

ANNEXURE TO EXPRESSION OF INTEREST (EOI)

LIQUID PROPULSION SYSTEMS CENTRE Indian Space Research Organisation Bengaluru – 560 008, Karnataka

Advt. Ref. No.:

Date:

Corrigendum Invitation for Expression-of-Interest

“Expression-of-Interest is invited from aerospace manufacturing Indian Industries for the operation of Integrated Titanium alloy Propellant Tank Production Facility (ITPF) being established by LPSC at Tumakuru campus (60 kms from Bangalore), Karnataka for the production of propellant tanks for various projects of ISRO on Government Owned Company Operated (GOCO) model.”

1. Introduction

Liquid Propulsion Systems Centre (LPSC), Indian Space Research Organisation (ISRO), Government of India is responsible for design, development, realization and delivery of propulsion systems for various spacecraft & launch vehicle programmes of ISRO. Propellant tank is one of the critical element in propulsion system. The design requirements of propellant tanks include weight optimization, selection of Titanium alloy compatible with propellants as material of construction and incorporation of propellant management devices (PMDs) to ensure gas-free propellant supply to the engines under microgravity environment encountered in space.

The spacecraft programme of ISRO is being enhanced considering the national needs. The additional hardware requirement due to this is being met by building additional capacity. Towards the requirement of higher number of propellant tanks, LPSC is establishing a dedicated state-of-the-art facility for the production of Titanium alloy propellant tanks (i.e., Integrated Titanium alloy Propellant Tank Production Facility-ITPF).

This production plant will have machining, chemical cleaning, welding including Electron Beam Welding, Inspection & Metrology & non-destructive inspection, precision assembly and test facilities including Quality Assurance/ Quality control (QA/QC) activities for realising flight worthy tanks.

LPSC proposes to effectively utilise the expertise, experience and capabilities of Indian Industries who are in the field of aerospace manufacturing and / or who possess prior experience in production of similar aerospace products. Accordingly, it is proposed to invite Expression-of-Interest (EOI) from Industries for the

operation of the production plant on GOCO model for the production of propellant tanks using LPSC established ITPF.

The spacecraft propellant tanks are of volumes varying from 30 litres to 1,500 litres. The diameters vary from 400 mm to 1,400 mm. Thin walled, machined hemispheres along with propellant management devices (PMDs) are electron-beam-welded for realising the propellant tanks. Additional central cylinders are added to obtain higher volume propellant tanks as variants. In certain cases Cassini-shaped end-domes are used in place of hemispherical end domes.



650L SPACECRAFT PROPELLANT TANK (Dia.870mm)

The volumes of PS4 propellant tank (for 4th stage PSLV) varies from 2,000 litres to 2,500 litres approximately. The diameter is 1,380 mm. This is a bi-compartmental propellant tank with Propellant Acquisition System (PAS). In this case also the thin walled, machined end-dome and cylindrical-shells are electron beam welded to realise the propellant tanks.



PS4 PROPELLANT TANK (Dia.1380mm)

2. Scope of work for the Indian Industry envisaged at ITPF

The scope-of-work encompasses operation of the ITPF by the aerospace manufacturing Indian Industry for the production and delivery of approximately 110 Nos. of spacecraft propellant tanks, 30 Nos. of PS4 propellant tanks along with

30 sets (i.e., 60 nos.) of propellant acquisition system (PAS) over a period of 5 years. Annual requirements being flexible shall be given in due course. Draining devices & PMD parts, machined parts for PAS and anti-slosh baffles for PS4 propellant tank will be issued as free-issue-material (FIM) by LPSC. The period of contract may be extended for further duration on mutually agreed terms and conditions.

3. **Operations and involved facilities in ITPF for the production of Titanium alloy spacecraft propellant tanks and PS4 propellant tanks:**

ITPF is a self contained plant and includes full complement of machining, welding (including Electron Beam Welding), inspection & QC, chemical cleaning, vacuum heat-treatment, non-destructive inspection, assembly clean-rooms and test facilities. The plant also includes captive power supply, UPS back up and utilities such as gas bank with network of distribution lines for various gases such as GN₂, GHe, GAr, compressed air, etc.

The bird's eye view of the various facilities & operations involved are detailed below.

- 3.1. **Storage:** Receipt and storage of titanium alloy forgings, machined parts, standard parts and consumables at bonded stores. Safe storage of sub-assemblies and finished propellant tanks in respective bonded stores.
- 3.2. **High precision machining:** Machining of hemispherical / ellipsoidal /Cassini shaped domes, cylindrical rings with stringent geometrical & dimensional tolerances are carried out in machining facility. The high precision machine tools used are: Ø 1500 mm class horizontal heavy duty CNC lathe, Ø 600 mm class horizontal CNC lathe, 4 axes mill-turn centre, Ø 1500 mm vertical turn-mill centre, precision lathe, CNC milling machine, general purpose lathe and precision de-burring equipments & tools, etc.
- 3.3. **Inspection & Metrology :** Thorough inspection of machined parts such as thickness mapping of domes, visual and dimensional inspection is carried out in metrology and inspection facility. The high-end metrology inspection equipments used are co-ordinate measuring machine, height measuring instrument, surface finish measuring machine (portable), ultrasonic thickness gauge and other precision measuring instruments. Inspection is required to be carried out at various stages such as part level, sub-assembly level, final assembled propellant tanks, etc.
- 3.4. **Surface treatment:** Chemical cleaning of machined parts, preparation of weld joint surfaces, etc., is carried out in the chemical cleaning facility.
- 3.5. **Pre-assembly operation:** Precision de-burring of machined parts & sub-assemblies under microscope, visual inspection of standard parts, tube bending, matching, etc., are carried out in the pre-assembly area.
- 3.6. **Sub-assembly conversion:** Assembly of machined parts is carried out in clean environment i.e., 1,00,000 Class clean-room. Orbital TIG welding is used to join the

tubes of propellant / gas ports, etc., The final tank assembly and cleanliness verification is carried out in 10,000 Class clean room.

- 3.7. **Welding & heat treatment:** Joining of machined parts & standard parts using electron beam welding / M. TIG welding processes are carried out in this facility. The machines used are: Electron beam welding machines and MTIG welding machine. The finished Titanium alloy spacecraft propellant tanks are heat treated in vacuum furnace (ageing).
- 3.8. **Non-Destructive Inspection (NDI):** The sub-assemblies and finished propellant tanks are subjected to elaborate non-destructive inspection in individual facilities. The weld joints are subjected to X-ray radiographic inspection, ultrasonic inspection and fluorescent penetrant inspection. Certain parts are inspected by eddy current method including robotic eddy current testing and the body of spacecraft propellant tank is subjected to shearography inspection.
- 3.9. **Sub-assembly / final machining:** Precision turning, milling and drilling/reaming operations are carried out on sub-assembly/finished spacecraft propellant tanks in a special purpose 4 axes mill-turn centre. In addition, riveting is carried-out for fixing plate-nuts. Finally, the tank surfaces are manually polished.
- 3.10. **Testing and facilities:** The sub-assemblies and final assembled propellant tanks are subjected to various tests such as functional tests, pressure test, leak test, vibration test, cleanliness verification test etc.
- 3.11. The propellant tanks are subjected to hydraulic/pneumatic pressure tests. Separate hydraulic and pneumatic test facilities are employed for this. The facilities are fully instrumented.
- 3.12. External leak measurements of the propellant tanks are carried out in dedicated leak test chamber.
- 3.13. The spacecraft propellant tanks will be subjected to vibration testing with the tanks filled with simulant fluid to simulate mass and under pressure. These tests will be carried out in vibration test facility which has suitable rating vibration shaker along with instrumentation and data acquisition system.
- 3.14. Verification of Interface Control Dimensions (ICD) of the final tank prior to delivery.
- 3.15. On-line quality surveillance at all stages of assembly & testing operations.
- 3.16. Documentation, packing & delivery.

4. **Criticalities involved**

Machining of high-value Titanium alloy hemispherical domes / cylinders, etc., with varying surface profile from a stock thickness of 20.0 mm to varying thicknesses up

to 0.8 mm final thickness. Adherence to geometrical tolerances as per drawings for jobs up-to dia. 1500 mm is a challenging work.

- 4.1 Assembly of high value added thin shells with draining device & PMD parts-in clean environment.
- 4.2 Electron beam welding of sub-assemblies and assemblies to realise the full propellant tank.
- 4.3 Advanced NDI of the propellant tanks which include X-ray radiography, ultrasonic inspection, eddy current inspection and Shearography inspection.
- 4.4 Testing of the propellant tanks which include functional testing (bubble point, flow characterisation, expulsion efficiency) pressure testing, leak testing, vibration testing, etc.
- 4.5 Safe handling of parts, sub-assemblies, and full propellant tanks during assembly and testing with stipulated safety measures during the realisation process. Ensuring proper storage of these items during work.

The free-issue-materials (FIM) comprising of Titanium alloy forgings, value added propellant management devices and anti-slosh baffles are long lead/high value items. Rejections at any stage of production in ITPF would impact delivery schedules and have major cost implications.

5. **Who can participate in the EOI**

Indian industries that have experience in aerospace or defence manufacturing to the ones described under points in paragraph (3) regarding operation of ITPF, who have the skilled human resources for such critical activities, who have the requisite work experience & financial credentials can participate in the EOI. However, all necessary information shall be furnished by the participating Industry to facilitate evaluation of offers by LPSC.

6. **Human resources required for the operation of ITPF and HR policy of the Industry / company :**

- 6.1. The Industry / company shall deploy the necessary workforce to operate the ITPF facility.
- 6.2. Industry / Company workforce should be qualified, experienced and possess requisite skill-sets for operation of the dedicated facilities in ITPF and perform production work as specified.
- 6.3. It is anticipated that a work-force of about 86 personnel (comprising of Graduate Engineers, Diploma Engineers & Technicians) may be required to be deployed by the Industry/company for the production task.
- 6.4. The Industry/ company shall have a HR policy of retaining the LPSC trained (as under para 7) workforce. This is very essential since attrition would lead to

derailment of production activities, affect quality, result in delay in delivery schedule and lead to uncertainty in contract execution.

7. Training of Industry / company workforce of the Industry:

The Personnel to be deployed by the Industry shall possess basic skills in the broad areas identified under 3&4 above.

LPSC shall impart essential job-specific training to the company / Industry workforce in relevant critical areas. LPSC will provide training initially for identified personnel from the industry. Subsequently the trained personnel from industry shall impart the training to other personnel.

Other requirements to be met by Industry/company

8. Security: The Industry/Company workforce shall comply with security regulations of LPSC.

9. Safety: Industry/Company workforce shall follow all safety stipulations.

10. Secrecy: The work if entrusted shall be treated as confidential and shall not be divulged to any 3rd party. Industry/Company and their workforce shall abide by instructions of LPSC in vogue and shall provide undertaking to this effect.

11. Criteria for scrutiny and evaluation of EOI proposals

11.1. General

11.1.1. The EOI shall contain complete information of the Industry /company such as line of business, human-resources, infrastructure, assets, financial standing and credentials.

11.1.2. Self assessment on technical and organisational competence to respond to the EOI of this nature and magnitude by the participating company / Industry to be furnished.

11.2. Essential criteria for evaluation of EOI proposals

11.2.1. The Industries/companies desirous of submitting EOI proposals shall mandatorily be accredited with valid AS9100 or ISO9100 certification for the last 3 years of the Industry's/company's existing operations.

11.2.2. Prior experience of more than 3 years is essential in working with aerospace or defence sectors involving in manufacturing (such as machining, welding, heat-treatment, inspection/NDI) assembly, testing, evaluation and production of precision / complex / critical aerospace assemblies.

11.2.3. The Industry/company shall possess human resource with adequate knowledge, skill and experience in the areas of manufacturing, metrology inspection, assembly, advanced non-destructive inspection, testing and quality control.

- 11.2.4. Average annual turnover of the Industry/company for similar nature of work in aerospace / defence manufacturing should be Rs. 3.00 crores or higher per annum during the last 3 financial years (FY: 2019-20, 2020-21 & 2021-22) ending 31st March of corresponding year.
- 11.2.5. The company / Industry should not have incurred any loss in more than 1 year during the last 3 financial years (FY: 2019-20, 2020-21 & 2021-22) ending 31st March of corresponding year. Certified copies from Chartered Accountant for the annual financial turnover and balance sheet showing profit / loss to be furnished.
- 11.2.6. Viable plan for Liquidity and Solvency during the currency of the project to an extent of Rs. 2.50 crores to be outlined.

Note:

- (1) For clauses under Sl. No. 11, all information provided by the Industries/ companies shall be backed by documentary evidences. Printed brochure of the Industry/company to be enclosed.
- (2) The final evaluation of the responses will be based on inputs furnished against our criteria, assessment based on facility visit, if necessary, feedback from customers and overall assessment.
- (3) The information pertaining to clauses in paragraph (9) to be furnished as per the checklist provided in Annexure-1.
- (4) Last Date for Submission of EOI is 30.11.2022; 14:00 HRS**

Annexure-1

Compliance matrix regarding document submissions by company / Industry

(Explanation should be in detail, supported by documents with page Nos.)

Sl. No.	Item Description	Furnished/ Compliance Yes/No	remarks, if any, Supporting documents with page Nos.
1	Industry/Company Name / Title and Address		
2	Contact details (Name, designation, phone no., e-mail, fax no., etc.)		
3	Line of business		
4	Details of human resources (relevant to the nature and magnitude of the scope of work)		
5	Experience in similar nature of works: (Work order/purchase order/ contract copies, satisfactory work completion certificates from Agencies where work was executed, with details regarding the nature and magnitude of work, etc.)		
6	Self assessment on technical and organisational competence to respond to the EOI of this nature and magnitude. (In the relevant areas of detailed in the scope of work)		
7	Details of infrastructure available with the company/Industry		
8	Documentary evidence for accreditation to valid AS9100		

Sl. No.	Item Description	Furnished/ Compliance Yes/No	remarks, if any, Supporting documents with page Nos.
	or ISO9100 certification for the past 3 years.		
9	Details regarding financial credentials such as:	--	
9.1	Annual financial turnover for the preceding 3 Financial Years (i.e., FY 2017-18, FY 2018-19, FY 2019-20)		
9.2	Audited balance sheet and profit & loss statement for the preceding 3 Financial Years (i.e., FY 2017-18, FY 2018-19, FY 2019-20)		
9.3	IT Returns for the preceding 5 Financial Years. (i.e., FY 2015-16, to FY 2019-20)		
9.4	Viable plan for Liquidity and Solvency during the currency of the project to an extent of Rs. 2.50 crores.		
10	Details of similar works / projects in hand of value more than Rs. 3.00 crores.		
11	Details of similar works / projects completed in the preceding 3 years of value more than Rs. 3.00 crores.		
12	Manufacturing work-orders and contracts completed /ongoing for ISRO, if any		
13	Any other relevant information.		