REQUEST FOR PROPOSAL FOR
DESIGN, DEVELOPMENT, QUALIFICATION, AND SUPPLY OF SPACE QUALITY LOOP HEAT PIPES TO U R RAO SATELLITE CENTRE, BANGALORE, INDIA

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TECHNOLOGY DEVELOPMENT SECTION
ADVANCED THERMAL CONTROL DIVSION
THERMAL SYSTEMS GROUP, URSC

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1. INTRODUCTION

U. R. Rao Satellite Centre (URSC) is the lead centre of Indian Space Research Organization (ISRO) for design, manufacturing and testing of spacecrafts in India. Thermal Systems Group (TSG) is responsible for thermal management of URSC built spacecrafts. As a part of various technologies for future spacecrafts, advanced thermal management devices are under development by TSG. Loop Heat Pipe (LHP) is one such advanced thermal device that can passively transport large heat loads from evaporator (heat collection zone) to condenser (heat rejection zone), utilizing a passive porous wick in the evaporator to circulate the working fluid passively within the loop and maintain a near constant temperature at the evaporator. The schematic of LHP with all the components of LHP are shown in the **Figure 1** given below.

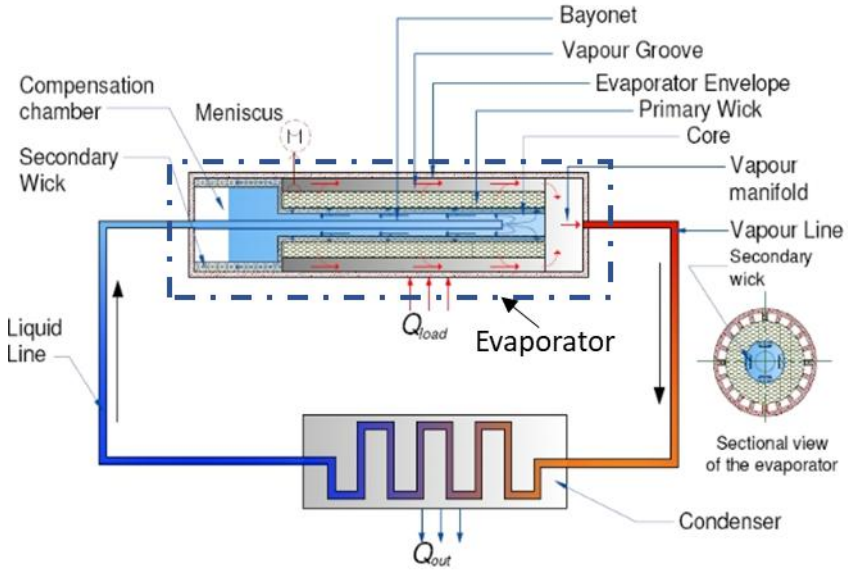

Figure 1: Schematic of Loop heat pipe.

URSC invites the proposal from Indian vendors who are interested and capable of supplying space quality LHPs as per specifications briefly outlined in the **Table 1** given below.

Table 1 LHP specifications.

Activity / Parameter	**Value/ Description**	
Maximum heat load per model	2 kW	
No. of Evaporators	2 to 4 nos. (Will be informed by URSC after PO release)	
Minimum heat load for start up	25 W	
Working fluid	Anhydrous Ammonia (purity: 99.9995)	
Operating temperature (°C)	**Acceptance**	**Qualification**

Activity / Parameter	**Value/ Description**	
	Min: -30	Min: -40
	Max: 60	Max: 70
Non-operating temperature (°C)	Min: -70	Max: 80
Maximum allowed temperature difference between heater plate and condenser (°C)	≤ 25 (between any heater plate average temperatures of evaporator to condenser average at peak load)	
Evaporator	a. Evaporator is a component that directly absorbs the heat dissipated from the electronic packages. b. It is designed such that one side of the evaporator is directly in contact with the electronics package and the other side is thermally insulated to avoid heat losses to surroundings. c. A heater plate has to be in good thermal contact with evaporator bottom for testing the evaporator of LHP with simulated heaters (cartridge or foil) on the heater plate. d. Numerous numbers of test sensors to be placed on the evaporator (10 nos. each), compensation chamber (10 nos. each) and condenser (20 nos. each) for measuring the average temperature difference between any of these components. **Material of construction**: Al6061-T6 Primary wick: Nickel porous (porosity 60%, pore radius ≤ 5 µm and permeability 1 x 10^{-14} m^2) Secondary wick: Nickel foam (porosity >90%) Secondary mesh: SS316 **Note**: 1. All pores to be interconnected. 2. The properties of the primary wick (porosity, pore radius and permeability) and secondary wick (porosity)	

Activity / Parameter	Value/ Description
	shall be proved/ demonstrated by the vendor at their premises in presence of URSC officials before assembling it in to the evaporator and compensation chamber. 3. A good thermal contact conductance between the porous wick and the evaporator must be ensured. 4. Cylindricity and straightness of Nickel porous wick is a major parameter for ensuring good thermal contact conductance between evaporator and porous wick.
Compensation chamber	a. It allows fluid volume variations in the loop during different operating temperatures of the evaporator b. By controlling the compensation chamber temperature (and thus the saturation pressure) the evaporation temperature is controlled. c. It acts as a phase separator or phase trap for restricting any vapor entry to the evaporator. **Material of construction:** SS316 **Temperature control**: within ± 1°C **Temperature difference:** (from evaporator to the compensation chamber) ≤ 5°C
Condenser	Condenser is a device where the working fluid in vapour phase condenses and releases heat (latent heat of vaporization) to the radiator. **Type**: Extruded smooth walled flanged tubes (Electro-polished from inside as per ASTM standards, standard internal surface finish 100 µ inch or better and cleaning should be in accordance with ASTM A632 S3) **Material of construction**: Al 6061-T6 **Diameter**: Suitable to withstand the maximum pressure **Length**: 3.0 to 5.0 m
Transport lines (Vapor and Liquid)	**Material**: Stainless Steel (SS) 316 or Al6061-T6

Activity / Parameter	Value/ Description
	Routing: Should be possible to bend for aligning the metallic bellows (Electro-polished from inside as per ASTM standards) **Diameter**: Suitable to withstand the maximum pressure **Length**: up to 10 m. **Type**: Extruded smooth tubes (Electro-polished from inside as per ASTM standards, standard internal surface finish 100 µ inch or better and cleaning should be in accordance with ASTM A632 S3)
Flexible thermal joints	a. Metallic bellows to be available on both the liquid and vapor lines and to withstand > 250 bar pressure b. Relative angular motion up to 180° should be possible c. Length: ~ 0.5 to 1.0 m d. Quantity: 2 nos. per LHP
Pressure transducer	Shall be placed at various locations in the LHP to acquire the pressure data for various operating conditions. Minimum 2 nos. per LHP
Maximum loop length (m)	~ 15.0
Adverse elevation/ tilt	**Tilt**: Evaporator above compensation chamber by 3 mm **Elevation**: Evaporator is above condenser by 1000 mm **Note**: 1. In both the cases, the temperature difference between any heater plate average and condenser average temperature shall be ≤ 25°C at peak load. 2. Vendor shall built the adverse elevation test facility for characterizing the evaporator at their premises and vendor shall demonstarte the performance of evaporator to URSC officials.

Activity / Parameter	Value/ Description
Mass of the evaporator including compensation chamber (kg)	≤ 2.0
Helium leak rate for integrated system (m bar-l/s)	≤ 1×10^{-9}
Spacecraft bus voltage (V)	70 ± 1 / 100 ± 1
Thermal instrumentation for tests	• Cartridge, tape or foil heaters • Thermistors, PRTs, thermocouples • Superlon Insulation • Pressure transducers
Operating life in Space	15 years
Shelf life on Ground	5 years
Note:	a. All the passive components, including flow lines, used in the LHP shall be chemically cleaned before final assembly. b. Chemical cleaning process for different materials will be shared by URSC at appropriate time. c. All finer details for the design & realisation of LHP should be worked out by the vendor in mutual consent with URSC engineers.

The stages in the procurement of LHPs by URSC are:

1. Pre-bid meet
2. Receipt of tender document in two parts
3. Technical evaluation
4. Price bid opening
5. Award of contract

This document first outlines the detailed technical specifications of the LHP to be procured from Indian vendors, followed by the modalities as per specifications. The term **vendor** refers to a company or a firm which is an Indian manufacturer and/or its authorised representatives interested in supplying loop heat pipe to URSC. The purchaser and its representatives are referred to here as URSC.

2. SCOPE OF THE WORK

The proposed LHP includes evaporator, Nickel porous wick, Nickel porous foam, stainless steel mesh, compensation chamber, flexible hoses, flow transport lines, condenser, temperature sensors, pressure sensors and test heaters. The major functions of proposed LHP are:

i. to transport heat from evaporator (heat collection zones) to the condenser (heat rejection zone)
ii. to maintain evaporator and condenser within a specified range of temperatures

As per the contract, the vendor shall design, develop, manufacture, test, qualify and supply the three model of LHPs, as per the given technical specification, to ISITE/ URSC within the stipulated time.

2.1 Three numbers of LHPs have to be designed, developed, qualified and performance tested to meet stringent space quality standards of URSC. The three numbers of LHPs to be realised are:

1. Development Model (DM)
2. Flight Model (FM)
3. Life test Model (LM)

2.2 Development of each LHP includes design and realisation of:

i. Nickel porous wick (properties as mention in the specifications) which can continuously supply working fluid passively to the evaporator's of LHP,
ii. evaporator/s and condenser/s which can handle up to 2 kW heat load per model,
iii. compensation chamber to control the density variations of working fluid,
iv. maintain the evaporators at desired saturation temperature and ensure the flow of working fluid to the evaporator from the condenser is only in liquid phase by completely condensing the vapor in the condenser,
v. liquid and vapor transport lines, welding and joining of similar / disimilar materials,
vi. design and implementation of heater blocks with cartridge heaters/ foil heaters to simulate total heat load (up to 2 kW) on evaporator/s per each model,
vii. sensors for measuring pressure and temperature at various locations,
viii. mounting, handling and test fixtures,

ix. assembly, integration, and performance testing of each model of LHP to space quality standards as specified by URSC,

x. demonstration of functioning (start-up) of the LHP at ISITE/ URSC and

xi. space qualification / acceptance tests by URSC.

3. DESIGN ASPECTS

Vendor shall provide the compliance to all the LHP thermal specifications/ requirements. The design details are given in the following section.

3.1 Typical design requirements / overall specifications

Table 1 gives overall design requirements of each LHP model which can transport up to 2 kW heat load from evaporator/s to condenser/s. Each model of LHP along with its accessories and test instrumentation shall be assembled on a honeycomb panels (source and radiator) or on a Aluminium plate with tube in tube heat exchanger fixed at the bottom of the plate, before delivery to URSC. Evaporator/s along with the compensation chamber is to be assembled on a source panel.

The condenser is a compact heat exchanger (tube configuration) which is connected to the LHP flow lines using flexible thermal joint (metallic bellows) which are to be assembled on a radiator panel. **Figure 2** shows a typical schematic of the system architecture of the LHP integrated with spacecraft. The evaporator/s and condenser will have a flanged footprint and will be mounted on the surface of the panels using nuts and bolts. The evaporator/s are mounted on the package of a spacecraft panel whose waste heat will be collected and dumped to the deep space using condenser which is mounted on the dedicated deployable radiator panel. The radiator panel will be in stowed condition on the ground and will deploy once reaches the orbit. The flexible links will allow for stowing and deployment of the radiator panel. **Figure 3** shows the representative schematic of LHP realization with evaporator/s and condenser for this RFP.

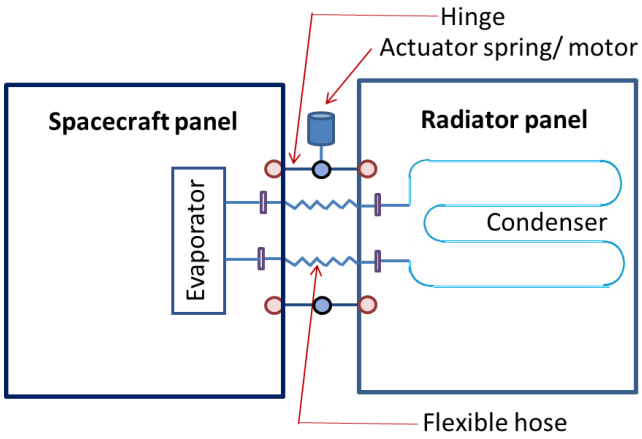

Figure 2: Schematic showing a representative configuration of the LHP with DTR in a typical spacecraft application.

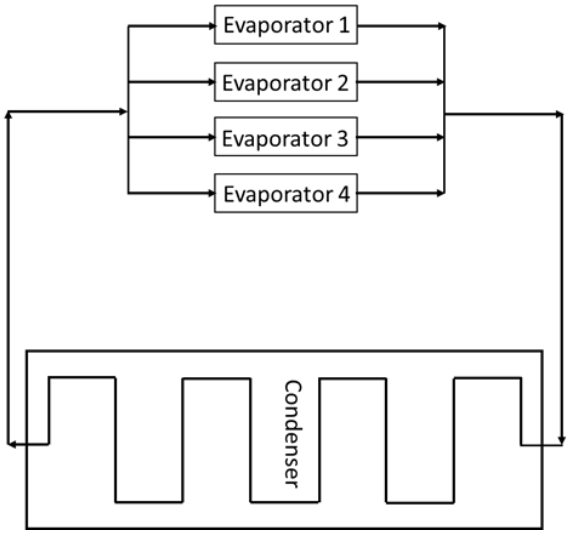

Figure 3: Schematic showing representative configuration of LHP realisation.

4. DELIVERY SCHEDULE

Delivery schedule is the essence of this contract. All the activities shall be completed as per the delivery schedule given in **Table 2**. Final acceptance of each model of LHP is subject to successful completion of all space qualification tests at URSC (tests listed in Sl. No. 4, 5, 6, 7 & 8 of **Table 3**). If any anomaly/ issues are found or LHP is found not meeting the specifications during the test, the responsibility of taking the LHP from URSC/ ISITE to vendor premises and delivering back after suitable corrections/ modifications (if any) lies with the vendor. In such case, URSC will repeat the qualification tests before final clearance/ acceptance. Payment for such model will happen only after final clearance on pro-rata basis. Models need to be taken back for corrections/ modifications by vendor until it is accepted by URSC.

The total contract period for supply of items shall not exceed 36 months from the date of release of Purchase order**.** Once the Development Model (DM) is delivered by vendor and accepted by URSC after successful completion of all space qualified tests, the contract period for the supply of other two models i.e., FM (8 months after DM delivery and acceptance) and LM (8 months after FM delivery and acceptance) to URSC shall not exceed 36 months from the date of PO release. Detailed delivery schedules are given in **Table 2**.

Table 2 Delivery schedule.

Sl. No.	Activities	Milestone Schedule
1.	Purchase Order (PO) release *	T0
2.	Detailed Design Review (DDR) of final design before initiating procurement* and fabrication of the components for LHPs.	T0 + 6 months
3.	Submissions of all Process Identification Documents (PIDs) and Declared Materials List (DML). Manufacturing Readiness Review (MRR) by URSC, before initiating final fabrication of the DM LHP. Clearance by URSC for final fabrication of DM LHP.	T0 + 8 months
4.	Test data Results Review (TRR) by URSC after completion of all specified tests on DM LHP. Clearance by URSC for final fabrication of FM LHP.	T0 + 14 months
5.	Pre-Shipment Review (PSR) by URSC and delivery of DM LHP assembled on a suitable platform as specified by URSC, for space qualification tests at URSC.	T0 + 16 months
6.	Completion of all space qualification tests on DM LHP by URSC.	T0 + 20 months
7.	Test data Results Review (TRR) by URSC after completion of all specified tests on FM LHP. Clearance by URSC for final fabrication of LM LHP.	T0 + 22 months
8.	Pre-Shipment Review (PSR) by URSC and delivery of FM LHP assembled on a suitable platform as specified by URSC, for space qualification tests at URSC.	T0 + 25 months
9.	Completion of all space qualification tests on FM LHP by URSC.	T0 + 28 months

Sl. No.	Activities	Milestone Schedule
10.	Test data Results Review (TRR) by URSC after completion of all specified tests on LM LHPs	T0 + 30 months
11.	Pre-Shipment Review (PSR) by URSC and delivery of LM LHP assembled on a suitable platform as specified by URSC, for space qualification tests at URSC.	T0 + 33 months
12.	Completion of Space qualification tests on LM LHP by URSC.	T0 + 36 months

***** Action may be taken to procure long lead items/ components, in consultation with URSC, immediately after PO release.

Note:

1. The above-mentioned milestone schedules are with maximum allowed time. Efforts need to be put to complete the activities in advance to the given schedule.
2. However, if any delay in achieving the milestones within time, vendor should immediately inform the technical and purchase team with proper justification for the delay. URSC will review and discuss the process of delay with the vendor and appropriate measures will be taken and suggestions will be provided to vendor to proceed further in realizing the models.

All three models of LHP shall meet following requirements:

- The overall specifications/ design requirements as mentioned in **Table 1**
- The delivery schedule given in the **Table 2**
- Test matrix as shown in **Table 3**

Table 3 Test matrix.

Sl. No	Test	Development Model (DM)	Flight Model (FM)	Life test Model (LM)
1.	Proof pressure test & Burst pressure test on a sample specimen loop	√	-	-
2.	Proof pressure test on full-fledged LHP	√	√	√
3.	Helium leak test	√	√	√

Sl. No	Test	Development Model (DM)	Flight Model (FM)	Life test Model (LM)
4.	Thermal cycling test*	√ (QL)	√ (AL)	√ (AL)
5.	Thermal ambient performance test*	√ (QL)	√ (AL)	√ (AL)
6.	Thermo-vacuum performance test*	√ (QL)	√ (AL)	√ (AL)
7.	Vibration and shock tests*	√ (QL)	√ (AL)	-
8.	Life test*	---	---	√

QL = Qualification limits as provided by URSC,

AL = Acceptance limits as provided by URSC

Note*: Tests listed in Sl. No. 4, 5, 6, 7 & 8 in the Table 3 **will be carried out by URSC.** The space qualification tests will be carried out by URSC at ISITE/ URSC, in view of the limited availability of the required facilities in India. Each LHP model is declared as accepted, after the successful completion of all space qualification tests by URSC.

5. OTHER REQUIREMENTS

i. Vendor/s shall have prior field or industrial experience or engineering expertise in design, manufacturing and use of equipment such as heat exchangers, porous wicks, tungsten inert gas welding, electron beam welding, friction welding, automation of thermal equipment, handling of corrosive fluids & refrigerants, etc.

ii. Vendor/s having experience in design, fabrication and qualification of material/ working fluids for aerospace / defence / space or allied applications is desirable.

iii. Vendor shall submit the documentary proof such on previous works completed in relevent field, engineering expertise, PO copies and industrial experience during submitting the offer.

iv. The vendor/s may be asked to give detailed presentations about their understanding of the requirement to URSC, Bangalore, before bid opening. Outstation based vendor/s can choose the option of presenting through video conference mode.

v. Vendor shall confirm the participation by contacting purchase and stores officer at email: pso_e@ursc.gov.in. The date and time will be intimated a day before the presentation is scheduled.

vi. Vendor/s shall submit, along with the offer, necessary technical details as evidence for previous turn key projects of similar nature.

vii. Vendor shall provide the certificate on purity of the raw material and gases to be used as specified in the technical specifications during the review process.

6. MATERIALS

Metallic materials used in realization of all three models of LHP shall comply with the standards document, MSFC- STD-3029 or ECSS-Q-ST-70-36.

7. SAFETY REQUIREMENTS

A safety analysis (at all stages of manufacture, assembly / integration, test and operation) shall be performed. All three models of LHP i.e., DM, FM and LM shall have the following safety specifications:

i. All the materials and working fluid used in LHP should have anti-corrosive properties, high purity and inflammable. All the selected materials should have compatibility with high vacuum and working fluid should be compatible with the materials being used.

ii. For maximum pressure conditions reached during ground operations i.e., Maximum Effective Operating Pressure (MEOP), LHP flow lines, condenser and all the weld joints shall have an ultimate factor of safety greater than or equal to 1.5.

iii. The responsibility of handling and safety of each model of LHP lies with the vendor during the transportation till such model is finally accepted by ISITE/ URSC.

8. TESTING ASPECTS

The mechanical testing aspects on LHP include burst pressure test, proof pressure test and helium leak proof test. The burst pressure test shall be carried out on a specimen loop having multiple weld joints in coordination with URSC team, and to be demonstrated for loop strength before taking up the fabrication of DM, FM and LM. Whereas, the proof pressure test and helium leak test shall be carried out on the complete assembly of each LHP model i.e., DM, FM and LM. Tests listed in Sl. No. 1, 2 & 3 of **Table 3** shall be carried out by the vendor

at vendor premises and should be part of quoted price. Further details on these tests if any required will be provided by URSC after PO release. The mechanical tests to be conducted by the vendor as part of development is given in the **Table *4***.

Table 4 Tests to be conducted as part of development.

Following tests shall be conducted to demonstrate the strength of weld joints of the LHP Specimen loop before fabrication the DM	
Burst Pressure Test (Destructive test) on weld joints at selected interfaces	• The samples used for burst pressure test shall be subjected to Helium leak test before taking up for burst pressure test. • Burst pressure test shall be carried out on at least two sets of weld joints. The burst pressure shall be ≥ 2.0 times maximum expected operating pressure (MEOP) and all joints used for burst test shall pass through the test. MEOP is the pressure of the fluid at the maximum operational temperature. • Note: Burst test for the selected joints shall be carried out in coordination with URSC.
Visual Inspection	A visual inspection shall be carried out on the burst samples after the burst test for location of burst / crack, etc.
Following tests shall be conducted for all models of LHP by the Vendor	
Proof Pressure Test	• Nitrogen proof pressure test on LHP should be conducted for duration of 10 minutes (Nominal). • Proof pressure at room temperature shall be ≥ 1.5 times the MEOP with temperature compensation at MEOP. • Oil-free dry nitrogen gas shall be used for the proof pressure test at room temperature. Nitrogen gas purity level and contaminants shall be supplied.
MSLD Helium leak Test	Leak rate shall be ≤ 1 x 10^{-9} std.cm^3/ sec.

9. RESPONSIBILITY DEFINITION

The responsibility of the URSC and vendor is discussed below.

9.1 Responsibility of URSC

1) Provide necessary test procedures, work instructions, checklists and guidelines.

2) Periodic review as per the **Table 2**.
3) Space qualification tests on all models of LHP prior to final acceptance as mentioned in **Table 3**.

9.2 Responsibility of vendor

1) Design, development, fabrication and supply of fully welded and hermetically sealed LHP assembly models (DM, FM and LM) to T6 lab, ATCD/ TSG, ISITE/ URSC.
2) Vendor/s shall have techinically capable engineers for the design and development of LHP theroetical mathematical model for predicting the operating temperature with respect to the heat load, mass flow rate and pressures at the various locations of the loop using programmaing codes like Matlab.
3) Prepare, maintain and supply necessary log books, test reports, documentation, non-conformance reports, action taken reports, etc. of all activities / processes during the review process.
4) Data analysis, report generation and submission to URSC during review process.
5) Monthly progress report on each activity and status of all the three LHPs shall be communicated through email to the focal point.
6) Transportation (to & from ISITE/ URSC) of LHP post completion of all the tests at vendor facility and for testing at URSC, taking back to vendor facility for corrections, repair, final delivery, etc., whenever necessary till such LHP model accepted by URSC.
7) Declaration guarantying the shelf life of LHP's along with the technical offer (documentary proof).

10. QUALITY ASSURANCE AND RELIABILITY REQUIREMENTS

The quality assurance and the reliability requirements for the realization of LHPs are given in the below Table 5 .

Table 5 Quality assurance and reliability requirements.

Sl. No.	Description
1.	The vendor shall provide assurance for maintaining the overall quality.

Sl. No.	Description
2.	The vendor shall be responsible for verifying all the specification requirements in accordance with the product assurance and reliability specifications. The vendor shall also be responsible for compliance with all the technical specifications mentioned in chapter 3. Following methods shall be used to carry out verifications: A. Analysis B. Demonstration C. Inspection D. Test
3.	Any specific test performed by URSC, instead of the vendor/ subcontractor, shall not relieve vendor from the responsibility of compliance with all the technical requirements as per Chapter 3. The subcontractor quality shall also be controlled so as to meet the specification requirements.
4.	The qualification and acceptance tests shall be carried out in accordance with the test procedures approved by URSC. All test procedures and test plans shall be mutually agreed upon by vendor and URSC during Manufacturing Readiness Review (MRR).
5.	**PROCESS IDENTIFICATION DOCUMENT** Vendor shall submit for approval, the Process Identification Document (PID) describing the steps necessary to meet the requirements. In order to optimize cost, quality and schedules, these steps should utilize the existing procedures, which have been established over the years as a result of in-house programs. In case of variations in details and sequence, to comply with the requirements, the same may be proposed. The PID should include, though not necessarily limited to, the following: a. A detailed specification showing component parameters and other data to fully describe the LHP, its components and the allied materials proposed to be supplied. b. A detailed flow chart, showing all processing steps involved in the realization of the LHP. A list of QA check points during manufacture shall be included. c. A product flow chart, including the tests under the scope of vendor. d. Manufacturing drawing of the LHP, which complies with the specifications and reflects the hardware configuration when delivered.

Sl. No.	Description
6.	The vendor shall submit Declared Materials List (DML) for realizing the LHP. All materials to be used in the manufacture of LHP shall be traceable to the input lot whose characteristics shall have been measured, checked for uniformity and recorded during inspection. All material inspection reports shall be made available to URSC, whenever required.
7.	Manufacture of LHP shall be carried out in accordance with certified equipment / processes established and qualified for spacecraft. In-process quality assurance shall include the inspections/ tests/ measurements like physical dimensions, dimensional tolerances, litmus test for ammonia, mass, material composition, leak checks, proof pressure test, radiographic test for welded joints, etc. for each LHP.
8.	**Production Control** Vendor shall have complete traceability and lot-control over the complete production flow, beginning from raw material to final product. The lot-control shall include information and traceability to the raw material, processing information, date of processing, operators and equipment used for realizing the LHP. URSC reserve the right to station a resident engineer at the vendor facility during the period of the contract to monitor the LHP manufacturing, if necessary.
9.	A logbook of all the procedures, in-process checks and test conditions and results shall be maintained for each LHP. The logbook shall also include recent certifications of all equipment used. All logbooks/ records shall be accessible to URSC representatives.
10.	Human resources shall have suitably trained and only qualified/ certified persons shall carry out the activities.
11.	**Non-Conformance Management:** Any non-conformance encountered during the phases of realization of LHP shall be reported within 24 hours to URSC for formal clearance and approval.
12.	**Acceptance of LHP at URSC**: Final acceptance of the LHP is based on clearance from URSC after completion of all tests by URSC as per test matrix given in **Table 3**.

Sl. No.	Description
13.	URSC reserves the right to witness the qualification/acceptance tests and to review the progress of the work at various milestones of the programme. If any test is to be carried out at a place other than the vendor's premises the vendor shall give prior information to URSC regarding this.

11. PRODUCT DOCUMENTATION

The product document to be submitted online and it should contain the following

i) The design documents
   - Design overview
   - Drawings
   - Mathematical model
   - Interfaces
   - Mass budget
   - Power budget

ii) User manual and certificate of compliance (MIL standard or similar)

iii) LHP performance test reports
   - Temperature and pressure variation as a function of heat load
   - Qualification test results at various heat loads and different sink temperatures
   - LHP performance for various heat loads from 100W up to 2000W insteps
   - Startup behavior of LHP at 25W

Soft copy of all documents / reports / data, etc. with relevant information shall be submitted at least one week prior to the review date through e-mail. The timeline, delivery schedule and details of the review to be conducted by URSC is given in the **Table *2***. Subsequently, hardcopy of the End Item Data package (EIDP) shall be submitted to URSC after the completion of all for each model of LHP.

12. PATENTS AND COPYRIGHTS

The Intellectual Property Rights such as Patents, Copyrights, Documentations relating to Qualification testing and other quality procedures or any other details related to this activity that are provided by URSC shall remain the property of URSC. However, if any special methods

or procedure or processes are evolved on mutual interactions, the same may be owned jointly by both URSC and vendor.

13. INSTALLATION AND COMMISSIONING

The installation, commissioning and performance demonstration of all the models (DM, FM and LM) of LHP's to be carried out by the vendor at Technology Development laboratory, T6 lab, ATCD/ TSG/ MSA, ISITE campus/ URSC. All the materials/ test fixtures/test instrumentation and handling fixtures required for the performance demonstration of all the models of LHP needs to be carried by the vendor to the laboratory at ISITE, URSC.

14. NON-DISCLOSURE AGREEMENT

The contents of this document, technical specifications and any mode of communication received from URSC relating to this document are confidential and vendor shall not disclose, distribute or reproduce (partially or completely) to any other agency or vendor without prior permission from URSC, Bangalore.

15. ACCEPTANCE OF THE SYSTEM

The vendor shall demonstrate functionality test at vendor site and at ISITE, URSC, which includes the LHP operations like thermal performance at various heat loads up to 2kW and startup behavior.

- **One-to One Compliance**: The supplier shall provide printed catalogue of the system providing detailed specification and one-to-one compliance table as per the technical specifications. The offer should be complete with compliance statement for each of the specifications, offering technical features, safety features and optional items. Indicating merely 'YES', 'NO' or OKAY' in the compliance statement will not be considered.
- **Warranty:** The equipment shall have minimum warranty for 1 year from the date of acceptance of each model.

16. PRE-BID MEET

A pre-bid meeting will be arranged at U R Rao Satellite Centre, HAL Airport Road, Vimanapura PO, Bengaluru-560017 as detailed in **Table 6**. The prospective vendor should take part in the pre-bid meet, either in person or through video-conference, to

- Better understand the RFP;
- Clarify doubts, if any, relating to technical/commercial terms and conditions.

The vendor is required to carefully read and acquaint themselves with the technical specifications (**Table 1**), terms and conditions and other details relating to the RFP document before participating in the Pre-bid meet. The vendor should note:

a. Only such vendor[s] can participate in Pre-bid meet who understand and satisfy/comply scope of work (Chapter 2), technical specifications (Chapter 3), eligibility criteria (Chapter 17) and the terms & conditions (Chapter 19.2) stated herein.

b. "Rescheduling" of pre-bid meet, will not be entertained under any circumstances.

c. Representatives/Agents of the vendor can also participate in the pre-bid meet in person or through video-conference. However, participation in person is encouraged. No separate sessions of the pre-bid meet shall be arranged.

d. Preparation (connectivity test) for pre-bid meet through video-conference shall be communicated to vendor a couple of hours in advance.

e. It may be noted that participation in pre bid meeting is not mandatory for submitting the proposal.

f. URSC will evaluate all received eligible offers based on merit, content of each offer, experience of the vendor and its relevance to meet the current requirements.

g. Vendor shall be responsible for delivery of the assembled LHPs to Technology Development lab, T6 lab, ATCD/ TSG/ MSA-ISITE/ URSC, Bangalore, India.

h. Offers without the above information or offers with incomplete/ inaccurate/ false information will be rejected.

i. Only Indian manufacturers are eligible to participate in tendering process.

j. Please note that this product is not divisible in nature for splitting the order. Only one vendor needs to execute this order.

17. Eligibility Criteria

The eligibility criteria of vendors for submitting proposal are:

a. Only the Indian manufacturer in India.

b. Offers will be rejected if other than Indian manufacture is quoted.

c. Vendor should have the established facilities at their premises, like; working fluid (Ammonia) charging facility, material machining facility, vacuum pumping stations, proof pressure test facility, burst pressure test facility, MSLD leak test equipment, hot and cold chamber and welding facility (Electron beam, tungsten inert gas and friction welding) at their premises.

d. URSC reserves the right to inspect the above facilities at vendor premises if these are not already qualified by URSC/ ISRO before opening the price bid.

18. Submission for pre-bid meet

Table 6 outlines the details relating to the schedule for the pre-bid meet. The vendor should provide the details of their representative[s] taking part in the pre-bid meeting. Any queries related to RFP may be sent to focal point in advance before the pre-bid meet.

Table 6 Details of pre-bid meet.

1.	Intimation of pre-bid meet	Date and time will be intimated in advance.
2.	Venue of the pre-bid meet	**Venue**: Guest House at U R Rao Satellite Centre, Vimanapura PO, Bengaluru-560017. The date and time for telecom shall be communicated to the vendors
3.	Focal person for pre-bid meet	**Name**: Purchase and Stores Officer **Phone**: 080 2508 4018 **Email**: pso_e@ursc.gov.in

19. REQUEST FOR PROPOSAL

This section outlines the requisite contents of the RFP, eligibility criteria and the terms and conditions. While completing the RFP response, the company should accept the eligibility criteria (Chapter 17) and the terms and conditions (Chapter. 19.2) without any compromise.

19.1 Request for proposal contents

A request for proposal should contain the following submissions:

a. Vendor portfolio:
   i. Registered address of the Company/Firm with Phone, Email, Web etc.
   ii. List of major customers for LHPs during the preceding 5 Years (2019-2024) with their full address and contact person.
   iii. The Profile of the vendor clearly bringing out the capability of the vendor to supply high quality loop heat pipes within the stipulated time period. The areas of Strength & Weaknesses, and certifications may also be indicated.
   iv. Email address, Postal-address and phone number of vendor's Focal person (responsible representative of the vendor) with whom subsequent communication in context of this RFP can be established. If need arises, any change of the focal person can be communicated by the authorised signatory later.
b. Statement of compliance of eligibility criteria (Chapter. 17) with a note substantiating it;
c. **Table** 3 should be used to establish compliance of item b) in Chapter. 17;
d. Statement of acceptance of terms and conditions in this note (Chapter. 19.2);
e. Technical compliance matrix as per compliance in Chapter 24.
f. Compliance for LHP technical specifications and the delivery schedule (**Table** 1 and Table 2) based on guidelines issued during the pre-bid meet. Additional remarks corresponding to various specification may be provided by suitably citing the corresponding number. The vendor is at liberty to provide additional information/data in order to provide a comprehensive compliance package.
g. In case of partial compliance of any specification, the vendor shall provide reason/ justification/ alternate solution, indicating why the particular partial compliance will not impact the overall performance. Acceptance of these is at the sole discretion of URSC.
h. All the pages of the proposal submitted must be numbered and signed by the authorized signatory.

19.2 Terms and Conditions

a. All submissions must be in the English language only.
b. The vendor shall be deemed to have understood the nature, scope and magnitude of the work as outlined in this note when they propose a proposal with full understanding of the implications.
c. Proposal document without the required information or offers with incomplete/ inaccurate/ false information are liable to be rejected.
d. All documents submitted in the proposal shall become the whole and sole property of URSC. Any information in such documents that is proprietary to the vendor should be specified clearly. At its own discretion, URSC reserves the right to disclose proposals within URSC fraternity to assist it in the evaluation.
e. Vendor to provide the detailed compliance in the comment's column of **Table** *8*.
f. The vendor shall act in the spirit of fairness and refrain from committing acts that compromise the competitiveness of the LHP procurement process.

20. GENERAL COMMENTS ON PROCUREMENT PROCESS

Based on the information provided in the proposal, vendors will be shortlisted based on merit – conformance with technical specifications, experience (in development, manufacturing and flight experience of similar system or components), techno-commercial capability, company profile, etc. for the next step of procurement.

21. TENDERING PROCESS

The tendering process is explained in this section.

1. RFP requests in the form of two-part tender viz; Part-1 [Technical and Commercial terms (without pricing information)] and Part-2 [Price Bid], both through e-procurement mode only.
2. Being a two-Part Tender, Part-1 will be scrutinized first by URSC and then the techno-commercially qualified vendors shall be eligible for the Part-2.
3. If required, URSC team shall have the right to visit vendor's premises, to verify and assess the capabilities in terms of Technical Competency, Infrastructure Capacity,

Quality Management Systems, Human Resource Management, and Financial Strength, etc. as stated in their proposals.

4. On completion of Technical and Commercial terms evaluation, Price Bids of techno-commercially suitable vendors will be opened.
5. The lowest price bid will be selected from among qualified techno-commercial Bids.
6. The contract signing date or Purchase Order (PO) release date will be taken as T0 for commencement of contract period.

22. PAYMENT AND OTHER TERMS AND CONDITIONS

The terms of payment are shown in the **Table *7*** below.

Table 7 Payment terms and conditions.

Sl. No.	Payment for the LHP models	Target Schedule
1.	PO release	T0
2.	Payment for DM LHP after final successful completion of all tests and final acceptance of DM LHP by URSC on pro rata basis	T0 + 20 months
3.	Payment for FM LHP after final successful completion of all tests and final acceptance of FM LHP by URSC on pro rata basis	T0 + 28 months
4.	Payment for LM LHP after final successful completion of all tests and final acceptance of LM LHP by URSC on pro rata basis	T0+ 36 months

T0 represents the PO release date. DM = Development model, FM = Flight model and LM = Life test model. T1 = payment for DM.

22.1 Important points regarding the payment terms and conditions:

- Payment for each LHP will be made to the vendor on pro-rata basis only after the final delivery and successful completion of space qualification tests and acceptance at URSC as shown in the **Table *4***.
- URSC reserves the right to terminate the contract in case any of the LHP models is not able to meet the technical specification specified in this document, even after multiple attempts (as decided by URSC) of rework / repair by the vendor.

- URSC also reserves the right to terminate the contract in case the progress of the work being carried out by the vendor is not to the satisfaction of URSC without assigning any reason thereof.

23. SUBMISSION OF OFFER

Offer shall be submitted by the vendor/s in two parts as below:

Part 1: TECHNO-COMMERCIAL (without price details)

This shall include the following:

- Compliance matrix for all the requirements / specifications with explanatory notes, wherever applicable
- All the relevant documents as mentioned in this document
- Payment terms and Performance Bank Guarantee (PBG)
- Any price details mentioned in technical bid will be outrightly rejected

Part 2: PRICE BID

- Price bid shall contain the price of each model of LHP separately with cost break-up
- Purchase order will be released on a shortlisted vendor with technically suitable lowest offer (L1). Total price (L1) of three units (models) of LHP will be considered for comparing the price of all shortlisted vendors.

24. TECHNICAL COMPLIANCE

Vendor shall provide the detailed compliance to each point as mentioned in the compliance matric given below separately. Vendors who just provide YES or NO instead of providing the complete details will not be consider for evaluating the technical/ price offer. If any deviation from the specifications, vendor shall clearly bring out such deviations in the comment's column as given in the **Table 8**.

Table 8 Compliance matrix

Activity / Parameter	Value/ Description	Compliance
Maximum heat load per model	2 kW	

Activity / Parameter	Value/ Description		Compliance
No. of Evaporators	2 to 4 nos. (Will be informed by URSC after PO release)		
Minimum heat load for start up	25 W		
Working fluid	Anhydrous Ammonia (purity: 99.9995)		
Operating temperature (°C)	**Acceptance**	**Qualification**	
	Min: -30	Min: -40	
	Max: 60	Max: 70	
Non-operating temperature (°C)	Min: -70	Max: 80	
Maximum allowed temperature difference between heater plate and condenser (°C)	≤ 25 (between any heater plate average temperatures of evaporator to condenser average at peak load)		
Evaporator	e. Evaporator is a component that directly absorbs the heat dissipated from the electronic packages. f. It is designed such that one side of the evaporator is directly in contact with the electronics package and the other side is thermally insulated to avoid heat losses to surroundings. g. A heater plate has to be in good thermal contact with evaporator bottom for testing the evaporator of LHP with simulated heaters		

Activity / Parameter	Value/ Description	Compliance
	(cartridge or foil) on the heater plate. h. Numerous numbers of test sensors to be placed on the evaporator (10 nos. each), compensation chamber (10 nos. each) and condenser (20 nos. each) for measuring the average temperature difference between any of these components. **Material of construction**: Al6061-T6 Primary wick: Nickel porous (porosity 60%, pore radius ≤ 5 µm and permeability 1 x 10^{-14} m^2) Secondary wick: Nickel foam (porosity >90%) Secondary mesh: SS316 **Note**: 1. All pores to be interconnected. 2. The properties of the primary wick (porosity, pore radius and permeability) and secondary wick (porosity) shall be proved/ demonstrated by the vendor at their premises in presence of URSC officials before assembling it in to the evaporator and compensation chamber. 3. A good thermal contact conductance between the porous	

Activity / Parameter	Value/ Description	Compliance
	wick and the evaporator must be ensured. 4. Cylindricity and straightness of Nickel porous wick is a major parameter for ensuring good thermal contact conductance between evaporator and porous wick.	
Compensation chamber	d. It allows fluid volume variations in the loop during different operating temperatures of the evaporator e. By controlling the compensation chamber temperature (and thus the saturation pressure) the evaporation temperature is controlled. f. It acts as a phase separator or phase trap for restricting any vapor entry to the evaporator. **Material of construction:** SS316 **Temperature control**: within ± 1°C **Temperature difference:** (from evaporator to the compensation chamber) ≤ 5°C	
Condenser	Condenser is a device where the working fluid in vapour phase condenses and releases heat (latent heat of vaporization) to the radiator. **Type**: Extruded smooth walled flanged tubes (Electro-polished from	

Activity / Parameter	Value/ Description	Compliance
	inside as per ASTM standards, standard internal surface finish 100 µ inch or better and cleaning should be in accordance with ASTM A632 S3) **Material of construction**: Al 6061-T6 **Diameter**: Suitable to withstand the maximum pressure **Length**: 3.0 to 5.0 m	
Transport lines (Vapor and Liquid)	**Material**: Stainless Steel (SS) 316 or Al6061-T6 **Routing**: Should be possible to bend for aligning the metallic bellows (Electro-polished from inside as per ASTM standards) **Diameter**: Suitable to withstand the maximum pressure **Length**: up to 10 m. **Type**: Extruded smooth tubes (Electro-polished from inside as per ASTM standards, standard internal surface finish 100 µ inch or better and cleaning should be in accordance with ASTM A632 S3)	
Flexible thermal joints	e. Metallic bellows to be available on both the liquid and vapor lines and to withstand > 250 bar pressure f. Relative angular motion up to 180° should be possible g. Length: ~ 0.5 to 1.0 m	

Activity / Parameter	Value/ Description	Compliance
	h. Quantity: 2 nos. per LHP	
Pressure transducer	Shall be placed at various locations in the LHP to acquire the pressure data for various operating conditions. Minimum 2 nos. per LHP	
Maximum loop length (m)	~ 15.0	
Adverse elevation/ tilt	**Tilt**: Evaporator above compensation chamber by 3 mm **Elevation**: Evaporator is above condenser by 1000 mm **Note**: 3. In both the cases, the temperature difference between any heater plate average and condenser average temperature shall be ≤ 25°C at peak load. 4. Vendor shall built the adverse elevation test facility for characterizing the evaporator at their premises and vendor shall demonstarte the performance of evaporator to URSC officials.	
Mass of the evaporator including compensation chamber (kg)	≤ 2.0	
Helium leak rate for integrated system (m bar-l/s)	≤ 1×10^{-9}	
Spacecraft bus voltage (V)	70 ± 1 / 100 ± 1	

Activity / Parameter	Value/ Description	Compliance
Thermal instrumentation for tests	• Cartridge, tape or foil heaters • Thermistors, PRTs, thermocouples • Superlon Insulation • Pressure transducers	
Operating life in Space	15 years	
Shelf life on Ground	5 years	
Note:	d. All the passive components, including flow lines, used in the LHP shall be chemically cleaned before final assembly. e. Chemical cleaning process for different materials will be shared by URSC at appropriate time. f. All finer details for the design & realisation of LHP should be worked out by the vendor in mutual consent with URSC engineers.	
