

GAS TURBINE RESEARCH ESTABLISHMENT, BANGALORE

Scope of Work for

Machining, Brazing & EBPVD/TBC Coating of Single Crystal castings of Turbine Blade and Nozzle Guide Vane, and supply 'ready to fit parts' on a turnkey basis

(Post cast operations on GTRE supplied SX castings)

Gas Turbine Research Establishment (GTRE), C. V. Raman Nagar, Bengaluru-560093, India, is developing aero gas turbine engines. Director, GTRE, on behalf of the President of India invites "Global Tender Enquiry" from established **Aerospace Industries/Organisations** for **manufacture of High Pressure Turbine Rotor Blades (HPTR) (250 Numbers) & High Pressure Nozzle Guide Vanes (HPNGV) (60 pairs) in a 'ready to fit conditions' on a turnkey basis.**

1. Objective:

GTRE shall provide Single crystal (SX) castings for the manufacturing activities. Industry Partner shall carryout complete machining, cooling holes drilling, fabrication, assembly, brazing and Pt-Al/ EBPVD-TBC coating and deliver ready to fit parts. 250 No's Blade HPT Rotor and 60 pairs (Twin Vanes configuration) of Vane HP Turbine Sub Assembly to be manufactured as per GTRE Drawings and specifications.

2. Pre-qualification criteria:

- a. Quality Management system of Industry Partner shall be AS9100 D certified or its equivalent will be preferred. Necessary documentary proofs to be submitted.
- b. Proposed demand is for manufacturing and supply of safety critical parts to be manufactured with stringent quality specifications and accuracies as per GTRE drawings & specifications. Industry Partner or their supply chain should have necessary infrastructure, facility and experience for executing contracts on a turnkey basis, for machining, cooling holes drilling, fabrication & assembly, EBPVD/TBC coating, brazing, Inspection and qualification.
- c. Industry Partner or its supply chain should have executed similar contracts for manufacturing and supply of turbine blades and Turbine vanes (HPNGV) on Directionally Solidified (DS)/Single Crystal (SX) castings for established aero engine houses or for aero engine applications. Industry Partner shall have the in-house inspection infrastructure facilities. The Industry Partner has to produce documentary proof along with tender documents with respect to availability of required

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Page 1 of 24

infrastructure with a minimum 40 % in-house facilities to carry out the engineering operation (as per Annexure – A). Special Technical Evaluation Committee (STCEC) will assess the in-house facilities/capabilities based on documentation/visit/interaction with Industry Partner.

- d. Any Industry Partner from such countries sharing a land border with India will be eligible to bid in any procurement whether of goods, services (including consultancy services and non consultancy services) or works (including turnkey projects) only if the Industry Partner is registered with the Competent Authority as provided in Government of India order (Public Procurement No.1) vide F. No. 6/18/2019 - PPD dated 23 July 2020. A certificate in compliance for the same to be submitted by the Industry Partner along with technical bid (Appendix B).

Note - Above mentioned clauses are mandatory and should be given on company letter head by the Industry Partners, without which quotations will not be considered for evaluation.

3. Product/ service details and specification:

250 No's of Blade HPT Rotor and 60 pairs (Twin Vane configuration) of Vane HP Turbine Sub Assemblies to be manufactured as per GTRE Drawings and specifications, as mentioned below.

3.1 List of drawings for manufacturing HPT Rotor Blades and HP Nozzle Guide Vanes (HPNGV) as per Table No. 1 (Drawings shall be provided after receipt and approval of NDA)

Table No. 1 - List of drawings for manufacturing of HPTR and HPNGV

| Sl. No. | Name | Drawing Number | Revision No. | Material |
|---------|-------------------------------------------------|--------------------|--------------|-------------|
| 1 | Blade HPT Rotor * | KF33042 | Nil | GTM- SU-SX4 |
| 2 | Vane HP Turbine Sub. Assy. * | KF31000 | Nil | GTM- SU-SX4 |
| 3 | Scheme for Brazing of HPT Rotor Blade | Scheme No-S03SC003 | Nil | - |
| 4 | Front Impingement Tube- Sub. Assy. – Vane HPT | KF31100 | Nil | L-605 |
| 5 | Front Impingement Tube - Vane HPT | KF31103 | Nil | L-605 |
| 6 | Cover Plate – Front Impingement Tube – Vane HPT | KF31104 | Nil | L-605 |

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|----|---------------------------------------------------|---------|-----|-------|
| 7 | Support Plate – Front Impingement Tube – Vane HPT | KF31105 | Nil | L-605 |
| 8 | Tube Impingement Aft. Sub Assy. Vane HPT | KF31200 | Nil | L-605 |
| 9 | Tube Impingement Aft. - Vane HPT | KF31206 | Nil | L-605 |
| 10 | Support Plate – Aft Impingement Tube – Vane HPT | KF31207 | Nil | L-605 |
| 11 | Cover Plate – Aft Impingement Tube – Vane HPT | KF31208 | Nil | L-605 |

* Except Blade and vane castings, all other materials to be purchased by the Industry Partner from approved aerospace industry supply chain

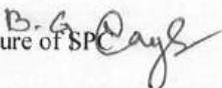
Table No. 2 – Casting drawing details (For Reference)

| Sl. No. | Name | Drawing Number | Revision No. | Material |
|---------|---------------------------|----------------|--------------|-------------|
| 1 | Blade HPT Rotor - Casting | KF302C | Nil | GTM- SU-SX4 |
| 2 | Vane HP Turbine – Casting | KF301C | Nil | GTM- SU-SX4 |

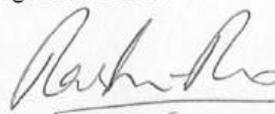
3.2 Technical Specifications and Process Development

3.2.1 Industry Partner shall qualify their special processes for coating and brazing of components as per specifications given in Table 3 and tests in Table 4 and Table 5.

- a) Industry Partner shall suitably extract specimens from GTRE supplied cast bars (round-40, flat-20 and test buttons-30). These will be supplied along with the blade and vane castings. Industry Partner shall extract specimens as per ASTM/GTRE specifications.
- b) Mechanical and other test facilities for verification of special process shall be NABL approved.
- c) Conformity checks report of the special process verification shall be submitted to GTRE after approval by Industry Partner QA as per GTRE specifications/drawings/applicable standards. Industry Partner should fill up the details of special process as per Form-2 of AS9102B.
- d) Industry Partner shall perform the special process on the actual component only after approval of GTRE in association with Certification authorities.

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e) Test coupons to be delivered to GTRE as per Para 11.16.

3.2.2 Table No. 3 gives the list of technical specifications drawn up for this scope of work.

Table No. 3 – List of Technical Specifications

| S.No | Documentation Number | Title |
|------|--------------------------------|-----------------------------------------------------------------------------------------------------------------------|
| 1 | GTRE-SX4-HPTR-BRAZE | SPECIFICATION FOR BRAZING ON SINGLE CRYSTAL BLADE CASTINGS |
| 2 | GTRE-SCP/HPT/B&V/TBC/BC/P T-AL | SPECIFICATION FOR PLATINUM-ALUMINIDE (PT-AL) BOND COAT ON SINGLE CRYSTAL NI-BASE SUPERALLOY BLADE & VANE CASTINGS |
| 3 | GTRE-SCP/HPT/SC-B&V/TBC/EBPVD | SPECIFICATION FOR TBC APPLICATION ON SINGLE CRYSTAL TURBINE BLADES & VANES |
| 4 | GTM-SU-SX4-HPTR-C | SPECIFICATION FOR NICKEL BASED SINGLE CRYSTAL SUPER ALLOY GTM-SU-SX4 FOR INVESTMENT CAST HIGH PRESSURE TURBINE BLADES |
| 5 | GTM-SU-SX4-HPNGV-C | SPECIFICATION FOR NICKEL BASED SINGLE CRYSTAL SUPER ALLOY GTM-SU-SX4 FOR INVESTMENT CAST HIGH PRESSURE TURBINE VANES |

3.3 Tooling & fixtures: The Industry Partner shall develop tooling, fixtures, inspection gauges, samples for tests, processes and process parameters for the manufacturing & other special processes of blades & vanes, as a part of one time development process. All production tooling and fixtures developed under this contract are property of GTRE. The Industry Partner shall safely retain all production tooling and fixtures for the period 10 years after the completion of contract. The tools & fixtures are required to be returned to GTRE on written communication from GTRE, any time after the completion of contract. GTRE will bear the expenses towards transit/insurance/transportation costs for the same.

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Page 4 of 24

4 Scope of work of Industry Partner:

4.1 Industry Partner to strictly comply with the Scope of work, deliverables and time schedules defined by GTRE. 2D Drawings are considered as the primary reference for all manufacturing and Quality Assurance (QA). GTRE shall not supply any CAD models and Industry Partner should generate any necessary CAD models based on 2D drawings supplied by GTRE. Discrepancy (if any) shall be referred back to GTRE for disposition. GTRE shall review the 3D CAD Model and provide feedback. Upon incorporation of feedback of GTRE, the 3D CAD Model shall be delivered to GTRE on suitable portable media along with hardware deliveries.

4.2 Scope of Work for Manufacturing and coating of HP Turbine Rotor Blade

The scope of this work consists of complete activities & processes related to blade manufacturing such as tooling for machining of Blade (Root, Platform and blade tip), hole drilling (varying film/cooling hole sizes of 0.35 to 1mm dia), high temperature brazing, heat treatment, Pt-Al, EBPVD-TBC coating, shot peening and airflow inspection as specified in the relevant drawings / documents.

4.2.1 Machining Activities

The Industry Partner has to ensure that the blade castings received are as per the casting drawings (Blade HPT Rotor - KF302C). Any deviations found in casting, should be discussed with GTRE, before taking up the machining activities. Manufacturing of blade HP turbine shall be carried out as per drawing KF33042, from GTRE supplied castings (as per drawing KF302C).

4.2.2 Hole Drilling

Hole drilling shall be carried out as per Drawings and diameter of film cooling holes, shall be within plus or minus 0.05 mm of its nominal value after coating. Further details are provided in drawing.

4.2.3 Brazing activities

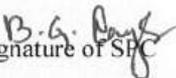
4.2.3.1 The HPT Blades are of cooled configuration, hollow and provided with serpentine passages for the flow of cooling air, designed with openings at the top and bottom ends, to provide support for the core prints while positioning the cores in the wax die. These blades openings, created for the purpose of cores support will have to be closed (four tip cap and three root plug) with suitable high temperature material and brazed to the parent material.

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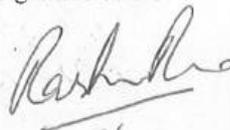
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Page 5 of 24

- 4.2.3.2** Brazing of HPT Blades to close core openings - The tip cap/root plug (four tip cap and three root plug) closure material and the brazing alloy shall be chosen by the Industry Partner (in concurrence with GTRE), shall be chemically compatible with the parent material.
- 4.2.3.3** The operating gas temperature of the part exposed is around 1400°C and the corresponding metal temperature is around 1100°C. Hence appropriate brazing process shall be evolved by the Industry Partner in concurrence with GTRE.
- 4.2.3.4** Brazing process chosen by the Industry Partner shall be equivalent to current practices followed by major aero engine houses. Required Brazing process is to be evolved by the Industry Partner. Suitable brazing alloy to be selected, procured and used. Industry Partner to furnish brazing process and quality reports, prior to bulk manufacturing.
- 4.2.3.5** During Brazing, air passages should not be blocked which shall be verified by pressure testing and air flow testing.
- 4.2.3.6** Carry out Quality Assurance tests for Brazing joint integrity i.e., tensile, shear and pressure testing as per GTRE specifications
- 4.2.3.7** Carry out visual inspection, Radiographic inspection and Microstructure evaluation as per GTRE specifications
- 4.2.4 Blade Throat Area Control** - Prior to machining, the blades shall be rotated about stacking axis to compensate for casting tolerances as per drawing (KF33042). The Industry Partner shall supply throat values and mass flow check values of FAIR 10 Nos. of blades before coating to GTRE and get approval for bulk production. 100% throat area values shall be supplied as part of release documentation. Industry Partner to carryout airflow check of all the blades on completion of the drilling of film cooling holes. Thorough cleaning of blades shall be ensured after drilling of holes. Throat area measurements and Mass flow checks to confirm to the values provided in drawing (KF33042).
- 4.2.5 Coating of Blades (EBPVD / TBC) – HPTR** The HPTR Blades shall be coated with EBPVD TBC consisting of Pt. Al bond coat and Ytria stabilized Zirconia (YSZ) top coat.


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Page 6 of 24

- 4.2.5.1 Industry Partner shall use the qualified coating process and mechanical tests which is in compliance to coating specifications of GTRE and international standards.
- 4.2.5.2 Test specimens shall undergo identical thermal exposure as that of the machined Blade.
- 4.2.5.3 The Industry Partner shall provide a quality / inspection report detailing coating process, thermal exposures, microstructure / macrostructure obtained, coating thickness etc. The total time and temperature exposure during coating shall be within the heat treatment requirement of the base alloy.
- 4.2.5.4 The Industry Partner shall supply throat values and mass flow check values of 10 Nos. of blades after coating to GTRE and get approval for bulk production.

4.2.6 Heat Treatment for HPT Blades

The machined and coated blades shall be subjected to the following ageing cycles given below.

Ageing: 2 hours at 1140°C/GFQ + 20 hours at 871°C/GFQ

GFQ: Gas Fan Quenching

- 4.2.6.1 All the castings and cast test bars shall be supplied to the Industry Partner in solution treated condition.
- 4.2.6.2 The above ageing schedules may be modified in mutual agreement with GTRE, if required.
- 4.2.6.3 Heat treatment shall be carried out maintaining total thermal exposure of the alloy with TBC coating thermal cycle.

4.3 Scope of Work for Manufacturing & Coating of HPNGV

- 4.3.1 List of Drawings for Manufacturing of HP Nozzle Guide Vanes (HPNGV) as per Table No. 1 (Drawings shall be supplied after receipt and approval of NDA)
- 4.3.2 **Machining of HPNGV** - Scope of work for HPNGV consists of complete manufacturing cycle and fabrication processes, Tooling & fixtures for the manufacturing of HPT Vanes (to be designed & developed by the Industry Partner), machining of Vanes, hole drilling and airflow inspection of single vanes, diffusion brazing of vanes in pairs, throat area inspection, final machining, fabrication of impingement tubes, heat treatment and final

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Page 7 of 24

airflow inspection. Manufacturing of vane HP turbine shall be carried out as per drawing KF 31000, from GTRE supplied castings (as per drawing KF301C). Any deviations found in casting, should be discussed with GTRE, before taking up the machining activities. Industry Partner shall procure all necessary/required material to fabricate the impingement tube and shall assemble as indicated in the drawing.

- 4.3.3 Fabrication of impingement tubes (Front-KF31100 & Aft KF31200 are to be machined) and assembly with vane S/A KF31000, drilling of impingement holes, it's assembly and tack welding of tubes on to vanes are to be carried out. Sourcing of L-605 , necessary fabrication, welding and assembly to be carried out by Industry Partner. The Industry Partner shall procure the L-605 material from aerospace industry approved Industry Partners, and ascertain the quality through necessary tests / inspection as provided in the specification. The material shall be procured in solution- treated condition.
- 4.3.4 **Hole Drilling:** Hole drilling shall be carried out as per drawings and diameter of film cooling holes, shall be within plus or minus 0.05 mm of its nominal value after coating. Further details provided in drawing.
- 4.3.5 **Vane Throat Area Control** – Prior to machining, the vanes shall be rotated about stacking axis to compensate for casting tolerances and achieve requisite throat area as per drawing (KF31000). The Industry Partner shall supply throat values and mass flow check values of FAIR 10 pairs of vanes to GTRE and get approval for bulk production. 100% throat area values shall be supplied as part of release documentation. Industry Partner to carryout airflow check of all the vanes on completion of the drilling of film cooling holes. Thorough cleaning of vanes shall be ensured after drilling of holes. Throat area measurements and Mass flow checks to confirm to the values provided in drawing (KF31000). Industry Partner to carryout airflow check of all the single vanes on completion of the drilling of film cooling holes. The Industry Partner shall integrate impingement tubes on 10 pairs and subject the assembly for flow checks. Mass flow shall be corrected to the STP conditions and reported to GTRE. Industry Partner shall carry out visual inspection, Radiographic inspection and Microstructure evaluation as per GTRE specifications.
- 4.3.6 **Brazing (Pairing of Vanes)** - The Industry Partner shall ensure that equal number of Vanes 1 & 2 are machined which will enable to form requisite brazed pairs. Industry Partner shall form pairs through suitable brazing process. The operating gas temperature of the part exposed is around 1400°C

B. G. P. Singh
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Page 8 of 24

and the corresponding metal temperature is around 1100°C. Hence, suitable brazing alloy is to be selected by the Industry Partner (in concurrence with GTRE), procured and used. While pairing, adequate care shall be taken to maintain the throat widths as indicated in the drawings. Industry Partner shall carry out visual inspection, Radiographic inspection and Microstructure evaluation as per GTRE specifications. Required Brazing process has to be evolved by the Industry Partner, which shall be equivalent to currently used, in major engine houses for turbines. Industry Partner shall provide the brazing process quality & inspection reports.

4.3.7 Coating of vanes (Pt-Al, EBPVD/TBC) - Vanes shall be coated with EBPVD - TBC consisting of Pt. Al bond coat and Ytria stabilized Zirconia (YSZ) top coat. The Industry Partner shall provide a quality / inspection report detailing coating process, thermal exposures, microstructure / macrostructure obtained, coating thickness etc. The total time and temperature exposure during coating shall be within the heat treatment requirement of the base alloy. The Industry Partner shall supply throat values and mass flow check values of 10 pairs of vanes after coating to GTRE and get approval for bulk production.

4.3.8 Heat Treatment for HPT Vanes

The machined and coated vanes shall be subjected to ageing cycles as specified in drawing KF31000

4.3.8.1 Heat treatment shall be carried out in accordance with Thermal Barrier Coating (TBC coating) thermal cycle.

4.3.8.2 Heat treatment for impingement tube sub assembly vane HPT, to be arrived after mutual discussion between GTRE and Industry Partner.

4.4 Inspection and testing:

4.4.1 Air flow Inspection of HPT Blades:

4.4.1.1 Industry Partner shall ensure that the airflow inspection system is adequately calibrated to the required international standard, prior to actual flow inspection of blades and provide the calibration data to GTRE.

4.4.1.2 Mass flows shall be corrected to standard temperature and pressure (STP) conditions and reported to GTRE.

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4.4.1.3 The Industry Partner shall carry out 100% airflow check on all blades after coating of the blades. The results shall be submitted to GTRE.

4.4.2 Air flow Inspection of HPT Vanes:

4.4.2.1 Industry Partner shall ensure that the airflow inspection system is adequately calibrated to the required international standard, prior to actual flow inspection of vanes and provide the calibration data to GTRE.

4.4.2.2 Mass flows shall be corrected to Standard Temperature and Pressure (STP) conditions and reported to GTRE

4.4.2.3 The Industry Partner shall carry out airflow check on 20 single vanes before pairing of the vanes

4.4.2.4 Industry Partner shall carry out the airflow inspection on 20 Nos. of vanes with impingement tube assembled and confirm that the mass flow meets the requirement provided in drawings. Thorough cleaning of tubes shall be ensured after drilling of holes. The results shall be submitted to GTRE for concurrence before proceeding with full production.

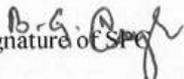
4.4.2.5 GTRE requires 100% inspection report in respect of mass flow through impingement tubes and the necessary documentation shall accompany the parts dispatch.

4.4.3 Brazed joint Qualification Tests: the following tests have to be carried out as per GTRE specification given in Table No.4.

Table No. 4 – Brazing Tests

| Brazing Tests | | Reference |
|---------------|-----------------------------|---------------------|
| 1 | Brazed Joint Integrity Test | GTRE-SX4-HPTR-BRAZE |
| 2 | Pressure Testing | |

4.4.4 Coating Qualification Tests: Testing of coated HPT Blades & Vanes to be carried out by the industry (Industry Partner or its supply chain) as per GTRE specifications given in Table No. 5.

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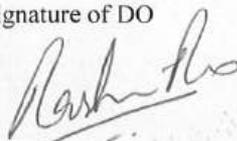


Table No. 5 – Coating Qualification Tests

| TBC COATING QUALIFICATION TESTS | | Reference documents (specification) |
|----------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------|
| 1 | BOND STRENGTH TESTS 1.1 As-coated bond strength tests 1.2 Residual bond strength tests | 1) GTRE-SCP/HPT/SC-B&V/TBC/EBPVD |
| 2 | COMPONENT LEVEL TESTS 2.1 Cyclic burner tests 2.2 Cyclic furnace test | |
| 3 | COUPON LEVEL TESTS 3.1 Endurance test 3.2 Thermal Shock Tests 3.3 Temperature Measurement 3.4 Cut-up evaluations 3.5 Quality assurance checks (thickness, coverage, micro structure, porosity, voids, visual examination) 3.6 Mechanical tests (bend test, coating life test) | 2) GTRE-SCP/HPT/B&V/TBC/BC/PT-AL |

4.5 Quality Assurance Requirements

4.5.1 First Article Inspection Report (FAIR): 10 No. of blades and 10 pairs of vanes shall be submitted to GTRE for approval prior to bulk manufacturing. The FAIR documents shall contain various aspects of hardware quality assurance such as dimensional inspections, NDT etc and qualification tests such as mechanical tests, coupon and component tests. The specifications are subjected to minor revisions based on interactions with Industry Partner.

4.5.2 Industry Partner shall prepare provisional QAP on receipt of the purchase order and submit to GTRE for approval prior to initiation of the manufacturing process. Provisional QAP shall be updated by the Industry Partner after approval of the FAIR and submit to GTRE for final approval.

4.5.3 Industry Partner shall perform 100 % inspection of incoming casting from GTRE. The inspection shall include all dimensions and aerofoil measurements as per the casting drawings requirements. Industry Partner shall have the in-house inspection infrastructure as mentioned in Table 6, as minimum requirement for deliverables as per the SOW

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Table 6 – Quality Assurance Requirements

| No. | Software/ Instruments | No. | Software/ Instruments |
|-----|------------------------------------------|-----|------------------------------------------------------------------------|
| 1. | Ballooning Software | 4. | Surface roughness tester for curved surface |
| 2. | Marking machine with bar coding facility | 5. | CMM - Size 700/900/500 Diameter:400mm Weight:300 Accuracy 0.9+L/350 |
| 3. | Visual Inspection bay | 6. | Fluorescent Penetrant Inspection (Tank sizes 1000x1000mm) |

4.5.4 Ballooning shall be done for all drawing characteristics for all parts/ components/ modules as per Aerospace industry practices and shall form part of the QAP documentation. Industry Partner shall use the standard software for performing the ballooning operations. Inspection report of the Industry Partner shall be traceable to ballooned drawing

4.5.5 Measurement Plan shall be prepared by the Industry Partner and shall form part of the QAP documentation submitted to GTRE for clearance. Measurement plan shall include dimensional, surface, NDT/I/E scan plan, technique sheets and other Visual Inspection requirements as per the drawings/standards

4.5.6 Traceability of casting supplied by GTRE must be maintained through all stages of manufacturing process, including inspection data, test record and inspecting personnel. Individual parts marking as per drawing requirements shall be carried by Industry Partner.

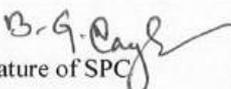
Special processes pertaining to manufacturing (Brazing, Heat Treatment, Coating etc) and inspection (NDT etc), others shall be NADCAP approved/Leading aero-engine house manufacturer. Industry Partner shall validate their special processes for manufacturing of GTRE hardware after receipt of castings and applicable specification. Test facilities for verification of special process shall be internationally accredited. Industry Partner shall fill up the details of special process in Form 2 of AS9102B as a part of validation. The interim reports and documents pertaining to the process, manufacture, brazing, coating or any significant stage (prior to full manufacture) shall be mailed by the Industry Partner to GTRE periodically to obtain concurrence/approvals/concessions. Industry Partner shall perform the special process on the actual part only after approval of GTRE/Certification bodies.

4.5.7 Industry Partner shall perform First Article Inspection as per AS 9102 Rev B Standard or its updates. Industry Partner shall perform Partial FAI for change in the manufacturing process/work center/ computer program for the manufacturing process/design/materials.

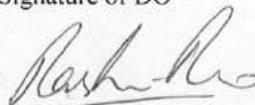
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- 4.5.8** Industry Partner shall proceed for bulk machining of components only after approval of FAIR by GTRE/Certification bodies
- 4.5.9** Industry Partner shall perform the stage inspection as per the approved QAP and Master Process Sheet. If gauges are intended to be used, they shall be verified and reports to be submitted to GTRE for approval. Industry Partner shall perform the stage dimensional and NDT inspection as per the plan with calibrated instruments
- 4.5.10** Industry Partner shall perform 100 percent Dimensional, Visual, NDI/E/T of all final components with calibrated equipments/facilities and performed by approved personnel as per the drawing requirements. Industry Partner shall submit the inspection reports to GTRE in mutually approved inspection template for all components, as part of delivery and incoming inspection requirements
- 4.5.11** Industry Partner shall perform Non- Conformance management as per AS 9131 standard and airworthiness regulations. Root Cause Analysis and proposed Correction /corrective actions for the non- conformance shall be submitted to GTRE Non Conformance Review Board (NCRB) as per applicable regulations for disposition. Unapproved non-conforming components shall be treated as rejected.
- 4.5.12** Certification by Technical Airworthiness Authority (TAA)
(CEMILAC/RDAQA/equivalent)
- Airworthiness Certification Committee shall be formed under the chairmanship of RCMA (GTRE)/CEMILAC. The chosen industry partner shall be the member of the committee. The certification tests prescribed by the committee are required to be carried out by the Industry partner and reports shall be submitted for the approval of the committee. RCMA-CEMILAC and DGAQA or their rep shall visit the facility of Industry Partner for inspection witnessing of tests and hardware realization processes.
- 4.5.13** Three sets of all quality and process control documents to be sent to GTRE along with the delivery of components. Also, soft copy in suitable portable media to be submitted.
- 4.5.14** All quality records pertaining to this contract but not explicitly covered in this scope shall be made available when needed for by GTRE for review and shall be retained by Industry Partner for a minimum period of 3 years from the date of acceptance of final delivery.
- 4.5.15** All tests/inspections mentioned in the component drawings to be carried out and reports to be submitted to GTRE (FPI, Radiography, Mass flow test, Pressure test etc.).


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Page 13 of 24

4.5.16 Industry Partner shall submit the pre despatch inspection (PDI) report to GTRE, at least 1 month before the final delivery of blades and vanes. Traceability records Inspection data sheet, Acceptance/Nonconformance disposition action duly verified by GTRE authorized suppliers inspector/GTRE QA / authorized signatory in approved format shall be submitted as documented information and record to GTRE along with the deliverables.

4.5.17 Industry Partner to plan for proper packing and preservation as per applicable aerospace standards of the project and shall perform and inspect for compliance to avoid FOD/transit damage. A certificate of compliance stamped by the authorized signatory approved by GTRE towards the same shall accompany the dispatch /delivery information.

4.5.18 GTRE or its committee representatives (3Nos.) may witness the quality assurance and qualification tests and inspect the manufactured components prior to final despatch, at Industry Partner's premises. For this purpose Industry Partner shall facilitate its premises, works and inspection facilities.

4.6 **Installation and commissioning:** <NA>

4.7 **Training:** <NIL>

5 Scope of work of GTRE:

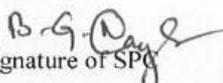
5.1 GTRE shall provide Drawings & technical specifications after signing up of 'Non Disclosure Agreement' (NDA) with GTRE

5.2 Interim reports, FAIR inspection report, test reports, process reports submitted to GTRE for vetting/concurrence, shall be cleared within 30 working days

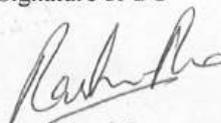
5.3 Supply of Single Crystal castings (HPTR-300 Numbers, HPNGV-150 Numbers and test bars as per specifications) costing about INR 36 Million, shall be issued within four weeks of signing up of contract. Industry partner will pick up the Free Issue of Material (FIM) from GTRE (Ex works) with freight, insurance and other statutory charges to be borne by the industry partner.

5.4 Supply of SX castings and test bars shall be in batches, as per SOW.

6 Deliverables by the Industry Partner: (Delivery at place unloaded (D.P.U) at GTRE, as per INCOTERM 2020)


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6.1 Hardware/ software deliverables:

Table No. 7: List of deliverables

| Item | Supply Order Qty. |
|---------------------------|----------------------------------------|
| Vane HP Turbine Sub Assy. | 60 pairs (Twin Vanes configuration) |
| Blade HPT Rotor | 250 Numbers |

6.2 Service deliverables: <NIL>

6.3 Documents, Reports & Certificate of tests

The Industry Partner shall furnish three sets of hard copies and soft copies of final documentation (as listed below) for verification and acceptance of deliverables. The documents shall include the test results, inspections, original photographs etc. The test certificate shall contain Purchase order number, Part drawing number & issue, Part identification number and GTRE specification number and issue number.

- 6.3.1** Documents: Process sheets, Method Sheets, Fixture drawings & Gauge drawings
- 6.3.2** FAIR and dimensional reports
- 6.3.3** Throat control reports
- 6.3.4** Mechanical testing reports
- 6.3.5** NDT inspection reports, Mass Flow test (before and after coating)
- 6.3.6** Non Conformance & concession approval reports (if any)
- 6.3.7** Brazing integrity and pressure test reports
- 6.3.8** Film hole drilling reports (dimensional)
- 6.3.9** Throat area reports (before and after coating) – 100% inspection
- 6.3.10** Qualification tests and inspection reports
- 6.3.11** Coating process and quality report (EBPVD-TBC and Pt-Al bond coat)
- 6.3.12** Coating qualification test reports (on coupons and components)
- 6.3.13** Any other reports specified as part of SOW, specifications, drawings
- 6.3.14** Any other reports sought by GTRE on the certificate of tests for acceptance of finished components

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6.3.15 Packing and forwarding documents.

6.3.16 Traceability reports

6.3.17 Radiography films if applicable to be submitted. Cost to be borne by the industry partner.

6.3.18 The 3D CAD models developed shall be delivered to GTRE on suitable portable media along with hardware deliveries.

7. Acceptance criteria: HPT Blades & Vanes

7.1 Based on the documents generated by Industry Partner, Pre delivery inspection will be done by GTRE inspector at Industry Partner's place.

7.2 Submission of documents as per Para 6.3 along with all the deliverables.

7.3 A certificate of compliance meeting Para 6.3, stamped by the authorized signatory of Industry Partner.

7.4 Acceptance of the deliverables shall be provided by GTRE based on the review of the documents and verification through counter inspection (if required) on case to case basis. GTRE (QA) will be the final authority for hardware acceptance.

8. Warranty: <NA>

9. Delivery schedule: As per Table No. 8. HPT rotor Blades and Vanes manufacturing activities to be carried out in parallel.

Table No. 8 – Delivery Schedule

| Sl. | Milestones | Quantity | Delivery Schedule (from the date of supply order) |
|-------------------------|-----------------------------------------------|----------|---------------------------------------------------|
| HPT Rotor blades | | | |
| 1 | FAIR (Blades) | 10 Nos. | T ₀ +10 months |
| 2 | Batch 1 | 70 Nos. | T ₀ +16 months |
| 3 | Batch 2 (HPT Rotor blades-complete supply) | 170 Nos. | T ₀ +23 months |
| HPT Vanes | | | |
| 4 | FAIR (Vanes) | 10 pairs | T ₀ +12 months |
| 5 | Batch 1 | 10 pairs | T ₀ +18 months |
| 6 | Batch 2 (HPT Vane-complete supply) | 40 pairs | T ₀ +26 months |

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10. Payment terms: As per GTRE standard terms and condition as per Table No. 9.

Table No. 9 – Payment Schedule

| Sl. No. | Payment Milestone | Delivery Schedule | Payment Condition |
|---------------------------------------------|-------------------|----------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1 | Advance Payment | - | Maximum of 15% of total basic cost (ie, HPTR+HPNGV) as advance payment against bank guarantee of 110 % of value of advance payment. Prorata adjustment of advance in subsequent payment. |
| Payment Schedule for HPT Rotor Blade | | | |
| 2 | Milestone 1(a) | T ₀ +16 months | 30% of the total cost of HPTR to be given on delivery of 80 No. of Blades including 10 Nos. of FAIR Blades. Total cost includes cost of tooling/development charges with prorata adjustment of advance. Delivery and acceptance of FAIR includes documentation as per Para 6.3 in SOW. |
| 3 | Milestone 1(b) | T ₀ + 23 months | 70% of the total cost of HPTR to be given on delivery of 170 Nos. of HPTR. Total cost includes cost of tooling/development charges with prorata adjustment of advance. |
| Payment Schedule for HPT Vane | | | |
| Sl. No. | Payment Milestone | Delivery Schedule | Payment Condition |
| 4 | Milestone 2(a) | T ₀ + 18 months | 30% of the total cost of HPNGV to be given on delivery of 20 pairs of vanes including 10 pairs. of FAIR Vanes. Total cost includes cost of tooling/development charges with prorata adjustment of advance. Delivery and acceptance of FAIR includes documentation as per para 6.3 in SOW. |

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Page 17 of 24

| | | | |
|---|-------------------|-------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 5 | Milestone 2(b) | T ₀ + 26 months | 70% of the total cost of HPNGV to be given on delivery of 40 pairs of HPNGV. Total cost includes cost of tooling/development charges with prorata adjustment of advance. |
|---|-------------------|-------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

Not more than 5 stage payment including advance will be paid as per given schedule.

11. General terms and conditions:

- 11.1 Monthly progress report/interaction/meeting to be submitted to GTRE, to assess the progress of work.
- 11.2 Quotation needs to be submitted by aerospace/ aero engine, turbine blade and vane manufacturer preferably for fighter aerospace engines and preferably be certified to AS9100D or equivalent international standard.
- 11.3 GTRE shall evaluate the demonstrated capability of the Industry Partner based on documents submitted by the Industry Partner in response to this RFP.
- 11.4 Responses from the Industry Partners, not meeting the requirements of the scope of work shall not be considered.
- 11.5 Industry Partners which require further technical details may contact GTRE before the due date of this RFP and refer the details if any for the further processing.
- 11.6 The Industry Partner to strictly comply with the scope of work, deliverables and time schedules defined by GTRE. Work execution plan for turn-key contract execution to meet the delivery schedule to be submitted along with RFP.
- 11.7 Director, GTRE may constitute an expert committee to evaluate the capability of the Industry Partner if required, as per requirements of GTRE.
- 11.8 The Industry Partner may sub contract any part of the jobs included in this contract to any reputable and qualified Industry Partners in the concerned field and approved for the supply of aero engine parts by concerned authorities (DGAQA/CEMILAC and/or equivalent) after obtaining approval from GTRE. However the responsibility for the assurance of quality and performance for such sub- contracted jobs shall lie with the Industry Partner.
- 11.9 The existing tie-ups with Indian / foreign companies shall not be a hindrance for participation in this programme. Industry partner, already having foreign collaboration and interested, shall obtain necessary clearance / approval from the collaborator to participate in this programme, like end user certificate.

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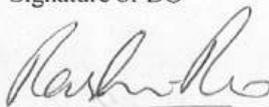
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- 11.10** All castings supplied to be checked/ inspected for dimension and supply condition prior to manufacturing of components.
- 11.11** Supply of SX castings and cast bars: In Two/ Three batches by GTRE, after discussions and mutual agreement with the selected Industry Partner. Specimen extraction from cast bars and qualification tests will be part of development cost.
- 11.12** The Industry Partner shall procure all other material, other than that supplied from GTRE, from aerospace industry approved Industry Partners, and ascertain its quality through necessary tests & inspection, as provided in the specification. The material shall be procured in solution- treated condition
- 11.13** The industry partner shall minimise the rejection of parts for process development in consultation with GTRE. For process development, metallurgically rejected castings can be provided to the Industry Partner on mutual agreement with GTRE. The maximum rejection of parts (during manufacturing) is limited to 15%. If industry partner is able to supply beyond 250 blades and 60 pairs of vanes, prorata payment will be considered.
- 11.13.1** Beyond Acceptable rejection - The cost of castings will be levied at the rate decided by GTRE and will be deducted from the immediate payment schedule and/or shall be paid by the vendor.
- 11.14** Free-issue of Raw-material (SX Castings) - Industry partner will pick up the Free Issue of Material (FIM) from GTRE (Ex works) with freight, transit insurance and other statutory charges to be borne by the Industry Partner. Necessary FIM (100% Bank Guarantee) to be taken care by industry partner.
- 11.15** Industry Partner shall design & manufacture necessary tooling, fixtures; inspection gages etc. for executing the contract. Industry Partners should bring out cost of manufacturing under various headings (like. Machining, Brazing, EBPVD-TBC coating, Tooling/Fixtures, Testing, Inspection etc.). Detailed break ups of costs must be provided while quoting for RFP/tender in commercial bid as per format enclosed in Appendix C.
- 11.16** Industry Partner has to return the unused castings/test bars, rejected parts, test coupons and castings used during process development to GTRE.
- 11.17** The Industry Partner/sub contractor should have carried out high temperature tip cap and bottom end brazing on nickel alloy castings of gas turbine blades and pair brazing of HPT vanes. Proof to be submitted.
- 11.18** Intellectual Property Rights if any developed under this contract will be the property of DRDO, Govt of India.


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Page 19 of 24

11.19 Exit Clause: The activities of this contract being technically challenging; the contract shall have the exit clause for short closure and part payment. This is applicable if the short closure is called for due to technical reasons only. Industry Partner shall submit a detailed technical report highlighting the reasons for failure to go ahead / short closure. The ground for the short closure and the extent of payment with respect to completed activities will be assessed by an independent committee constituted by Director, GTRE and will be binding on the Industry Partner. GTRE reserves the rights to short close the contract, if the progress of work is found unsatisfactory during any phase of project execution.

11.19.1 GTRE may, without prejudice to any other remedy for breach of supply order /contract, by written notice of default sent to the Industry Partner, terminate the supply order / contract in whole or in part if

i. The Industry Partner fails to deliver any or all of the stores or perform any other obligation within the time period(s) specified herein or any extension thereof granted by GTRE

ii. When the Industry Partner is found to have made any false or fraudulent declaration or statement to get the supply order / contract or he is found to be indulging in unethical or unfair trade practices.

iii. When the item offered by the seller repeatedly fails in the inspection and / or the seller is not in a position to either rectify the defects or offer items conforming to the contracted quality standards.

iv. When both parties mutually agree to terminate the supply order / contract

v. Any special circumstances, which must be recorded to justify the termination of a supply order /contract

vi. In pursuance of an award given by a court of law.

11.19.2 The supply order / contract is terminated in whole or in part due to default of Industry Partner; GTRE may take any one or more of the following actions

i. Performance security / Warranty bond will be forfeited and the amount will be remitted to government.

ii. The seller shall continue to perform the supply order / contract or the extent not terminated

iii. Any other action as deemed appropriate

11.19.3 Details of activities, timeline and exit clause actions are given in Table 10. The exit clause will be activated on recommendation of the committee.

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Page 20 of 24

Table No. 10 – Exit clause terms and payments

| Stage | Time frame | Failure in completion of activities as below | Exit clause Actions |
|-------|-------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1 | HPT Rotor blade : $T_0 + 6$ months HPT Vane : $T_0 + 6$ months | <ul style="list-style-type: none"> • Completion of process sheets by Industry Partner • Sign off process sheets by both the parties • Finalization of all Supply Chain by the Industry Partner | <ul style="list-style-type: none"> • No payment will be made by GTRE. • FIM to be returned to GTRE by Industry Partner |
| 2 | HPT Rotor blade : $T_0 + 11$ months HPT Vane : $T_0 + 14$ months | <ul style="list-style-type: none"> • Progress in order to meet the FAIR delivery date • Readiness of all toolings, fixture and gauges | <ul style="list-style-type: none"> • FIM to be returned. • No payment will be made. • Any advance paid to the Industry Partner will be returned with interest. • Director GTRE may constitute a committee to evaluate and suggest the payment to be done towards the extent of work carried out, if the work progressed to near to final stage. |
| 3 | HPT Rotor blade : $T_0 + 13$ months HPT Vane : $T_0 + 16$ months | <ul style="list-style-type: none"> • FAIR clearance submitted for all components | |

11.19.4 In addition to exit clause above, if there is a slippage by more than 20% of the delivery schedule for reasons not resolvable by the committee, Director GTRE reserves the right to take decision regarding short closure of the contract. The committee shall evaluate and suggest the payment to be done towards the extent of work carried out, if the work progressed to near to final stage.

12 Documents to be submitted along with quotation:

12.19 Industry Partner shall authenticate all the pages of the SOW with signature and seal for having read, understood and meet all the requirements

12.20 Work execution plan for turn-key contract execution to meet delivery schedule.

12.21 Acceptance to delivery schedule.

12.22 Documentary proof as per pre qualification criteria (Para 2a-2d and Para 11)

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12.23 Point wise Technical compliance matrix with respect to GTRE Scope of Work (SOW) to be provided in the following format, all sections

| Sl. No. | GTRE SOW/ Specifications | Industry Partner's Offer | Compliance Yes/No | Remarks |
|---------|--------------------------|--------------------------|-------------------|---------|
| | | | | |

12.24 Non compliance /failure to submit the above documents/ information shall result in rejection of quote.

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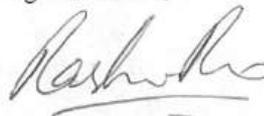
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Page 22 of 24

| Technical Assessment – Weightage for Operations as per Scope of Work (SOW) | | | |
|-----------------------------------------------------------------------------------|---|----------------------------------------------------------------------|------------------|
| | | Operations as per SOW | Weightage |
| HPT Blade | 1 | Engineering | 10 |
| | 2 | Machining activities (equipment (5)+machining technology(5)) | 10 |
| | 3 | Hole drilling(equipment (5)+machining technology(5)) | 10 |
| | 4 | Brazing(equipment (5)+brazing technology(10)+ material selection(5)) | 20 |
| | 5 | TBC coating((Pt-Al)10)+EBPVD equipment(10)+EBPVD technology (5)) | 25 |
| | 6 | Heat treatment (equipment only) | 10 |
| | 7 | Inspection (5) | 15 |
| | | Testing(5) | |
| | | Qualification(5) | |
| | | Total | 100 |
| HPT Vane | 1 | Engineering | 15 |
| | 2 | Machining activities (equipment (4)+machining technology(4)) | 8 |
| | 3 | Hole drilling(equipment (5)+machining technology(5)) | 10 |
| | 4 | Impingement tube fabrication | 7 |
| | 5 | Brazing(equipment (5)+brazing technology(5)) | 10 |
| | 6 | TBC coating((Pt-Al)10)+EBPVD equipment(10)+EBPVD technology (5)) | 25 |
| | 7 | Heat treatment (equipment only) | 10 |
| | | Inspection (5) | 15 |
| | | Testing(5) | |
| | | Qualification(5) | |
| | | Total | 100 |

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Price Bid Format**(Tooling and Development cost for the Post Cast Operations)**

| Sl. No. | Description | Units of Qty. | Unit | Unit Price (In respective Currency) | Total Price (In respective Currency) |
|-----------------------------------------------------------------------------------|-----------------------------------|---------------|------|-------------------------------------|--------------------------------------|
| 1 | Tooling cost for Blade HPT | No. | 01 | | |
| 2 | Development cost for Blade HPT | No. | 01 | | |
| 3 | Cost per piece of SX HPT Blade | No. | 250 | | |
| 4 | Tooling cost for HPT Vane | No. | 01 | | |
| 5 | Development cost for HPT Vane | No. | 01 | | |
| 6 | Cost per piece of SX HPT Vane | Pairs | 60 | | |
| 7 | Any other cost not included above | No. | 01 | | |
| Total Cost | | | | | |
| FOB/FCA/Ex-Works Cost * | | | | | |
| CIF/CIP Cost * | | | | | |
| *For foreign vendors please mention FOB/FCA/Ex-Works Cost, CIF/CIP (GTRE). | | | | | |

B. G. Singh
Signature of SPC
9/11/2025

Signature of DO