

TERMS AND CONDITIONS

1. Scope of Work

The scope of work involves Pre-processing, feedstock characterization, Additive manufacturing, heat treatment, post-processing, NDT, inspection and supply of the following parts as per table 1.

Table-1

Sl.No	Items Description	Specification	Qty.	Remarks
1	LME LOX Exhaust Casing	As per the drawing	2 Nos	LME 1100-LOX-50AY
2	Tensile Test Specimen (RT)	11 x 11 x 150 mm	16 Nos	(4 Nos in each H & V direction) x2 Build
3	Tensile Test Specimen (High Temp)	11 x 11 x 120 mm	8 Nos	(4 Nos in each H & V direction) x 1 Build
4	Impact Specimen (RT)	11 X11X56 mm	8 Nos	(4 Nos in each H & V direction)
5	Creep Specimens	12 x 12 x 120 mm	8 Nos	(4 Nos in each H & V direction)
6	Cubes	15 x 15 x 15 mm	8 Nos	1 Nos. in each corner for all the two builds
7	Full height specimens	20 x 20 x 240 mm	2 Nos	Till product height in each build of impeller

Applicable Standard: The parts shall be realized as per ASTM F3055.

2. Responsibility of the Vendor

2.1. Design

- 2.1.1. Model design for additive manufacturing with the 2D drawing/3D model supplied by LPSC.
- 2.1.2. Getting approvals for models generated including finalized orientation and supports.
- 2.1.3. Conversion of model to machine format for 3D printing.
- 2.1.4. Generation of inspection procedure for 100% inspection (Dimensions & NDT)
- 2.1.5. Shall prepare a build layout of part along with specimens to be printed and the same shall be submitted for approval from LPSC and the printing shall be carried out strictly as per the layout. A tentative build plan is attached as annexure-2. A digital photograph of the build after printing and before stress

relieving may be provided as a proof of conformation to the approved print plan.

2.1.6. Prepare manufacturing-cum-quality plan and shall be submitted to LPSC for approval.

2.1.7. Any clarifications/doubts during the above process shall be clarified before printing of the job.

2.2. **Material**

2.2.1. The vendor shall use **IN718** powder sourced from the same OEM to realize all the parts and specimen. The vendor shall submit the Manufacturer's Test Certificate for all the tests carried out as per 2.3.

2.2.2. Re-use and blending of powders is permitted as per ASTM F3055. It is preferable to use virgin powder for realization of parts and specimens. **Re-use of powders is permitted for a maximum of 5 times.** Further, the vendor shall specify the mixing ratio of virgin to used powder. In case of blending, powder characterization shall be done on the actual powder used for printing the job and results shall be submitted to LPSC for clearance.

2.3. **Feedstock characterization:** The vendor shall perform the following feedstock characterization for both virgin & reused powder as per ASTM F3055 and it should conform to the Manufacturer's Test Certificate. Feedstock characterization shall be done at NABL-accredited labs. The vendor shall provide 50 grams of virgin powder, along with 50 grams of the actual powder used during the printing process, for analytical purposes. Necessary test certificates of the powder shall also be provided along with the inspection report.

2.3.1. Chemical Composition Analysis

2.3.2. Oxygen, Nitrogen & Hydrogen Content

2.3.3. Powder shape and size distribution

2.3.4. Powder Morphology (SEM)

2.3.5. Apparent Density & Tap Density

2.3.6. Flow characteristics

2.4. **Powder clearance:** Details of Feedstock characterization before each build shall be supplied to LPSC for review and approval before realization of parts

2.5. **Additive Manufacturing:** Additive manufacturing of the parts and specimens through LPBF (Laser powder bed fusion) shall be as per the approved process plan /manufacturing plan approved by LPSC, including build layout.

- 2.5.1. Parts and specimens in each build cycle shall be built together using the same feedstock, machine, and process parameters.
- 2.5.2. The vendor shall use qualified LPBF machine for realization.
- 2.5.3. The identification of the specimen shall be in-situ printed with respective directions i.e. H & V directions.
- 2.5.4. Photograph (with date and time) of build layout shall be attached with inspection reports. There shall not be any change from the approved build layout.
- 2.6. **Post processing:**
- 2.6.1. Powder removal
- 2.6.1.1. Vendor shall ensure complete powder removal from the part.
- 2.6.1.2. Vendor shall use tapping, vibration, compressed air, etc. to ensure complete powder removal without any remnant debris.
- 2.6.2. Stress relieving (SR)
- 2.6.2.1. Stress relieving shall be carried out for hardware & specimens as per cycle given in Table-3
- 2.6.2.2. Furnace and controller calibration certificate of the proposed furnace for heat treatment shall be submitted to LPSC for review and clearance before stress relieving (applicable standard AMS 2750E).

Table-3

Sl. No	Heat Treatment	Furnace	Temperature	Soaking	Cooling
1	Stress Relieving	Class IV- Vacuum	1065 ⁺¹⁵ ₋₁₅ °C	90 ⁺¹⁵ ₋₅ min	Argon Gas quenching equivalent to air cool (2 to 3 bar)

- 2.6.3. Post processing after SR
- 2.6.3.1. Wire EDM process to be done to separate the parts & test samples from the build platform.
- 2.6.3.2. The hardware shall be cleaned by purging compressed air.

2.6.4. Rough machining shall be done to remove supports. The surface finish after post-processing (such as sand/grid blasting) should be less than 8 Ra.

2.6.5. DP test after support machining

2.6.5.1. 100% DP shall be done as per ASTM E1417 and the hardware shall be defect free

2.7. The vendor shall perform solution treatment & ageing of the hardware & specimens as per cycle given in Table-4. Furnace and controller calibration certificate of the proposed furnace for heat treatment shall be submitted to LPSC for review and clearance before STA. Applicable standards AMS 2750E

Table-4

Sl. No	Heat Treatment	Furnace	Temperature	Soaking	Cooling
1	Solution treatment	Class IV- Vacuum	980^{+14}_{-14} °C	60 min	Fast cooling with argon quenching (2 to 3 bar)
2	Ageing I		718^{+8}_{-8} °C	480^{+30}_{-0} min	Furnace Cool to 621^{+8}_{-8} °C @ 55^{+8}_{-8} °C/hr
3	Ageing II		621^{+8}_{-8} °C	480^{+30}_{-0} min	Argon Gas quenching equivalent to air cool (2 to 3 bar)

2.8. The vendor shall perform the final machining as per the approved drawing/model provided by LPSC and conduct dimensional inspection as per the drawing. In case inspection facility is not available in-house, the same shall be done in a NABL-accredited laboratory.

2.9. **NDT:** 100% DP shall be repeated at final machined area, as per ASTM E1417 and the hardware shall be defect free. X-ray radiography shall be done as per ASTM 1742 and acceptance criteria shall be as per clause 4.5

2.10. **Specimen Fabrication:** All specimens shall be fabricated as per table-4 and remaining specimens shall be supplied without machining.

2.11. **Mechanical Testing:** The mechanical test shall be done on specimens in H & V direction as per Table-5 in NABL accredited lab and properties of tensile test coupons (RT) shall meet the requirements as per clause no. 4.3. For testing mentioned in Sl No. 2 of Table-5 values are for reporting purpose only. Specimen shall be defect free and X-ray shall be taken before testing. Tested as well as unused specimens shall be sent back to LPSC for its further studies

Table-5

Sl. No	Specimen	Qty.	Reference Drawing	Remarks
1	Tensile Test Specimen (RT)	12Nos	LPSC/MME/AML/TT S/ROUND/RT, Sr.No 1	(3Nos in each H & V direction)x2 Build
2	Impact Specimen (RT)	6Nos	MME/AML/IMPACT/ V-NOTCH	(3 Nos in each H & V direction)

2.12. **Supply conditions:** The parts and specimens shall be supplied (with proper Identification) in solution treated & aged and machined condition.

2.13. The following document shall be provided by the vendor along with the hardware.

2.13.1. Test certificate from the powder manufacturer.

2.13.2. Certificate on feedstock characterization as given in clause 2.3

2.13.3. Certificate on process parameter (Power, Scan speed, layer thickness, laser type, re-coater & its speed, hatch distance and manufacturing strategy/total time taken for job printing) used for realisation of parts. Separate certificates shall be provided for different build cycles.

2.13.4. Laser power monitoring graph for each build.

2.13.5. Heat treatment certificate as per the clause no. 2.6.2.1 and 2.7

2.13.6. Furnace calibration certificate

2.13.7. NDT (DP & X ray report), mechanical test, Dimensional & visual inspection report of the parts as well as specimens.

2.13.8. Density report using one of the cube specimens from each build

2.13.9. Build plan photograph as per clause 2.5.4

2.14. Envisaged process flow chart is given in annexure-4

3. Responsibility of LPSC

3.1. LPSC will provide clearance for realization of builds after reviewing the model for Additive manufacturing and manufacturing cum quality plan/ process plan supplied by the vendor.

- 3.2. LPSC will provide clearance for realization after reviewing the feedstock characterization reports
- 3.3. LPSC will provide clearance for stress relieving after reviewing the 2D X-ray and furnace and controller calibration certificate.
- 3.4. LPSC will perform pre-delivery inspection. The vendor has to inform the readiness to the LPSC focal point in advance.

4. Inspection & Acceptance

- 4.1. **Dimensional Inspection:** 100% dimensional & visual inspection of parts shall be carried out by the vendor as per drawings/models.
- 4.2. The metal powder and test coupons shall have chemical composition of Inconel 718 as per **ASTM F3055-14a** given in Table- 6. LPSC will carry out the chemical analysis on specimens for reconfirmation.

Table- 6

Element (%wt)	LSL	USL
Carbon	0.00	0.08
Silicon	0.00	0.35
Manganese	0.00	0.35
Nickel	50.00	55.00
Chromium	17.00	21.00
Phosphorous	0.00	0.015
Sulphur	0.00	0.015
Molybdenum	2.80	3.30
Niobium	4.75	5.50
Titanium	0.65	1.15
Aluminium	0.20	0.80
Boron	0.00	0.006
Cobalt	0.00	1.00
Copper	0.00	0.30
Iron	Balance	

- 4.3. The Tensile test coupons (RT) shall have the minimum mechanical properties at ambient temperature (Heat Treated conditions) as shown in Table -7 as per ASTM F3055-14a.

Table -7

Specimen	UTS (MPa)	0.2% YS (MPa)	% of elongation (on GL=4D)	% of Reduction in area
X/Y(H)	1240	940	12	To be reported
Z(V)	1240	920	12	To be reported

- 4.4. Impact test (RT) values are for reporting purpose only.
- 4.5. No surface defects are permitted in DP.
- 4.6. Acceptance criteria of X ray shall be as per the requirements given in the Table-8.

Table- 8

Defects	Acceptance limits
Porosity	0.33t or 1.52 mm, whichever is less
Inclusions	Up to the extent of pores
LOF defects, Cracks & other linear indications	Not Permitted
Shrinkage defects	Not Permitted
Unconsolidated powder & Trapped powder	Not Permitted
Layer & Cross-layer	Not Permitted
Porosity & Inclusions accumulated	1.33 t or 6.1mm, whichever is less in 76.2 mm ²
Spacing between pores & inclusions	3 times larger discontinuity

- 4.7. The hardware shall be free from powders and debris.
- 4.8. The hardware & specimens will be accepted only if they meet the chemistry, mechanical properties, dimensions and NDT requirements.
- 4.9. The hardware supply shall be accompanied with all relevant reports (refer clause no. 2.13). The finished product shall be dispatched only after clearance by LPSC
- 4.10. No weld repair is allowed on the component. Also, building the thickness or a feature in a component by weld repair is not allowed.
- 4.11. Strictly no interruption of the build will be permitted

5. Focal Point

The focal point from both the vendor and LPSC for this work shall be identified in the purchase order. Any technical clarification needed shall be referred to the Focal point of

LPSC, identified for this purchase order. All commercial terms shall be referred to the purchase department with a copy to the contact point.

6. Delivery Period

The realisation and delivery of items of Table 1 shall be completed within 5 months of placement of PO or after supply of approved 3D model from LPSC whichever is later.

7. Quality & Workmanship

The Quality, workmanship, and tolerance of the work carried out shall be strictly by the engineering standards and requirements as called for in the drawings, models and specifications. No deviation shall be permitted and all the supplies shall strictly conform to the specifications given in the drawings and Purchase Order. Gross deviations in properties from 3D printing standards shall be compensated by additional builds.

8. Free Issue Materials

There is no free-issued material for this purchase order. The vendor shall procure the material for realization.

9. Pre-delivery inspection

Pre delivery inspection will be carried out by LPSC QC before dispatch of hardware at various stages (review of 2D-ray films, witnessing of SI.No.1 of table-5 & counter inspection of hardware dimensions)

10. Rework

Any rework that may be required to maintain the specified quality level (clause-4) shall be carried out by the contractor free of cost with due intimation & approval from LPSC. Details of reworks shall be furnished in the QC documents. After rework, the relevant dimensions shall be re-inspected and hardware with non-acceptable deviations shall get rejected, if it is not complying the quality requirements as per clause 4. No weld rework is allowed

11. Rejections

In case of any rejections due to non-compliance to clause 4, the vendor shall replace the item free of cost.

12. Ownership and custody of drawings and documents

The vendor shall be the custodian and shall be responsible for the safe custody of all the drawings, models, documents, etc., issued by LPSC as well as the documents generated during work. The destruction or reproduction of drawings shall be done only with the written consent of LPSC.

13. Heritage Requirement

The vendor must provide documentary evidence demonstrating a credible process history of utilizing IN718 for similar types of work. This requirement aims to verify the vendor's experience and capability

14. Non-Disclosure Agreement (NDA)

- 14.1. Vendor has to establish a Non-Disclosure Agreement (NDA) to protect proprietary information and sensitive details of this scope of work
- 14.2. The information related to this work will be treated as "secret" and that the contents of the drawings, process sheets or any other documents shall not be disclosed or parted with to any other individual, firm or company without the written authorization by the LPSC.
- 14.3. If the documents supplied by the Vendor are marked as 'restricted use' the Vendor shall take all necessary steps to ensure that the requirements of the purchase order or any specification, drawing, sample or information supplied by LPSC shall not be disclosed to any person other than a person employed or engaged by the LPSC, whether under SUB-CONTRACT or otherwise, for the performance of the purchase order.
- 14.4. Any disclosure to any person permitted under above shall be made in confidence and shall extend only as far as may be necessary for the purpose of the purchase order.
- 14.5. Mode of operation of non disclosure agreement (NDA)
 - 14.5.1. The vendors who are willing to participate in this tender shall enter a non disclosure agreement (NDA) with LPSC.
 - 14.5.2. The vendor shall submit the duly signed NDA as per attached format to ps0_2@lpsc.gov.in within a week from tender date.
 - 14.5.3. On receipt of NDA, LPSC will share the related 3D models / drawings for additive manufacturing.

15. Packing and delivery terms:

The vendor shall arrange to suitably pack the items and deliver them to LPSC stores.

16. Bid submission

The vendor shall submit their offers on two part bid basis in separately as under.

16.1. Part 1: Technical and commercial bid

16.1.1. This part shall cover all technical points.

16.1.2. Shall give details of facilities and plan of realization. The vendor shall provide documentary evidence demonstrating a credible process history of utilizing IN718 for similar types of work. This requirement aims to verify the vendor's experience and capability

16.1.3. Party shall also indicate other commercial terms and condition.

16.2. Part-II: Price bid

The price bid shall include the cost details as per tender.

17. Local Content Requirement Clause

The party shall ensure that a minimum of 20% of the total scope of work, including materials, labor, and services, is sourced locally within India. The party is required to provide appropriate documentation to confirm compliance with this requirement.

18. Correspondence:

All commercial correspondences in regard to this work order shall be addressed to the Senior Purchase & Stores Officer (Purchase), LPSC, Valiamala, Trivandrum- 695 547. You shall quote our work order number and date in all correspondences.