, Bring Reflectors on Tracking



9. Keep open the MOV and PCV of steam drum vent until steam comes, once it comes close MOV and put respective PCV at auto mode.

10. Open MOV of process

7. Shutdown Procedure

7.1. Normal shutdown

Table 8. Normal Shutdown Procedure

Sr. No.	Equipment	Action
1	Reflectors	Horizontal start
2	Recirculation Pump	OFF
3	Boiler Feed Pump	OFF
4	MOV	CLOSE
5	Reflectors	Parking (Should be done once all the reflectors are in horizontal position)
6	UPS	OFF
7	CPU Panel RTU	OFF
8	Remote Terminal Unit - RTU	OFF
9	VFD Panel	OFF
10	VFD Drive Main	OFF
11	Distribution Box (DB)	OFF
12	MOV Power Supply	OFF
13	MCB to Field	OFF
14	Analytical panel	OFF

7.2. Emergency Shutdown

Table 9. Emergency Shutdown Procedure

Sr. No.	Equipment	Action
1	Reflectors	Defocus
2	Reflectors	Horizontal start
3	Recirculation Pump	OFF
4	Boiler Feed Pump	OFF
5	MOV	CLOSE
6	Reflectors	Parking (Should be done once all the reflectors are in horizontal position)
7	UPS	OFF
8	CPU Panel RTU	OFF
9	Remote Terminal Unit - RTU	OFF
10	VFD Panel	OFF
11	VFD Drive Main	OFF
12	Distribution Box (DB)	OFF
13	MOV Power Supply	OFF
14	MCB to Field	OFF
15	Analytical Panel	OFF

7.3. Long Term Shutdown

Table 10. Long Term Shutdown Procedure

Sr. No.	Equipment	Action
1	Reflectors	Horizontal start
2	Recirculation Pump	OFF
3	Boiler Feed Pump	OFF
4	MOV	CLOSE
5	Reflectors	Parking (Should be done once all the reflectors are in horizontal position)
6	Solar Coil	Drain Out
7	Steam Drum	Drain Out
8	UPS	OFF
9	CPU Panel RTU	OFF
10	Remote Terminal Unit - RTU	OFF
11	VFD Panel	OFF
12	VFD Drive Main	OFF
13	Distribution Box (DB)	OFF
14	MOV Power Supply	OFF
15	MCB to Solar Field	OFF
16	Analytical Panel	OFF

8. Preventive Maintenance

Preventive maintenance is required on this solar energy system to maintain an optimum level of performance and to extend the life of the system.

Once every four months, visually inspect the solar energy system using the Visual Inspection and Maintenance Checklist are given below. Use the Maintenance Record Form to report a full year's inspection work.

- Controller
- Strainers
- Valves
- Solar Mirrors
- Linear Cavity receiver Window
- Tracking system
- Pumps
- Pipe Hangers & Supports

9. Solar Field

9.1. Reflector/Mirror

- Cleaning of mirrors once every three days using the DM water i.e. less than 1 PPM water will result in its high durability. Follow STP xx.

If there is lack of DM water supply for mirror cleaning at the supply points then high pressure pumps can be used. Ensure that the booster pump and the high pressure pumps are functioning properly. Notify the manufacturer if either of the pumps does not function properly.

- Reflector mirror should be replaced whenever required.

- Reflectivity of the mirrors should always be more than 90%.
- Deterioration of mirrors affects the performance of the system.
- Follow STP xx for replacement of mirrors.

9.2. Mirror Support Structure

- The galvanized steel elements of the MSS should be inspected once every **6 months** for any damages and corrosion.

In case any corrosion of the steel elements are detected; the affected area should be cleaned and zinc coating should be scrapped off with an emery paper. After scrapping this area should be cleaned with an industrial detergent and repainted with a zinc rich primer and aluminum paint or with a zinc rich aerosol. Follow STP xx.

9.3. A-Frame

- Ensure that the legs of the A-frame, steel guy wires, bolted joints and the welded joints are free from corrosion and external damages.
- The turn buckles of the guy wires should be kept properly oiled and greased. Routine check should be organized for the tightness of the guy wires once a year depending upon the climatic conditions.
- If sagging of the guy wire is noticed ensure that the hooks and accessories of the guy wire and turn buckles are intact. Afterwards tighten the turn buckle such that the guy wire does not sag and also make sure that the tightening does not deform the A-frame.

9.4. Linear Cavity Receiver

In case of low performance due to its low transmittance, clean the window glass.

- If you notice fade marks in the window glass, clean it using the DM water i.e. water with less than 1PPM will result in high durability of window glass. Follow STP xx.
- If any of the beadings are found to be burnt out, the respective beadings have to be replaced with the new beadings follow STP xx.

All the operations should be performed using a long boom crane which can reach the receiver from the service area of the solar field. Usually it requires experienced technical support. Contact the manufacturer in case any problem pertaining to receiver is detected.

9.5. Tracking System

Electronics Tracking System

- Air filter in the panel should be changed once in a year.
- Relay card contacts should be checked once in every six months and it should be changed if carbon is formed between contacts. Inform engineer/manufacturer in case of card problem.
- Periodical cleaning of the panel should be done with the help of blower.

Mechanical Tracking System

- Chains, sprockets, shafts in gear boxes and rollers have to be ensured that they are kept properly greased and oiled using any branded oil Routine check should be organized once every 3 months

- The tension on the chains and wind load arresting wire ropes is to be maintained such that the chains and wire ropes do not hinder the rotation of the reflectors.
- In case there is a derailment of the chain from the sprockets, the chains should be loosened at the ends using the chain tension mechanism and the chains should be placed in position.
- If the reflector struggles to rotate, check for mechanical resistance caused by jamming of the rollers by foreign objects or mechanical failure of the tracking system. Clear the obstacles around the rotating parts / joints to facilitate the rotation of the reflector. If the roller gets jammed due to the wear and tear of the Polyurethane (PU) coating on the roller please notifies the manufacturer.
- In case there is a mechanical deformation of the cam, notify engineer/manufacturer since it would require adjustment and to reset the alignment of the reflector.

10. Process and Instrumentation System

10.1. Pump Maintenance

Follow manufacturer's recommendations for lubrication. Tighten packing gland as required. Kindly have a look at the manual for individual pump maintenance.

10.2. Valves Maintenance

Pressure Relief Valves

Inspect pressure relief valves annually. Operate valves manually using the lift lever. Replace any valves that are frozen shut.

Check Valves

- Inspect check valves annually. Open the valve to verify that there is no erosion or corrosion, seat is not damaged, valve operates freely (does not stick), and the flapper or plunger is not pitted and has not accumulated scale.
- Replace the valve in case of any problem.

Manual Valves

- Operate all manual valves, i.e. open, close once a year. This will prevent freeze up of the valves.

Piping Maintenance

- Check all piping during visual inspection i.e. do a pipe-walk. Repair or replace torn/damaged/wet insulation. Wet insulation inside the insulating cover is sometimes hard to detect; however, puddling of collector fluid under the piping is a definite indication of a leak.
- Remove the pipe covering for several feet on either side of the puddle, it should be enough to locate the leak and perform repair activity.
- Check and adjust pipe hangers annually to ensure that they are providing proper piping support.

11. Troubleshooting

Problem 1: If mechanical systems are functioning properly but the reflectors are not tracking:

Solution: Perform the following steps:

Step 1: Check the Panel Devices

- **Check the Main power**
  - **a. Feeder to Main Junction Box**
    - Check the solar field (CLFR feeder) main power in switchyard and see whether it is in switched ON or OFF condition.
    - If it is OFF, inform to the respective field in-charge.

b. Main Junction Box to Field RTUs

- If the feeder is ON, check the contactor.
- If contactor is not picked up, check the pickup loop (see Instrumentation RTU panel wiring diagram).

c. Inside the Field RTUs

- If the contactor is ON, check power status in main terminal block (Tag ID: P, N, G) with multi-meter.
- Switch off the main selector switch on panel door if it is in ON position.

- **Check the MCB's Position (32A, 6A MCBs)**
  - Check the main MCB's position, if it is ON, indication on the right door will show the power status.
  - Check the MSS MCB's position, if it is ON then the particular SMPS will gets powered ON, if not check the MCB's condition.
  - Check the Panel 24V SMPS MCB position, if it is ON, Panel 24V SMPS will be powered ON, otherwise check the MCB's condition.

a. Check the I/O Modules power (24V SMPS)

- Check the status of Module MCB, if it is in OFF position, change the position.
- If the panel 24V SMPS MCB is ON, the modules automatically get powered ON, otherwise check the Module SMPS & Module MCB.

b. Check the Drive SMPS (48V SMPS)

If the MSS MCB is in perfect condition, then the particular drive SMPS will get powered ON, otherwise check the SMPS by using multi-meter.

Input: 230V, 50 Hz, single phase
Output: 48v, direct current

c. Check the Driver (Bipolar Stepper Drive)

If the SMPS is in perfect condition, check the Stepper Drive (fuse).

Step 2: Check the Field Devices

a. Check the Stepper Motor & Cables

Ensure that the panel devices are in perfect condition (including SMPS & Stepper Drive). Check the stepper motor and cabling in the field.

b. Check the Feedback Device I (Encoder)

To check the encoder, first check the wiring, and then check the 24V DC power supply to the encoder on the junction (inside the cable tray).

c. Check the Feedback Device II (Limit Switch)

- To check the Limit Switch, check the continuity in junction which is inside the cable tray when limit switch is pressed.

Prepared by

AnthroPower

D-66, 60 Feet Road, First Floor (Above Corporation Bank), Near Chattarpur Temple, New Delhi - 110074
Email: siva@anthropower.in Website: www.anthropower.in