INDIAN INSTITUTE OF SCIENCE
Bangalore 560012, INDIA

TENDER DOCUMENT

FOR

DETAILED DESIGN, FABRICATION, ERECTION, PROCUREMENT, INSTALLATION COMMISSIONING AND MAINTENANCE

OF

HIGH TEMPERATURE THERMAL ENERGY STORAGE SYSTEM

INDEX

1. INVITATION OF THE BIDS

1.1 Tender Details

Tender Number: **SB-1** Tender Type: Open No. of Covers: 2	Tender Date: 16.01.2018 Form of Contract: Buy

Payment Instruments

Payment Mode **Offline/Online** Instrument Type: **As per Tender Document**

Covers Information			
Cover No.	Cover Type	Description	Document Type
1	Technical	Tender Document, Pre-qualification responses Tender Fee, EMD, and Technical Specification	.pdf
2	Commercial	Commercial Bid / Price Bid	.pdf

Tender should be submitted on the schedule to tender and returned with your covering letter in the enclosed form duly signed. Tender should be sent in the sealed cover super scribed with 'Tender Number' and Due Date.

Two Bid System :

The two bid system will be followed for this tender. In this system bidder must submit their offer in separate sealed envelopes as

i. Technical Bid
ii. Commercial Bid

Separate technical bid and commercial bid envelopes should be clearly marked as

"**Envelope No. 1-Technical Bid**" and "**Envelope No. 2 - Commercial Bid**".

Both these sealed covers are to be put in a bigger cover which should also be sealed and duly **super scribed with our Tender No. & Due Date** and to be submitted to the concern department/section mentioned in tender document.

Note: The technical offer should not contain any price information. If the price quoted is submitted in technical bid the tender will be rejected at the sole discretion of IISc, Bangalore.

Initially Technical Bids will be opened and evaluated by the purchase committee. Commercial bids of only Technically qualified bidders will be opened later.

Contract/ Purchase Order will be awarded to the lowest bidder among them.

Tender Fee(INR): **500/-**	In the form of **Demand Draft** in favor of "**The Registrar, IISc, Bangalore**" payable at **Bangalore** to be submitted in Technical Bid.
Earnest Money Deposit Details	
EMD Fee (INR): **4,00,000/-**	In favor of "**The Registrar, IISc, Bangalore**" payable at **Bangalore** "Bank Guarantee" to be submitted in if the vendor is selected.

1.2 Item Details

Item Name	Item Description		
Appointment of vendor for detailed design, fabrication, erection, procurement, installation, commissioning and maintenance of high temperature thermal energy storage system	This Tender document is for 'Hybrid: Latent and Sensible heat thermal storage system for medium and high temperature CSP applications'. We are offering a complete turnkey project and looking for a vendor who can offer their services for the complete execution of the project from the design stage till the commissioning of the project with frequent operation and maintenance activities. The contractor will doing the detailed design engineering in close coordination with the team from IISc Bangalore and IISC Bangalore and the design must be signed off by both the contractor side and finally by the principal investigator of the project from IISc Bangalore. Once the design stage is complete, the contractor should start doing the manufacturing and fabrication of the project equipments with frequent updates regarding the progress of the project to the project coordinator at the IISc Bangalore and IISC Bangalore (can be done weekly). The clients will also be visiting the vendors manufacturing shop for the visual inspection and will prepare a report related to the progress whether it is satisfactory or not.		
Pre Qualification: Period of Work/ Delivery Period:	**As per Tender Document** **3.8 Years**	Bid Validity (Days)	**180**

1.3 Critical Dates

Bid Submission End Date Time	**15.02.2018** **5.00 pm.**	Bid Opening Date Time	**TBA** TBA
Place of Submission	**Prof. Saptarshi Basu** **Department of Mechanical Engineering** **IISc Bangalore – 560012** **Office- 080-22933367** **Mobile- 91-7760808825**	Bid Opening Place	**TBA**

1.4 Important Contacts

Technical Clarification: Name: Dept: Email: Contact No.	 **Prof. Saptarshi Basu** **Dept. Of Mechanical Engineering** **sbasu@IISc.ac.in** **saptarshibasukol@gmail.com** **Office- 080-22933367** **Mobile- 91-7760808825**
Tender Inviting Authority Name: Address: **Date: ----------**	 **Registrar** **IISc, Bangalore** **Bangalore-400076, India** **Signing Authority:** **Registrar**

2. PREQUALIFICATION CRITERIA

Pre-qualification criteria and process along with details and format of data to be submitted for selection:

Two bid system will be followed wherein the technical bids will be opened first and evaluated. Bidders whose technical bids are acceptable as per the selection criteria (elaborated below), will be considered for opening of the respective commercial bids. Detailed format for the data to be submitted for the technical bid is given below:

1. Bidder should have well established own establishment (**Enclose Company Registration Certificate**)
2. Bidder quoting as a consortium of entities shall provide documentary evidences (**letter from each entity / MOU / board resolution** etc.) of such consortium along with the technical bid. The document forming the basis of the consortium shall explicitly state the division of the various works involved in this bid between the members of the consortium. The bidder shall not make any change in the consortium until successful completion of the contract.

3. The bidder on its own should have successfully executed at least one designing, fabrication, erection, commissioning and maintenance project of high temperature molten salt closed loop liquid system or similar type projects value not less than Rs .50 Lakhs during last 5 (five) years ending 31st Dec 2017 involving mechanical, electrical, instrumentation controls and civil works. (**Self declaration-Annexure-2**)

4. The bidder on its own or through its consortium partner / s should have successfully executed minimum 2 projects involving manufacturing of specialized equipment / machinery with high degree of skills and accuracy of millwright fitting (normally expected machine tolerances) for equipment / machinery with large dimensions.
5. The bidder on its own or through its consortium partner / s should have successfully executed minimum 3 projects involving procurement, supply, and installation and commissioning of PLC systems with SCADA or similar automation technology (like DCS).
6. Bidder (including all consortium partner /s) shall submit information sought below of successful completion of the works meeting the criteria stated above and other works executed in the last three years. A purchase committee may also choose to get the feedback from bidder's client to check the fulfilment. Following information / documents shall be provided of the works executed. (**Annexure-3)**

a. Name of the client with corporate address, site address

b. Name of contact person/s and phone/email of the contact person

c. Description and scope of job (mechanical, electrical, instrumentation controls and civil works, manufacturing of specialized equipment / machinery with high degree of skills and accuracy of the millwright fitting (normally expected machine tolerances), procurement, supply, and installation and commissioning of PLC systems with SCADA or similar technology like DCS)

d. Order value in Indian Rupees

e. Year of start and job completion

6. Documentary evidence provided, like copy of POs, reports, appreciation letters; etc.Bidder (including all consortium partner /s) shall submit financial statements such as balance sheets and P&L statements of the last 3 financial years.
7. The Bidder should not be currently blacklisted by any institution, bank in India or abroad (**Self declaration-Annexure-4)**
8. The Bidder should accept tender terms & conditions (**Annexure-5)**
9. The decision of the purchase committee on the eligibility of the bidder shall be final and binding on the bidder.

Note: **Compliance requirements checklist satisfying above criteria must be submitted as per the format in "COMPLIANCE REQUIREMENTS CHECKLIST" added to Technical Bid, without which tender will be rejected.**

Commercial bid:

All bids qualifying the prequalification criteria will be stand eligible for opening of commercial bid.

Bidder with lowest commercial bid will be awarded the contract.

3. INSTRUCTIONS TO BIDDERS

Preparation and Submission of offers:

- The Quotation MUST BE ENCLOSED IN A SEALED COVER super scribing Tender number / due date & should reach the undersigned on or before due date mentioned in the tender notice. If the quotation cover is not sealed, it will be rejected.
- Tender should be dropped in the tender box kept in the office of concerned Department / Section or to Indenter. No tender is to be handed over to our staff personally unless otherwise specified. All communications are to be addressed to the undersigned only. In case due date happens to be holiday the tender will be accepted and opened on the next working day.
- The bid can be submitted in person or through post/ courier (IISc Bangalore shall not be responsible for any postal delays or any other reason for not submitting the bid in the specified time and resulting in disqualification / rejection of any bid) so as to reach on or before the due date and time.
- Leaflets, catalogue, additional information, etc. should be sent invariably so that a proper evaluation of the equipment offered is possible.

Cost of Bidding:

- The Bidder shall bear all costs associated with the preparation and submission of its Bid and the Purchaser shall not be responsible or liable for those costs regardless of the conduct or outcome of the bidding process.

Validity of the Bid:

- 180 Days from the last date of submission of bid.

Amendment of Bidding Documents:

- At any time prior to the deadline for submission of bids, IISc Bangalore may, for any reason, whether on its own initiative or in response to the clarification request by a prospective BIDDER may modify the bid document.
- All prospective BIDDERs who have downloaded the bidding document may visit IISc Bangalore, website for amendments / modifications which will be binding on them.

Deadline for Submission of Bids

- Bids must be received by IISc Bangalore before the due date and time at the address specified in the tender document. In the event of the specified date for the submission of bids being declared as a holiday for IISc Bangalore the bid closing deadline will stand extended to the next working day up to the same time.

Late Bids:

- IISc Bangalore will not be responsible:
    i) For delayed / late quotations submitted / sent by post / courier etc.

    ii) For submission / delivery of quotations at wrong places other than the mentioned in the tender.
    iii) Fax / Email / Telegraphic / Telex tenders will not be considered.
    iv) Any bid inadvertently received by IISc Bangalore after the deadline i.e. due date & time for submission of bids, will not be accepted and returned unopened to the BIDDER.

Supplementary offer /Modification of Original Bid:

- Tender submitted against Notice Inviting Tender (NIT) shall not be returned in case the tender opening date is extended/postponed. BIDDER desirous to modify their offer/terms may submit their revised/ supplementary offer (s) within the extended Tender Opening Date (TOD) by clearly stating to the extent of updation done to the original offer. The purchaser reserves the right to open the original offer along with the revised offer.

Confidentiality:

- Information relating to the evaluation of Bids, and recommendation of Contract award, shall not be disclosed to Bidders or any other persons not officially concerned with such process until information on Contract award is communicated to all Bidders.
- Any attempt by a Bidder to influence the Purchaser in the evaluation of the Bids or Contract award decisions may result in the rejection of its Bid.
- Notwithstanding, from the time of Bid opening to the time of Contract award, if any Bidder wishes to contact the Purchaser on any matter related to the bidding process, it shall do so in writing.

Deviation, Reservations and Omissions:

- During the evaluation of Bids, the following definitions apply:

  i. "Deviation" is a departure from the requirements specified in the Bidding Documents;
  ii. "Reservation" is the setting of limiting conditions or withholding from complete acceptance of the requirements specified in the Bidding Documents; and
  iii. "Omission" is the failure to submit part or all of the information or documentation required in the Bidding Documents.

Correction of Arithmetical Errors:

- Provided that the Bid is substantially responsive, the Purchaser shall correct arithmetical errors on the following basis:

a) If there is a discrepancy between the unit price and the line item total that is obtained by multiplying the unit price by the quantity, the unit price shall prevail and the line item total shall be corrected, unless in the opinion of the Purchaser there is an obvious misplacement of the decimal point in the unit price, in which case the line item total as quoted shall govern and the unit price shall be corrected;

b) If there is an error in a total corresponding to the addition or subtraction of subtotals, the subtotals shall prevail and the total shall be corrected; and

c) If there is a discrepancy between words and figures, the amount in words shall prevail, unless the amount expressed in words is related to an arithmetic error, in which case the amount in figures shall prevail subject to (a) and (b) above.

Bidders shall be requested to accept correction of arithmetical errors. Failure to accept the correction in accordance with the same shall result in the rejection of the Bid.

Evaluation of Bid:

- IISc Bangalore will evaluate technical and commercial acceptable offers on landed net Price basis.
- In case any BIDDER is silent on any clauses mentioned in this tender documents, IISc Bangalore shall construe that the BIDDER had accepted the clauses as per the invitation to tender no further claim will be entertained.
- No revision in the terms and conditions quoted in the offer will be entertained after the last date and time fixed for receipt of tenders.

Corrupt & Fraudulent Practices:

- IISc Bangalore requires that bidders, suppliers, contractors and consultants, if any, observe the highest standard of ethics during the procurement and execution of such contracts. In pursuit of this policy,

    A. The terms set forth below are defined as follows:

        i) "Corrupt practice" means the offering, giving, receiving, or soliciting, directly or in directly, of anything of value to influence the action of a public official in the procurement process or in contract execution;
        ii) "Fraudulent practice" means a misrepresentation or omission of facts in order to influence a procurement process or the execution of a contract;
        iii) "Collusive practice" means a scheme or arrangement between two or more bidders, designed to establish bid prices at artificial, non-competitive levels; and
        iv) "Coercive practice" means harming or threatening to harm, directly or indirectly, persons or their property to influence their participation in the procurement process or affect the execution of a contract;

    B. IISc Bangalore will reject a proposal for award if it determines that the Bidder recommended for award has, directly or through an agent, engaged in corrupt, fraudulent, collusive or coercive practices in competing for the Contract in question.

Communication for Nonparticipation of Tenders:

- For registered vendors with IISc Bangalore, in case you choose not to participate in the tender a regret letter by way of fax/letter/email may be submitted before the due date duly super scribing "**Regret**" and tender No. If no communication received by the due date and time, it shall be inferred that you are not interested in participation and your name is liable to be removed from the vendor's list.

Cancellation of Tender:

- Notwithstanding anything specified in this tender document, Purchaser / IISc Bangalore in his sole discretion, unconditionally and without having to assigned any reasons, reserves the rights:

    a) To accept OR reject lowest tender or any other tender or all the tenders.
    b) To accept any tender in full or in part.
    c) To reject the tender offer not confirming to the tenders terms.
    d) To give purchase preference to Public Sector undertakings when applicable as per Govt. Policy/ Guidelines.

Offer which deviates from the vital conditions (as illustrates below) of the tender shall be rejected:

    e) A nonsubmission of complete offers.
    f) Receipt of offers after due date and time and or by email / fax (unless specified otherwise).
    g) Receipt of offers in open conditions.

Price Bid:

- Bid Prices MUST BE SUBMITTED IN ENCLOSED PRICE BID FORM ONLY.
- If the price is not quoted in Price Bid Form provided in tender document then, IISc Bangalore will reject bid. If supplier wishes to give pricing details may be attached in separate sheet.
- Any new taxes and duties liable on the subject contract due to change in legislation during the contract period shall be reimbursed subject to the applicability of the said act to the satisfaction of the purchaser and the production of documentary evidence after availing of statutory concession, benefits etc.
- The supplier shall pay and bear all other liabilities, taxes and duties not specifically agreed by the Purchaser in the contract.
- VAT/Other Govt. Taxes: Excise Duty (ED), other taxes, levies, like Service Tax (ST), Education Cess, etc., are to be indicated separately. BIDDER should mention Central and State Sales Tax/VAT Registration, PAN Number are to be necessarily indicated in the offer.
- We are not authorised to issue any Sales Tax forms.

Legal Matter:

All Domestic and International disputes are subject to Bangalore Jurisdiction Only.

Transfer and Subletting:

- The seller shall not sublet, transfer, assign or otherwise part with the acceptance to the tender or any part thereof, either directly or indirectly, without the prior written permission of the Purchaser.

Force majeure:

- Force Majeure will be accepted on adequate proof thereof.

Penalty/ Liquidated Damages:

- Timely delivery is essence of the contract and hence if any consignment be delayed, liquidated damages at the rate 0.5% of the price of the delayed consignment, for each week or part whereof shall be levied and recovered subject to maximum of 10% of total purchase order value.
- IISc Bangalore reserves the right to cancel the order in case the delay is more than 10 weeks. Penalties if any will be recovered by forfeiting PBG.

4. TERMS AND CONDITIONS

1. Detailed Design, fabrication, erection, procurement, installation, commissioning and maintenance of "High temperature thermal energy storage system" shall be a FIXED PRICE Lump sum Contract.

2. Bidder shall ascertain all work item quantities in conformity to Tender requirements and quote FIXED Lump sum PRICE. The price shall be inclusive of designing, fabrication, erection, procurement, installation, automation, commissioning and maintenance including all labour costs, taxes, duties, charges, loading, unloading, transport, storage, safe-keeping, insurance, statutory payments towards material and labour etc. The bidder shall also submit prices of cost drivers as sought in the price bid. For successful bid, the prices shall remain firm for the entire duration of the contract including any extension thereof.

3. It is not the intent to specify herein all aspects of engineering and construction. The Bidder shall provide all materials, equipment and services, specified or otherwise (unless specifically excluded) which are required to fulfil the intent of ensuring operability and the reliability of the complete system covered under this specification.

4. The bidder shall submit Quality Assurance Plan for all items of supply and execution along with the bid document. However, such plan shall not be limiting / binding on the client for the bidder's supplies / work to meet the stated / required quality of work and shall be duly extended as per instructions and requirements to ensure compliance with the requirements and specifications.

5. The bidder shall not state any clarifications, assumptions in the offer. Clarification, if any required, shall be obtained by the bidder before submission of the bid.

6. Any failure on the part of the bidder to progress with / complete the work / rectify work defects as per schedule will entitle the client to deploy resources as required to complete the work and recover all such costs towards deployment of the resources at twice the cost incurred by the client from pending bills or the security deposits of the contractor. The decision of the client in this regard shall be final and binding on the contractor.

7. The contractor should provide comprehensive warranty for any operational malfunction of the equipment for a period of 2 years. A replacement for the same must be provided as soon as possible.

8. Frequent maintenance and service of equipment are also required from the contractor side for duration of 2 years. The maintenance checks must be approved by the project coordinator from IISc Bangalore, IIT Bombay.

Bidder shall also furnish Item Rates and amount against all "Cost Driver Items of Price Bid". This shall form basis to arrive at compensation towards additional work ordered / reduction for deleted work, if any.

Detailed phased payment schedule linked to the deliverables along with expected time line is mentioned below.

Delivery linked payment schedule

Sr. No	Key Deliverables	Payment (%)	Delivery in Weeks from PO Date
1	Analysis report (includes calculations, simulations and satisfying standards) of the entire thermal storage system. Completion of design document of molten Salt Storage-PCM hybrid Loop along with PLC based control system. Detailed engineering drawing (CAD drawing) and specifications of equipments, piping, and instrumentation diagram. Hazop Analysis certified by third party (**PART-1**)	35 %	8 months
2	Fabrication of different components of the thermal storage system along with procurement of necessary equipments as per the specifications of Part 1. (**PART-2**)	30 % (release of payment can be made in instalments according to the percentage of completion of the job)	1.2 years
3	Installation, commissioning and successful testing of automated (PLC control) thermal energy storage system. (**PART-3**)	30%	1.8 years
5	Project support and maintenance	5 % (paid in equal quarterly instalments)	1.8-3.8 years

The bidder should quote in the above schedule, the period of Delivery from PO Date for Key Deliverables Listed so as to fit within an overall delivery period as mentioned in the above schedule from the date of Letter of intent / PO whichever is earlier. The overall delivery period shall be inclusive of design, procurement, fabrication, erection, testing, pre-commissioning, automation, commissioning, documentation and training etc.

5. TECHNICAL BID

5.1 Project Description

This project aims towards development and set up of a lab scale 20 KWh novel thermal energy storage system in which the energy is stored in different ways, for example, in molten salt, various PCM etc.

The description of the whole system and individual subsystem is given in the following section in detail.

System, subsystems and their description with operation sequence of each

Under the current project, we are integrating two subsystems for use as thermal energy storage. The two subsystems are:

- Molten salt based thermocline energy storage system with inclusion of nanoparticles using thermosyphon effect (20 KW capacity).
- Thermal energy storage system using encapsulated phase change material (PCM) as the storage medium (2-5 KW capacity).

Figure 1 shows the schematic of the whole storage system under study. The above two subsystems are further described individually to get more clarity.

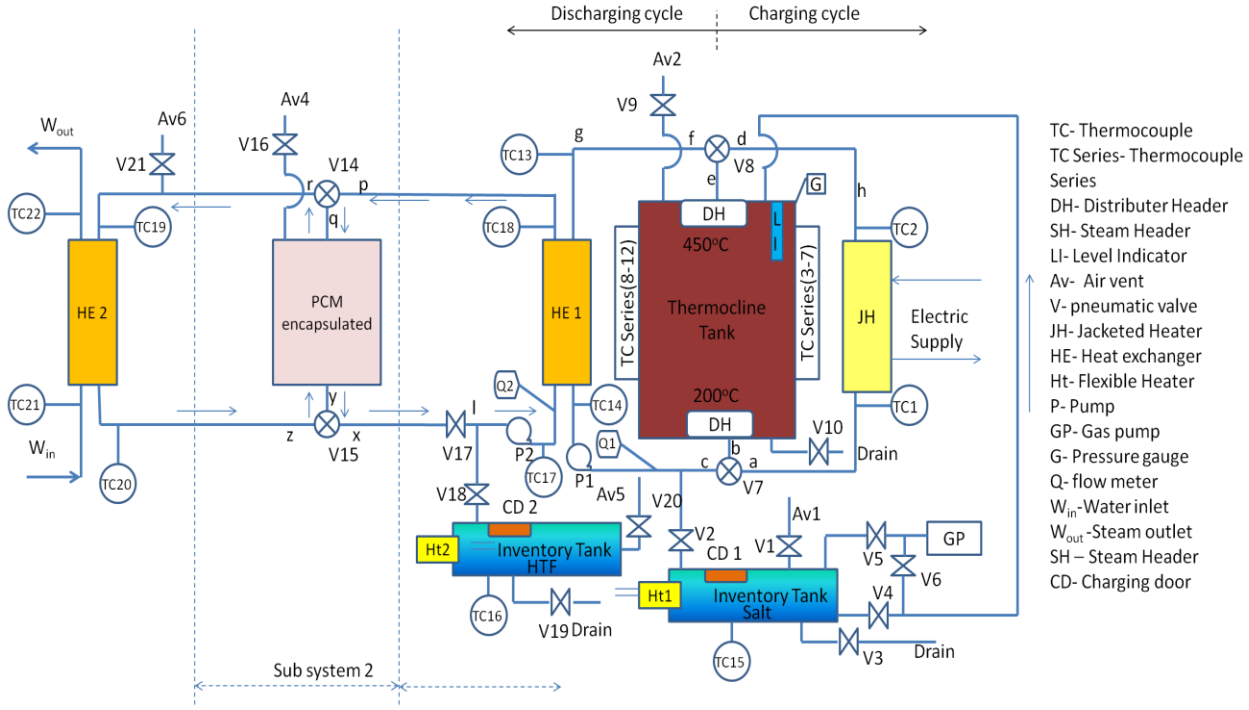


Figure 1: Schematic of the storage system as a whole

5.1.1 *Molten salt based thermocline energy storage system with inclusion of nanoparticles using thermosyphon effect (20 KW capacity)*

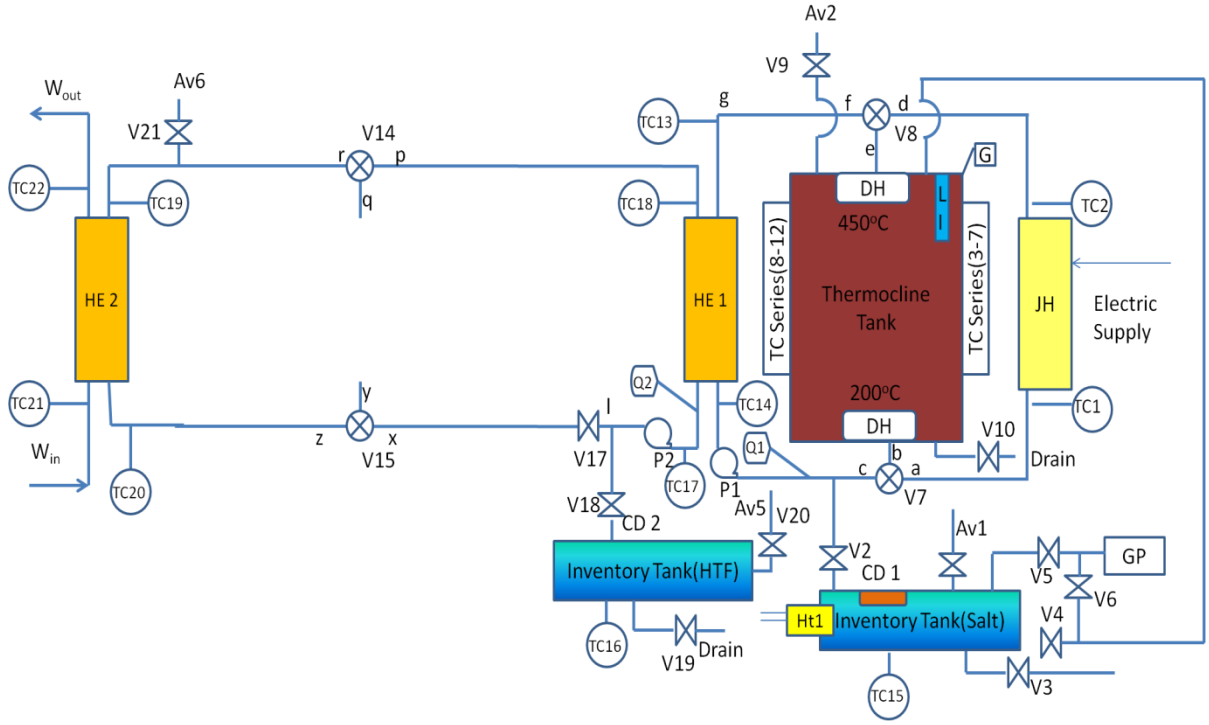


Figure 2: Schematic of the thermocline energy storage system

The abovementioned subsystem is the requirement from IISc Bangalore side, headed by **Professor Saptarshi Basu**. All the energy requirements will be met after extracting heat from the above-mentioned system. Under the current subsystem, we are aiming to design and develop a 20 KW molten salt based thermocline energy storage system with inclusion of nanoparticles and using thermosyphon effect. Thermocline energy storage system is showing a promising future for the storage of energy and also reduces the cost of two tank storage system. In a thermocline energy storage system, the storage medium (molten salt) is kept at two different temperatures in the same tank. The hot and the cold fluid are separated due to buoyancy forces (density difference) only. The process of energy exchange consists of a cycle which includes two phases namely Charging and Discharging phase. During the charging phase, the hot fluid (molten salt here) takes the heat from the solar field and is stored in a tank for use when the sunlight is not available. During discharging phase, the hot fluid stored in the tank is used to extract energy and generate power. A schematic of the molten salt thermocline energy storage system is shown in Figure 2.

Thermocline Storage System with Thermosyphon

The current subsystem proposes a very unique idea in which, the energy storage during charging is done without the help of any prime mover (excluding pump). As the cold fluid (the fluid at a lesser temperature) at the bottom of storage tank takes heat from the heaters or solar field, it moves upwards automatically due to density difference. This phenomenon is called thermosyphon effect and is used for the charging of the thermocline tank in our present system. During discharging process, the hot fluid will be taken from the top of the storage tank and after energy discharge, will come back as a cold fluid from the bottom of the storage tank. So we need a pumping system for the discharging process for which we can incorporate a pump at the inlet of the storage tank at the bottom.

Thermal Storage Tank design parameters and calculations

Inventory of molten salt available: 700 Kg

Mass flow rate of the molten salt taken = 0.1 kg/sec

Time for which the tank can be used for discharging = 700/0.1 sec

T = 7000 sec

Taking the total usable mass of molten salt that can be stored in tank for charging = 650 Kg

Volume of molten salt = 650/ρ

Where

ρ = density of molten salt

ρ = 1756 Kg/m3

Volume = 0.370 m3

Considering a cylindrical tank with an aspect ratio of 2:1 we get,

Diameter of the tank d = 0.61 m

Height of the tank H = 1.23 m

Provision of distributor heads or the plenum inside the storage tank

We will be requiring two distributor headers or plenums (upper and lower) inside the storage tank. The main purpose of the distributors will be to maintain uniform flow of the molten salt across the cross section of the tank and to avoid the splashing of the inlet salt with the molten salt present inside the tank; else the thermocline formation will be effected. A suitable wire mesh (honeycomb structure) needs to be mounted after the distributor plate for smooth functioning of the thermocline. Figure 3 shows the location of distributors inside the storage tank.

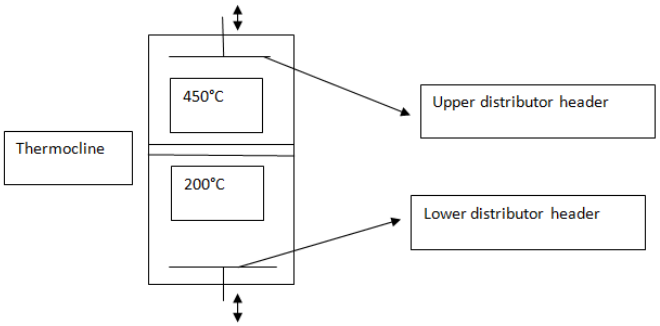


Figure 3: Location of distributors inside the storage tank

Note: Preliminary design is under IISC scope. However, matching the same with respect to the actual system is completely in vendor scope. The vendor must utilize his own experience to come with better design.

Charging and discharging operation of the thermocline system

Charging Mode sequence:

Figure 4 shows the charging mode operation of thermocline storage tank with flow direction (red arrow).

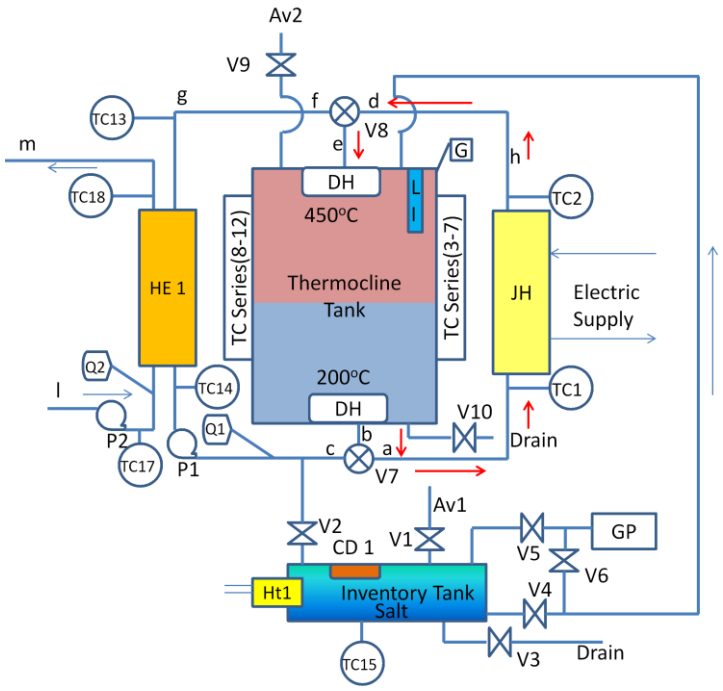


Figure 4: Charging mode operation of thermocline storage tank with flow direction

- V7, V8, V14 and V15 are 3 way valves, such that at a particular instant any two directions can be connected.
- Close V2 and open Av1, V3, V4 and Av2.
- Open V5 and start Argon Gas pump, to flush out the air from the inventory tank and molten salt line.
- Close Av1, V3, V4 and V5.
- Open V2.
- Connect b,c and f,e side of the V7 and V8 valves respectively.
- Open V5 to drain out air from the storage tank and pipeline b,c,g,f,e.
- Close V5.
- Connect b,a and f,d side of the valves V7 and V8 respectively.
- Open V5 to flush out air from pipeline d,h,a through the storage tank.
- Now, it can be ensured that whole of the air, from the storage tank and pipelines, is evacuated.
- Close V5, V2.
- Open charging door CD1 and pour raw salt into the inventory tank. After filling close the door.
- Start heater HT1, so that the molten salt can be melted to cold operating temperature (200°C).
- After ensuring the molten salt is reached at 200°C, stop HT1.
- Start the line heaters for the loop a-h-d-e-b and line f-g-c.
- Connect b,a and d,e side of the valves V7 and V8 resp.
- Open V4 and V5 to start filling molten salt inside the storage system and piping b-a-h-d-e.
- Once the above loop is filled as shown be the level indicator LI, connect c,a and f,d side of V7 and V8 valves to ensure that line f-g-c is also filled with molten salt .
- Close Av2, V4 and V5.

- Start the jacketed heater and gradually increase the load in steps of 400 W.
- This will make the thermosyphon effect to take place and charging will start.
- Slowly the thermocline will start to form and move downwards.
- After the molten salt inside the storage tank is at 450°C, charging is said to be completed. Scope of work

Discharging mode sequence:

Figure 5 shows the discharging mode operation of thermocline storage tank with flow direction (red arrows).

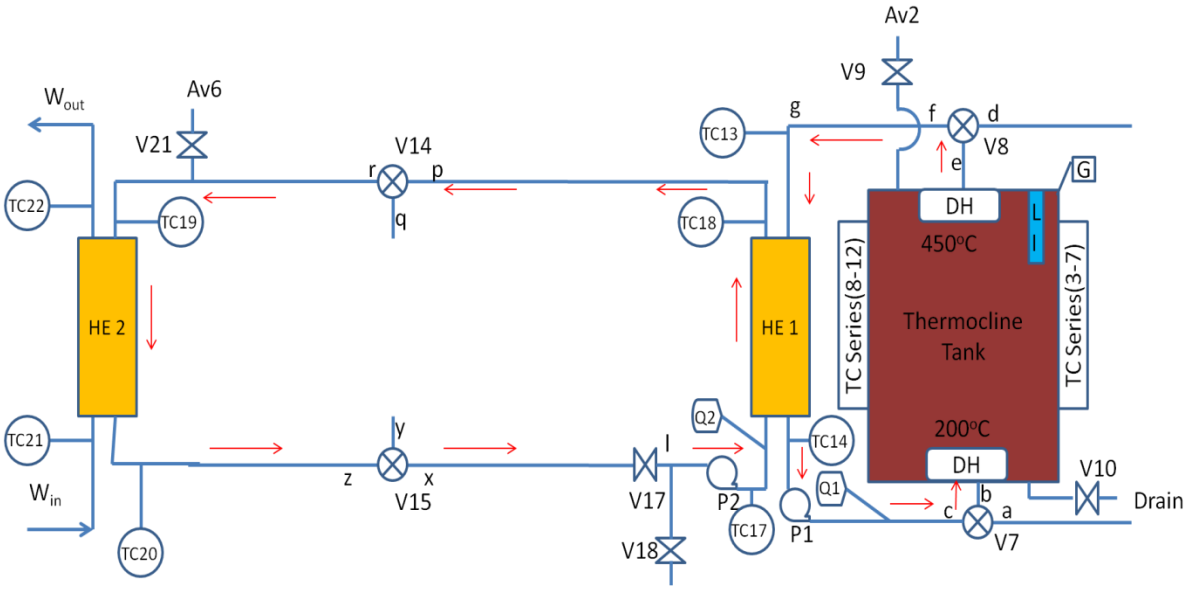


Figure 5: Discharging mode operation of thermocline storage tank with flow direction

- Connect c,b and f,e side of the V7 and V8 valves resp.
- Open CD2, Av5 and fill the HTF inside the inventory tank for HTF.
- Close Av5 and CD2.
- Open V18, V17 and Av6.
- Connect (p,r) and (z,x) of valves V14 and V15 resp.
- Start the pump P2 and fill the HTF inside the line m-o-p-r-z-x-u-s-l.
- Close V18 after the HTF is filled.
- Now start the pump P1, extracting hot molten salt from the top at ‘e’ port.
- The hot molten salt will deliver its energy in the form of heat to the HTF.
- The HTF in turn will flow across the HE2 and will reject the heat taken from the molten salt.
- The cold molten salt will come through the bottom of the storage tank at ‘b’ and will start forming thermocline moving upwards.
- When the whole of the storage tank is at a temperature of 200°C, the discharging is said to be complete.

5.1.2 Thermal energy storage system using encapsulated phase change material (PCM) as the storage medium (2-5 KW capacity)

Figure 6 shows the schematic of encapsulated PCM based energy storage system.

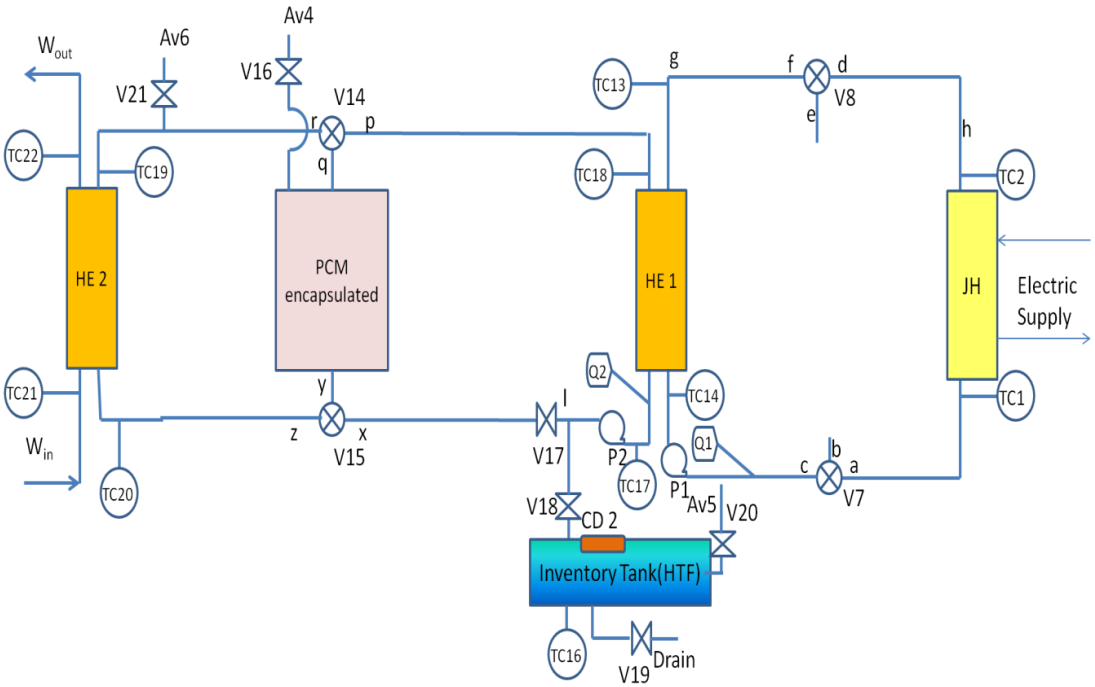
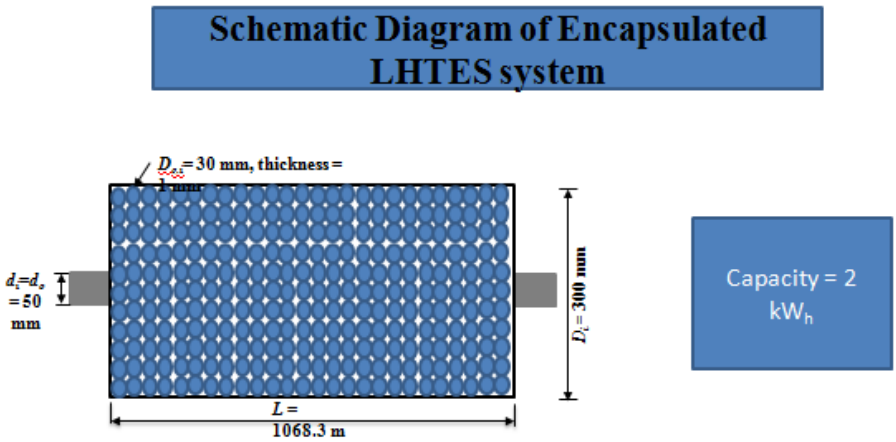


Figure 6: Schematic of encapsulated PCM based energy storage system

The abovementioned subsystem is the requirement from IIT Bombay side, which is headed by **Dr. Sandip Kumar Saha**. The above system takes the advantage of the encapsulated phase change material as the storage medium. The PCM material will be stored inside encapsulated balls made up of SS316 material and will store energy in the form of latent heat. The setup for this storage subsystem consists of a storage tank, inside which SS balls are distributed according to the power rating of the system. The operational cycle of the system consists of two phases namely charging and discharging. During the charging phase the hot HTF delivers its energy to the PCM thereby melting it and storing the energy in the form of latent heat, while during discharging, the same HTF but cold, takes away the latent heat from the PCM capsules and delivers it to the required space.

Following are the specification of the subsystem as received from IIT Bombay side:



Design Parameters

Capacity	**2 kW_t**
Power generation extension	**3600 s**
Technology	**Encapsulated Phase Change Materials**
Phase Change Material	**A164 (Melting temperature = 168.7 °C)**
Encapsulation Material	**SS316**
Porosity	**0.386**
Outer diameter of Capsules	**31 mm (for both the materials)**
Inner diameter of Capsules	**30 mm**
Operating temperature range	**170 -300 °C**
Pressure drop across the storage system	**0.549 bar**
Diameter of storage system	**0.3 m**
Height of storage system	**1.068 m**
Number of balls	**1700**
Inlet and outlet diameters of storage system	**d_i = 50 mm and d_o = 60 mm**
Storage system material	**SS316**
Thickness of sheet of storage system	**20 mm (350 °C, 25 bar, joint efficiency factor for division 1: 0.85, division 2: 1, vessel thickness as per ASME Sec VIII, standard ASTM)**

Charging and discharging of the storage subsystem

Charging mode sequence:

Figure 7 Charging mode operation of encapsulated PCM storage tank with flow direction (red arrows)

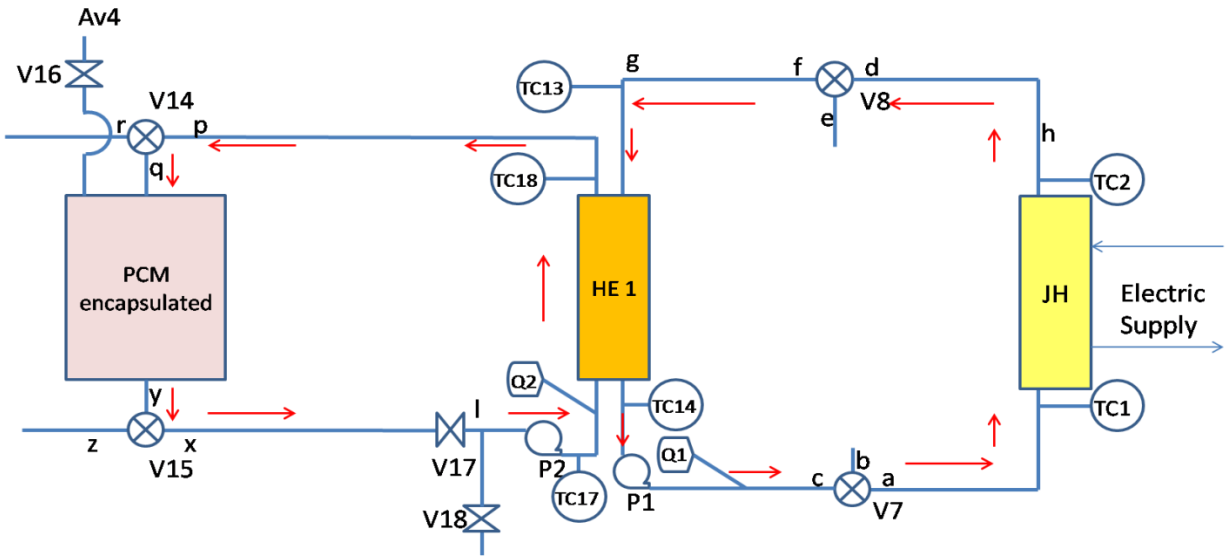


Figure 7: Charging mode operation of encapsulated PCM storage tank with flow direction

- After the air has been evacuated from the pipelines and storage tank, fill the molten salt inside the storage tank and the pipelines.
- Once the above procedure is completed, we will be ensured that the loop a-h-f-g-c is full of molten salt at cold temperature (200°C).
- Now we can start the charging of encapsulated PCM storage system.
- In order to do so, first ensure all the flexible heaters wrapped around the molten salt pipeline are working properly.
- Connect (c,a), (d,f), (p,q) and (y,x) side of valves V7, V8, V14 and V15 resp.
- Open V17.
- Start jacketed heater and gradually increase the load as per demand of temperature at inlet in steps of 400 W.
- Start the pump P1 and P2 such that the flow of molten salt and HTF in both the loops is started.
- The HE1 will now create exchange of heat from the molten salt to the HTF.
- The HTF in turn will deliver this heat via another heat exchanger inside the storage system, thereby starting the charging of the system.
- Once the whole system comes to the inlet temperature, we can say that the charging has been done.
- After the charging is done, switch off the jacketed heaters, P1, P2 and close valve V17.

Discharging mode sequence:

Figure 8 Discharging mode operation of encapsulated PCM storage tank with flow direction (red arrows).

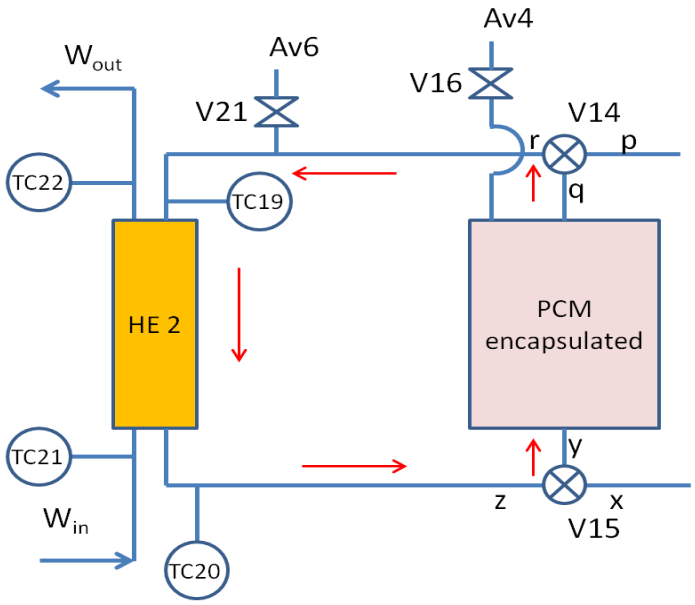


Figure 8: Discharging mode operation of encapsulated PCM storage tank with flow direction

- After ensuring that the HTF is in the loop zyqr, we can start the discharging process.
- Connect z,y and q,r side of valves V15 and V14 resp.
- Start the pump P2.
- This will start the process and the HTF will start absorbing heat from the PCM storage system and will give away the same heat to the water based heat exchanger HE2.
- Once HTF and the PCM storage system, both are at the same temperature then there will not be any heat transfer and hence the discharging is said to be complete.

[Additional information for some specific items and activities are provided in Annexure-10]

5.2 Scope of Work

The scope shall include all systems and units as shown in the overall layout of the project in the Figure 1.

The work includes:

Part 1: Design document and analysis report of automated molten Salt Storage-PCM hybrid Loop system

[Note: All the designs, drawings and specifications must be certified by third party experienced consultants]

1. Document PFD in line with client input
2. Design Basis
3. Document Technical Specifications of "Molten Salt and PCM" in line with client input
4. Document Technical Specifications of "Heat Transfer Fluid" in line with client input
5. Develop P & ID in line with PFD and client input
6. Evolve Control Philosophy
7. Evolve Start up and Shut down Process
8. Evolve Block Equipment Layout
9. Present P & ID for HAZOP Study (Should be validated by a certified third party)
10. Update P & ID in line with Safety Precautions Recommended under HAZOP Study
11. Equipment Specifications / Manufacturing Drawings (CAD)
    - i. Thermocline Tank with Distributer Header
    - ii. Inventory Tank Salt with Flexible Heater Ht1
    - iii. Inventory Tank HTF with Flexible Heater Ht2
    - iv. Cylindrical Vessel for PCM
    - v. Heat Exchanger 1
    - vi. Heat Exchanger 2
    - vii. Jacketed Heater
12. Heat Loss and Thermo-Syphoning Calculations
13. Tank Nozzle Orientation
14. Equipment Layout Suitable for Skid Mounted Plant
15. Skid Foundation Drawing with BOQ
16. Piping Layout, Extracted from 3D Model
17. Piping MTOs
18. Pipe Stress Analysis
19. Electrical Load List
20. Electrical Single Line Diagram
21. Electrical Cable Tray Layout
22. Earthing Layout
23. Electrical MTO
24. Control System I/O List
25. Instrument Cable Tray Layout
26. Instrument MTO
27. Project Implementation Planning.

Note: Vender will search Third Party, only for certification, and will mention the payment towards Third Party as an optional item, separately, including in the price bid. However, all equipments and process have to be validated from vendor's end.

Part 2: Fabrication of different components of the thermal storage system along with procurement of necessary equipments

1. Fabrication of Components, Subassemblies.
2. Monitor QA and QC Plan for all Fabricated Components and Subassemblies.
3. Monitor Delivery Acceptance Tests.
4. Monitor Procurement / Manufacturing / Transport Activity Progress.
5. **Procurement of equipment and accessories as per design Specifications**:
    a. Salt Pump P1, HTF Pump P2 and Gas Pump
    b. Cooling Tower
    c. Flow meter
    d. PCM Balls
    e. Valves & Fittings
    f. MCC / Electrical Control Panel / Distribution Boards/ UPS, Battery
    g. AC / DC Motors
    h. Electrical Cables
    i. PLC / Control Panel
    j. Control / Monitoring Instrument
    k. Instrument Cables
6. Mounting Skid
7. Piping Isometrics
8. Pipe Supports
9. Insulation Schedule
10. Cable Schedule
11. Lightning Protection

Part 3: Installation, commissioning and successful testing of automated (PLC control) thermal energy storage system.

1. Commissioning Procedure
2. Installation and Commissioning of Package Items and Boughtout Items at site with support from the suppliers.
3. Monitor Installation Activity Progress
4. Installation, Assembly, Erection and Commissioning of all Components, Subsystems and Assembled Systems at IISc Bangalore Site. Test data from running the setup
5. Spares List – Commissioning and O & M

Note: Free issue items will be made available by IISc and IITB at the assembly site.

Part 4: Project Support and Maintenance

1. Carryout System Commissioning and Performance Testing at Bangalore Site.
2. Frequent maintenance and service of equipment
3. O & M Manual
4. Documenting the Plant Hand Over.

5.3 Resources Scope:

Contractor: Project cum Inspection / Expediting Cum Site Engineer and Commissioning Expert, Erection / Commissioning / O & M Technicians / Workers for Site Activities

1. A separate team of dedicated engineers and fabricators must be available for the project such that the progress or any issue with the project can be discussed in detail with the team lead (there can be a weekly meeting on skype).

[**During and after the design finalization (after all the design calculations have been approved by IISc and IITB), all the drawings and design documents must be shared with the coordinating personnel at IISc and IITB side**]

2. For the fabrication process, the material inspection will be done by IISc and IIT B side.
3. Regular photography (in case of fabrication process) of the progress of the project needs to be shared with the teams at IISc and IITB.
4. Reports and Meetings
    i. Weekly meetings via online (Skype/Cisco WebEx).
    ii. Progress report in every 21 days.
    iii. Quarterly onsite meetings.
5. A separate HAZOP analysis will be coordinated and reviewed by an experienced technical committee.

[**Once the above requirements are met, funds will be released as per the order document**]

5.4 Operational and Maintenance Responsibility:

The contractor should provide comprehensive warranty for any operational malfunction of the equipment for a period of 2 years. A replacement for the same must be provided as soon as possible.

Frequent maintenance and service of equipment are also required from the contractor side for duration of 2 years. The maintenance checks must be approved by the project coordinator from IISc Bangalore, IIT Bombay.

5.5 Major Requirements from vendor

Part	Specifications	Design standards recommended (IS/ASME standards as applicable)
Plant capacity	• 20 KW	-
Storage tank (molten salt)	• Diameter : 0.61 m • Height : 1.23 m • Total volume : 0.37 m^3 • Thickness of tank : up to 5 mm • Material : SS 316L • Ceramic coating inside of the tank to reduce the heat losses.	• IS 14404:1996
Inventory tank (molten salt)	• Capacity : 0.4m^3 (0.85*0.85*0.5) • Thickness of tank : up to 5 mm • Material : SS 316L • Ceramic coating inside of the tank to reduce the heat losses.	• IS 14404:1996
PCM tank And Inventory tank(HTF)	• Material : Carbon steel can be used. • Capacity: depending on requirement of HTF inside the loops (1 to 2 barrel would be approx)	• IS 14404:1996
Heater	• For charging, jacketed type heater around the pipe is to be used. Should be in the range of 1 KW to 25 KW (to be increased in steps of 400 W). • There must be provision of flexible heater around inventory tank in order to avoid solidification of salt • Flexible heaters are to be wrapped around the storage tank for initial operation. • Apart from storage tank, other parts are also needed to be covered by flexible heaters.	• IEC60050
Joints	• All the joints must be tested (whether welded, flanged or any other) with hydraulic testing. • Welded joints must be used wherever possible as the flange joint might leak at elevated temperatures. • **Welded joints must meet the IBR standards (XRD test, DP tests).** • The welding should be done in two processes. The base weld should be done with TIG welding for pressure parts and the final welding can be done by electric arc welding.	• IS 1239 (Pt. 1 & Pt. 2), IS 4270
Sealants	• Gaskets between the joints must be of spiral type. Metals gaskets can be used as the temperature application is high. • In the pressure part side, strictly metal spiral gaskets must be used • **Type : DEACON 770 P** (used for high temperature metal to metal joints)	• IS 2712 :1998

Pipe material	• SS316L for charging side application. • Carbon steel for the pressure parts of power block side.	• IS 1239 (Pt. 1 & Pt. 2), IS 4270
Heat exchanger	Power block side: • One on the power block side. • One heat exchanger used to heat syltherm 800 (Shell and Tube type) at 300°C. • One heat exchanger for the PCM CEG storage tank mentioned in the slides above. • One heat exchanger for rejecting heat by HTF to the feed water tank. Charging side: • One on charging side for future provision of connecting with solar field (Shell and Tube type).	• IS 4503
Insulation	Glass wool (min. 100 mm thickness) with a thermal conductivity of 0.04 W/m K.	• IS 3144: 1992 • IS 14164: 2008
PLC control system with automation	Full plant automation is to be done with a PLC control. The code can be changed at will so there should be a provision for that also.	• IEC 61131-3

5.6 Parts to be procured by IISc [Specifications and list of companies with details must be provided by vendor]

Part	Specifications
Valves	• High temperature application (up to 500°C) • All the valves should of pneumatic type. • Should be made of non-corrosive material.
Storage material	• Molten salt mainly nitrate salt with a melting point range of 140 to 160°C • HITEC, Solar salt. • Nanoparticles like cuprous oxide will also be included to enhance specific heat.
Heat transfer fluid	• Syltherm 800 (stable upto 400°C but costly Rs 2500/Kg) • Dowtherm (boiling point 350°C but cheap Rs 600/Kg)
Thermocouples	• Range up to 1000°C • Type : (K Type, chromel and alumel) • Number : 25 to 35 approx • Range : -200 to 1350°C • Pressure limit: up to 20 Kg/cm^2
Pressure gauge	Pressure range (up to 40 Kg/cm^2) to measure pressure of gas.
Level Indicator	• Must be able to withstand a higher temperature (up to 500°C application). • Non corrosive to molten salt. • Calibrated. • Should give very high, high, low and very low signals for the level of molten salt inside the tank.
Flow meter	• High temperature application. • Fully calibrated. • Range : up to 5 kg/sec (molten salt) • Range : up to 5 kg/sec (syltherm 800 or Dowtherm)

5.7 Quality Tests during Procurement, Erection and Commissioning

The plan for quality test during Procurement, Erection and Commissioning is shown below

Sr No	Equipment / Sub System	Quality Stages	Remarks
1	• Thermocline Tank-Molten Salt Storage • PCM Tank	1. Material Test Certificate 2. Dimensional checks for components as per drawing 3. Welding Procedure approval 4. DP test, radiography / Ultrasonic testing of weld joints 5. Stress relieving (if needed) chart inspection 6. Assembly dimension check 7. Final Hydrotest	Vender shall provide internal quality inspection reports. Third party inspection will be performed after that.
2	Inventory Tank-Molten Salt Storage	As above in Sr No. 1	As above in Sr No. 1
3	HTF Storage Tank-Syltherm	As above in Sr No. 1	As above in Sr No. 1
4	Inventory Tank-Syltherm	As above in Sr No. 1	As above in Sr No. 1
5	Heat Exchanger	1. Material Test Certificate 2. Dimensional checks for components as per drawing 3. Welding Procedure approval 4. DP test, radiography / Ultrasonic testing of weld joints 5. Stress relieving (if needed) chart inspection 6. Assembly dimension check 7. Final Hydrotest	As above in Sr No. 1
6	Salt Handling Loop	1. Material Test Certificate 2. Vendor certificates for bought items like pump, valves, instruments etc. 3. Dimensional checks for components as per drawing 4. Welding Procedure approval 5. DP test, radiography / Ultrasonic testing of weld joints 6. Stress relieving (if needed) chart inspection 7. Assembly dimension check 8. Final Hydrotest	As above in Sr No. 1
7	Utilities Like Nitrogen/Inert gas, Steam Line	As above in Sr No. 7	As above in Sr No. 1 along with IBR norms and regulations.
	Fire Fighting System	Vender to provide inspection details	

5.8 List of documents and drawing to be submitted by the bidder:

Deliverable documents and drawings of this turnkey project are listed below

Documents:

1. Specifications for all the components
2. Data sheets for the bought out / out sourced items
3. Enquiry documents for all the bought out / out sourced items
4. Bill of material for all the items
5. Line List and Equipment List
6. Electrical Load List
7. Instrument List
8. Inspection Reports for all the outsourced items
9. Testing procedures for the items to be tested
10. Operating Manual for the system

Drawings:

1. Overall plot plan
2. P&I D
3. Layouts and G.A. Drawings
4. Piping Layouts and Isometrics
5. Interlock Diagrams
6. Electrical SLDs
7. Fabrication / Construction Drawings

The technical bid should contain the following

i. Technical details and commercial terms and conditions

ii. A case study and solution for a similar requirement implemented in India

iii. Customer reference for the above

[The technical bid should not contain any price information. Non-conformance will result in disqualification]

6. PRICE BID

Tender No: Due Date: Time:

Sr. No.	Description of Item & Specification	Qty & Units	Lump Sum Price (in Rs.)	VAT , WCT, Service Tax & other taxes / charges if any please specify details (%/ in Rs.)	Total Price (in Rs.)
1	**Design, fabrication, erection and Commissioning Contract for Execution Of the project "High temperature thermal energy storage system"**	1 No.			
2	.....	...	...	.....	.....

1. The bidder should quote the price on the lump-sum basis for the scope mentioned in scope of work, design, materials, fabrication, commission, automation, facilitation of intermittent & final inspection, including warranty and maintenance as applicable for and arising from the work (no cost will be borne by IISc Bangalore/ IITB), for the entire duration of the contract including extension, if any, thereof.
2. The bidder is required to provide item rates in Cost Drivers Details vide separate sheet.

Validity - The bidder shall hold the bid valid for 180 days from the date of submission of quotation/tender.

Delivery period .....days

PAN No:.....

VAT/TIN Registration No:.....

Signature: .....

Name:.....

Place:

Business Address:.....

Date:

Affix Rubber Stamp:.....

7. ANNEXURES

Annexure-1:

Bidder details

The bidder must provide the following mandatory information & attach copies wherever mentioned:

	Details of the Bidders	
No	**Description**	**Particulars**
1	Name of the Bidder	
2	Nature of Bidder	
	(Pvt Ltd or Public Ltd Co/ Partnership firm etc)	
	(Attach attested copy of Certificate of Incorporation/ Partnership Deed)	
3	Registration No/ Trade License, (if any attach copy)	
4	Registered Office Address	
5	Address for Communication	

6	Contract person Name Designation	
7	Telephone No	
8	Email ID Website	
9	PAN No. (attach copy)	
10	CST/VAT No. (attach copy)	
11	Service Tax registration No. (attach copy)	
12	Annual Turnover (attach audit reports) 2014-15 2015-16 2016-17	
14	Tender Cost (Rs 500/-)	Demand Draft No. Name Of The Bank: Date:

(Signature of the Bidder)

Printed Name

Designation, Seal

Annexure-2:

Declaration Regarding Experience

To,

The Registrar
Indian Institute of Science
Bangalore-560012

Ref : Tender No: SB-1 **Dated: 16th January 2018**

DETAILED DESIGN, FABRICATION, ERECTION, PROCUREMENT, INSTALLATION COMMISSIONING AND MAINTENANCE OF HIGH TEMPERATURE THERMAL ENERGY STORAGE SYSTEM

Sir,

I've carefully gone through the Terms & Conditions contained in the above referred tender. I hereby declare that my company / firm has more than five years of experience and successfully executed at least one designing, fabrication, erection, commissioning and maintenance project of high temperature molten salt closed loop liquid system or similar type projects value not less than Rs .50 Lakhs during last 5 (five) years to Central/State Govt. Departments/ PSUs/institutions/reputed organizations.

(Signature of the Bidder)
Printed Name

Designation, Seal Date :

Annexure-3:

Previous Supply Order Format

Name of the Firm _____

Order placed by (Full address of Purchaser)	Order No. and Date	Description and quantity of ordered equipment	Value of Order	Date of completion of delivery as per contract	Remarks indicating reasons for late delivery, if any and justification for price difference of their supply order & those quoted to us	Has the Equipment being installed satisfactorily (Attach a Certificate from the Purchaser/ Consigner)	Contact Person along with Telephone No., Fax No. and e-mail address.

Signature and Seal of the Manufacturer / Bidder _____

Place: _____

Date: _____

Annexure-4:

Declaration Regarding Clean Track by Bidder

To,

The Registrar

Indian Institute of Science

Bangalore-560012

Ref: SB-1 **Dated:** 16th January 2018

DETAILED DESIGN, FABRICATION, ERECTION, PROCUREMENT, INSTALLATION COMMISSIONING AND MAINTENANCE OF HIGH TEMPERATURE THERMAL ENERGY STORAGE SYSTEM

Sir,

I've carefully gone through the Terms & Conditions contained in the above referred tender. I hereby declare that my company / firm is not currently debarred / black listed by any Government / Semi Government Organizations / Institutions in India or abroad. I further certify that I'm competent officer in my company / firm to make this declaration.

Yours faithfully

(Signature of the Bidder)

Printed Name

Designation, Seal Date :

Annexure – 5:

Declaration for Acceptance Of Terms And Conditions

To,
The Registrar
Indian Institute of Science
Bangalore-560012

Ref: Tender No: SB-1 **Dated: 16th January 2018**

DETAILED DESIGN, FABRICATION, ERECTION, PROCUREMENT, INSTALLATION COMMISSIONING AND MAINTENANCE OF HIGH TEMPERATURE THERMAL ENERGY STORAGE SYSTEM

Sir,

I've carefully gone through the Terms & Conditions as mentioned in the above referred RFP document. I declare that all the provisions of this RFP are acceptable to my company. I further certify that I'm an authorized signatory of my company and am, therefore, competent to make this declaration.

Yours faithfully,

(Signature of the Bidder)
Printed Name

Designation,Seal Date :

Annexure – 6:

Earnest Money Deposit

[To be typed on Nonjudicial stamp paper of the value of Indian Rupees of One Hundred]

(TO BE ESTABLISHED THROUGH ANY OF THE NATIONALED BANKS (WHETHER SITUATED AT BANGALORE OR OUTSTATION) WITH A CLAUSE TO ENFORCE THE SAME ON THEIR LOCAL BRANCH AT BANGALORE OR ANY SCHEDULED BANK (OTHER THAN NATIONALISED BANK) SITUATED AT BANGALORE. BONDS ISSUED BY COOPERATIVE BANKS ARE NOT ACCEPTED)

LETTER OF GUARANTEE

To,
Registrar,
Indian Institute of Science,
Bangalore, Karnataka – 560012.

IN ACCORDANCE WITH YOUR TENDER No:..... dated..... for supply/service of ....., M/s. ..... (Hereinafter called the "Bidder") having its Registered Office at ....., wish to participate in the said bid for the supply/service ..... as an irrevocable Bank Guarantee against Earnest Money Deposit for an amount of Rs. ..... (Rupees.....) valid up to ..... **(180 days from the date of issue of Bank Guarantee)**, is required to be submitted by the bidder as a condition precedent for participating in the said bid, which amount is liable to be forfeited by the Purchaser on, (1) the withdrawal or revision of the offer by the bidder within the validity period, (2) Non acceptance of the Letter of Indent / Purchase order by the Bidder when issued within the validity period, (3) failure to execute the contract as per contractual terms and condition with in the contractual delivery period and (4) on the happening of any contingencies mentioned in the bid documents.

During the validity of this Bank Guarantee:

We, ...(Bank name) having its registered Office at .....guarantee
And undertake to pay immediately on first demand by ..... the amount of
Rs.....(Rupees) without any reservation, protest, demur and recourse.

Any such demand made by the IISc Bangalore shall be conclusive and recourse. Any such demand made by the purchaser shall be binding on the Bank irrespective of any dispute or difference raised by the Bidder.

The Guarantee shall be irrevocable and shall remain valid up to ….....(180 days from the date of issue of Bank Guarantee) If any further extension is required, the same shall be extended to such required period on receiving instruction form the Bidder, on whose behalf the is Guarantee is issued.

Notwithstanding anything contained herein:

Our liability under this Bank Guarantee shall not exceed Rs..... (Rupees.....)

This Bank Guarantee shall be valid up to ….....(date).

We are liable to pay the guaranteed amount or any part thereof under this Bank Guarantee only and only if you serve upon us a written claim or before .....(date)

This Bank further agrees that the claims if any, against this Bank Guarantee shall be enforceable at our branch office at ..... situated at ..... (Address of local branch).

Yours truly,

Signature and seal of the guarantor:

Name of Bank:

Address:

Date:

Instruction to Bank: Bank should note that on expiry of Bond Period, the Original Bond will not be returned to the Bank. Bank is requested to take appropriate necessary action on or after expiry of bond period.

Annexure – 7:

Performance Guarantee Bond

[To be typed on Non judicial stamp paper of the value of Indian Rupees of One Hundred]
{TO BE ESTABLISHED THROUGH ANY OF THE NATIONAL BANKS (WHETHER SITUATED AT BANGALORE OR OUTSTATION) WITH A CLAUSE TO ENFORCE THE SAME ON THEIR LOCAL BRANCH AT BANGALORE OR ANY SCHEDULED BANK (OTHER THAN NATIONALISED BANK) SITUATED AT BANGALORE. BONDS ISSUED BY COOPERATIVE BANKS ARE NOT ACCEPTED.}

To,
Registrar,
Indian Institute of Science,
Bangalore, Karnataka – 560012.

LETTER OF GUARANTEE

WHEREAS Indian Institute of Science, Bangalore (Buyer) have invited Tenders vide Tender No..... dated ..... For purchase of .....

AND WHEREAS the said tender document requires that any eligible successful tenderer (seller) wishing to supply the equipment / machinery, service etc. in response thereto shall establish an irrevocable Performance Guarantee Bond in favour of "Registrar Indian Institute of Science, Bangalore" in the form of Bank Guarantee for Rs ……(5% of the order value), and valid till **three year and eight months** from the date of issue of Performance Guarantee Bond may be submitted within30 (Thirty) days from the date of Acceptance as a successful bidder.

NOW THIS BANK HEREBY GUARANTEES that in the event of the said tenderer (seller) failing to abide by any of the conditions referred in tender document / purchase order / performance of the equipment / machinery, etc. this Bank shall pay to Indian Institute of Science, Bangalore on demand and without protest or demur Rs ..... (Rupees.....)

This Bank further agrees that the decision of Indian Institute of Science, Bangalore (Buyer) as to whether the said Tenderer (Seller) has committed a breach of any of the conditions referred in tender document / purchase order shall be final and binding.

We ..... (name of the Bank & branch) hereby further agree that the Guarantee herein contained shall not be affected by any change in the constitution of the Tenderer (Seller) and/ or Indian Institute of Science, Bangalore (Buyer).

Notwithstanding anything contained herein:

I. Our liability under this Bank Guarantee shall not exceed Rs. ..... (Indian Rupees ..... only).

II. This bank guarantee shall be valid up to .....(date) and

III. We are liable to pay the guaranteed amount or any part thereof under this bank guarantee only and only if IISc Bangalore serve upon us a written claim or demand on or before..... (date)

This Bank further agrees that the claims if any, against this Bank Guarantee shall be enforceable at our branch office at ..... situated at ..... (Address of local branch).

Yours truly,

Signature and seal of the guarantor:

Name of Bank:

Address:

Date:

Annexure – 8:

Format For Deviations / Exclusions Schedule

Proposal Ref No. and Date

Name and Address

To,

Indian Institute of Science, Bangalore
Department of Mechanical Engineering,

Sub: IISc Bangalore Tender Ref :

Dear Sir,

We declare that the following are the only deviations, variations and exceptions / exclusions to the supply, services terms and conditions as outlined in your Bidding Documents. The Schedule has been filled in accordance with the Bidding Documents. Except these deviations, subject to the approval and acceptance by IISc, the entire work shall be performed as per your requirements and bidding documents. Further, we agree that additional conditions, if any found elsewhere in the offer other than those stated below, save that pertaining to any rebates / discounts offered, shall not be given effect to :

Serial No.	Clause No.	Page No.	Statement of deviation & variation / exclusion	Cost of withdrawal of deviation & variation / exclusion

Place: Date:

Signature:
Name:
Designation:
Common Seal:

Notes:

- The bidder may use additional sheets of like size and format, if required
- The technical compliance/deviation should be supported by relevant technical literature.
- If specification in Superior/inferior than asked for the enquiry, it should be clearly brought out in the justification.
- If the bidder offers more than one model, then the technical compliance statement must be enclosed for each and every model separately.

Annexure – 9:

COMPLIANCE REQUIREMENTS CHECKLIST

Sl. no	Document Title	Yes/No
1	Experience in handling design, fabrication and commissioning of High temperature molten salt closed loop fluid systems or similar projects	
2	Certifications and testimonials from reputed companies, institutions or organizations	
3	List of 5 largest clients in past 3 years, demonstrating prior experience with relevant past performance records. Information and 5 current references. Reference shall include type of work performed for the clients, year, and client contact information (Name, Position, Phone number, Email address)	
4	A hardcopy brochure of organization with history of company and financial statements for past 3 year	

Compliance Checklist: Major Requirements

Part	**Specifications**	**Design standards recommended (IS/ASME standards as applicable)**	**YES/ NO**
Plant capacity	• 20 KW	-	
Storage tank (molten salt)	• Diameter : 0.61 m • Height : 1.23 m • Total volume : 0.37 m^3 • Thickness of tank : up to 5 mm • Material : SS 316L • Ceramic coating inside of the tank to reduce the heat losses.	• IS 14404:1996	
Inventory tank (molten salt)	• Capacity : 0.4m^3 (0.85*0.85*0.5) • Thickness of tank : up to 5 mm • Material : SS 316L • Ceramic coating inside of the tank to reduce the heat losses.	• IS 14404:1996	
PCM tank And Inventory tank(HTF)	• Material : Carbon steel can be used. • Capacity: depending on requirement of HTF inside the loops (1 to 2 barrel would be approx)	• IS 14404:1996	
Heater	• For charging, jacketed type heater around the pipe is to be used. Should be in the range of 1 KW to 25 KW (to be increased in steps of 400 W). • There must be provision of flexible heater around inventory tank in order to avoid solidification of salt • Flexible heaters are to be wrapped around the storage tank for initial operation. • Apart from storage tank, other parts are also needed to be covered by flexible heaters.	• IEC60050	

Joints	• All the joints must be tested (whether welded, flanged or any other) with hydraulic testing. • Welded joints must be used wherever possible as the flange joint might leak at elevated temperatures. • **Welded joints must meet the IBR standards (XRD test, DP tests).** • The welding should be done in two processes. The base weld should be done with TIG welding for pressure parts and the final welding can be done by electric arc welding.	• IS 1239 (Pt. 1 & Pt. 2), IS 4270	
Sealants	• Gaskets between the joints must be of spiral type. Metals gaskets can be used as the temperature application is high. • In the pressure part side, strictly metal spiral gaskets must be used • **Type : DEACON 770 P** (used for high temperature metal to metal joints)	• IS 2712 :1998	
Pipe material	• SS316L for charging side application. • Carbon steel for the pressure parts of power block side.	• IS 1239 (Pt. 1 & Pt. 2), IS 4270	
Heat exchanger	Power block side: • One on the power block side. • One heat exchanger used to heat syltherm 800 (Shell and Tube type) at 300°C. • One heat exchanger for the PCM CEG storage tank mentioned in the slides above. • One heat exchanger for rejecting heat by HTF to the feed water tank. Charging side: • One on charging side for future provision of connecting with solar field (Shell and Tube type).	• IS 4503	
Insulation	Glass wool (min. 100 mm thickness) with a thermal conductivity of 0.04 W/m K.	• IS 3144: 1992 • IS 14164: 2008	
PLC control system with automation	Full plant automation is to be done with a PLC control. The code can be changed at will so there should be a provision for that also.	• IEC 61131-3	

Annexure – 10:
Technical guidelines to specific items and activities

In general some specific items and activities are described in the following sections. These can be used as guidelines to starting of the project. Vender must come with their own calculations according to the scope of the project.

Heat Exchanger

To transfer the heat from the molten salt to the HTF, we require a heat exchanger which will ensure that the HTF is at a desired temperature for delivering the required heat. Figure 9 shows the schematic of the heat exchanger showing inlet and outlet temperatures.

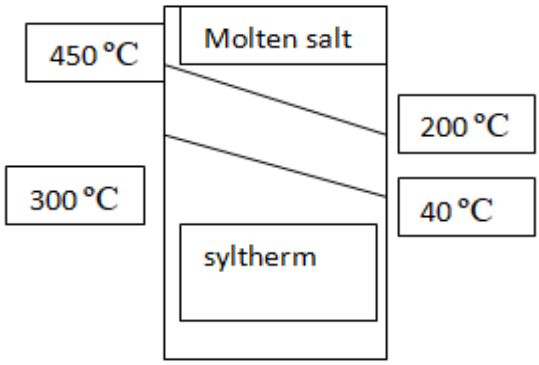


Figure 9: Schematic of the heat exchanger showing inlet and outlet temperatures

Mass flow rate required	: 0.05 to 0.3 Kg/sec
Density	: 1756 kg/m^3 at 450°C
	1931 kg/m^3 at 200°C
Specific heat	: 1560 J/Kg K
Dynamic Viscosity	: 0.0202 Pa.s

Specifications of Syltherm 800:

Mass flow rate required	: 0.05 to 0.3 Kg/sec
Density	: 679 kg/m^3 at 300°C
	920 kg/m^3 at 40°C
Specific heat	: 2070 J/Kg K at 300°C
	1640 J/Kg K at 40°C
Thermal conductivity	: 0.0824 W/m K at 300°C
	0.1312 W/m K at 40°C
Approx heat transfer coeff.	: 200 to 500 W/m^2 K

Electrical Supply Requirements

The design of electrical system and the installation shall be in accordance with the relevant Indian Standards, IEC Standards, CEA guidelines, Indian Electricity Act & rules and Local Rules and Regulations.

- Three phase supply (4 wires) at 415 V with a variation of 5%.
- The motor and pump must be connected to three phase windings.

Safety Precautions

- Interlocks must be in order before the operational sequence is started.
- Proper equipments must be provided to the operational person working near the plant as a very high temperature is in business.
- In case of emergency shutdown, the molten salt must be drained from the storage tank to the inventory tank. This provision is to be given in the PLC programme.
- A first aid kit must be in place near the operator's reach.
- In case of any fire, sand buckets should be available near the site.
- A **fusible plug** arrangement must be made such that the whole plant is shut down with the help of just one switch.

Thermal Energy Storage Tank Requirements:

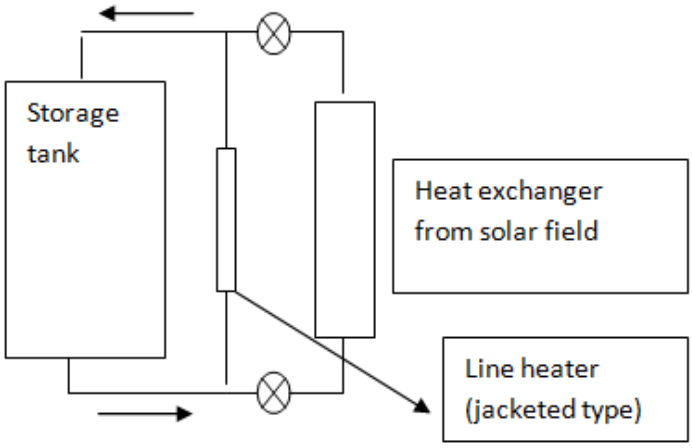
- Material of the storage tank : SS 316L
- Diameter of the storage tank : 0.61 m
- Height of the tank : 1.23 m (from preliminary design calculations can be modified appropriately)
- Wall thickness of the tank : 12 mm
- There should be a ceramic coating inside the storage tank in order to reduce the heat loss to the environment.
- Thermocouples (K type, total 12) should be placed at 6 axial and 2 radial locations to monitor the thermocline movement.
- The thermocline maximum and minimum temperature difference which will be used is 250 ºC and 50 ºC. So the provision must be made accordingly (like the tank dimensions)
- Two distributors header setup must be installed inside the tank near the inlet and outlet in order to ensure the uniform flow of the molten salt inside the tank during charging and discharging.
- A honeycomb structure type wire mesh (non corrosive to molten salt) must also be provided.
- An air vent for the release of air pressure induced during the initial filling and final extraction of the molten salt from and to the inventory tank respectively.
- Provision of a level indicator which gives the topmost level of the molten salt in the tank. There should be an interlock such that the operation of charging and discharging cannot start until the level inside the tank is maintained.
- Provision of a ladder inside the tank for cleaning purpose.
- Provision of a manhole (elliptical shape).
- A drain outlet is required separately to take sample of the molten salt for study at frequent intervals.

- Flexible heaters of 1 KW/m rating must be wrapped around the storage tank for initial operation.
- The fabrication work of the storage tank must be verified by various tests like **XRD, DP tests for welding, hydraulic tests for any leakage** etc. These will be verified by the project coordinator before moving further.

Heater on the solar field side for charging with thermosyphoning effect:

- As of now we are going to charge the storage tank with simulating the solar field by provision of flexible heaters.
- The flexible heaters must be provided in 2 segments (first half meter separate and second half separate) with a power rating ranging from 1 KW to 25 KW (in steps of 400 W) which can be regulated by PLC at will or can be automated according to the need of mass flow rate.
- The charging pipeline from the outlet of the storage tank at the bottom till the inlet of the storage tank at the top is of 15 mm diameter and 1.5 mm thickness.
- The total length of the piping during charging will be approximately 4 m.
- As we are planning to integrate the plant with the solar field in future, hence a provision must also be made to switch the charging loop to the solar field from the flexible heaters. This is to be done by providing a heat exchanger separately so that the molten salt gets heated inside the heat exchanger till 500 ºC.

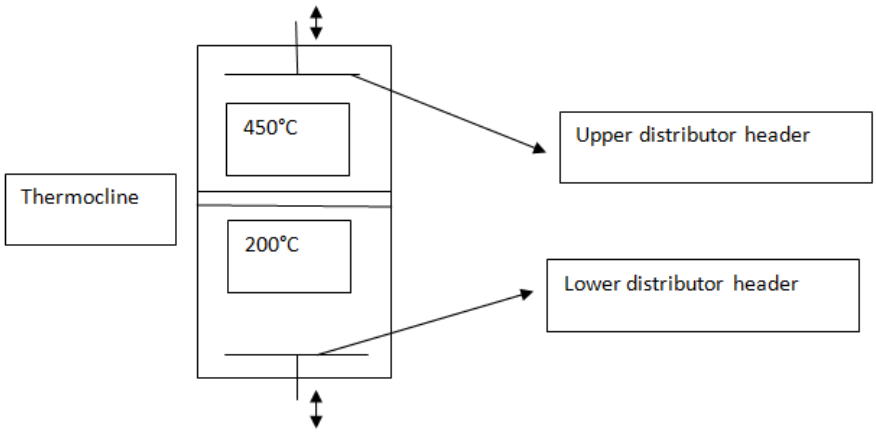
Two thermocouples must also be provided at the inlet and outlet of the heat exchanger system in order to monitor the temperature of molten salt entering and leaving the storage tank.



Provision Of Distributor Heads Or The Plenum Inside The Storage Tank

We will be requiring two distributor headers or plenums (upper and lower) inside the storage tank. The main purpose of the distributors will be to maintain uniform flow of the salt across the cross section of the tank and to avoid the splashing of the inlet salt with the molten salt present inside the tank, else the thermocline formation will be effected. A suitable wire mesh (honeycomb structure) needs to be mounted after the distributor plate for smooth functioning of the thermocline. A schematic is shown in the figure below.

Another set of distributor heads will be required for the encapsulated PCM storage system (temperature application and material might be different).



Inventory Tank:

- A separate inventory tank needs to be provided which will be used to fill and empty the storage tank (Both Salt and HTF) at will.
- The storage tank should be filled by giving some pressure from the gas pump that will be used. The gas which will come into play will be a either nitrogen or argon.
- An inbuilt heater (around 25 KW) should be there inside the inventory tank (molten salt/HTF) for the purpose of melting molten salt.
- In order to make the system compact or lesser footprint, we can keep the storage tank assembly just above the inventory tank and the inventory tank can be provided with wheels, so that the assembly can be moved to a different location at will.

Gas Pump For Inventory Tank:

- A separate argon or nitrogen gas pump must be provided with a mechanism such that whole of the high temperature molten salt in the inventory tank can be filled in the storage tank and the pipelines connected to the storage tank (till the tank and all the lines are filled).

Heat Exchangers On The Power Block Side Using Pumps:

- One heat exchanger is required during the discharging phase of the cycle. The heat exchanger will be used to heat syltherm 800 as the HTF.
- The heat exchangers used will be of shell and tube type, in which syltherm 800 will pass inside the tube and molten salt outside. The calculations for the heat exchanger are required to done by the contractor.
- During the discharging phase, we will be requiring a pump to drive the molten salt in the discharge loop as the mass flow rate required is higher in this case. The pump in this scenario must be able to withstand a temperature of 500 ºC. The flow rate will be from low to medium volume application.
- A separate pump P2 for HTF will also be required for taking the HTF and delivering it to the heat exchanger where it will be heated. Again the pump used here should be of higher head capacity and low to medium discharge GRUNDFOS make will be suitable).

- Thermocouples must also be provided at the inlet and outlet of the heat exchanger for measuring and calculating the output of the work that can be extracted from the power block side.
- A flow meter for measuring the molten salt flow rate is to be provided with a control valve operation with temperature application of up to 500 ºC.
- A separate flow meter for measuring the flow rate of steam again with a control valve operation with temperature application of up to 350 ºC.

A provision should be made, such that if in future, the plant is integrated with the power producing device like turbine, generator, so that can be done without any problem.

Insulation:

- Thermal conductivity of glass wool insulation to be wrapped : 0.04 W/m K
- Heat transfer coefficient of air(free convection) : 10 W/m^2 K
- So thickness of insulation = 100 mm
- This insulation must be wrapped on the entire surface which is at elevated temperature including inventory tank also.

Vents:

- Air vent and an expansion tank must be provided at the top of the storage tank to compensate for any pressure surge.
- An air vent is required for the inventory tank also.

Feed Water Tank:

- A tank must also be fabricated at the site by the contractor which must be able to store the water for continuous supply to take the heat rejected by the HTF during the discharging phase of the individual subsystems.
- A heat exchanger is also needed for rejecting heat by the HTF during discharging processes.

Valves:

- All the valves must be able to sustain a temperature of around 500 ºC.
- Three way valves are required at the storage tank inlet and outlet such that charging and discharging can be done using these two valves only. If it is not possible then we might have to go for separate inlet and outlets for charging and discharging.
- A butterfly valve for the opening and closing of air vent at the top of storage tank.
- A control valve (2 way pneumatic) required for filling and emptying the storage tank, from the inventory tank.
- A separate drain valve (butterfly type) at the bottom of the storage tank to collect samples of molten salt.
- Another control valve (2 way pneumatic) for operation of inventory tank to deliver the molten salt by the gas pump.

***Pressure Gauges And Instrumentation**:*

- A pressure gauge is required to measure the pressure of the gas pump, which will be automated by providing higher and lower pressure values for operation.

Pneumatic Control Of Valves:

- A provision for compressed air should be made which will be used for operation of the valves wherever necessary (An air compressor, compressed air storage tank, moisture removing system, piping etc.)

PLC Control Of The Whole Plant

- The whole plant needs to be automated with a Programmable Logical controller or SCADA with certain interlocks ensuring the safe and logical operation of the system.
- A provision is also required to code a different program as per the operational requirements of the project.

***Interlocks**:*

- Until the whole of the setup is at the cold temperature of the molten salt, the inventory tank should not start delivering the molten salt into the storage tank.
- After the inventory tank delivers the molten salt to the storage tank, the level indicator should come into action and the process of charging and discharging should not start until a suitable level of molten salt is shown in the level indicator.
- The level in the storage tank must not go above the highest limit of the level indicator, which can lead to overflowing of molten salt.

8. CHECKLIST

The following items must be checked before the Bid is submitted:

1. **Envelope "1" Technical Bid**
   a. Demand Draft of Rs.500/- (Rs. Five Hundred only) towards cost of Bid document ☐
   b. Technical Bid (each pages duly sealed and signed by the authorized signatory) ☐
      ANNEXURE 1: Bidder details ☐
      ANNEXURE 2: Declaration Regarding Experience ☐
      ANNEXURE 3: Previous Supply Order Format ☐
      ANNEXURE 4: Declaration Regarding Clean Track by Bidder ☐
      ANNEXURE 5: Declaration for Acceptance Of Terms And Conditions ☐
      ANNEXURE 7: Performance Guarantee Bond ☐
      ANNEXURE 8: Format For Deviations / Exclusions Schedule ☐
      ANNEXURE 9: Compliance Requirements Checklist ☐
   c. Copy of this tender document duly sealed and signed by the authorized signatory on every page ☐
   d. Checklist ☐
2. **Envelope "2" Commercial Bid**
      Commercial Bid: (Price to be quoted in Indian Rupees INR) ☐

[Note: Bank Guarantee for Rs. 4, 00,000/-- (Rs. Four lakh only) towards Earnest Money Deposit (ANNEXURE 6) In favor of "**The Registrar, IISc, Bangalore**" payable at **Bangalore** to be submitted if the vendor is selected in the technical bid]

Your quotation must be submitted in two envelopes **Technical Bid (Envelope 1) and Price Bid/commercial bid (Envelope 2)** superscribing on both the envelopes the Tender no. and the due date and both these sealed covers are to be put in a bigger cover which should also be sealed and duly superscribed with our **Tender No. & Due Date.**