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प्लाज्मा अनुसंधान संस्थान
INSTITUTE FOR PLASMA RESEARCH
परमाणु ऊर्जा विभाग, भारत सरकार का एक सहायता प्राप्त
संस्थान
An Aided Institute of Department of Atomic Energy,
Government of India



इन्दिरा पुल के पास, भट, गांधीनगर - 382 428 भारत
दूरभाष: (079) 2396 2020/2021/2028
फैक्स: 91-079-23962277
वेब: www.ipr.res.in

NEAR INDIRA BRIDGE, BHAT
DIST. GANDHINAGAR - 382 428 (INDIA)
Phone: (079) 2396 2020/2021/2028
Fax : 91-079-23962277
Web : www.ipr.res.in

ENQUIRY

ENQUIRY NO : IPR/EQL/18-19/255
Date : 26-10-2018

Due on : 29-11-2018 by 1:00 PM IST

Please send your offer in sealed envelope specifying Enquiry No, Date & Due Date, ALONG WITH your credentials for the following items:

Important Note:

Please note that e-mail quotations are not acceptable however you may send your queries (if any) to localpurchase@ipr.res.in

Please ensure your sealed quotation reaches this office not later than above mentioned due date and time.

Kindly go through the following documents properly before quoting which are available on the IPR web portal i.e., http://www.ipr.res.in/documents/tender_terms.html / attached herewith.

- 1) Instructions to the bidders & Terms and conditions (refer Form No: **IPR-LP-01.V4**)
- 2) Bidding format

GST for Goods and Services (IGST/CGST/SGST TAX BENEFITS): Please refer **clause no: 8** of Form No: **IPR-LP-01.V4**

QUOTATION SHOULD BE ADDRESSED TO PURCHASE OFFICER ONLY

Sr No	Description	Quantity
1	Design, fabrication, testing and supply of Pb-Li/Thermic Fluid Heat Exchanger as per the attached technical specification	1.0 Nos.
2	Design, fabrication, testing and supply of Thermic Fluid /Water Heat Exchanger as per the attached technical specification	1.0 Nos.

Note: 1. Please quote with complete technical details (Technical compliance sheet and product data sheet).
2. TDS as per CGST Act: As per provisions of section No. 51 of the CGST Act 2017, TDS @2% (IGST 2% or CGST 1% and SGST 1%) will be deducted while making payment to the suppliers where total value of orders/contracts/work orders exceeds Rs. 2.5 lakhs, in the event of order in Indian Rupees. Necessary TDS Certificate will be issued to the supplier after TDS deduction.

Encl: As per attachment.

Sd/-

Mr. D. Ramesh
Purchase Officer-II

Information to Vendors: We are working towards a single platform for our future requirement. Hence, please refer IPR website i.e, <http://www.ipr.res.in/documents/tendersenq.html> for our future requirement.

Design, fabrication, testing and supply of Pb-Li/Thermic Fluid Heat Exchanger and Thermic Fluid /Water Heat Exchanger

1. Introduction:

As part of R & D activities in liquid metal technology, Lead Lithium Magneto Hydro Dynamics (LLMHD) experiment is being set up at IPR. LLMHD experiment is designed to operate with molten Lead-Lithium Eutectic (Pb-Li) as a working fluid at 5 bar pressure, 3-7 kg/s flow rate and 300-330 °C temperature. The main objective of this LLMHD loop is to perform series of thermo fluid MHD experiments with different flow geometries under the magnetic field. The LLMHD loop (refer Fig 1) consists of equipment such as MHD test mock up, Pb-Li/Thermic Fluid heat exchanger (Pb-Li/TF HX), Thermic Fluid/Water heat exchanger(TF/Water HX), electromagnetic pump, dump tank, expansion tank, diagnostics system and instrumentation & control system. This document covers the detailed technical specification for the design, fabrication, testing and supply of Pb-Li/Thermic Fluid Heat Exchanger and Thermic Fluid /Water Heat Exchanger.

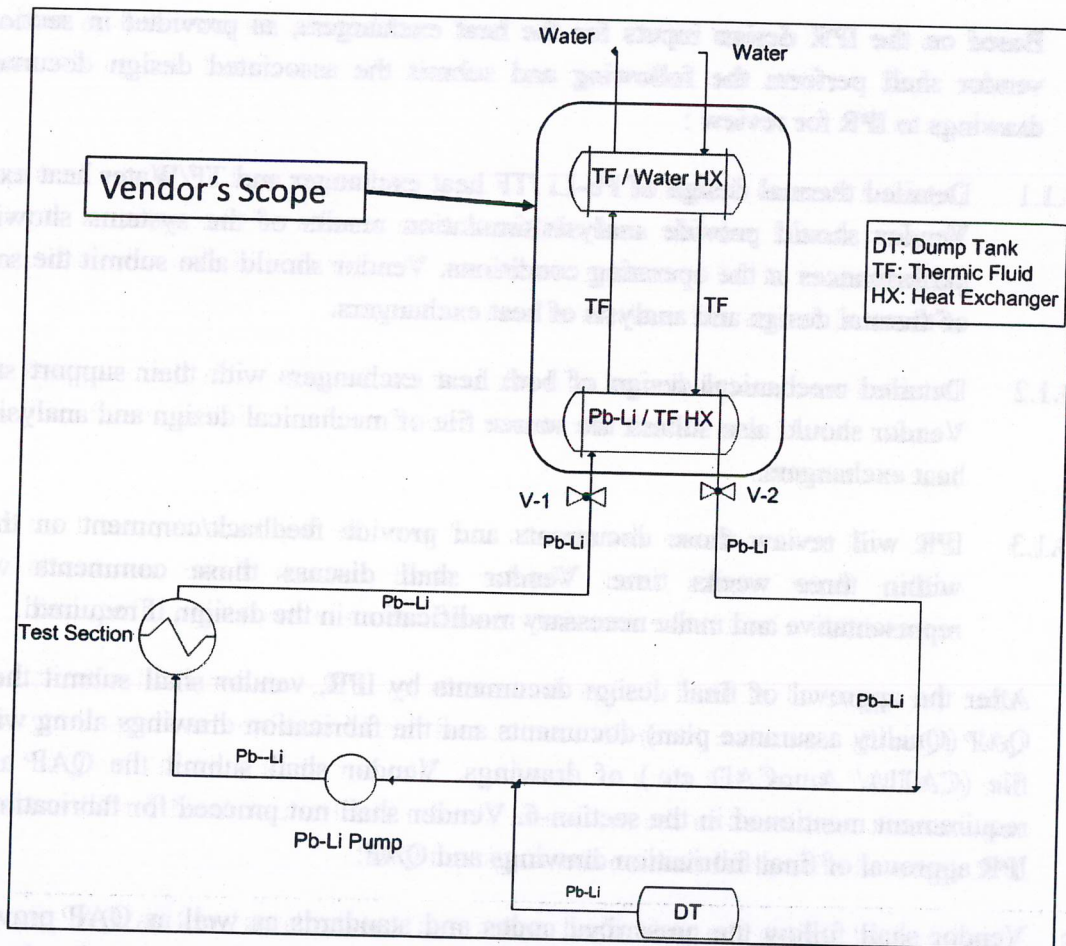


Figure 1: Schematic of the Pb-Li MHD loop

2. Brief description of the LLMHD System and Pb-Li/TF HX and TF/Water HX

LLMHD system is a closed loop, where Pb-Li will be circulated in the loop by EM pump. The test section in the loop will be heated to desired temperature by installing plate type heaters on its surface. The hot Pb-Li coming from the test section will be cooled down to desired temperature (300 C) by passing it through Pb-Li/ Thermic Fluid (TF) heat exchanger. The Pb-Li coming from Pb-Li/TF HX outlet will be fed back to the inlet of EM pump. A separate TF/Water heat exchanger system will be required to remove the heat from the Thermic Fluid (TF) as shown in Fig-1.

3. Scope of supply:

This work involves the design, fabrication, testing and supply of Pb-Li/TF heat exchanger and TF/Water heat exchanger. The enclosed portion of the schematic in Fig 1 indicates the heat exchangers whose design, fabrication, testing and supply will be completely under vendor's scope. Detail scope of the work is described below.

- 3.1 Based on the IPR design inputs for the heat exchangers, as provided in section 4, the vendor shall perform the following and submit the associated design documents and drawings to IPR for review :
 - 3.1.1 Detailed thermal design of Pb-Li /TF heat exchanger and TF/Water heat exchanger. Vendor should provide analysis/simulation results of the systems showing their performances at the operating conditions. Vendor should also submit the source file of thermal design and analysis of heat exchangers.
 - 3.1.2 Detailed mechanical design of both heat exchangers with their support structures. Vendor should also submit the source file of mechanical design and analysis of both heat exchangers.
 - 3.1.3 IPR will review those documents and provide feedback/comment on the design within three weeks time. Vendor shall discuss those comments with IPR representative and make necessary modification in the design, if required.
- 3.2 After the approval of final design documents by IPR, vendor shall submit the detailed QAP (Quality assurance plan) documents and the fabrication drawings along with source file (CATIA/ AutoCAD etc.) of drawings. Vendor shall submit the QAP as per the requirement mentioned in the section-6. Vendor shall not proceed for fabrication without IPR approval of final fabrication drawings and QAP.
- 3.3 Vendor shall follow the prescribed codes and standards as well as QAP provisions for material procurement, fabrication and testing as described in the section- 5 and section-6.
- 3.4 Vendor shall procure the required materials as per section 4.3 and submit the material test certificate prior to fabrication.

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- 3.5 Vendor shall fabricate the Pb-Li/TF heat exchanger and the TF/Water heat exchanger as per the approved fabrication drawings.
 - 3.6 Pre-Dispatch Inspection (PDI) will be performed in the presence of IPR representatives and/or IPR authorized experts at the vendor's site as per the test described in section-7. Vendor shall arrange all the required test facilities and instrumentation for PDI at his site.
 - 3.7 All the test results shall be submitted to IPR for review. Dispatch clearance will be provided based on the acceptance of the test reports.
 - 3.8 After issuance of dispatch clearance by IPR, the Pb-Li/TF heat exchanger and the TF/Water heat exchanger shall be suitably packed by the vendor to avoid any damage during transportation. Vendor should also ensure that the both heat exchangers are pressurized with inert gases to restrict the corrosion of material. Safe transportation of whole system to the IPR is the responsibility of the vendor.
 - 3.9 Vendor shall submit the two sets of the design documentation and analysis report, fabrication drawings, material test certificates, inspection and testing reports and operation and maintenance manual along with the delivery of the equipments.
 - 3.10 After the delivery of the systems (Pb-Li/TF HX and TF/Water HX), acceptance test will be performed at IPR, as mentioned in section 9. After the successful completion of the acceptance test at IPR site, acceptance will be provided to the vendor.

4. Design Inputs

4.1 Pb-Li/TF Heat Exchanger:

- 4.1.1 Type of Heat Exchanger: Shell and Tube (BEM Type)
- 4.1.2 Process Fluid 1 (Tube Side): Pb-Li (Refer Annexure-1 for physical properties of Pb-Li)
- 4.1.3 Process Fluid 2 (Shell Side): Therminol-55
- 4.1.4 Heat Load to be removed : maximum 20 kW
- 4.1.5 Pb-Li inlet/outlet nozzle size : 50NB with SORF flange and grafoil gasket
- 4.1.6 TF inlet/outlet nozzle : 25 NB with SORF flange and grafoil gasket
- 4.1.7 Code requirement: Refer section 5
- 4.1.8 Design Temperature: 400 C
- 4.1.9 Design Pressure: 7 bar (g)

4.1.10 During the design of system, vendor shall ensure the following

- The length of heat exchanger should not be more than ~1m
- Complete draining of Pb-Li and oil from the heat exchanger after the operation.

4.1.11 Operating Parameters of Pb-Li/TF heat exchanger are shown in the Table-1 below.

Table 1: Operating Parameters of Pb-Li/TF Heat Exchanger

Process Fluid	Heat Load	Flow Rate	Inlet Temperature	Outlet Temperature	Maximum Inlet Pressure (g)	Maximum allowable pressure drop
Pb-Li (Tube Side)	20 kW	7 kg/s	315 C	300 C	5 bar	1 bar
Therminol-55 (Shell Side)	20 kW	0.36 kg/s	250 C	270 C	3.5 bar	0.5 bar

4.2 TF/Water HX system

4.2.1 Type of Heat Exchanger: Shell and Tube (BEU Type)

4.2.2 Process Fluid 1 (Tube Side): Therminol-55

4.2.3 Process Fluid 2 (Shell Side): Water

4.2.4 Heat Load: 20kW

4.2.5 Code requirement: Refer Section 5

4.2.6 Design Temperature: 300 C

4.2.7 Design Pressure: 5bar (g)

4.2.8 TF inlet/outlet nozzle : 25 NB with SORF flange and grafoil gasket

4.2.9 Water Inlet/Outlet Nozzle Size: 32 NB with SORF flange with PTFE gasket

4.2.10 During the design of system, vendor shall ensure the following

- The length of heat exchanger should not be more than ~ 1m

5.2 Material Code

5.2.1 ASME Section II : Boiler & Pressure Vessel Codes

5.3 Inspection and Testing Codes

5.3.1 ASME Section V : Non-Destructive Test

5.3.2 ASTM : Standards of Material of Construction and Testing

6. Quality Assurance Plan and fabrication requirement

6.1 General QAP requirements

6.1.1 Vendor shall submit the Quality Assurance Plan (to be supplied after acceptance of the design documents) document to IPR prior to start of the fabrication addressing the below points. The QAP shall show review, hold point and witness for the specific jobs. The same shall be mutually agreed. QAP should also include the Witness final and important tests/inspections and issuance of inspection release notes. QAP shall also include the review of material test certificate by IPR.

6.2 Quality control documents

Vendor shall submit following quality control documents.

- 6.2.1 Material test certificates
- 6.2.2 Welding documents (WPS, WPQ, PQR)
- 6.2.3 Dimension Inspection report
- 6.2.4 Liquid penetrant test procedure and report
- 6.2.5 Procedure for radiography
- 6.2.6 Hydro Test report
- 6.2.7 Helium leak test procedure and report

6.3 Material and testing

6.3.1 Vendor shall procure all the required materials for both heat exchangers (Pb-Li/TF HX and TF/Water HX). No free issue material will be supplied by IPR. All the raw material shall be identified / stamped by the vendor to enable subsequent identification and verification.

6.3.2 Copy of test certificates (mill test certificates) for chemical composition and mechanical properties shall be furnished for all the material. In case of non-availability of copy of test certificates, vendor shall arrange for carrying out of complete testing as called for in the standards from the Govt. approved laboratory. Mechanical testing shall be carried out as per ASTM A-370. Raw material for critical parts of both heat exchanger shall be ultrasonically tested. The vendor shall

- Complete draining of oil and water from the heat exchanger after the operation of the HX.

4.2.11 Operating Parameters of TF/Water heat exchanger are shown in the Table-2 below.

Table 2: Operating Parameters of TF/Water HX

Process Fluid	Heat Load	Flow Rate	Inlet Temperature	Outlet Temperature	Maximum Inlet Pressure (g)	Maximum allowable pressure drop
Therminol-55 (Tube Side)	20 kW	0.36 kg/s	270C	250C	3.5 bar	0.5 bar
Water (Shell Side)	20kW	0.48 kg/s	35C	45C	2.5 bar	0.5 bar

4.3 Materials

4.3.1 Material of Construction for Pb-Li /TF heat exchanger : SS316L for tube side and SS304 for shell side

4.3.2 Material of Construction for TF/Water heat exchanger system: SS 304

5. Applicable Codes & Standards

The following Standards, Codes and Regulations whichever is applicable in their latest edition including their addenda shall form the basis for design, fabrication, inspection, testing Pb-Li/TF HX and TF/Water HX

5.1 Design & Fabrication Codes and Standards:

- 5.1.1 ASME Section VIII Div. 2 : Boiler & Pressure Vessel Code
- 5.1.2 ASME Section IX : Welding Qualifications
- 5.1.3 ASME B16.9 : Standard for butt welded fittings
- 5.1.4 ASME B31.3 : Piping design
- 5.1.5 TEMA Class 'C' : Shell and Tube Heat Exchanger Design
- 5.1.6 ANSI B16.5 Rating #150 : Flange Rating

7. Factory Acceptance Test

Following test should be carried out at the vendor's site in presence of the IPR representative: The vendor is responsible for arranging all the necessary man power and tools for performing all inspection and testing as described below at their own cost.

7.1 **Dimensional Checks:** Dimension of both Pb-Li/TF HX and TF/Water HX will be measured and verified with the approved fabrication drawing.

7.2 Hydro Testing:

7.2.1 Vendor shall perform the hydro-testing for each heat exchanger (Pb-Li/TF HX and TF/Water HX) at Room Temperature.

7.2.2 The hydrostatic test shall be performed using demineralized water as per ASME Section VIII Div.2. The individual heat exchanger will be held at the test pressure (1.5 times design pressure) for minimum duration of 30 minutes.

7.2.3 After hydro-test, each component shall be cleaned internally and externally to remove scale, dirt, water & foreign matter and thereafter it will be dried. All end connections shall be blanked, plugged, capped or otherwise suitably sealed to prevent the ingress of moisture.

7.3 Helium Leak Testing:

7.3.1 After completion of hydro testing of Pb-Li/TF HX, the vendor shall perform the helium leak testing of Pb-Li/TF HX at Room Temperature. The procedure for leak testing shall be prepared by the vendor and submitted to the IPR for approval.

7.3.2 Vendor shall perform helium leak testing of tube to tube-sheet joints in compliance with ASME section V.

7.3.3 The leak test shall be carried out at room temperature; the leak rate value for heat exchanger shall be $\leq 1 \times 10^{-4}$ mbar l/s.

7.3.4 If the measured local leak rate is found higher than specified value, the heat exchanger shall be repaired by the vendor and the testing shall be repeated sequentially as mentioned.

8. Packing and Supply

8.1 After issuance of dispatch clearance by IPR both heat exchangers (Pb-Li/TF HX and TF/Water HX) shall be suitably packed by vendor to avoid any damage during transportation. Safe transportation of whole system to IPR is the responsibility of the vendor.

8.2 The packages shall be delivered to IPR, Bhat, Gandhinagar 382-428, Gujarat, India

identify and include the details of critical parts of both heat exchangers for ultrasonic testing in the finalized QAP.

- 6.3.3 The material shall not be accepted, if any unacceptable defects are found. All cost towards such testing and inspection shall be borne by the vendor.

6.4 Fabrication

- 6.4.1 Fabrication procedure shall be as per ASME Section VIII Div.2
- 6.4.2 Vendor shall prepare fabrication procedure with sequence of operation during fabrication and shall submit to IPR for approval prior to fabrication.
- 6.4.3 Vendor shall execute the fabrication work of Pb-Li/TF HX and TF/Water HX as per approved drawing (tolerance should be indicated as per ASME) by IPR.
- 6.4.4 Integral reinforcement shall be provided for all nozzle openings, if required. Nozzle welds to the core of heat exchanger shall be of full penetration type.

6.5 Welding

- 6.5.1 All welding shall be performed by qualified welders only using the procedure under ASME Section IX.
- 6.5.2 Welding consumables shall be in accordance with ASME Section II, Part C for ASME based material.
- 6.5.3 All pressure bearing welds shall be of full penetration type.
- 6.5.4 Vendor shall submit the welding procedure specification (WPS), Welder performance qualification (WPQ) and procedure qualification records (PQR) to IPR for approval.
- 6.5.5 All weld joints of both systems shall be qualified as per standard codes and practices.

6.6 Liquid Penetrant Test

- 6.6.1 Liquid Penetrant Test shall be carried out for all weld joints (external /internal surfaces, weld etc) in Pb-Li/TF HX and TF/Water HX as per ASME Section V. The procedure shall be submitted to IPR for approval.

6.7 Radiography Testing of Butt Welds

- 6.7.1 X-ray radiography testing shall be carried out for some of the important butt weld joints mutually agreed during the finalization of QAP in both systems (Pb-Li/TF HX and TF/Water HX) as per ASME.
- 6.7.2 Radiographic film interpretation shall be done by personnel certified to ASNT level II, film interpreter or approved equivalent. Any defect found will be rectified by vendor free of cost.

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9. Acceptance Test at IPR:

After delivery of the both heat exchangers (Pb-Li/TF HX and TF/Water HX) at IPR, visual inspection will be carried out to check that no damage is done during the transportation.

10. List of Deliverables

- a) Pb-Li/TF HX and TF/Water HX
- b) Process and thermal design report of both heat exchangers
- c) Mechanical design report of both heat exchangers
- d) Two sets of final fabrication drawings of both heat exchangers
- e) The relevant source file of design and drawings
- f) All test reports mentioned in QAP
- g) All test reports for the test performed during factory acceptance test

11. Delivery period and Time Schedule of Activities:

Both heat exchangers shall be delivered to IPR within 8 months after the placement of purchase order. The list of activities and required time duration are provided in following table.

S. No.	List of Activities	Time Duration (Months)
1	Placement of PO	T0
2	Submission of following documents <ul style="list-style-type: none">a. Thermal design and analysis report of both HXb. Mechanical design and analysis report (including piping and support structure analysis) of both HX	T0+2
2	Review of design reports by IPR	T0+3
3	Submission of QAP and final fabrication drawings of both HX and review of drawings by IPR	T0+4
5	Completion of Fabrication of both HX	T0+7
6	Inspection and Testing at vendor's site (FAT) and supply of heat exchangers	T0+8

12. Warranty: Vendor shall provide one year warranty on both heat exchangers for any fabrication defects.

Annexure- I

Pb-Li Properties

Pb-Li is the eutectic material with the melting temperature of 235 °C (508K).

Parameter	Correlation
Density (g/cm ³)	$\rho = 10.45 (1 - 161 \times 10^{-6} T)$ for T _m -880K
Specific Heat (J g ⁻¹ K ⁻¹)	$C_p = 0.195 - 9.116 \times 10^{-6} T$ for T _m -880K
Thermal conductivity (Wcm ⁻¹ K ⁻¹)	$\lambda = 1.95 \times 10^{-2} + 19.6 \times 10^{-5} T$ for T _m -625K
Dynamic Viscosity (Pa*s)	$\mu = 1.87 \times 10^{-4} \exp(11640/RT)$ for T _m -625K
Coefficient of thermal expansion (K ⁻¹)	$\beta = 1.124 \times 10^{-4} + 1.505 \times 10^{-8} T$ for T _m -880K
T _m : Melting Temperature	

S. No.	List of Activities	Time Duration (Months)
1	Placement of PO	T0
2	Submission of following documents a. Thermal design and analysis report of both HX b. Mechanical design and analysis report (including piping and support structure analysis) of both HX	T0-2
3	Review of design reports by IPR	T0-3
4	Submission of QAP and final fabrication drawings of both HX and review of drawings by IPR	T0-4
5	Completion of Fabrication of both HX	T0-7
6	Inspection and testing at vendor's site (PAT) and supply of heat exchangers	T0-8