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Vikram Sarabhai Space Centre
Department of Space
Indian Space Research Organisation
Thiruvananthapuram-695022
Kerala, India

Request For Proposal (RFP)

on

GOCO MODE OF OPERATION FOR MATERIAL PROCESSING, SPECIMEN PREPARATION AND OPERATION OF EQUIPMENTS FOR CHARACTERISATION, MECHANICAL TESTING OF MATERIALS & FASTENERS USED FOR LAUNCH VEHICLE APPLICATIONS

at

Vikram Sarabhai Space Centre, Thiruvananthapuram

on

Government Owned Company Operated (GOCO) mode

Materials & Mechanical Entity
Vikram Sarabhai Space Centre
Thiruvananthapuram

Issue Date	:
Closing Date	:

1. Introduction

Request For Proposal for *"GOCO Mode of Operation for Material Processing, Specimen Preparation and Operation of Equipments for Characterisation, Mechanical Testing of Materials & Fasteners Used for Launch Vehicle Applications"* at Vikram Sarabhai Space Centre (VSSC), Thiruvananthapuram using VSSC established facilities on Goverment Owned Company Operated (GOCO) mode.

2. Preamble

Vikram Sarabhai Space Centre (VSSC), Thiruvananthapuram, is the lead centre of ISRO responsible for the design and development of launch vehicle technology. VSSC is an ISO 9001:2015 certified organization and following established standards, norms, procedures and practices. In order to meet the increasing demand of operational launches, industry participation for production, testing and supply of sub-systems & systems are solicited. Delivery of products/services of/for various systems for launch vehicles and associated technologies in compliance with the quality standards, schedule and strict adherence to the safety and security norms prevailing inside the campus shall enable a productive aerospace ecosystem in the country. Towards this the Government Owned Company Operated (GOCO) mode of operation was implemented in VSSC. To include more activities under this umbrella, VSSC is looking forward to participation of private industry for the production, testing and supply of launch vehicle systems and sub-systems. Among other aspects, Characterization/ testing of materials/ processing/measurement etc. through Contractors is being explored.

3. Objective

To carry out "GOCO Mode of Operation for Material Processing, Specimen Preparation and Operation of Equipments for Characterisation, Mechanical Testing of Materials & Fasteners Used for Launch Vehicle Applications" through the personnel deployed at VSSC facility(s) by the CONTRACTOR in compliance with the defined quality standard & schedule as finalized by VSSC for GOCO mode of operation.

4. Scope of the Contract

The activities planned, quantified and scheduled under GOCO contract is attached as ***Annexure 1***. The Contractor shall execute the work using Contractor's work force as per the contract terms and conditions. The activities shall be carried out by the Contractor at identified facilities and compliance to safety in such activities shall be ensured by the CONTRACTOR through their Safety Officer wherever applicable. The CONTRACTOR should have an established safety management system and be conversant with applicable safety practices and carry out all the activities with utmost safety. VSSC shall conduct periodic safety inspection and audit for activities.

5. Facilities and Process

The facilities, tools, machines, equipment, fixtures, utilities and raw materials essentially required to carry out the activities to deliver the product/service are given in ***Annexure 2*** under specific heads, which shall be provided by VSSC. The routine up keeping of such process equipment is in the scope of the GOCO team and shall be carried out as mentioned in ***Annexure 2***. The facility/equipment, if required, shall be shared with VSSC. All necessary consumables, accessories & spares for upkeep shall be provided by VSSC.

The process to be followed to carry out each activity/service/product is given in ***Annexure 3***. A detailed presentation with respect to the processes to be followed shall be presented in pre-bid meeting.

6. Contract Management Committee

After award of the contract, a Contract Management Committee (CMC) shall be constituted by VSSC with identified members from VSSC and Contractor representative. CMC shall be responsible for review of progress of training, certification of Contract manpower for production, throughput monitoring, monitoring quality of activities completed, change in hardware quantity, monitoring efficiency of manpower, additional requirement of Contract manpower/resources, accounting of rejections, recommendation for invoking LD, etc. The CMC shall essentially meet at the end of every month to evaluate the performance and clear the monthly payment based on the activity completed in the month and also meet at any time as deemed necessary. All issues pertaining to occupational safety, security shall be reported to CMC. Any damages caused to VSSC, as such, by Contract personnel shall be assessed by CMC and compensation if any, shall be recovered. Decision of CMC shall be final and binding.

6.1. Contract and Facility Managers

The Contract shall be managed by the Contract Managers from Contractor and Facility Manager from VSSC and duly nominated by them. During the currency of the Contract, any change in the designated Contract/Facility Manager shall be intimated to the other party. The Contract/Facility Manager shall be responsible for the day-to-day management of the activities under the Contract and they shall act as the focal point of the Contract for their respective entities –Contractor and VSSC.

7. Human Resources

VSSC has arrived at and identified the minimum work force both in terms of category of qualification and number required to execute the activities. To carry out the activities stated in ***Annexure 1***, human resources requirements are tabulated in ***Annexure 4***. Being mission critical activities, quality of products/services are utmost important in conjunction with the delivery schedule. Process team as in ***Annexure 4*** shall be required to be deployed by the Contractor to carry out the activities in GOCO mode. Hence, Contractors shall always ensure the availability of qualified, and skilled

personnel in GOCO facilities. The verification of the proposed team of Contractor for their technical capability shall be done by VSSC.

VSSC prefer to entrust the activities with a team with prior experience in similar field of operation. For propellant and related processing PESO licensed Contractors are mandatory. As the components and sub-assemblies to be handled are critical to mission application, stipulated quality and safety are of utmost importance and the same shall be adhered to. Retaining of trained human resources is purely the responsibility of the Contractor to ensure quality safety and delivery schedule.

Other requirements

Security : GOCO team shall comply with the security regulation of VSSC.

Safety : GOCO team shall follow all safety stipulations/guidelines.

Secrecy : The CONTRACTOR and their production team shall abide by the INDIAN OFFICIAL SECRETS ACT and its amendments in vogue and shall provide information of awareness of the crew on the matter in writing.

8. Schedule

The schedule for the activities to be carried out and the throughput requirements as in ***Annexure 1*** shall be prescribed by CMC and honored by the Contractor. Continuity of the activity shall be maintained and completion within stipulated period shall be ensured to maintain anticipated quality & quantity and any halt in process shall be mutually discussed and agreed in CMC, properly assessing the impact on quality & schedule. Facility Manager shall issue the individual activity with schedule of delivery to the Contract Manager. In case of conflict between schedule and activities being carried out, a revised schedule to be prepared by Contract Manager in consultation with Facility Manager. Adherence to schedule and throughput shall be logged for verification by Facility Manager. The quality checkpoints are embedded in the schedule and QA team of Contractor shall generate report at specific stages mentioned in process flow chart for later verification by Facility Manager. Mid-course corrections, if warranted shall be implemented by the Contractor as per the instructions of CMC.

9. Issue of Hardware/ Raw Material

Facility Manager shall issue the necessary hardware/raw materials required for carrying out the activities as per the material issue plan. It is the responsibility of the Contractor to properly store the Raw Material/Hardware, if any, drawn from the stores/supplied for processing at identified places/ discard the byproducts/waste materials at identified places only. The Contractor is also responsible for the storage/protection of finished and semi-finished items, if any. The Raw Material/Hardware, if any, given should be under safe custody of the Contractor. The Contractor has no right to take the Raw Material/Hardware or part of Raw Material/Hardware, whatever provided, out of VSSC or replace a part of it with same material from other sources.

All Raw Material/Hardware, if applicable, shall be handled with care and the Contractor should ensure that the physical damages of any kind do not occur during handling. In case of any damage, the same shall be reported to facility manger immediately.

10. Responsibilities of the Contractor

The Contractor shall form their own Team comprising of supervisors, processing/working personnel for the GOCO activity in VSSC. Safety officers, quality control team shall be a part of GOCO team wherever applicable. The members of the GOCO Team shall be above 18 years and below 60 years of age while working at VSSC. The Contractor should necessarily have experience in “GOCO Mode of Operation for Material Processing, Specimen Preparation and Operation of Equipments for Characterisation, Mechanical Testing of Materials & Fasteners Used for Launch Vehicle Applications” as specified in ***Annexure 4***. The Contractor should provide the bio-data, police verification certificate, EPF details, credentials and technical capability of the GOCO Team for verification by VSSC prior to start of Contract. The Team shall be positioned at GOCO facility within 2 weeks from the signing of the Contract.

VSSC shall provide support and guidance to the GOCO Team during the initial Phase. However, Contractor should ensure that necessary competence is built up within the GOCO Team so that they can independently take full charge of the activity. The Contractor should also try to retain the competence, so as to ensure seamless progression of activities/services.

The following are the responsibilities of the Contractor:

a. Deploy sufficient and competent human resources within 2 weeks of the date of release of GOCO Purchase Order, to progress and complete the work/ activities/ services meeting the schedule, quantity and quality requirements."
b. The Procedure/ Process Document/ Checklist shared by VSSC shall be studied and strictly followed/heard by the Contractor and any doubts, clarifications etc. must be settled prior to start of activity/ services
c. Schedule the processing/ servicing and activities as per the requirement projected by VSSC under the directions of CMC.
d. Ensure readiness of the facilities, equipment, consumables, tooling and other aids required for the processing/ carrying out the activities.
e. Preparation and maintenance of all process/test logs as per the Procedure/ Process Documents/ Checklist to be ensured.
f. Carry out the activities as per Procedure/Process Document/ Checklist. Major steps involved in the activity are detailed in ***Annexure 3***.
g. Preparation of Production Document/ Activity log for quality/ safety audit and product acceptance/ completion of activities.
h. Routine housekeeping, minor maintenance/cleaning/upkeep of the equipment, fixtures and tools wherever applicable.

i. Contractor shall follow the byproducts/ waste materials disposal mechanisms/guidelines formulated by CMC for the GOCO activities.

11. Inspection, Quality Control, Quality Assurance and Quality Audit

Inspection, Quality Control (QC) and Quality Assurance (QA) procedures and acceptance methodology at various stages of activity shall be as per the Procedure/Process Document issued by the VSSC after the award of contract. Quality/Safety Audits on the activity shall be carried out by VSSC once in every six months (or as and when required). The Contractor shall furnish all the required documents/reports to VSSC. Final assessment of the product shall be carried out by the QA agency of VSSC.

12. Verification

The Facility Manager/ QA team/ Safety/ CMC shall have the right to verify the process, product, logs, records etc. as applicable during the activity. Such inspection/verification/clearance by CMC does not absolve the Contractor from their responsibility of delivering/meeting the quality &specification spelt out in the Contract.

13. Process Rejections and Replacements

Acceptance/ Rejection criteria of the activity shall be clearly mentioned in the Procedure/Process Document.The non-acceptance of product, if any, shall be studied and root-cause analysis shall be established by Facility Manager and presented to CMC. If the cause of non-acceptance is due to a wrong/careless process by Contractor, then the cost accrued towards the rejection/damage shall be borne by the Contractor after assessment by CMC. The decision of the VSSC shall be final in this respect. In cases of non-acceptance of products for reasons other than by that of Contractor, the payment for such products shall only be made after clearance by CMC with approval of VSSC.

14. Facility Sharing

VSSC shall provide facilities, equipment, fixtures, etc. required for the activity as included in ***Annexure 2***. Facilities are common and used for both development & production. All facilities offered to use by Contractor on a sharing basis with VSSC shall be agreed to by the Contractor. Whenever needed, priority override shall be discussed in CMC and mutually agreed upon. The Contractor should be willing to reschedule the planned activities accordingly. In case of equipment/facility where usage/ requirement is less, sharing is to be done. The processing schedule for such shared facilities/equipment/items shall be worked out by CMC.

15.Safety, Occupational Health and Environment Management

Proposed GOCO activity of “GOCO Mode of Operation for Material Processing, Specimen Preparation and Operation of Equipments for Characterisation, Mechanical Testing of Materials & Fasteners Used for Launch Vehicle Applications” may involve certain operations which are critical in nature. It is Contractor's responsibility to conduct the activities in a safe manner. Towards this, following are the various aspects that have to be taken care of:

15.1. Support from VSSC

Following infrastructure to ensure safety, occupational health and environment protection shall be provided by the VSSC.

a. Service of first aid centre and ambulance in case accidents/medical emergencies.
b. Facility housekeeping (janitorial support only) is the responsibility of the VSSC.
c. Wash room facility – facility available in the campus shall be extended to the Contractor.
d. Drinking water facility – facility available in the campus shall be extended to the Contractor.
e. Essential telephonic connections available in the facility can be utilized by the Contractor.

15.2. General Procedure and safe work practices

a. Work instruction and safety instruction for the production activity shall be as per the Procedure/Process Document of VSSC. GOCO Team must follow the work instructions.
b. Applicable PPEs shall be arranged for the GOCO Team by VSSC.
c. Facility housekeeping shall be the responsibility of the Contractor. Man/material limit as per the safety guidelines should be strictly adhered by the Contractor

15.3. Inspection, testing and preventive maintenance of safety critical equipment and facility

The periodic inspection/testing and preventive maintenance of safety critical equipment/items like building electrical system, fire protection system, crane, building and structure, fire extinguishers and other tools shall be done by VSSC.

15.4. Work permits

Contractor shall not carry out any unplanned works or any other non-routine job not covered in SOP in the facilities offered to them. For carrying out any work or maintenance activities in the facility, work permits shall be obtained from CMC.

15.5. Emergency Planning and Response

Contractor shall follow VSSC emergency plans and instructions. Contractor shall participate in the drills conducted periodically in the VSSC campus.

15.6. Reporting of accidents/ incidents/ near miss and investigation

Any incident/accident that occurs during the activity or any other occasion within the premises of VSSC shall be immediately reported to Facility Manager. Reporting of accidents/ incident or near misses shall be done as per VSSC procedure. Investigation shall be done by VSSC.

15.7. Continuous Improvement

Corrective actions can be suggested during accident/incident/near miss investigation, safety inspection, safety surveillance, safety audit etc. If the corrective actions suggested are related to the Contractor's purview, then the same shall be implemented by the Contractor. A report on action taken in VSSC prescribed format shall be submitted within three days. Action taken reports shall be verified by VSSC.

15.8. Safety Monitoring

Contractor shall have internal mechanism for monitoring the implementation of safety protocols in the work place through safety inspection. VSSC shall monitor the safety performance of the Contractor through periodic safety surveillance, safety inspection and safety audit.

VSSC safety agency shall have the full authority to stop the work in case of any critical violation of safety requirements. Decision on the nature of violation is fully under the purview of VSSC safety agency. Non-conformances pointed out by the safety officers should be promptly addressed and corrective actions shall be taken.

15.9. Safety Review

Implementation of safety aspects by the Contractor shall be reviewed periodically as decided by the CMC.

16. Alteration/Modification of Facilities/Equipment

The Contractor is not permitted to alter or modify or make any changes to the existing facilities and equipment and machineries. In case any change or modification is an absolute necessity to sustain the activity, the modification need shall be proposed in writing to CMC for perusal and implementation. The decision of CMC shall be final.

17.Statutory Requirements

The contract agency shall comply with the safety regulations and safety guidelines of ISRO/DOS in all their activities. In respect of all personnel, directly or indirectly engaged by the Contractor shall abide by the rules and safety provisions as governed by the below listed requirements with latest amendments.

- The Contractor shall ensure that all the relevant labour laws, applicable from time to time, are adhered to. Contractor shall comply with provisions of Contract Labour Regulation and Abolition Act (CLRA Act).
- All Risk Insurance Policy (ARIP) for a minimum amount of Rs.10 Lakhs (comprehensive scheme covering against all accidents/mishaps or exigencies that can arise while working) for the GOCO team shall be taken by the Contractor for the full contract period. Documentary evidence for the same shall be submitted before engaging the Work Force.
- Contractor shall comply with Factories Act/Rules, as applicable, or Occupational, Safety, Health and Working Conditions Code 2020 in respect of working hours, rest intervals, leave and overtime etc., to their employees. Contractor shall ensure provision for social security measures under Employee State Insurance Act and Employee Provident Fund and Miscellaneous Provision Act and Employees Compensation Act.
- The holidays shall be in accordance with VSSC as per the existing rules and amendments from time to time.
- Contract agencies/companies should not employ any personnel below 18 years of age on the site.
- The liability for any compensation on account of injury sustained by an employee of the Contractor shall be exclusively that of Contractor and as per statutory norms.
- Contractor shall comply with all statutory requirements, rules, regulations and amendment made time to time by the concerned authorities with respect to the employment and employees.
- Only Indian Nationals shall be engaged as employees by Contractor.
- Other statutory requirements which are applicable, but not limited to, are the following:
    - The Environment Protection Act and Rules
    - The Explosives Act and Rules
    - Petroleum Act and Rules
    - Factories Act and Rules
    - Labor Laws and Rules
    - Gas Cylinder Rules
    - Radiation Protection Rules
    - Static and Mobile Pressure Vessel Rules and
    - Occupational Health and Safety Working Code
- In addition to the above, the contract agency shall observe and abide the safety rules and regulations of ISRO/DOS while undertaking any work within the premises.

Contract Manager shall ensure adequate systems to prevent any loss/ damage due to unsafe conditions of GOCO team/damage to VSSC property. Documentary evidence/ undertaking for the same shall be submitted to VSSC before engaging the GOCO Team.

VSSC shall not be responsible for any loss of life/injury or property that has happened by way of an incident/accident due to mismanagement of the facility/poor workmanship/non-compliance to work instructions and safety guidelines during execution of the Contract by the Contractor. The entire responsibility including cost of damages/legal issues, compensation etc. shall be with the Contractor.

18. Changes and Modifications

VSSC reserves the right to modify the qualitative/quantitative requirements and other specifications related to the work at any time that shall be covered by the Contract.

19. Duration

It is envisaged that the GOCO CONTRACT shall be operated for an initial period of 2 years and can be extended for one year each in maximum two times.

20. Payment terms

The cost and applicable GST towards the activities carried out in GOCO mode at VSSC shall be paid to the Contractor after completion of activity and submission of corresponding Document. On completion of processing, the Contractor shall submit the adequate documents in prescribed format. Based on review of the Documents, CMC shall recommend for the payment and the same shall be made with the approval of the competent authority. Contractor shall submit the invoice based on CMC clearance. The payment cleared by CMC shall be made subject to submission of Invoice and supporting documents.

100 % payment (on monthly basis) shall be released for the all completed / stage activities by the contractor. If any rework is caused due to the inefficiency / deviation from the Contractor, no payments will be made for the rework items / activities. For reworks called for due to reasons other than that of the Contractor, payments will be made as per the original type, and will be treated as fresh activity. The items / activities that are beyond the scope of rework, the recovery of the cost of Raw material/ Hardware shall be applicable.

VSSC shall take all efforts to ensure continuous production. However, in the event of nil production due to unforeseen circumstances, and the reason(s) for nil production is not attributable to the Contractor, and the Contractor is retaining the minimum specified manpower inside VSSC premises, for 2 consecutive months, the Contractor will be entitled for Subsistence Amount for each month at a flat rate of 2% of the total PO value per month (i.e approximately 50% of monthly expected production). Contractor is not eligible for claiming payment for the production output if any (based on unit cost or stage wise cost) whenever Subsistence amount is claimed. Quantification of the production output, during the period in which Subsistence Amount is claimed by the party, will be

finalized by CMC based on defined stage wise cost. In the event of the period of nil production (where subsistence amount is claimed by the Contractor) continuing beyond 2 months, VSSC and Contractor can jointly decide for a planned activity call-off for a stipulated period with notice period not less than one month. The decision of the planned call-off shall be recorded in CMC and signed by the representatives of both VSSC and Contractor.

During the period of planned activity call-offs jointly taken by VSSC and Contractor due to change in the requirement or due to any other reason, no payment shall be made by VSSC to the Contractor.

If the period of no production is due to reasons totally attributable to the Contractor, no payment shall be made by VSSC for the period, and a penalty as approved by CMC shall be recovered from the Contractor (as per LD clause).

21. General guidelines

21.1. Working schedule

The working schedule shall be planned by the Contractor towards meeting the requirements. Under normal conditions only regular shift operation is envisaged for the GOCO model. However, in case of exigencies Contractor shall depute personnel for extended working hours in order to complete the work as per the schedule indicated by VSSC.

The working time for the regular shift shall be from 0845hrs to 1715hrs from Monday to Friday. Activities requiring 3 shift operations are mentioned explicitly. However, for meeting the production requirements or completing certain activities that cannot be discontinued unfinished, the working time can be started/extended before/beyond regular time or work can be planned on holidays on a case-to-case basis with the prior permission of VSSC. For any work beyond office hours or specific GOCO where round the clock operation is envisaged, deployment of personnel in 24x7 (3 shift operations) is also envisaged based on the CMC recommendations.

Contract Manager of Contractor shall prepare the daily schedule of activity in advance according to the CMC cleared production/activity schedule and get approval from the Facility Manager of VSSC. The respective Contract /Facility Manager shall be the focal point for the activities and shall be responsible for the day-to-day management and monitoring of the production activities.

21.2. Guidelines for Contractor

- Contractor shall ensure medical fitness of GOCO Team. Annual medical checkup of all members of the GOCO Team must be done preferably by a Doctor qualified in Occupational Health or by a General Physician (MD General Medicine) and

the reports to be made available for audit by VSSC. The cost towards this shall be borne by the Contractor.

- Exclusive tamper proof Contractor's Identity Cards shall be issued by the Contractor for the persons of the GOCO Team. Entry of GOCO Team members into VSSC campus shall be controlled by smart card that shall be provided by VSSC. Only authorized persons of the Contractor shall enter VSSC campus for executing the Contract. VSSC shall implement security measures such as CCTV surveillance, Biometric access control entry for the GOCO Team members at their workplaces.
- Members of the GOCO Team of Contractor shall open a savings bank account in a Nationalized Bank and Contractor shall furnish the bank details of their GOCO Team members to VSSC. Contractor should credit monthly salary of the GOCO Team members to their respective bank accounts and give the monthly salary payment statement to VSSC. Contractor shall produce the insurance premium payment status to VSSC for verification.
- Electronic gadgets like Mobile phone/Laptop/portable storage devices or any other electronic gadgets are NOT PERMITTED inside VSSC campus.

21.3. Liquidated Damages (LD)

The schedule of the activity/service is the essence of the Contract. In the event of the Contractor failing to complete the activity within schedule and if the delay or failure is entirely attributable to Contractor, VSSC shall have the right to recover as LD (as approved by CMC) from the Contractor, a sum at the rate of half per cent per week or the part thereof not exceeding a total of 10% (ten percent) of the cost of the activity or combination of activities, so delayed.

21.4. Price Variation Formula

The best and final quoted price shall remain firm and fixed from the date of commencement of the operation. After 24 months, if the contract is extended based on mutual consent, price variation as per GFR 2017 (Appendix-11) guidelines shall be applied and agreed upon during the course of finalization of the CONTRACT. Details at ***Annexure 5.***

21.5. Security Deposit

To ensure successful completion of the Contract, the Contractor should furnish interest free Security Deposit in the form of Bank Guarantee/FDR/ISB/DD from any Scheduled Bank for 3% of the annual value of the Contract without GST and the same should be valid beyond two months from the validity of the Contract. The Security Deposit shall be returned only after successful completion of all contractual obligations.

21.6. Statutory Duties and Taxes

All statutory levies, as applicable from time to time shall be claimed by the Contractor and shall be paid by VSSC. However, in case any special exemption/concession from

payment of the same is notified by the Government, the Contractor shall avail the same by obtaining the necessary Certificate, if any, from VSSC.

In the event of such payments of duties and taxes still being demanded, Contractor shall make the payment under protest after obtaining the concurrence of VSSC. For this purpose, the Contractor shall comply with the instructions given by VSSC and provide all requisite information as may be required by VSSC.

21.7. Exchange of Additional Technological Data

If at any time during the tenure of this Contract, any additional technological data relating to the "GOCO Mode of Operation for Material Processing, Specimen Preparation and Operation of Equipments for Characterisation, Mechanical Testing of Materials & Fasteners Used for Launch Vehicle Applications" is generated by VSSC, the same shall be communicated to the Contractor by VSSC. Such additional data generated by VSSC, if necessary, shall be incorporated in the Procedure/Process Document.

21.8 Confidentiality

The Contractor shall be abided by the following:

a. All information and documents to be exchanged pursuant to the contract shall be kept confidential by the Contractor andshallbe used subject to such terms as each party may specify. The Contractor shall not use the information for purposes other than that specified without prior written consent of VSSC.

b. All confidential information shall remain the exclusive property of VSSC. The Contractor agrees that this Contract and the disclosure of the confidential information do not grant or imply any license, interest or right to the recipient in respect to any intellectual property of VSSC.

c. Unpublished information, whether oral, in writing or otherwise, discovered or conceived by the Contractor and exchanged under the provisions of this contract shall not be transmitted to a third party unless otherwise agreed by VSSC.

d. The Contractor shall not sub-license, assign or sub-assign partly or fully the activities, rights, obligations, permissions, etc. received in the Contract to third parties, under any circumstances without the prior written permission of VSSC.

e. VSSC shall enter in to Non-Disclosure Agreement with the Contractor at the time of PO placement.

21.9. Security

The Contractor shall follow all VSSC security instructions applicable for people & processes prevailing at present and those issued from time to time. If any person/persons of the GOCO Team of Contractor violates the security instruction(s) of VSSC, misbehaves or commits any misconduct, VSSC reserves the right to refuse permission to such persons to enter VSSC. In such cases VSSC shall have the right to terminate the Contract without notice.

21.10. Technology Rights

Notwithstanding any further development in technology of the GOCO activity by the Contractor, the technical know-how and technology shall remain the property of VSSC even after completion of the Contract.

21.11. Sales to Third Party

At any time during the tenure of this Contract, the Contractor shall not sell or exchange or mix with or part with technology, drawings, data, process and Production Documents, hardware etc. related to "GOCO Mode of Operation for Material Processing, Specimen Preparation and Operation of Equipments for Characterisation, Mechanical Testing of Materials & Fasteners Used for Launch Vehicle Applications" to any third parties.

Violation of this clause made by the Contractor, if any, shall lead to termination of the Contract by VSSC unilaterally in addition to initiation of legal action by VSSC.

21.12 Security and Protection of information & Intellectual Property

The Contractor shall not divulge the process know-how and basic engineering data regarding the "GOCO Mode of Operation for Material Processing, Specimen Preparation and Operation of Equipments for Characterisation, Mechanical Testing of Materials & Fasteners Used for Launch Vehicle Applications" to any third party or otherwise make it public. However, this provision shall not apply to such technical information and data those are available in the public domain. The Contractor shall not disclose the terms and conditions of this agreement to any third parties during & after completion of the Contract without prior written consent of VSSC except as required under any law or for compliance with any statutory requirements.

The Contractor shall not assign any rights and obligations arising out of the Intellectual Property Rights (IPRs) generated from inventions/activities carried out under the contract to any third Party, without prior written consent of VSSC. All confidential information shall remain the exclusive property of VSSC. Disclosure of the confidential information shall not be construed as licence, interest or right to the receipt in respect to any Intellectual Property Right of the Other party. An undertaking shall be obtained from the contractor in stamp paper.

Party should not copy the Procedure/Process Documents/drawings/Log sheets/Test reports or any other documents pertaining to activity, in part or full and take it outside premises of VSSC as hard copy or soft copy. The personnel involved in the work are to be confined within their area of work, shall not move out of work place and should not interfere with the works carried out in other areas.

21.13 Grievance Redressal and Arbitration

The technical/administrative issues, clarifications and other matters that needs resolution during the execution of the Contract shall be discussed and resolved in CMC.

Such decisions shall be approved by Deputy Director (MME), VSSC. The appellate authority for the CMC decisions shall be DD, MME. Issues related to financial matters shall be discussed and decided by Competent Authority as per norms of VSSC.

Any dispute, disagreement or question arising out of or relating to or in consequence of the Contractor to its fulfilment, or the validity of enforcement thereof which cannot be settled mutually through CMC or by DD, MME or by any Competent Authority of VSSC or the settlement of which is not herein specifically provided for, shall be referred to arbitration within 30 (thirty) days from the date either party informs the other in writing that such dispute, disagreement exists.

The Arbitration proceedings shall be conducted in the court of Thiruvananthapuram District, in accordance with and subject to the provisions of Indian Arbitration and Conciliation Act 1996 (Act 26 of 1996) and Arbitration and Conciliation [Amendment] Act, 2015 and as amended from time to time. Each party shall bear its own cost of preparing and presenting its case. The cost of arbitration including the fees and expenses of the Arbitrator shall be shared equally by the parties unless the award provides otherwise. The enforcement of the award shall be governed by the rules and procedures in force in the state of Kerala in which it is to be executed. Performance under this Contract shall, however, continue during arbitration proceedings and no payment due or payable by the parties hereto shall be withheld unless any such payment is/or forms a part of the subject matter of arbitration proceedings.

21.14. Indemnity

The Contractor shall indemnify VSSC for any patent infringement on the process knowhow supplied by VSSC. Also, the Contractor shall be required to indemnify VSSC for any damage to VSSC or to third parties due to negligence on his part (including actions of his GOCO Team).

21.15. Force Majeure

Neither VSSC nor Contractor shall be considered in default in the performance of its obligations under the Contract, if such performance is prevented or delayed for any causes beyond the reasonable control of the party affected by eventualities such as war, hostilities, revolution, riots, civil commotion, strikes etc., or because of any epidemics, fire accidents, floods, earthquake etc., or because of any law and order situation, proclamation or regulation or ordinance of any government or sub-division thereof, or because of an act of God provided notices in writing of any such cause with necessary evidence that the obligation under the agreement is affected or prevented or delayed is given within 14 days from the happening of the event and in case it is not possible to serve notice within the said fourteen day period, then, within the shortest possible period without delay. As soon as the cause of force majeure has been

removed, the party whose ability to perform his obligation has been affected shall notify the other party of the actual delay that has occurred due such force majeure condition.

21.16. Termination of Contract

Under normal circumstances, termination of the contract is not foreseen. However, in the case of non-compliance to or non-performance of the terms and conditions of the agreement set out in this Contract by either the Contractor or VSSC, both the parties shall have the right to terminate this Contract, wholly or partly, by giving a notice of one month in writing to the other party. The termination of this Contract for any other reason shall be by mutual consent.

Upon termination of the Contract:

a. The Contractor shall not be entitled either to use in part or full the know-how relating to "GOCO Mode of Operation for Material Processing, Specimen Preparation and Operation of Equipments for Characterisation, Mechanical Testing of Materials & Fasteners Used for Launch Vehicle Applications" obtained from VSSC or to transfer it to any third party.
b. The Contractor shall return to VSSC forthwith all technical documents, technical data, including drawings, free issues etc. given by VSSC or generated during the Contract period by the Contractor.
c. Both parties shall settle accounts expeditiously, by mutual agreement.

21.17. Ownership

The complete ownership of the facility shall be with VSSC, ISRO, Govt. of India and the Contractor shall at no point of time have any ownership rights on the facility. The GOCO Team deployed shall be employees of the Contractor and shall not claim to have been employed by VSSC. VSSC has no responsibility towards the Contractor's employees.

21.18. Applicable Law

This Contract shall be governed by and interpreted and construed in accordance with the laws of India.

21.19. Jurisdiction

The Courts of Thiruvananthapuram District only shall have jurisdiction to deal with the award and decide any matter relating to disputes arising out of this Contract.

21.20. Infringement

VSSC shall not be responsible if the Contractor infringes any applicable laws or statutes in force during the currency of the Contract.

21.21. Notices

Any notice to either party under this agreement shall be deemed to be validly served, if sent by registered post or electronically like fax/e-mail followed by a copy in confirmation by registered post to the registered office, hereinbefore mentioned.

21.22. Languages and System of Measurement

All documents and correspondence should only be in the English-Hindi language. The SI system of measurement shall be used for this Contract.

21.23. VSSC's Banker

VSSC's Bankers shall be State Bank of India (SBI), Thumba Branch, Thiruvananthapuram, Pin 695022, Kerala, India.

22. Criteria for Evaluation of Proposal

22.1. General

The RFP responses shall contain complete information of the Contractor, its human resources, infrastructure, assets, financial standing, line of business and credentials, details of similar works executed etc. Every claim shall be supported with documentary evidence. The responses shall be evaluated and processed with the objective of maximizing production while minimizing the unit cost of production.

22.2. Essential criteria for evaluation of Proposal

1. Contractors registered in India under Company Act/Society/JV firm, Partnership firm/Pvt. Ltd. Company/Public Ltd. Company/ PSE/ LLP need only participate.
2. The activities in VSSC are unique, schedule critical, highly specialized and complex in nature. Hence it is necessary for the Contractors to have adequate experience in the specified domain of activities. Towards this, prior experience of the contractor for a minimum period of 2 years strictly in the specified domain of activities as per ***Annexure 1*** is essential. Relevant purchase orders/ work orders executed need to be attached with the bid.
3. The contractor should have executed at least a single purchase order of the bidding value or two purchase orders each for 50% of bidding value or three purchase orders each for 33% of bidding value with in last 5 financial years starting with the current financial year.
4. Contractors should have an established management structure and shall possess human resources with adequate knowledge, skill and experience in the areas of activity domain specified.

5. For participation in bidding process and submission bids, all interested bidders shall attend the pre-bid meeting online or offline and the date of which is indicated in the RFP document/tender.

6. The Government of India has enacted the Micro, Small and Medium Enterprises Development (MSMED) Act, 2006 and the preferences that are extendable to the MSME Units including Women and SC/ST Entrepreneur's as issued by the Government of India from time to time and wherever feasible, will be applicable for this RFP. In order to avail of the benefits extended by the Government of India to Micro and Small Enterprises, Contractors are requested to submit Entrepreneur Memorandum Part-II duly signed by the General Manager, District Industries Centre or NSIC Registration/Udyog Aadhar/Udyam Registration details.

Note:

1. *All information provided above by the CONTRACTOR shall be supported with documentary evidence. Brochure, if any, detailing the CONTRACTOR profile shall be submitted. Copy of the previous similar purchase/work orders executed by the CONTRACTOR also may be appended.*
2. *The final evaluation of the responses form Contractors* shall *be based on inputs furnished against our criteria, assessment based on feedback from customers and overall assessment.*

Contractors who are meeting the requirements as specified in clause 22.2 above and are interested in associating with ISRO for "GOCO Mode of Operation for Material Processing, Specimen Preparation and Operation of Equipments for Characterisation, Mechanical Testing of Materials & Fasteners Used for Launch Vehicle Applications" at VSSC, Thiruvananthapuram shall submit their bid along with copies of supporting documents for verification/evaluation at VSSC and attend the mandatory pre-bid meeting.

Checklist *for the supporting documents*
(Filled checklist to be submitted by the Contractor along with the bid)

Table 1: Checklist for Supporting Document

Sl. No.	Document / Proof	Attached/ Not-attached	Page number of supporting documents attached	Remarks
1	Company registration details *(Clause 22.2.1)*			
2	Proof of prior experience of the contractor for a minimum period of			

Sl. No.	Document / Proof	Attached/ Not-attached	Page number of supporting documents attached	Remarks
	2 years strictly in the specified domain of activities as per ***Annexure 1*** *(Clause 22.2.2)*			
3	Copy of previous purchase/work orders executed by the Contractor (least a single purchase order of the bidding value or two purchase orders each for 50% of bidding value or three purchase orders each for 33% of bidding value with in last 5 financial years starting with the current financial year*)(Clause 22.2.3)*			
4	Company profile, management structure, human resources and their experience *(Clause 22.2.4)*			

23. RFP Process

23.1 RFP Terminology

Table 2: Terminology

Acceptance tests	Testing/evaluation done in test facility/laboratory to evaluate the quality and accept the product for use.
Accounts	The Division in VSSC dealing with payment of bills and settling the payment related matters pertaining to this Contract.
DD Entity	Deputy Director of respective Entity in VSSC.
Calibration	Process by which all the measuring/testing/analysis equipment/ instruments are verified periodically for accuracy & precision.
Contract	An agreement between the VSSC and the Contractor mentioning the agreed terms for the execution of the activities as stipulated in the RFP.
Contract Manager	Officer duly appointed by the Contractor representing their respective entities and responsible for managing and monitoring the day-to-day activities under the Contract.

Facility Manager	Officer duly appointed by the VSSC representing their respective entities and responsible for managing and monitoring the day-to-day activities under the Contract.
Configuration Control	The process of approving drawings/documents supplied by the VSSC by the Configuration Control Board (CCB) set up by the VSSC. Any change from the existing approved drawing/document shall be reviewed and approved by CCB.
VSSC	Vikram Sarabhai Space Centre (VSSC), the lead center of ISRO, which is soliciting the RFP.
ISRO	Indian Space Research Organisation
DOS	Department of Space
Drawings	The drawings of all the components, finished product, accessories and fixtures, sub-assemblies and stages which form part of Process Document supplied by VSSC.
Engineer	Qualified personnel (Graduate engineer/Science post-graduate level) who are responsible for overall supervision and management of each process/stage ensuring safety and quality as per specified safety/ process document. He shall responsible for safe conduct of all the operations during processing as per the safety precautions mentioned in the Procedure/Process Document.
FIM	Free Issue Materials are chemicals/materials/equipment/ accessories/spares issued by VSSC to the Contractor during the Contract period. The items other than consumables and raw materials for processing are to be returned by the Contractor in good condition on completion/termination of Contract. Necessary security/indemnity requirement as specified by the VSSC shall have to be borne by the Contractor in this regard. The Contractor shall also provide a periodic consumption statement for the consumable and raw materials.
Fixtures	The accessories like work tables, compressors, furnaces etc. provided by VSSC for component fabrication, assembly etc.
Inspection	Activity carried out to check the quality of the process/activity/product at an intermediate stage. This includes dimensional inspection and non-destructive (Visual, Radiography and Ultrasonic test) evaluation.
CMC	Contract Management Committee (CMC) formed with persons from both VSSC and Contractor respectively. The CMC is formed to schedule and monitor the production activities as per the RFP. All the issues related to schedules and processing activities shall be brought to the CMC for its resolution. The CMC shall also certify the production for the month at the end of each month which shall be the basis for the payment to the Contractor.

PPE	Personal Protection Equipment employed for safe conduct of all the process operations without personal injury/suffocation/illness to operators and staff working in the facility. Supply of PPEs shall be decided on case by case by CMC.
Production Schedule	The schedule prepared jointly by VSSC and the Contractor that details the item wise production quantity and sequence with start time/date and end time/date.
Process/ Process document	A document supplied by the VSSC that contain descriptive details of the activity/system, specification, sequential process steps involved, elements/components required (wherever applicable). The Procedure/Process Document also contain details of consumables, tools, equipment required to perform the activity & their specification as well as process log sheets, checklists and drawings.
Production Document	A document containing all the end-to-end essential details of the whole process and product including date/period of activity, identification numbers, process parameters, test results and product evaluation parameters. This document is to be generated by the Contractor and submitted to VSSC for review along with each product/batch in the format prescribed by CMC. This along with Quality Assurance Report generated by the quality agency of VSSC shall be the basis for evaluation of the final product clearance.
Properties	Parameters of intermediate/final product evaluated at identified laboratories for its characterization/evaluation.
Purchase	The Division in VSSC dealing with rules and regulations pertaining to awarding the Contract and operating the same for a specified period.
QC Officer	Quality Control Officer responsible for maintaining the overall quality of all the operations as per the specifications mentioned in the Procedure/Process Document. Qualified QC officers should be deputed by the Contractor and they shall be responsible for in-process checks, and overall quality of activity.
Store	Identified location inside the VSSC premises where all the raw materials, accessories and consumables are stored under specified conditions.
Safety Officer	Officer responsible for maintaining the safety management system and general safety protocols in force. Safety officers shall be deputed by the Contractor and they shall be responsible for in-process & overall safety. Safety lapses, if any, shall be reported to VSSC's Facility Manager.
Supervisor	Qualified personnel (Engineering diploma/Science graduate level) who is responsible for supervising the individual process operations

	and ensuring safety for the operations and quality of the product as per specified safety/Process Document.
Technician	Staff engaged in conducting the operations as directed by supervisor/engineer.
Contractor	A Contractor who enters into a Contract with VSSC for providing the services as stipulated in the RFP.

24. Per month throughput & human resources contribution

The human resources requirement per item description and the expected throughput of human resources per month (25 days) is as given below for correlating human resources with the item description.

Table 3: HR contribution

Sl No	Item Description	**Work Contribution in %**						Maximum Quantity Possible Per Month (25 Days)	Unit of measure
		B Tech	M Sc	Dip	BSc	ITI/CC	8-12 Class		
1	Optical microscopy specimen preparation and image acquisition of Al alloys, Ti alloys, super alloys/copper and other ferrous and non-ferrous alloys	5			100			57	Nos
2	Optical microscopy specimen preparation and image acquisition of bimetallic/weld/ decarburization specimens, material with defects	5			100			40	Nos
3	Optical microscopy preparation of difficult to polish and etch material (pure aluminum, lead, brazed joints, columbium alloys, powder metallurgy materials, materials with defect or	5			100			17	Nos

	porosities, cold spray, 6000/3000 series aluminum alloys, Grain boundary precipitation, multiple etch specimens etc.)								
4	Microhardness testing and data recording of metallic specimens	5			100			200	Nos
5	Microhardness testing and data recording of welds/coating/decarburization	10			100			33	Nos
6	Inward inspection of raw materials/specimens	5			100			400	Nos
7	Visual inspection of specimens/welded joints	5			100			400	Nos
8	Raw material inspection/verification for analysis	5			100			400	Nos
9	Raw material handling of ferrous and non-ferrous materials/specimens	5			100			400	Nos
10	Cleaning of laboratory glasswares	5			100			400	Nos
11	Preparation of standard solutions/reagents	5			100			400	Nos
12	Periodic calibration of equipments	5			100			200	Nos
13	Operation and maintenance of microscopes	5			100			200	Nos
14	Storage of items in automated storage/ dessicator	5			100			400	Nos
15	Preparation of test reports, filing and dispatch to concerned indentors	5			100			200	Nos

16	Specimen preparation for XRD bulk samples	5		100				400	Nos
17	Specimen preparation for XRD powder samples	5		100				400	Nos
18	X-ray diffraction analysis of metallic/non-metallic materials for phase analysis	5		100				133	Nos
19	X-ray diffraction analysis for phase quantification	5		100				80	Nos
20	X-ray diffraction analysis for crystallite size measurements	5		100				67	Nos
21	Oxygen, Nitrogen and Hydrogen analysis in Titanium alloys and steel	5		100				80	Nos
22	Pressure cylinder connections and regulator operations	5		100				400	Nos
23	Pressure cylinder transportation	5		100				400	Nos
24	Transmission Electron Microscopy specimen preparation with twinjet	100						50	Nos
25	Transmission Electron Microscopy specimen preparation with PIPS	100						33	Nos
26	Scanning Electron Microscopy specimen preparation for powder/fractography	100						400	Nos
27	Scanning Electron Microscopy specimen preparation for microstructure analysis	100						33	Nos
28	Scanning Electron Microscopy using SE&BSE imaging	100						200	Nos
29	Scanning Electron Microscopy using SE&BSE imaging and EDS	100						100	Nos

30	Assisting in preventive maintenance and upkeeping of facility instrumentation system	100						100	Nos
31	Providing support for the operation of roughing/ rotary pumps, turbo pumps	100						400	Nos
32	Providing support for the operation of chiller unit, air compressors	100						400	Nos
33	Assisting in data acquision during test activities and offline data processing.	100						200	Nos
34	Assisting in test preparation, check list verification, logging of test details in log book.	100						400	Nos
35	Maintenance of vacuum pumping system	100						400	Nos
36	Non-Destructive in-situ metallography of Titanium alloy hemispherical dome forgings and rings/Al/ steels/ superalloys alloy forgings	10				100		50	Nos
37	Specimen preparation for EBSD	5				100		25	Nos
38	Hot/cold mounting of metallography specimens	5				100		400	Nos
39	Cutting of ferrous and non-ferrous materials/specimens	5				100		200	Nos
40	Periodic maintenance of cutting machines	5				100		200	Nos
41	Storing of materials, components/specimen at identified locations	5				100		400	Nos

42	Ultrasonic cleaning of components/specimens	5				100		400	Nos
43	Operation and maintenance of ovens	5				100		400	Nos
44	Periodic maintenance of air compressors, air driers	5				100		400	Nos
45	Maintenance of workshop equipment and portable power tools/equipment	5				100		400	Nos
46	Tensile test of specimens	20		20		63		267	Nos
47	Tensile testing of fibers/Yarn	20		20		63		400	Nos
48	Compression test of specimens	20		20		63		267	Nos
49	Compression test of hardware	20		20		63		200	Nos
50	Flexural test of specimens	30		35		45		200	Nos
51	Instrumented Charpy Impact test of specimens at RT	25		50		25		400	Nos
52	Instrumented Charpy Impact test of specimens at 77K	30		50		20		133	Nos
53	Hardness test of specimens	20		40		40		400	Nos
54	Shear test of specimens	22		40		38		200	Nos
55	Lap shear test of specimens	22		40		38		200	Nos
56	High temperature Tensile test of specimens	25		65		13		40	Nos
57	Stiffness test of springs	25		50		30		133	Nos
58	Cryo Tensile test of specimens	25		70		10		40	Nos
59	Fracture toughness testing (KIc)	40		60				29	Nos

60	Fracture toughness testing (JIc)	40		60				25	Nos
61	Tensile test of specimens at QCM	10				100		267	Nos
62	Hardness test of specimens and hardware at QCM	10				100		400	Nos
63	Compression test of specimens and hardware at QCM	10				100		200	Nos
64	Inward/outward inspection of fasteners	5				100		800	Nos
65	Dimensional inspection including gauging of fastener	5				100		800	Nos
66	Visual inspection of fasteners (10 nos. = 1 unit)	7				100		12500	Nos
67	Physical verification of materials and fasteners	5				100		2000	Nos
68	Segregation of fasteners	16				100		2000	Nos
69	Suiting of thread inserts	12				100		2000	Nos
70	Helicoil thread insert fixing	10				100		1000	Nos
71	Product Tensile test of fastener	10				100		601	Nos
72	Proof load test of fastener	10				100		601	Nos
73	Shear test of fastener	10				100		601	Nos
74	Torque test (Sustained load test / Wedge torque test / Failure torque test) of fastener	5				100		343	Nos
75	Segregation and issue of fasteners	5				100		2000	Nos
76	Tapping of fasteners	5				100		1000	Nos
77	Screw lock insertion	5				100		1000	Nos

78	Formability test of rivets	5				100		343	Nos
79	Installation test of Helicoils, Visu-Lok, Composi-Lok fasteners	5				100		300	Nos
80	Multiple cycle locking torque tests for anchor nuts, Nyloc nuts and crimped nuts	5				100		200	Nos
81	NDT /UT of metallic components, bi-metallic components, friction welded components	5				100		200	Nos
82	Dimensional inspection of components	5				100		400	Nos
83	Assembly/dis-assembly of test fixtures	5				100		400	Nos
84	Assembly/dis-assembly of test set-up	5				100		400	Nos
85	Quarantine of rejected components/fasteners	5				100		2000	Nos
86	Mixing/Milling of Powders (1kg batches) for hot pressing	35				100		20	Nos
87	Sample preparation (Nos.) for hot pressing/diffusion bonding	33				100		40	Nos
88	Powder compaction (1kg batches) for hot pressing	33				100		25	Nos
89	Sieving and coating of powders (1kg batches) for hot pressing	33				100		20	Nos
90	Heat treatment of components using oven (Nos.)	33				100		20	Nos
91	Weight, thickness & Density measurement of samples (Nos.)	33				100		40	Nos

25. Bid Format

This offer is invited on a two-part bid basis, namely, **Part-I**: Techno Commercial bid & **Part-II**: Price bid

25.1. Part-I: Techno Commercial bid:

This part of the bid shall consist of compliance and confirmation of technical specifications of this enquiry. Minor deviations if any, shall be clearly spelt out, without which it shall be deemed that the offer is in compliance with the tender enquiry specification in total (details of parties' capabilities, previous experience etc.). Compliance matrix attached as per ***Table 1*** shall be duly filled up with appropriate comments, wherever warranted and supporting documentary evidence(s).

25.2. Part-II Price bid:

The price bid shall be submitted in the format given below for the detailed scope of workdefined under in this RFP.

The Service Provider for GOCO shall submit their quote as per the following matrix:

Table 4: Quote Matrix

Sl No	Item Description	Quantity Per Year	Unit of measure	Unit Rate in Rs.	Cost for ONE Year
1	Optical microscopy specimen preparation and image acquisition of Al alloys, Ti alloys, super alloys/copper and other ferrous and non-ferrous alloys	250	Nos		
2	Optical microscopy specimen preparation and image acquisition of bimetallic/weld/ decarburization specimens, material with defects	300	Nos		
3	Optical microscopy preparation of difficult to polish and etch material (pure aluminum, lead, brazed joints, columbium alloys, powder metallurgy materials, materials with defect or porosities, cold spray, 6000/3000	200	Nos		

	series aluminum alloys, Grain boundary precipitation, multiple etch specimens etc.)				
4	Microhardness testing and data recording of metallic specimens	200	Nos		
5	Microhardness testing and data recording of welds/coating/decarburization	225	Nos		
6	Inward inspection of raw materials/specimens	100	Nos		
7	Visual inspection of specimens/welded joints	100	Nos		
8	Raw material inspection/verification for analysis	100	Nos		
9	Raw material handling of ferrous and non-ferrous materials/specimens	300	Nos		
10	Cleaning of laboratory glasswares	100	Nos		
11	Preparation of standard solutions/reagents	100	Nos		
12	Periodic calibration of equipments	50	Nos		
13	Operation and maintenance of microscopes	50	Nos		
14	Storage of items in automated storage/ dessicator	150	Nos		
15	Preparation of test reports, filing and dispatch to concerned indentors	350	Nos		
16	Specimen preparation for XRD bulk samples	350	Nos		
17	Specimen preparation for XRD powder samples	350	Nos		
18	X-ray diffraction analysis of metallic/non-metallic materials for phase analysis	250	Nos		
19	X-ray diffraction analysis for phase quantification	200	Nos		

20	X-ray diffraction analysis for crystallite size measurements	200	Nos		
21	Oxygen, Nitrogen and Hydrogen analysis in Titanium alloys and steel	350	Nos		
22	Pressure cylinder connections and regulator operations	50	Nos		
23	Pressure cylinder transportation	50	Nos		
24	Transmission Electron Microscopy specimen preparation with twinjet	100	Nos		
25	Transmission Electron Microscopy specimen preparation with PIPS	100	Nos		
26	Scanning Electron Microscopy specimen preparation for powder/fractography	100	Nos		
27	Scanning Electron Microscopy specimen preparation for microstructure analysis	100	Nos		
28	Scanning Electron Microscopy using SE&BSE imaging	200	Nos		
29	Scanning Electron Microscopy using SE&BSE imaging and EDS	100	Nos		
30	Assisting in preventive maintenance and upkeeping of facility instrumentation system	50	Nos		
31	Providing support for the operation of roughing/ rotary pumps, turbo pumps	50	Nos		
32	Providing support for the operation of chiller unit, air compressors	50	Nos		
33	Assisting in data acquision during test activities and offline data processing.	100	Nos		
34	Assisting in test preparation, check list verification, logging of test details in log book.	150	Nos		
35	Maintenance of vacuum pumping system	50	Nos		

36	Non-Destructive in-situ metallography of Titanium alloy hemispherical dome forgings and rings/Al/ steels/ superalloys alloy forgings	200	Nos		
37	Specimen preparation for EBSD	120	Nos		
38	Hot/cold mounting of metallography specimens	300	Nos		
39	Cutting of ferrous and non-ferrous materials/specimens	250	Nos		
40	Periodic maintenance of cutting machines	50	Nos		
41	Storing of materials, components/specimen at identified locations	100	Nos		
42	Ultrasonic cleaning of components/specimens	150	Nos		
43	Operation and maintenance of ovens	50	Nos		
44	Periodic maintenance of air compressors, air driers	50	Nos		
45	Maintenance of workshop equipment and portable power tools/equipment	50	Nos		
46	Tensile test of specimens	1500	Nos		
47	Tensile testing of fibers/Yarn	500	Nos		
48	Compression test of specimens	350	Nos		
49	Compression test of hardware	400	Nos		
50	Flexural test of specimens	400	Nos		
51	Instrumented Charpy Impact test of specimens at RT	250	Nos		

52	Instrumented Charpy Impact test of specimens at 77K	243	Nos		
53	Hardness test of specimens	250	Nos		
54	Shear test of specimens	300	Nos		
55	Lap shear test of specimens	297	Nos		
56	High temperature Tensile test of specimens	300	Nos		
57	Stiffness test of springs	250	Nos		
58	Cryo Tensile test of specimens	300	Nos		
59	Fracture toughness testing (KIc)	150	Nos		
60	Fracture toughness testing (JIc)	150	Nos		
61	Tensile test of specimens at QCM	1400	Nos		
62	Hardness test of specimens and hardware at QCM	1200	Nos		
63	Compression test of specimens and hardware at QCM	2400	Nos		
64	Inward/outward inspection of fasteners	200	Nos		
65	Dimensional inspection including gauging of fastener	200	Nos		
66	Visual inspection of fasteners (10 nos. = 1 unit)	5000	Nos		
67	Physical verification of materials and fasteners	5025	Nos		
68	Segregation of fasteners	500	Nos		

69	Suiting of thread inserts	500	Nos		
70	Helicoil thread insert fixing	500	Nos		
71	Product Tensile test of fastener	500	Nos		
72	Proof load test of fastener	400	Nos		
73	Shear test of fastener	1500	Nos		
74	Torque test (Sustained load test / Wedge torque test / Failure torque test) of fastener	750	Nos		
75	Segregation and issue of fasteners	1400	Nos		
76	Tapping of fasteners	500	Nos		
77	Screw lock insertion	200	Nos		
78	Formability test of rivets	200	Nos		
79	Installation test of Helicoils, Visu-Lok, Composi-Lok fasteners	1000	Nos		
80	Multiple cycle locking torque tests for anchor nuts, Nyloc nuts and crimped nuts	480	Nos		
81	NDT /UT of metallic components, bi-metallic components, friction welded components	400	Nos		
82	Dimensional inspection of components	50	Nos		
83	Assembly/dis-assembly of test fixtures	50	Nos		
84	Assembly/dis-assembly of test set-up	100	Nos		
85	Quarantine of rejected components/fasteners	100	Nos		
86	Mixing/Milling of Powders (1kg batches) for hot pressing	150	Nos		
87	Sample preparation (Nos.) for hot pressing/diffusion bonding	150	Nos		
88	Powder compaction (1kg batches) for hot pressing	150	Nos		

89	Sieving and coating of powders (1kg batches) for hot pressing	112	Nos		
90	Heat treatment of components using oven (Nos.)	150	Nos		
91	Weight, thickness & Density measurement of samples (Nos.)	225	Nos		
Total cost for one year (A)					
Total cost for two years (B=A x 2)					
Goods & Service Tax (GST)(C=18% of B)					
Grand Total (D=B+C)					

Note:

- Quantity per year is for calculation purpose only. VSSC reserves the right to reduce/ increase or not to order.
- It shall be noted that Only Offers with total basic price (B) equal to or higher than 90% of total estimated basic cost of the tender only shall be qualified for tender evaluation. From the qualified offers, the one, in which, the landed cost (grand total) is the lowest, shall be selected.

25. Time Frame for The Implementation of the Purchase Order

T0 = Order acceptance date (order acceptance shall be communicated within reasonable period)

T1 = T0+2 weeks = Within 2 weeks complete the recruitment, verification, medical check-up of all personnel's who are going to be deployed for GOCO operation.

T2 = T1+1 week = Deployment of Personnel at VSSC for work.

Annexure-1

Major Process/activities (planned, quantified, scheduled) and deliverables of Proposed GOCO Activity

Table-5: Job requirement per year for material characterisation and specimen preparation at MCD lab

Sl No	**Item description/** ***Type of test***	***Standard/ Work procedure***	***Facility / Instruments***	***Approx. Time required per test (in Hrs)***	***Quantity per year, Nos***
Technical activities related to Optical Microscopy Specimen Preparation and Analysis & Microhardness Analysis					
1	Optical microscopy specimen preparation and image acquisition of Al alloys, Ti alloys, super alloys/copper and other ferrous and non-ferrous alloys	ASTM-E3, ASTM-E407, ASTM E340, ASTM E-1558, ASTM-E112, ASTM-E45, MCD/WP/01	Metallography Polishing/lapping machines, Electrolytic polisher/etching system, Optical microscopes and stereo microscopes	3.5	250
2	Optical microscopy specimen preparation and image acquisition of bimetallic/weld/ decarburization specimens, material with defects	ASTM-E3, ASTM-E407, ASTM E340, ASTM E-1558, ASTM-E112, ASTM-E45, MCD/WP/01	Metallography Polishing/lapping machines, Electrolytic polisher/etching system, Optical microscopes and stereo microscopes	5	300
3	Optical microscopy preparation of difficult to polish and etch material (pure aluminum, lead, brazed joints, columbium alloys, powder metallurgy materials, materials with defect or porosities, cold spray, 6000/3000 series aluminum alloys, Grain	ASTM-E3, ASTM-E407, ASTM E340, ASTM E-1558, ASTM-E112, ASTM-E45, MCD/WP/01	Metallography Polishing/lapping machines, Electrolytic polisher/etching system, Optical microscopes and stereo microscopes	12	200

	boundary precipitation, multiple etch specimens etc.)				
4	Microhardness testing and data recording of metallic specimens	ASTM-E384, MCD/WP/02	Microhardness tester	1	200
5	Microhardness testing and data recording of welds/coating/decarburization	ASTM-E384, MCD/WP/02	Microhardness tester	6	225
6	Inward inspection of raw materials/specimens			0.5	100
7	Visual inspection of specimens/welded joints			0.5	100
8	Raw material inspection/verification for analysis			0.5	100
9	Raw material handling of ferrous and non-ferrous materials/specimens			0.5	300
10	Cleaning of laboratory glasswares			0.5	100
11	Preparation of standard solutions/reagents			0.5	100
12	Periodic calibration of equipments			1	50

13	Operation and maintenance of microscopes			1	50
14	Storage of items in automated storage/ dessicator			0.5	150
15	Preparation of test reports, filing and dispatch to concerned indentors	MCD/ WP/03	Report preparation computer	1	350
Technical activities related to X-ray Diffraction Specimen Preparation and Analysis & Oxygen, Hydrogen, Nitrogen analysis					
16	Specimen preparation for XRD bulk samples	MCD/ WP/07	Belt grinder, Polishing machines	0.5	350
17	Specimen preparation for XRD powder samples	MCD/ WP/07	Specimen holders/Glass plate	0.5	350
18	X-ray diffraction analysis of metallic/non-metallic materials for phase analysis	MCD/ WP/07	X-ray Diffraction system	1.5	250
19	X-ray diffraction analysis for phase quantification	MCD/ WP/07	X-ray Diffraction system	2.5	200
20	X-ray diffraction analysis for crystallite size measurements	MCD/ WP/07	X-ray Diffraction system	3	200
21	Oxygen, Nitrogen and Hydrogen analysis in Titanium alloys and steel	ASTM-E1019, ASTM-E1447, ASTM-E1409, MCD/WP/08	OHN Analyser	2.5	350
22	Pressure cylinder connections and regulator operations			0.5	50
23	Pressure cylinder transportation			0.5	50

Technical activities related to Transmission Electron Microscopy, Scanning Electron Microscopy Specimen Preparation and Analysis					
24	Transmission Electron Microscopy specimen preparation with twinjet	MCD/ WP/04	Precision cutting machine, lapping kit, Disc punch, Dimpling machine, Twin-jet polisher	4	100
25	Transmission Electron Microscopy specimen preparation with PIPS	MCD/ WP/04	Precision cutting machine, lapping kit, Disc punch, Dimpling machine, Ion-beam polisher	6	100
26	Scanning Electron Microscopy specimen preparation for powder/fractography	MCD/ WP/06	Ultrasonic cleaner, low speed saw, Carbon tape with stub	0.5	100
27	Scanning Electron Microscopy specimen preparation for microstructure analysis	MCD/ WP/05	Belt grinder, Polishing/lapping machines, Electrolytic polisher/etching system	6	100
28	Scanning Electron Microscopy using SE&BSE imaging	MCD/ WP/06	Scanning Electron Microscope	1	200
29	Scanning Electron Microscopy using SE&BSE imaging and EDS	MCD/ WP/06	Scanning Electron Microscope	2	100
30	Assisting in preventive maintenance and upkeeping of facility instrumentation system			2	50
31	Providing support for the operation of roughing/ rotary pumps, turbo pumps			0.5	50
32	Providing support for the operation of chiller unit, air compressors			0.5	50
33	Assisting in data acquision during test activities and offline data processing.			1	100
34	Assisting in test preparation, check list verification, logging of test details in log book.			0.5	150

35	Maintenance of vacuum pumping system			0.5	50
Technical activities related to Non-destructive in-situ metallography, EBSD specimen preparation, hot/cold mounting, specimen cutting, maintenance of equipments etc.,					
36	Non-Destructive in-situ metallography of Titanium alloy hemispherical dome forgings and rings/Al/ steels/ superalloys alloy forgings	ASTM-E1351, MCD/ WP/10	Portable grinder, Portable microscope, Optical microscopes	4	200
37	Specimen preparation for EBSD	MCD/ WP/09	Belt grinder, Polishing machines, Electrolytic polisher, Vibratory polishing machine	8	120
38	Hot/cold mounting of metallography specimens	MCD/ WP/11	Hot mounting press	0.5	300
39	Cutting of ferrous and non-ferrous materials/specimens	MCD/ WP/12	Specimen cutting machines	1	250
40	Periodic maintenance of cutting machines			1	50
41	Storing of materials, components/specimen at identified locations			0.5	100
42	Ultrasonic cleaning of components/specimens			0.5	150
43	Operation and maintenance of ovens			0.5	50
44	Periodic maintenance of air compressors, air driers			0.5	50
45	Maintenance of workshop equipment and portable power tools/equipment			0.5	50

Table-6: Job requirement per year for mechanical testing of materials at MTD lab.

Sl. No.	*Type of test*	*Standard*	*Facility / Instruments*	*Time required per test*	*Quantity per year, Nos*
46	Tensile test of specimens	ASTM E8M	Universal Testing machines (UTM)	45 min	1500
47	Tensile testing of fibers/Yarn	ASTM D2256	Universal Testing machines (UTM)	30 min	500
48	Compression test of specimens	ASTM E9	Universal Testing Machines (UTM)	45 min	350
49	Compression test of hardware	Custom procedure	Universal Testing Machines (UTM)	1 hr	400
50	Flexural test of specimens	ASTM C1161	Universal Testing Machines (UTM)	1 hr	400
51	Instrumented Charpy Impact test of specimens at RT	ASTM E23, E2298, E2248	Instrumented Charpy Impact Testing Machine	30 min	250
52	Instrumented Charpy Impact test of specimens at 77K	ASTM E23, E2298, E2248	Instrumented Charpy Impact Testing Machine	90 min	243
53	Hardness test of specimens	ASTM E10, E18, E92	Universal Hardness testing machines	30 min	250
54	Shear test of specimens	ASTM B565	Universal Testing Machines (UTM)	1 hr	300
55	Lap shear test of specimens	ASTM D1002	Universal Testing Machines (UTM)	1 hr	297
56	High temperature Tensile test of specimens	ASTM E21	High temperature Tensile testing machine	5 hrs	300
57	Stiffness test of springs	As per internal standard	Universal Testing Machines (UTM)	90 min	250
58	Cryo Tensile test of specimens	ASTM E8	Universal Testing Machines (UTM)	5 hrs	300
59	Fracture toughness testing (K_{Ic})	ASTM E399	Servo-hydraulic UTM's	7 hrs	150

60	Fracture toughness testing (J_{Ic})	ASTM E1820	servo-hydraulic UTM's	8 hrs	150

Table 7 - Job requirement per year for mechanical testing of specimens, hardware and fasteners at QCM Lab

Sl. No.	***Type of test***	***Standard***	***Facility / Instruments***	***Approx. Time required per test***	***Qty per year***
61	Tensile test of specimens at QCM	ASTM E8M	Universal Testing machines (UTM)	45 min	1400
62	Hardness test of specimens and hardware at QCM	ASTM E10, E18, E92	Hardness testing machines	30 min	1200
63	Compression test of specimens and hardware at QCM	ASTM E9	Universal Testing Machines (UTM)	60 min	2400
64	Inward/outward inspection of fasteners	Product drawings	Conventional measuring instruments & gauges	15 min	200
65	Dimensional inspection including gauging of fastener	VSSC Std.	Naked eye & Magnifiers	15 min	200
66	Visual inspection of fasteners (10 nos. = 1 unit)	ASTM F606M	Universal Testing Machines (UTM)	1 min	5000
67	Physical verification of materials and fasteners			6 min	5025
68	Segregation of fasteners	MIL-STD-1312-20	Universal Testing Machines (UTM)	6 min	500
69	Suiting of thread inserts	MIL-STD-1312-20 & F606M	Torque wrenches and fixtures	6 min	500
70	Helicoil thread insert fixing	VSSC Std.	Universal Testing Machines (UTM)	12 min	500

71	Product Tensile test of fastener	Product drawings	Installation tools and fixtures	20 min	500
72	Proof load test of fastener	ISO 7481	Torque wrench, Motorized locking torque tester and fixtures	20 min	400
73	Shear test of fastener			20 min	1500
74	Torque test (Sustained load test / Wedge torque test / Failure torque test) of fastener			35 min	750
75	Segregation and issue of fasteners			6 min	1400
76	Tapping of fasteners			12 min	500
77	Screw lock insertion			12 min	200
78	Formability test of rivets			35 min	200
79	Installation test of Helicoils, Visu-Lok, Composi-Lok fasteners			40 min	1000
80	Multiple cycle locking torque tests for anchor nuts, Nyloc nuts and crimped nuts			60 min	480
81	NDT /UT of metallic components, bi-metallic components, friction welded components			60 min	400
82	Dimensional inspection of components			30 min	50

83	Assembly/dis-assembly of test fixtures			30 min	50
84	Assembly/dis-assembly of test set-up			30 min	100
85	Quarantine of rejected components/fasteners			6 min	100

Table 8 - Job requirement per year for material processing in MMG and AMG

S. No.	Description of the Work	Qty. of units per year (Nos)
86	Mixing/Milling of Powders (1kg batches) for hot pressing	150
87	Sample preparation (Nos.) for hot pressing/diffusion bonding	150
88	Powder compaction (1kg batches) for hot pressing	150
89	Sieving and coating of powders (1kg batches) for hot pressing	112
90	Heat treatment of components using oven (Nos.)	150
91	Weight, thickness & Density measurement of samples (Nos.)	225

Annexure-2

List of Facilities, tools, machines, equipment, fixtures, utilities and raw materials, routine up keeping

Table-9: Facilities at MCD lab.

Sl No.	***Name of facility/equipment***
1.	Optical Microscopes
2.	Stereo Microscopes
3.	Microhardness tester
4.	Belt grinder
5.	Polishing/lapping machines
6.	Electrolytic polisher/etching system
7.	Vibratory polishing machine
8.	Report preparation computer
9.	X-ray Diffraction system
10.	Water chiller for X-ray Diffraction system
11.	Specimen holders for X-ray Diffraction system
12.	Powder holders for X-ray Diffraction system
13.	OHN Analyser
14.	Water chiller for OHN Analyser
15.	Disc punch
16.	Dimpling machine
17.	Twin-jet polisher
18.	Diamond wire saw
19.	Lapping kit
20.	Hot plate

21.	Precision Ion-beam polisher
22.	Holder/fixtures for Precision Ion-beam polisher
23.	Scanning Electron Microscope
24.	Specimen stubs for Scanning Electron Microscope
25.	Specimen holders for Scanning Electron Microscope
26.	Portable grinder
27.	Portable microscope
28.	Replication kit
29.	Hot mounting press
30.	Cold mounting kit
31.	Low speed saw
32.	High speed cutting machine
33.	Magnifiers
34.	Tweezers
35.	Vacuum tweezers
36.	Liquid dispensers
37.	Ultrasonic cleaner
38.	Vacuum desiccator with pump
39.	Raw materials: Polishing emery papers, belt emery, alumina suspension, diamond lapping compound, lapping cloths Cutting blades.
40.	Routine maintenance: Cleaning of all the above-mentioned facilities/equipment daily basis after completion of each operation.

Table-10: Facilities at MTD lab.

Sl No.	**Name of facility/equipment**
1	Electromechanical Universal Testing Machines (UTM)
2	Servohydraulic Universal Testing Machines (UTM)
3	High temperature Tensile testing machines
4	Universal Hardness Testing Machines
5	Conventional Measuring Instruments live Vernier, height gauge and micrometers
7	Instrumented Charpy Impact Testing Machine
8	Microscopes for crack size measurement

Table-11: Facilities at QCM lab

Sl No.	***Name of facility/equipment***
1.	Universal Testing Machines (UTM)
2.	Rockwell Hardness Testing machines
3.	Universal Hardness Testing Machines
4.	Brinell cum Vickers Hardness Testers
5.	Portable Hardness testers (Leeb type)
6.	Torque wrenches, Digital Continuous indicating type
7.	Torque wrenches, Dial continuous indicating type
8.	Conventional Measuring Instruments
9.	Thread ring & plug gauges
10.	Test fixtures - various types
11.	UTM grips - various types
12.	Grinding machines for specimen preparation
13.	Files, Cutting machines, polishing papers for specimen preparation

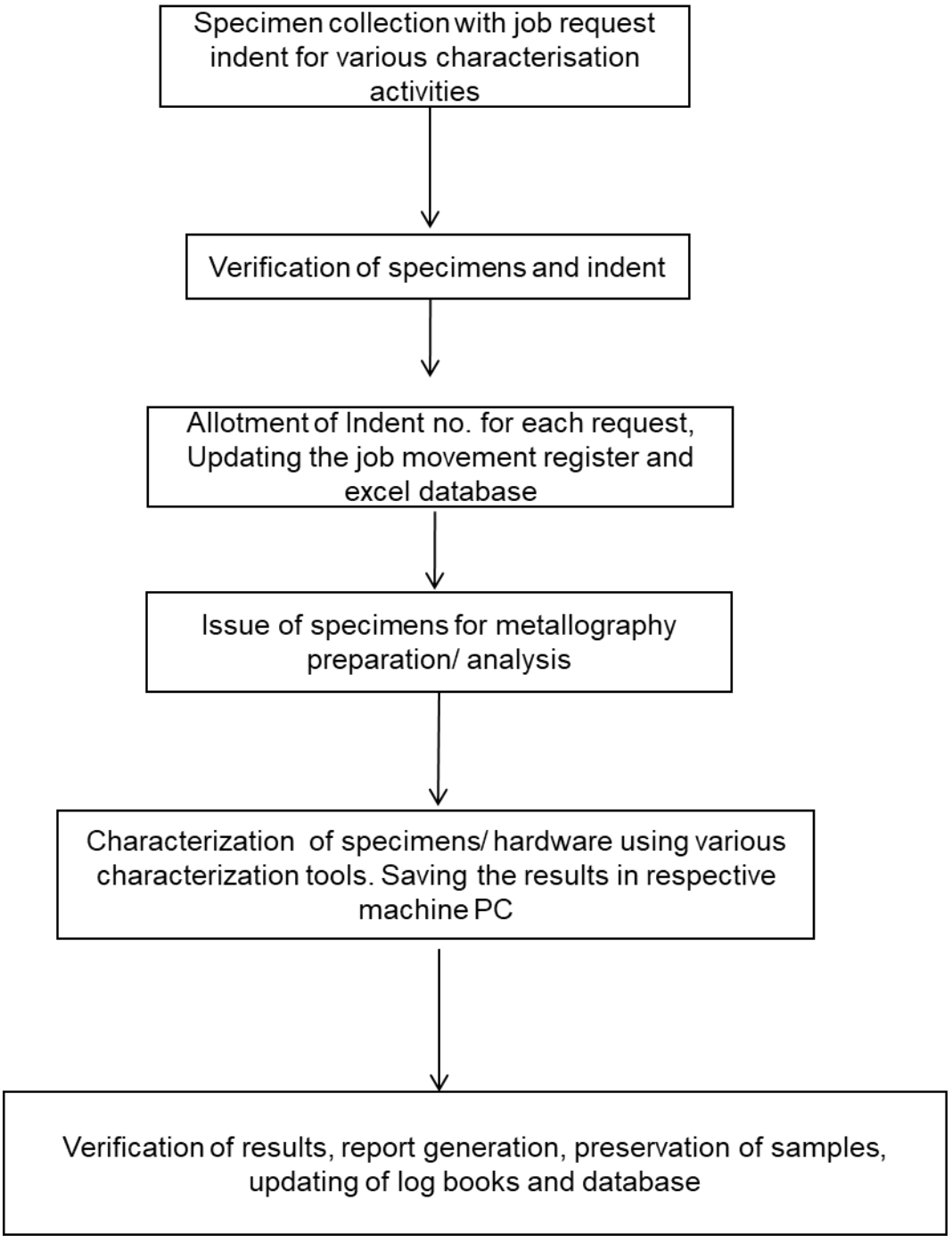
Table-12: Facilities for material processing at MMG

SN	***Name of facility/equipment***
1.	Roll mills [150 RPM]
2.	Electric Oven [400°C]
3.	Ball mills [400 RPM]
4.	Attritor Mills [600 RPM]
5.	Cutting Machines [1000 RPM]
6.	Sieve Shaker
7.	Turbo mixer
8.	Compaction press [200 tonnes]
9.	Density meter
10.	Polishing Machines

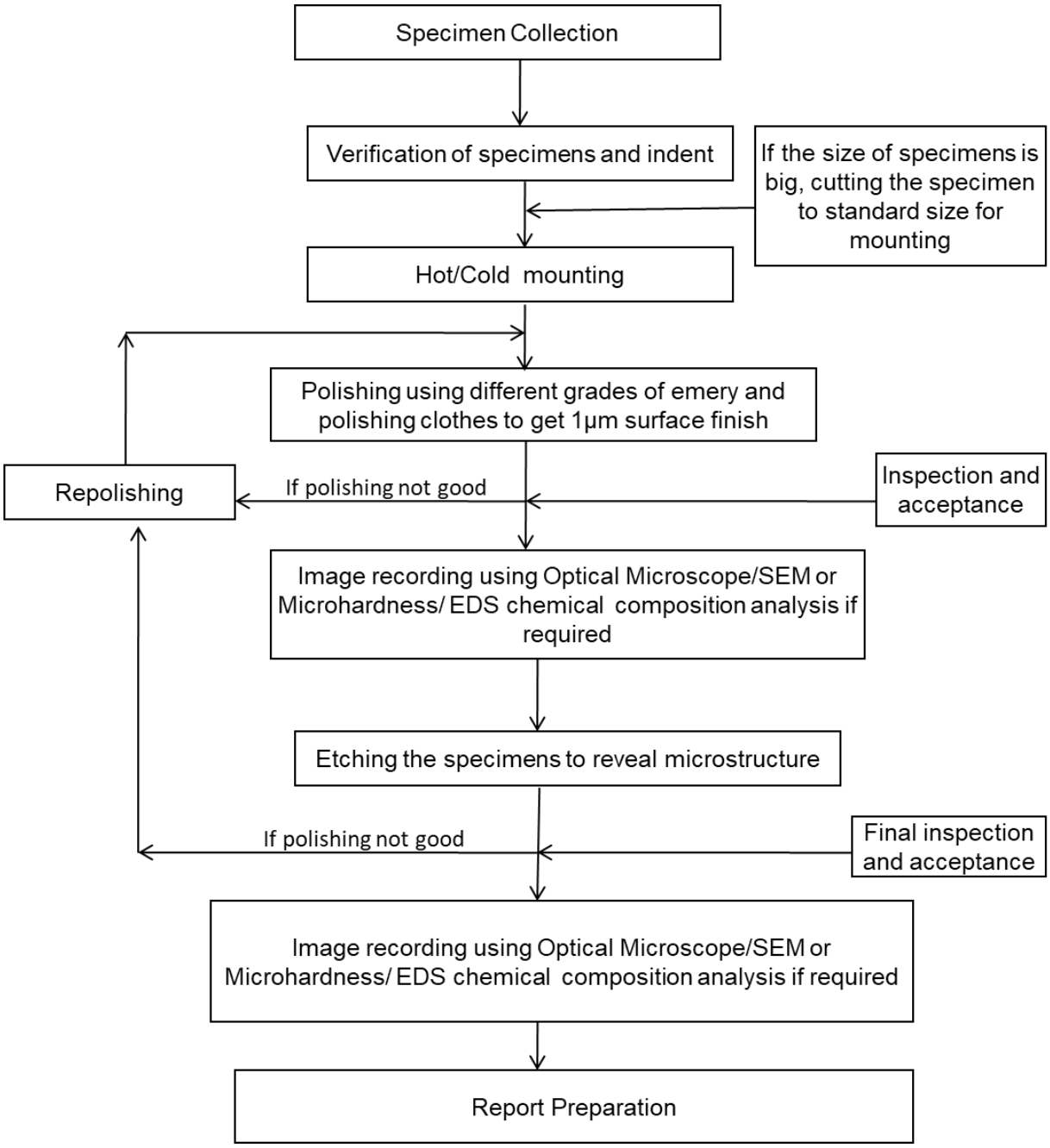
Annexure 3.

Process flow chart, schedule, QC and safety procedure to be followed

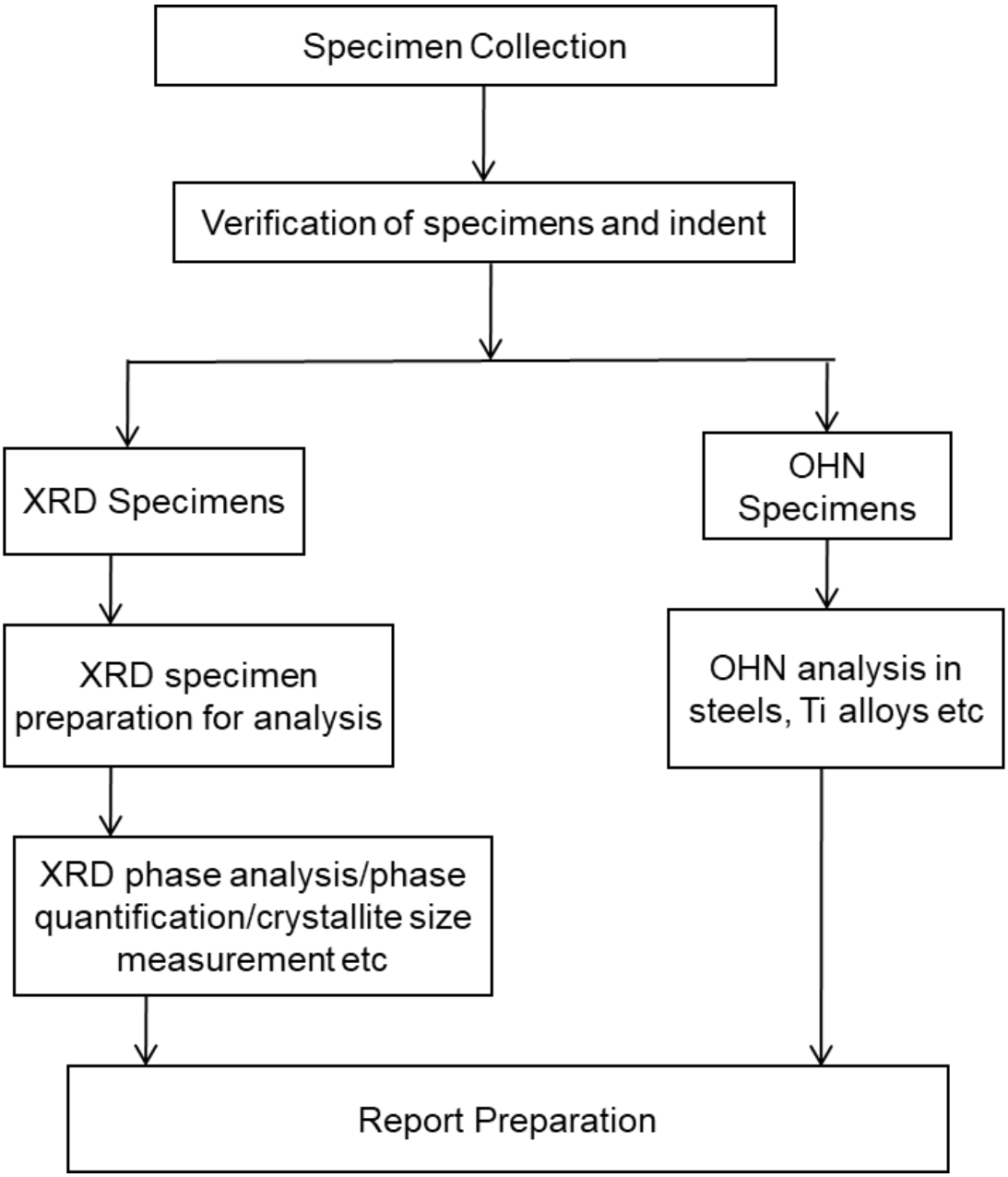
1. ***Process flow chart of jobs in GOCO mode for Specimen preparation and Operation of Equipments for Characterisation of Materials.***



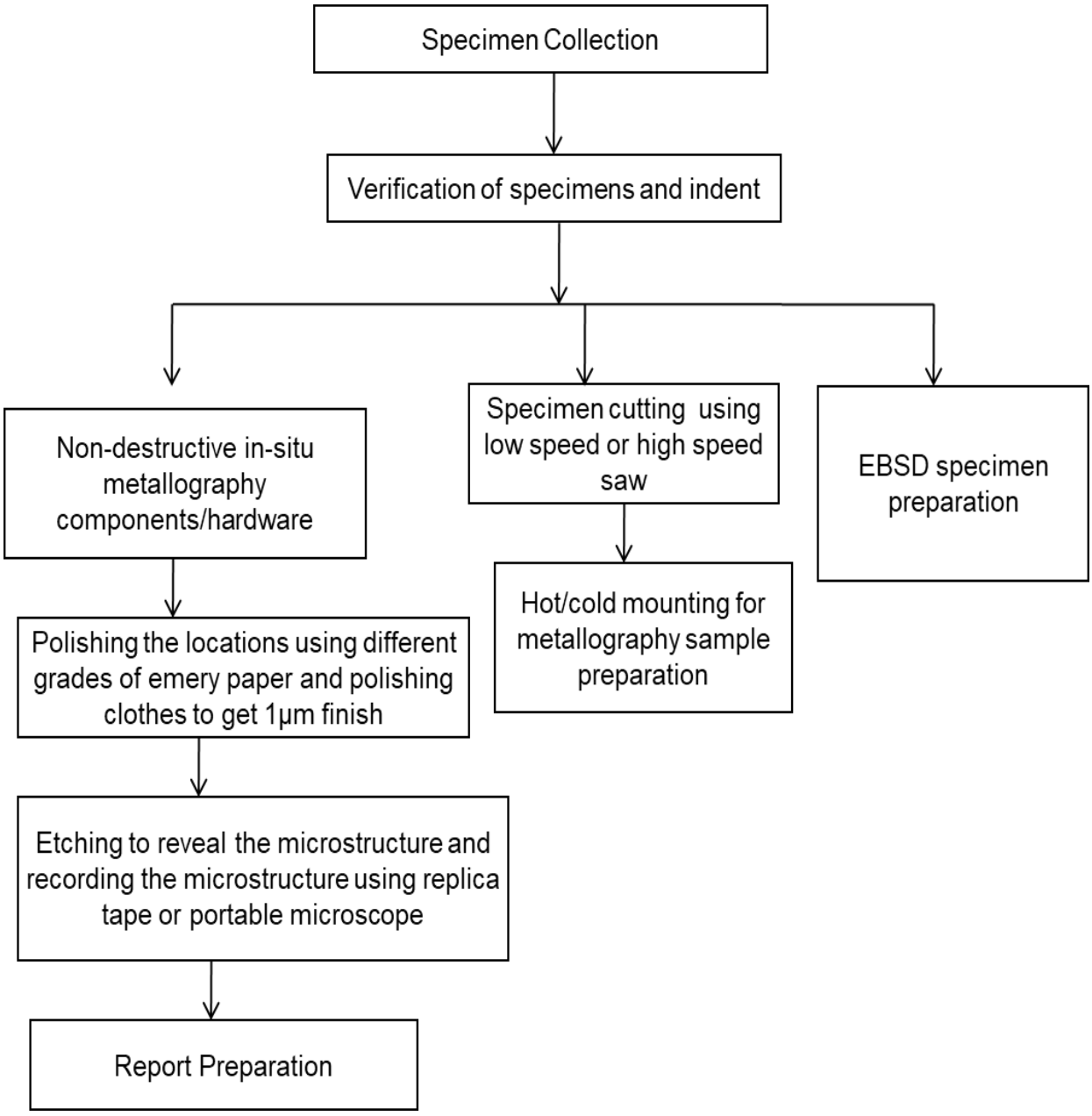
2. Process flow chart for Metallography specimen preparation and Microhardness



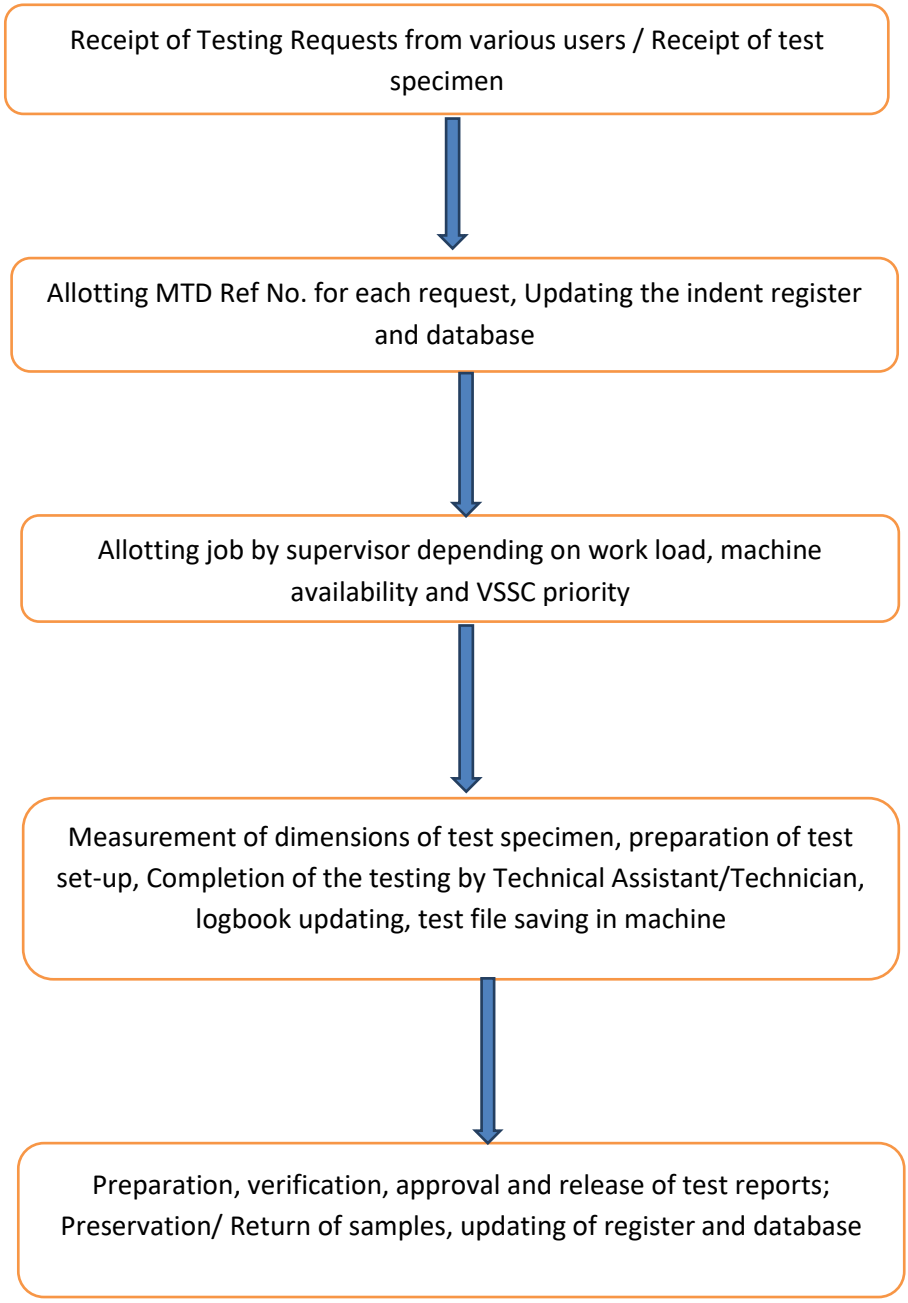
3. Process flow chart for X-ray Diffraction analysis and Oxygen, Hydrogen, Nitrogen analysis



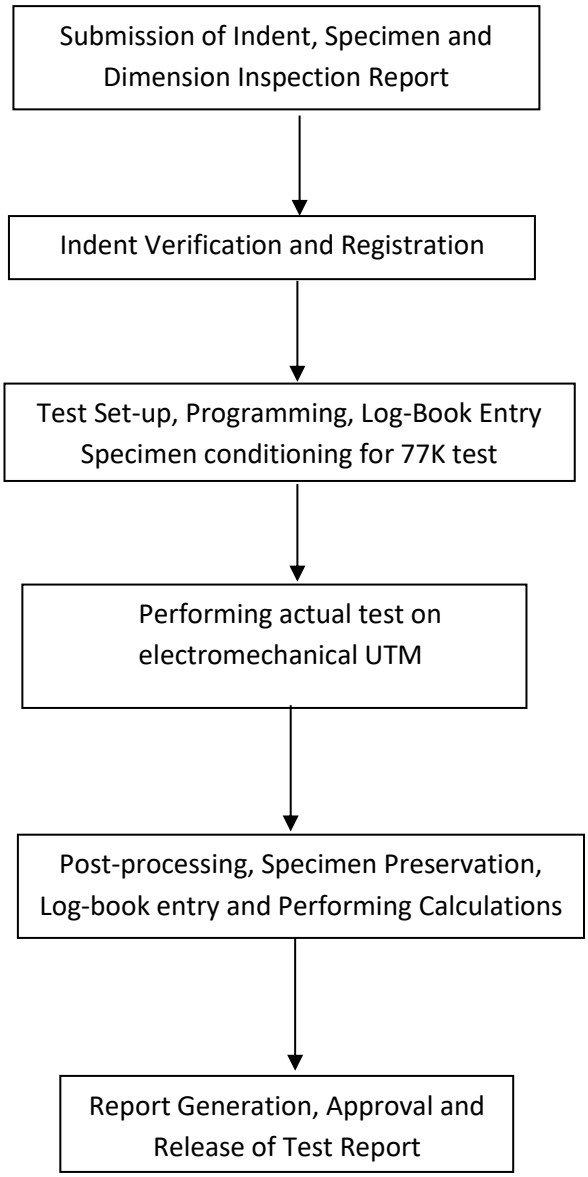
4. Process flow chart for Non-destructive in-situ metallography, hot mounting, specimen cutting, EBSD specimen preparation etc,



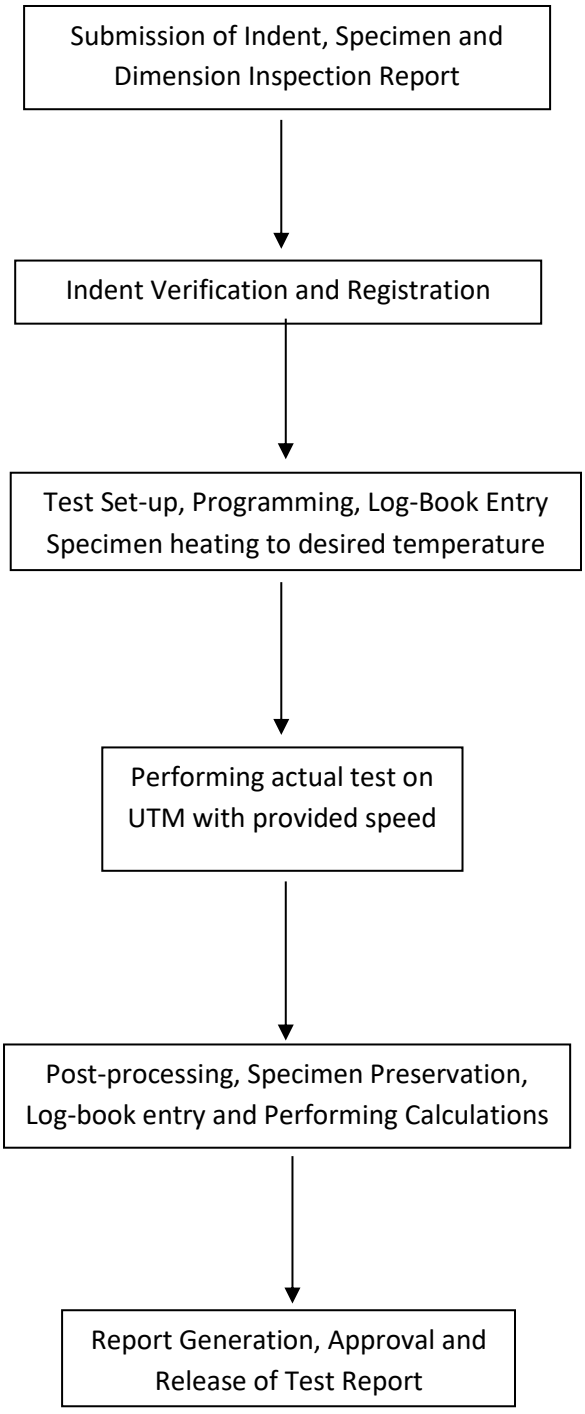
5. Process flow chart in Mechanical testing of material



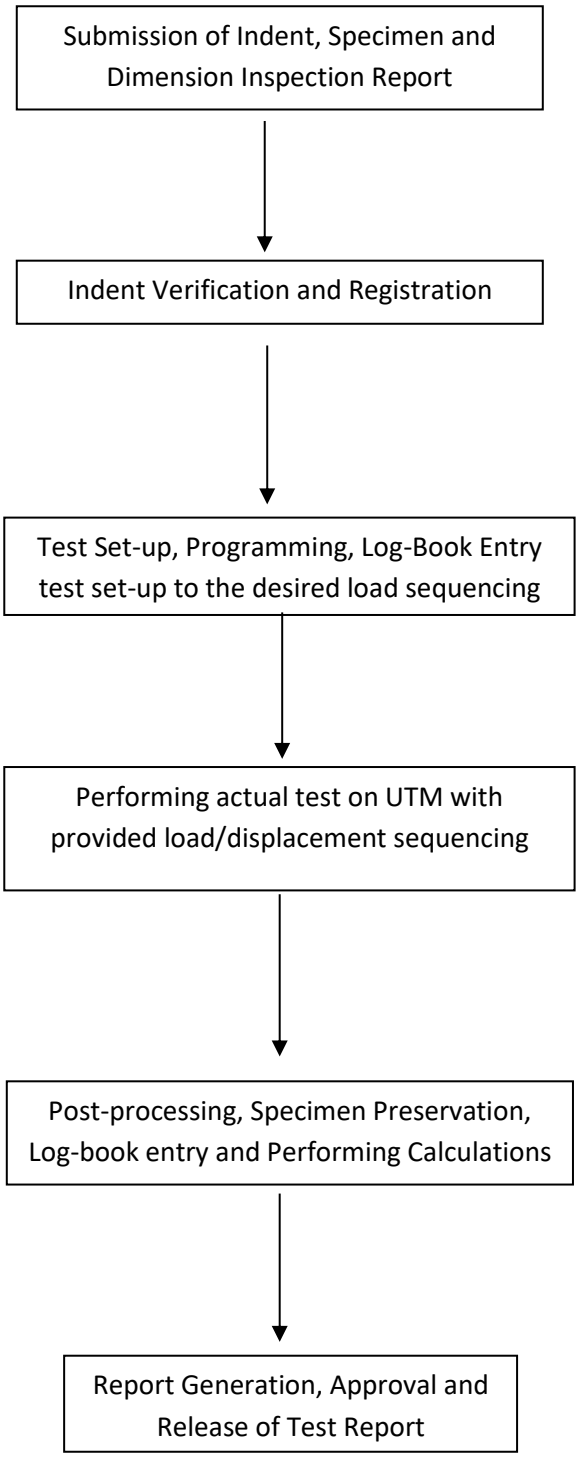
6. Process flow chart for mechanical testing at RT/77K



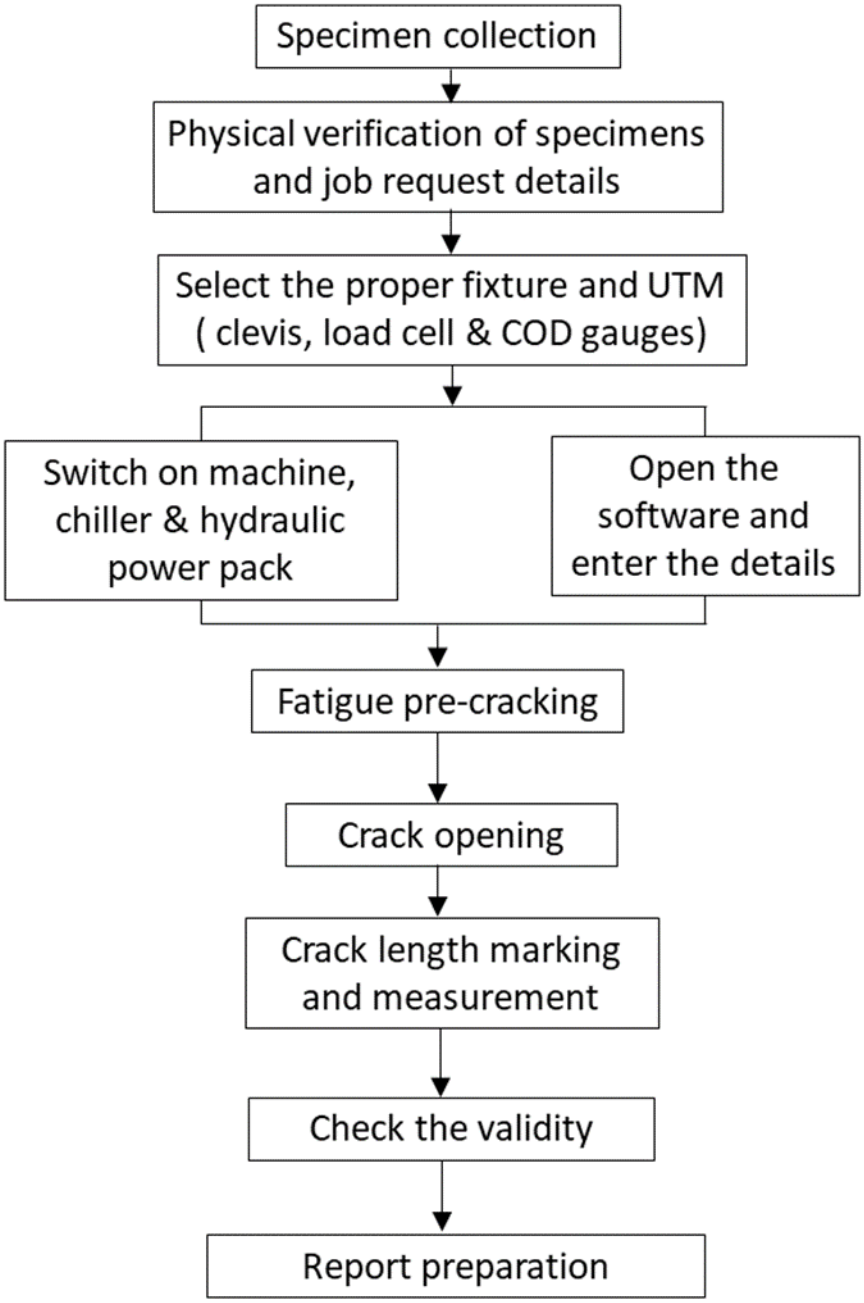
7. Process flow chart for mechanical testing at elevated temperatures



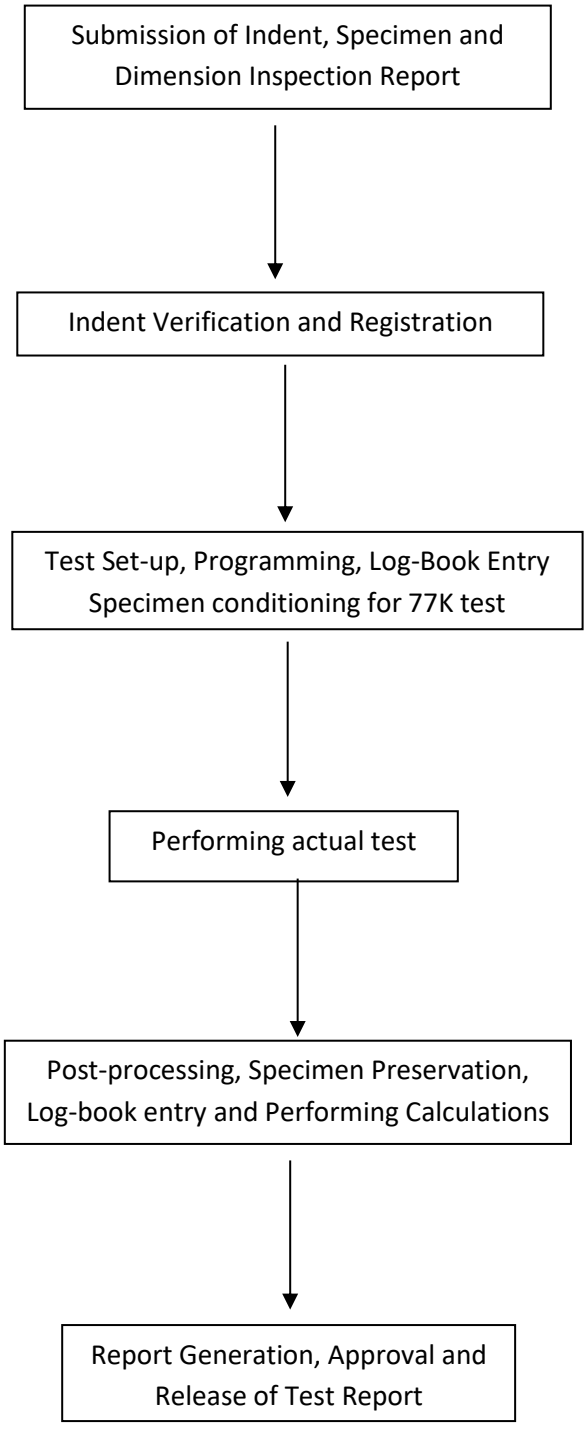
8. Process flow chart for mechanical testing of structural components



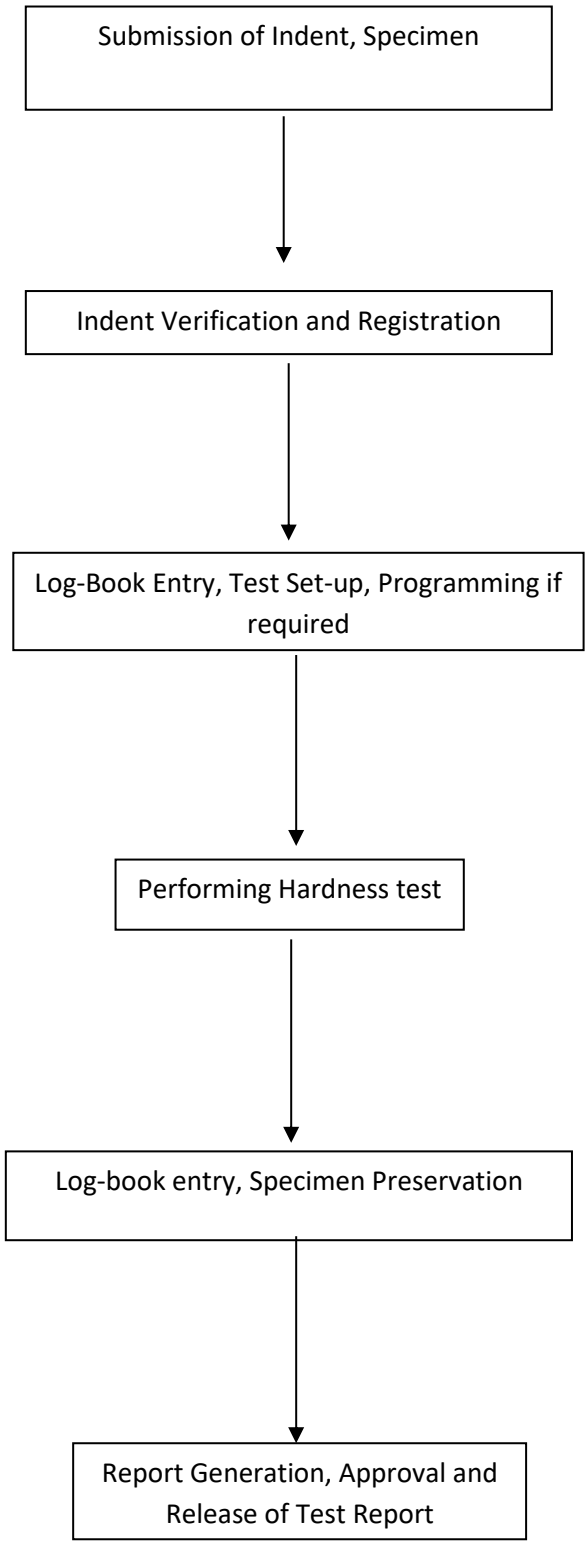
9. ***Process flow chart for mechanical testing of KIC/JIC testing***



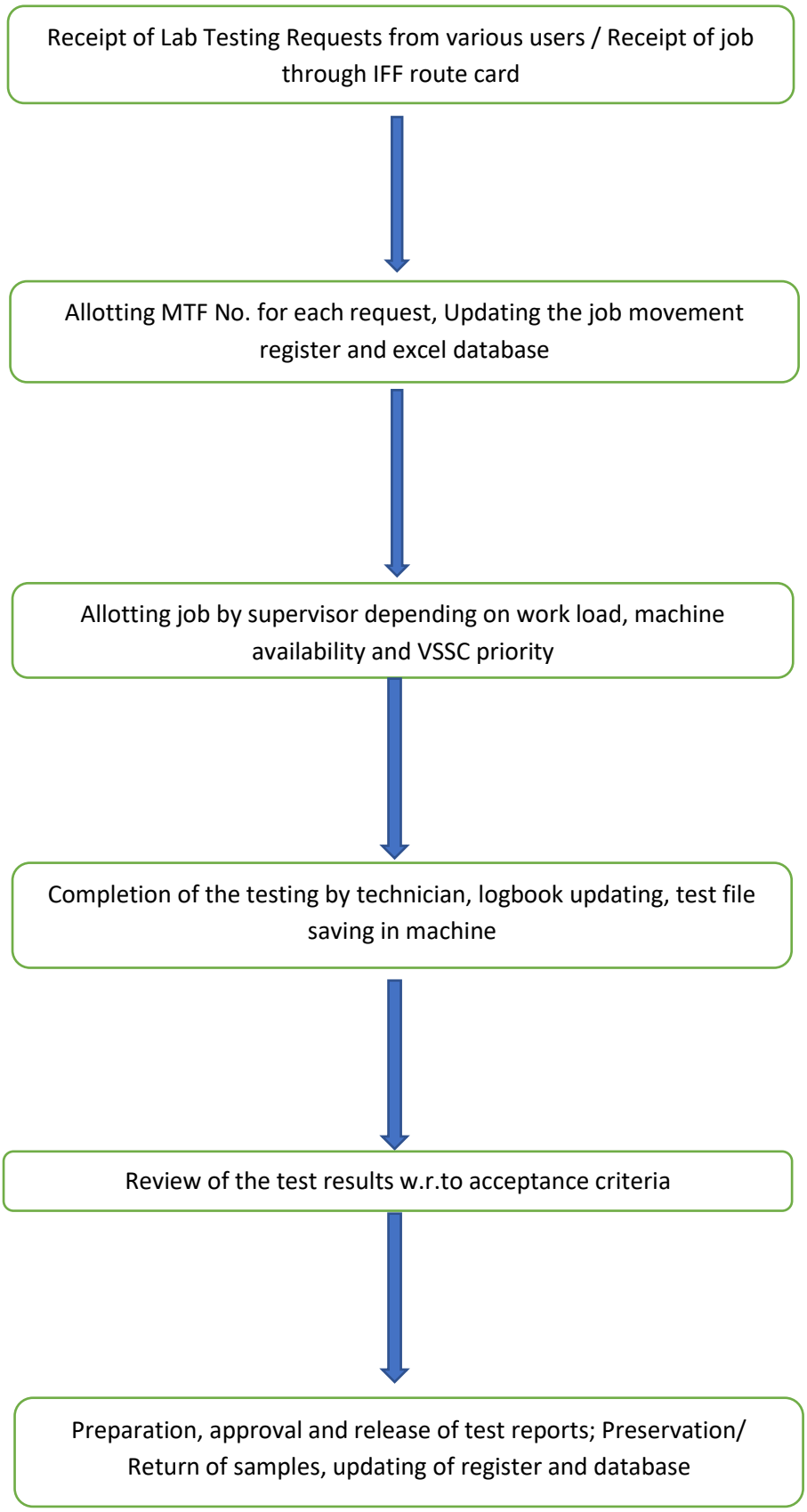
10. Process flow chart for Instrumented Charpy Impact Test at RT/77K



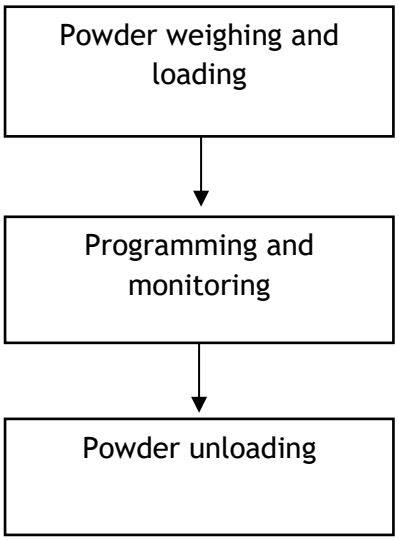
11. Process flow chart for Hardness Test of Specimens



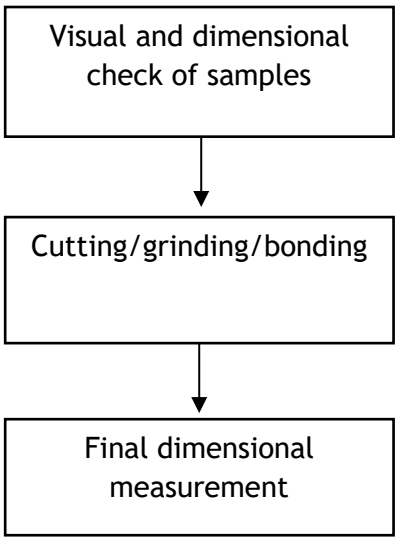
12. Process Workflow in QCM Lab



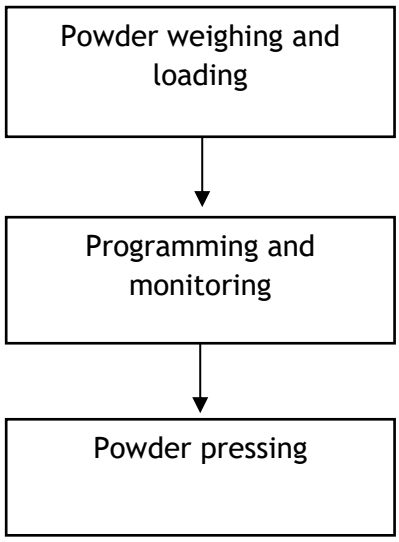
13. Process flow chart for powder milling for hot pressing



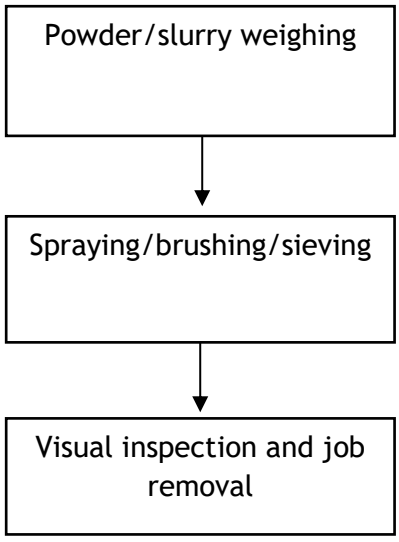
14. Process flow chart for sample preparation for hot pressing/diffusion bonding



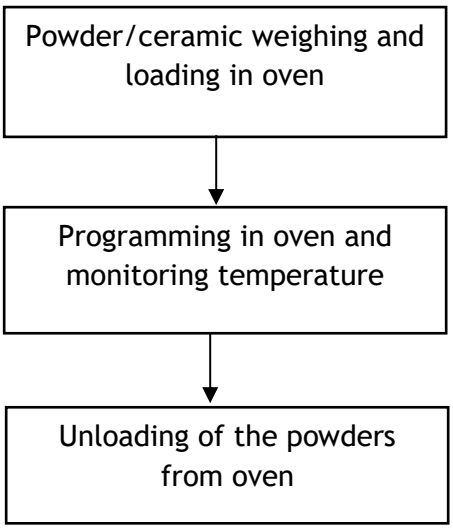
15. Process flow chart for powder compaction for hot pressing



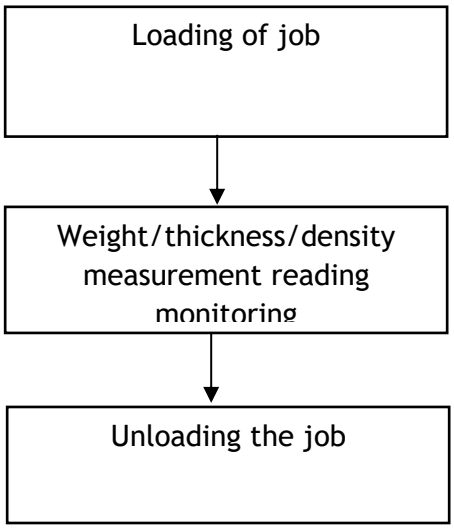
16. Process flow chart for sieving and coating of powders for hot pressing



17. Process flow chart for heat treatment of components using oven



18. Process flow chart for Weight, thickness & density measurement of samples



Work Procedure/Process Document: 1	DOCUMENT NO. MCD/ WP/01

TITLE: Metallography specimen preparation and image acquisition.

PURPOSE: For the evaluation of microstructure of the material.

DEFINITIONS AND SYMBOLS: Metallography, Microstructure, Etching

SCOPE:

1) Metallography specimen preparation and image acquisition

PROCEDURE:

- Small specimens are mounted either in a cold setting resin or in a hot Bakelite mould for metallography specimen preparation.
- The large size specimen can be prepared without mounting.
- The specimen/ mould is then belt ground on coarse belt grinder with 80 or 120 grit and emereyed on a series of emery papers starting from 220/280/400/600/800 grit emery papers in a sequence.
- The final polishing is carried out by wet alumina and on a diamond paste of 0.5 or 1 micron size to obtain scratch free surface suitable for etching.
- The specimen after obtaining a scratch free surface is thoroughly cleaned with soap and thoroughly dried using hot air blower and preserved for etching.
- Recording the image using optical microscope in unetched condition if required.
- Inclusion rating measurements are carried out as per ASTM E45-13.
- The polished specimen with scratch free surface is taken and etched with freshly prepared etchants.
- The various etchants and etching methods are followed according to the standards laid down in ASTM E407-07.

- For electrolytic etching, the polished specimen with scratch free surface is etched electrolytically by using electrolytic etching unit with the specified electrolyte, voltage, current and time as given in ASTM E1558-09.
- After etching, the specimen is washed in water thoroughly, cleaned and dried. The specimen is ready for observation under microscope.
- Grain size measurements are carried out as per ASTM E 113-13.
- Coating thickness application measures the thickness or width of a coating at multiple positions along a sample.
- Recording the images using bright field, dark field and DIC techniques using optical microscope.
- Image analysis software is used for grain size, coating thickness, decarburization thickness, etc

REFERENCES: ASTM E3-11, ASTM E407-07, ASTM E45-13, ASTM E 113-13, ASTM E1558-09

DOCUMENTATION/ EXHIBITS: Log Book, Status Book, Indent File/ Analysis report.

Schedule: Activity to be completed within 30 days from date of allotment.

Quality Check (QC): Quality check of specimen includes the surface preparation condition of specimens after polishing and etching.

Acceptance /Rejection Criteria:

1. The metallography specimens with scratch marks at any place/location in specimen at any stage of polishing will be rejected.
2. Etched specimen with etch pits, over-etch/under-etch, water marks, non-uniform etching, will be rejected.

Safety Procedure: Metallography specimen preparation to be carried out using safety gloves and apron

Work Procedure/Process Document: 2	DOCUMENT NO. MCD/ WP/02

TITLE : Microhardness testing and data recording

PURPOSE: Measurement of hardness on the micro constituents of the microstructure and other phases.

DEFINITIONS: Microhardness, load, Indentation, diagonals etc.

SCOPE: Microhardness testing

PROCEDURE:

- The polished specimens are etched with suitable etchant to reveal the grain boundaries and micro constituents.
- The microstructure is observed on the micro hardness tester at different magnifications and the area of interest is located in the frame of observation in the computer.
- The proper load is selected from the load range to get a good indentation.
- The indentation using Vickers or Knoop indenter is made at the location of interest.
- The indentation is observed at suitable magnification and two diagonals of indentation is measured either manually or automatically by software.
- The corresponding micro hardness value is obtained on the screen and the values are recorded for reporting purpose.

REFERENCES: ASTM E-384 –11

DOCUMENTATION: Log Book, Status Book, Indent File/ Analysis report

Schedule: Activity to be completed within 30 days from date of allotment.

Quality Check (QC): Quality check of specimen flatness, shape of indent

Acceptance /Rejection Criteria: Improper indent shape gives erroneous reading and hence it is rejected.

Safety Procedure: Microhardness testing to be carried out using safety gloves and apron

Work Procedure/Process Document: 3	DOCUMENT NO. MCD/ WP/03

TITLE : Metallography Report preparation

PURPOSE: Report preparation for various Projects, Committees, R&D activities etc

DEFINITIONS: Microstructure, Microhardness etc.

SCOPE:

1) Report preparation

PROCEDURE:

- The representative microstructures form the recorded images have to put in the report as per the requirement.
- The micro hardness values in tabular form have to put in the report if required.
- Captions should be there for all images and tables.
- Report should contain all observations regarding microstructure and micro hardness values.

DOCUMENTATION: Status Book, Analysis report

Schedule: Activity to be completed within 30 days from date of allotment.

Quality Check (QC): Quality check of activity includes selection of relevant images for the required analysis

Acceptance /Rejection Criteria: Report with improper selection of images will be rejected.

Safety Procedure: No specific safety procedure

Work Procedure/Process Document: 4	DOCUMENT NO. MCD/ WP/04

TITLE: Transmission Electron Microscopy specimen preparation

PURPOSE: For the understanding of the nanoscale microstructure of the material.

DEFINITIONS AND SYMBOLS: Microstructure, precipitates, dislocations

SCOPE: Transmission Electron Microscopy specimen preparation

PROCEDURE:

- Bulk metallic specimen under investigation is sliced in to a thickness 200 to 300 μm.
- Sliced specimen is polished upto a thickness of less than 100 μm by using different grit of emery papers.
- The polished specimens are punched into a size of 3.05 mm dia. using Disc Punching unit for metallic specimens. For ceramic or composite specimens, the Ultrasonic cutting unit is used to core or drill out 3.05 mm diameter disc.
- The 3.05 mm disc (either metallic or ceramic) is further lapped down to a thickness of less than 50 μm using lapping discs of 45 μm, 15 μm and 5 μm grit papers.
- The lapped disc is further dimpled using a dimpling grinder unit to the least possible thickness.
- Final thinning of the specimen is done by precision ion polishing (PIPS) or electrochemical polishing unit (twinjet). In this operation, the specimen is milled or polished to have electron transparent area surrounding the hole made by the corresponding technique. The specimen is preserved for TEM observation.
- For ultra fine powders, TEM grids coated with ultra thin carbon are used to scoop out the powders. Due to variation in the surface energies, the sample adheres to the grids. The rest of the powder is dropped back and the TEM grid is directly used for TEM studies.

REFERENCES:

1. Goodhew, P.J. Specimen preparation for transmission electron microscopy of materials, Oxford University Press, Royal Microscopical Society, 1984

DOCUMENTATION/ EXHIBITS: Log Book, Status Book, Indent File

Schedule: Activity to be completed within 30 days from date of allotment.

Quality Check (QC): Quality check of specimen includes thickness checks at every step

Acceptance /Rejection Criteria: Specimen with more thickness will be rejected.

Safety Procedure: Metallography specimen preparation to be carried out using safety gloves and apron

Work Procedure/Process Document: 5	DOCUMENT NO. MCD/ WP/05

TITLE: SEM specimen preparation for microstructure analysis

PURPOSE: Microstructure Analysis

DEFINITIONS AND SYMBOLS: Metallography, Microstructure

SCOPE: Specimen preparation for SEM

PROCEDURE:

- Small specimens are mounted either in a cold setting resin or in a hot bakelite mould for metallography specimen preparation.
- The large size specimen can be prepared without mounting.
- The specimen/ mould is then belt ground on coarse belt grinder with 80 or 120 grit and emereyed on a series of emery papers starting from 220/280/400/600/800 grit emery papers in a sequence.
- The final polishing is carried out by wet alumina and on a diamond paste of 0.5 or 1 micron size to obtain scratch free surface suitable for etching.
- The specimen after obtaining a scratch free surface is thoroughly cleaned with soap and thoroughly dried using hot air blower and preserved for etching.
- Recording the image using SEM in unetched condition if required.
- The polished specimen with scratch free surface is taken and etched with freshly prepared etchants.
- The various etchants and etching methods are followed according to the standards laid down in ASTM E407-07.
- For electrolytic etching, the polished specimen with scratch free surface is etched electrolytically by using electrolytic etching unit with the specified electrolyte, voltage, current and time as given in ASTM E1558-09.
- After etching, the specimen is washed in water thoroughly, cleaned and dried. The specimen is ready for observation under SEM.

DOCUMENTATION/EXHIBITS: Log Register

Schedule: Activity to be completed within 30 days from date of allotment.

Quality Check (QC): Quality check of specimen includes the surface preparation condition of specimens after polishing and etching.

Acceptance /Rejection Criteria: The specimens with scratch marks at any place/location in specimen at any stage of polishing will be rejected. Etched specimen with etch pits, over-etch/under-etch, water marks, non-uniform etching, will be rejected.

Safety Procedure: Specimen preparation to be carried out using safety gloves and apron

Work Procedure/Process Document: 6	DOCUMENT NO. MCD/ WP/06

TITLE : Scanning Electron Microscopy (SEM)

PURPOSE: Surface Morphological Inspection, analysis on polished, fractured, and failed specimens, observation of non-conducting specimens without conductive coating by using extended pressure mode, micro-chemical analysis by EDS and texture analysis using EBSD.

DEFINITION: Fractography, ductile, dimples, fatigue striations, inclusions, extended pressure mode, chemical analysis etc.

SCOPE:

1) Scanning Electron Microscopy specimen preparation for powder/fractography.

2) Scanning Electron Microscopy using SE&BSE imaging

3) Elemental composition analysis using EDS

PROCEDURE:

- The fractography specimens are cut into 10-20 mm height and base of the specimens should be flattened for observation under SEM.
- The specimens should be ultrasonically cleaned before loading in SEM.
- The powder specimens should be deagglomerated and sticked on carbon tape before loading for SEM observation..
- The specimen is fixed on the prescribed specimen holder by means of silver paint/carbon paste/carbon tape with the surface to be observed facing pole piece.
- The specimen holder thus made is inserted in to the specimen chamber and evacuated.
- Once the vacuum is obtained to the operational level as indicated by the machine, the specimen stage has to be adjusted by using CCD camera in TV mode, High voltage is switched ON and the surface features are observed in the SEM with

instructions as given in the manual.

- In the case of nonmetallic specimens, material surface to be observed is made conductive by thin coating of gold/carbon to avoid charging effect and to obtain clear details on the surface.
- The chemical composition of micro-constituents using EDS detector is carried out in point mode, area mode, line scan and elemental mapping method. After the acquisition of EDS spectrum, data is analyzed to get the chemical composition through the software.
- Texture analysis is carried out using EBSD detector.
- The data acquired using EBSD detector is analysed using software.

REFERENCES:

- Metals hand book Vol.9 (fractography) ASM Metals Park, Ohio and Atlas of fractographs).

DOCUMENTATION: Indent File/ Analysis report/ Log book / Computer storage.

Schedule: Activity to be completed within 30 days from date of allotment.

Quality Check (QC): Quality check includes proper focusing of images before recording

Acceptance /Rejection Criteria: Images with improper focusing and clarity will be rejected

Safety Procedure: Activity to be carried out using safety gloves and apron.

Work Procedure/Process Document: 7	DOCUMENT NO. MCD/ WP/07

TITLE : X-ray diffraction (XRD) Analysis

PURPOSE: To identify the crystalline phases present in the material, quantitative estimation of phases and crystallite size measurements by scherrer equation.

DEFINITIONS ANDSYMBOLS:

λ: Wavelength of the target used in A°

θ: Bragg angle in degrees,

d :Inter phase spacing in A°

Frequently used equation:

$\lambda = 2\ d \sin \theta$ (Bragg's equation)

SCOPE:

1) Specimen preparation for XRD bulk samples
2) Specimen preparation for XRD powder samples
3) X-ray diffraction analysis of metallic/non-metallic materials for phase analysis
4) X-ray diffraction analysis for phase quantification
5) X-ray diffraction analysis for crystallite size measurements

PROCEDURE:

- The powder specimen or solid specimen can be used for XRD analysis.
- Powder specimens are prepared on the rectangular aluminum specimen holder or glass slides.
- Bulk solid specimens are placed directly on the specimen holder.

- Oversized specimens should be cut in to standard size using low speed/high speed saw.
- Some specimens are to be metallographically polished before loading for XRD.
- The X-ray diffraction unit is operated and controlled by the computer as per the instructions given in the manual.
- The high tension is switched on by turning the key.
- After switching on the x-ray tube, the voltage and current setting is changed according to the requirement.
- The XRD scan is performed and XRD pattern saved after completion of the scan.
- The XRD pattern is analyzed for phase analysis, phase quantification and crystallite size measurement by using the software supplied with the instrument and ICDD Database.

REFERENCES:

- ICDD Database
- Elements of X-ray diffraction by B.D.Cullity,2001.

DOCUMENTATION: Indent file/ Analysis report /Log book / Computer storage

Schedule: Activity to be completed within 30 days from date of allotment.

Quality Check (QC): Quality check of specimen includes the flatness of specimen, proper holding of specimen. Quality of XRD pattern.

Acceptance /Rejection Criteria: The specimen with improper flatness and holding will be rejected. XRD pattern with more background and less intensity counts will be rejected.

Safety Procedure: XRD specimen preparation to be carried out using safety gloves and apron

Work Procedure/Process Document: 8	DOCUMENT NO. MCD/ WP/08

TITLE : Oxygen, Hydrogen, Nitrogen (OHN) analysis

PURPOSE: To analysis gas content like Oxygen, Hydrogen, Nitrogen in metals and alloys

DEFINITION AND SYMBOLS: Oxygen, Hydrogen, Nitrogen

SCOPE: Oxygen, Nitrogen and Hydrogen analysis

PROCEDURE:

- The cylindrical specimens of 3mm dia and length ≤10mm are prepared for the OHN Analysis. The specimens are cleaned in acetone and completely dried before analysis.
- Run three blanks with empty crucibles.
- Calibrate the analyzer with suitable calibration material.
- Fill one empty inner crucible in the outer crucible and place on the electrode tip and close the furnace.
- Weigh the sample, put them through the sample drop mechanism and start the analysis.
- The results will be displayed in the software.

REFERENCES: ASTM E 1019-11, ASTM E1447, ASTM E1409

DOCUMENTATION: Indent file /Analysis report / Log book / Computer storage

Schedule: Activity to be completed within 30 days from date of allotment.

Quality Check (QC): Quality check of specimen includes the surface condition specimens, weight and size of specimens.

Acceptance /Rejection Criteria: Specimens with corroded/ rough surface and improper weight and size will be rejected. The specimen with improper calibration graph will be rejected.

Safety Procedure: Activity to be carried out using safety gloves and apron

Work Procedure/Process Document: 9	DOCUMENT NO. MCD/ WP/09

TITLE: Specimen preparation for EBSD

PURPOSE: Texture analysis, strain analysis, phase quantification in metals and alloys.

DEFINITION AND SYMBOLS: Texture, strain. Phase quantification, Diffraction

SCOPE:

1) EBSD specimen preparation

PROCEDURE:

- Small specimens are mounted either in a cold setting resin or in a hot bakelite mould for metallography specimen preparation. .
- The specimen/ mould is then belt ground on coarse belt grinder with 80 or 120 grit and emereyed on a series of emery papers starting from 220/280/400/600/800 grit emery papers in a sequence.
- The final polishing is carried out by wet alumina and on a diamond paste of 0.5 or 1 micron size to obtain scratch free surface.
- The specimen after obtaining a scratch free surface is thoroughly cleaned with soap and thoroughly dried using hot air blower.
- Polish the specimen using vibration polishing unit to get a surface finish of less than 0.5 µm.
- Check the specimes under optical microscope for any scratches.

DOCUMENTATION: Indent file / Log book

Schedule: Activity to be completed within 30 days from date of allotment.

Quality Check (QC): Quality check of specimen includes the surface preparation condition of specimens after polishing.

Acceptance /Rejection Criteria: The specimens with scratch marks at any place/location in specimen at any stage of polishing will be rejected.

Safety Procedure: Specimen preparation to be carried out using safety gloves and apron

Work Procedure/Process Document: 10	DOCUMENT NO. MCD/ WP/10

TITLE: Non-Destructive In-situ Metallography

PURPOSE: Non-destructive evaluation of microstructure of large sized components/raw materials.

DEFINITIONS AND SYMBOLS: Metallography, microstructure, magnifications, grain boundary etc.

SCOPE: Non-Destructive in-situ metallography

PROCEDURE:

- The surface of the component where microstructure has to be evaluated is polished locally with portable grinder using 220/280/400/600/800 grit emery papers in the order mentioned respectively and with a finish polish of diamond paste of 0.5 or 1 micron size.
- The localized area is polished scratch free and etched with standard etchants (refer Metals Hand book Vol.9 Metallography for standard etchants).
- The polished and etched area is observed under portable optical microscope.
- For the purpose of recording, microstructure is replicated using replicating tape and replicating solution or the microstructure is recorded using the digital or eyepiece camera.
- The replica is subsequently observed under optical microscope for recording the microstructures.
- Preparation of reports.

REFERENCES: ASTM E1351-01

DOCUMENTATION/EXHIBITS: Indent File/ Log Register/ Analysis report

Schedule: Activity to be completed within 30 days from date of allotment.

Quality Check (QC): Quality check of specimen includes the surface preparation condition of specimens after polishing and etching.

Acceptance /Rejection Criteria: The specimens with scratch marks at any place/location in specimen at any stage of polishing will be rejected. Etched specimen with etch pits, over-etch/under-etch, water marks, non-uniform etching, will be rejected.

Safety Procedure: Specimen preparation to be carried out using safety gloves and apron.

Work Procedure/Process Document: 11	DOCUMENT NO. MCD/ WP/11

TITLE: Hot/Cold mounting of metallography specimens

PURPOSE: For the evaluation of microstructure of the material.

DEFINITIONS AND SYMBOLS: Metallography, Microstructure

SCOPE: Hot/cold mounting of metallography specimens

PROCEDURE:

- Cold setting resin and liquid are mixed in a specific proportion for cold mounting of specimens. After keeping the specimens in the mould, pour the mixed compound in the mould. Wait for 30 minutes for curing.
- Opaque/transparent Bakelite powder is used for hot mounting of specimens. After keeping the specimens on the holder put sufficient Bakelite powder on it and set the pressure, temperature and time. Wait for 30 minutes approximately for mould setting.
- The prepared cold/hot mount can be used for metallographic polishing.

DOCUMENTATION/EXHIBITS: Log Register

Schedule: Activity to be completed within 30 days from date of allotment.

Quality Check (QC): Quality check of specimen includes the proper placement of specimen in mount. Proper identification of specimens in mount.

Acceptance /Rejection Criteria: The specimens mounted without proper identification will be rejected.

Safety Procedure: Specimen preparation to be carried out using safety gloves and apron

Work Procedure/Process Document: 12	DOCUMENT NO. MCD/ WP/12

TITLE: Precision cutting of metallography specimens

PURPOSE: For metallography

DEFINITIONS AND SYMBOLS: Metallography, Microstructure

SCOPE:

1) Precision cutting of metallography specimens

PROCEDURE:

- Oversized specimens have to cut into standard size for cold/hot mounting.
- Cutting can be done using low speed or high speed cutting machines using abrasive or diamond cutting wheels.
- Precision cutting can be done using diamond wire saw.
- The prepared specimens can be used for cold/hot mounting or can be used for SEM/EBSD analysis.

DOCUMENTATION/EXHIBITS: Log Register

Schedule: Activity to be completed within 30 days from date of allotment.

Quality Check (QC): Quality check of specimen includes the cutting at marked locations, straightness of cutting.

Acceptance /Rejection Criteria: The specimens with improper cutting and slanted cutting will be rejected.

Safety Procedure: Specimen preparation to be carried out using safety gloves and apron

Work Procedure/Process Document: 13	DOCUMENT NO. MTD/ WP/13

TITLE: Mechanical testing of Aerospace materials using Elecro-Mechanical UTM

PURPOSE OF TEST: To evaluate the mechanical (Tensile, compression, Flexural, Shear, Lap shear) properties of Aerospace materials.

DEFINITION: As per the relevant ASTM standards

SCOPE: Determination of mechanical properties of Aerospace materials.

SCHEDULE: 30 days per test

PROCEDURE:

- Physically verify the supplied samples are as per standard. Check the dimensional inspection report for any deviation.
- Select the UTM and ensure proper load cell and Extensometer selected and connected to the respective ports and AC must be switched on in the room.
- Select proper test fixture/grip based on the given test specimens. Switch on UTM controller and PC. Wait for some time to establish connection between machine and PC.
- Open the main software and application software enter the request and specimen details.
- Mount the specimen as per relevant ASTM standard.
- While mounting the specimen, ensure specimen protection is enabled.
- Ensure load limit and extension limit are enables in the test program.
- Ensure test speed and specimen dimensions are entered in the test program and start the test.
- Enter all the test details in the log book.
- Prepare the report for verification and approval.
- Once the entire tests were completed, close the test software and switch off the controller and PC. Clean the machine work place and surroundings.

QUALITY CHECK:

- Physical verification of tested specimens.
- Verify the test results such as test curves, Modulus, offset, strength parameters and ductility parameters.
- Check the enter values for validity checking.

SAFETY:

- Before starting the test, ensure appropriate load limit, position limit and extensometer limits are enables in the test software.
- If any malfunction noticed during test, immediately press emergency button and inform to the supervisor.
- Wear the personnel protection equipment's like, gloves, safety shoe, etc.
- Restrict others.

ACCEPTANCE /REJECTION CRITERIA:

1. Accept if all the steps are followed as per the relevant ASTM standard.
2. Reject if any deviation in the procedure as per the relevant ASTM standard.

REFERENCES:

1. ASTM E 8, Standard test method for tension testing of metallic materials, Annual book of ASTM standards, Vol. 3.01.

2. ASTM E 9, Standard test method for compression testing of metallic materials, Annual book of ASTM standards, Vol. 3.01.

3. ASTM C 1161, Standard test method for flexural testing of advanced ceramic materials, Annual book of ASTM standards, Vol. 3.01.

4. ASTM B565, Standard test method for Shear testing of materials, Annual book of ASTM standards, Vol. 3.01.

5. ASTM D1002, Standard test method for Lap shear testing of adhesive sealant, Annual book of ASTM standards, Vol. 3.01.

DOCUMENTATION: Job request file/ Test machine log book / Results file / Computer storage.

Work Procedure/Process Document: 14	DOCUMENT NO. MTD/ WP/14

TITLE: Structural load testing of Aerospace components.

PURPOSE OF TEST: To do structural load testing of Aerospace components based on the test requirement.

DEFINITION: As per the test procédure provided by the end user.

SCOPE: Structural load testing of Aerospace components.

SCHEDULE: 30 days per test

PROCEDURE:

- Physically verify the supplied components and check the dimensional inspection report for any deviation.
- Select the UTM and ensure proper load cell and Extensometer selected and connected to the respective ports and AC must be switched on in the room.
- Select proper test fixture/grip based on the given test specimens. Switch on UTM controller and PC. Wait for some time to establish connection between machine and PC.
- Ensure proper interfacing of components with UTM
- Open the main software and application software enter the request and specimen details.
- Mount the component as per the test requirement.
- While mounting, ensure specimen protection is enabled.
- Ensure load limit and extension limit are enables in the test program.
- Ensure test speed and specimen dimensions are entered in the test program and start the test.
- Enter all the test details in the log book.
- Prepare the report for verification and approval.
- Once the entire tests were completed, close the test software and switch off the controller and PC. Clean the machine work place and surroundings.

QUALITY CHECK:

- Physical verification of tested components.
- Verify the test results such as alignment, test curves, test data and load values.
- Check the enter values for validity checking.

SAFETY:

- Before starting the test, ensure appropriate load limit, position limit and extensometer limits are enables in the test software.
- If any malfunction noticed during test, immediately press emergency button and inform to the supervisor.
- Wear the personnel protection equipment's like, gloves, safety shoe, etc.
- Ensure proper shielding test space and restrict others.

ACCEPTANCE /REJECTION CRITERIA:

1. Accept if the test requirements are meeting as per the end user.
2. Reject/repeat based on the feedback by end user.

REFERENCES:

Test procedure/document provided by the end user.

DOCUMENTATION: Job request file/ Test machine log book / Results file / Computer storage.

Work Procedure/Process Document: 15	DOCUMENT NO. MTD/ WP/15

TITLE: High temperature mechanical testing of Aerospace materials.

PURPOSE OF TEST: To evaluate High temperature mechanical (Tensile, compression, Flexural, short terms creep) properties of Aerospace materials.

DEFINITION: As per the relevant ASTM standards

SCOPE: Determination of High temperature mechanical properties of Aerospace materials.

SCHEDULE: 30 days per test

PROCEDURE:

- Physically verify the supplied samples are as per standard. Check the dimensional inspection report for any deviation.
- Select the test Furnace and ensure proper load cell and Extensometer selected and connected to the respective ports and AC must be switched on in the room.
- Select proper test fixture/grip based on the test requirement. Switch on UTM controller and PC. Wait for some time to establish connection between machine and PC.
- Open the main software and application software enter the request and specimen details.
- Mount the specimen and attach thermocouple with the specimen.
- Ensure the alignment of extensometer before start of the test and detach the extensometer.
- While mounting the specimen, ensure specimen protection is enabled.
- Ensure load limit and extension limit are enables in the test program.
- Ensure test speed, test temperature & duration and specimen dimensions are entered in the test program and start the test.
- Attach the extensometer before start of the test and detach the extensometer after reaching the set strain.
- Once test is completed, switch off the furnace.
- Enter all the test details in the log book.
- Prepare the report for verification and approval.
- Once the entire tests were completed, close the test software and switch off the controller and PC. Clean the machine work place and surroundings.

QUALITY CHECK:

- Physical verification of tested specimens.
- Verify the test results such as test curves, Modulus, offset, strength parameters and ductility parameters.
- Check the enter values for validity checking.

SAFETY:

- Before starting the test, ensure appropriate load limit, position limit and extensometer limits are enables in the test software.
- If any malfunction noticed during test, immediately press emergency button and inform to the supervisor.
- Ensure chiller unit function during the test.
- Wear the personnel protection equipment's like, gloves, safety shoe, goggles etc.
- Ensure furnace should not open at high temperature.

ACCEPTANCE /REJECTION CRITERIA:

1. Accept if all the steps are followed as per the relevant ASTM standard.
2. Reject if any deviation in the procedure as per the relevant ASTM standard.

REFERENCES:

1. ASTM E 21, Standard test method for elevated temperature tension testing of metallic materials, Annual book of ASTM standards, Vol. 3.01.

2. ASTM E 139, Standard test method for creep, creep-rupture and stress-rupture testing of metallic materials, Annual book of ASTM standards, Vol. 3.01.

DOCUMENTATION: Job request file/ Test machine log book / Results file / Computer storage.

Work Procedure/Process Document: 16	DOCUMENT NO. MTD/ WP/16

TITLE: Plane strain fracture toughness (K_{Ic}) of metallic materials

PURPOSE OF TEST: To evaluate the plane strain fracture toughness (K_{Ic}) of metallic materials.

DEFINITION: As per ASTM E399 and ASTM B645

SCOPE: Determination of the plane strain fracture toughness (K_{Ic}) of metallic materials by tests using a variety of pre-cracked specimens.

SCHEDULE: within 30 days after clearing for testing

PROCEDURE:

- Physically verify the supplied samples are as per standard. Check the dimensional inspection report for any deviation.
- Select the UTM and ensure proper load cell and COD gauges selected and connected to the respective ports and AC must be switched on in the room.
- Select proper test fixture (clevis) based on the given test specimens. Switch on UPS power, UTM controller and PC. Wait for some time to establish connection between machine and PC.
- Switch on the chiller unit and hydraulic power pack.
- Open the main software and application software enter the request and specimen details.
- Mount the specimen and do the fatigue precracking and followed by crack opening as per ASTM E399 and ASTM B645. Write the log book entry.
- Mark the lines with height gauge on broken specimen on both side.
- Measure the crack length with microscope and record it.
- Check the validity and prepare the report for verification and approval.
- Once the entire tests were completed, close the application software and main software, switch off the controller, hydraulic power pack, chiller unit and PC. Clean the machine work place and surroundings.

QUALITY CHECK:

- Verify the deviation if any on load vs COD curve of tested specimen.
- Physically verification of tested specimens.
- Check the enter values for validity checking.

SAFETY:

- Before starting the test, ensure appropriate load limit, position limit and COD limits must be provided in the software.
- If any malfunction noticed during test, immediately press emergency button and inform to the supervisor.
- Wear the personnel protection equipments like, safety shoe, etc.

ACCEPTANCE /REJECTION CRITERIA:

1. Accept if all the steps as per ASTM E399 and ASTM E645.
2. Reject if any deviation in the procedure as per ASTM E399 and ASTM E645.

REFERENCES:

1. ASTM E 399, Standard test method for plane strain fracture toughness of metallic materials, Annual book of ASTM standards, Vol. 3.01.
2. ASTM E 645, B645 Practice for Linear-Elastic Plane–Strain Fracture Toughness Testing of Aluminum Alloys, Annual book of ASTM standards, Vol. 3.01.

DOCUMENTATION: Job request file/ Test machine log book / Results file / Computer storage.

Work Procedure/Process Document: 17	DOCUMENT NO. MTD/ WP/17

TITLE: Fracture toughness (J_{Ic}) of metallic materials

PURPOSE OF TEST: To determine the fracture toughness (K, J, and CTOD (δ)) of metallic materials in the opening mode (Mode-I) of loading for metallic materials.

DEFINITION: As per ASTM E1820

SCOPE: Determination of fracture toughness in terms of K, J, and CTOD (δ) for metallic material. Toughness can be measured in the R-curve format or as a point value.

SCHEDULE: Activity to be completed within 30 days from date of allotment.

PROCEDURE:

- Physically verify the supplied samples are as per standard. Check the dimensional inspection report for deviation if any.
- Select the UTM and ensure proper load cell and COD gauges selected. They connected to the respective ports. AC must be switched on in the room.
- Select proper test fixture (clevis) based on the given test specimens. Switch on UPS power, UTM controller and PC. Wait for some time to establish connection between machine and PC.
- Switch on the chiller unit and hydraulic power pack.
- Open the main software and application software enter the request and specimen details.
- Mount the specimen and do the fatigue precracking and followed by crack opening as per ASTM E1820. Write the log book entry.
- Mark the lines with height gauge on broken specimen on both side.
- Measure the crack length with microscope and record it.
- Check the validity and prepare the report for verification and approval.

- Once the entire tests were completed, close the application software and main software, switch off the controller, hydraulic power pack, chiller unit and PC. Clean the work place and surroundings of the machine.

QUALITY CHECK:

- Verify the deviation if any on load vs COD curve and J vs crack extension of tested specimen.
- Physical verification of tested specimens.
- Check the enter values for validity checking.

SAFETY:

- Before starting the test, ensure appropriate load limit, position limit and COD limits must be provided in the software.
- If any malfunction noticed during test, immediately press emergency button and inform to the supervisor.
- Wear the personnel protection equipments like, safety shoe, etc.

ACCEPTANCE /REJECTION CRITERIA:

1. Accept if all the steps as per ASTM E1820.
2. Reject if any deviation in the specimen and test procedure as per ASTM E1820.

REFERENCES:

1. ASTM E 1820, Standard test method for measurement of fracture toughness. Annual Book of ASTM standards, Vol. 3.01.

DOCUMENTATION: Job request file/ Test machine log book / Results file / Computer storage.

Work Procedure/Process Document: 18	DOCUMENT NO. MTD/ WP/18

TITLE: Instrumented Charpy Impact Testing of metallic materials

PURPOSE: To evaluate Impact Strength of metallic materials at RT & 77K. Characteristic force, displacement, energy data will also be obtained from the test. Above data will be utilized to characterize and compare metallic materials for engineering use, ascertaining ductile to brittle transition and to understand fracture process.

SCOPE: Metallic materials of standard, sub-size or miniature Charpy configurations can be tested in this machine (300J capacity) at RT & 77K temperature through advanced instrumentation. Initial velocity of impact can be varied by changing angle of pendulum. Capacity of machine can be raised to 450J.

PROCEDURE:

1. Machine Set-up: Load and energy estimation is done for the specimen and accordingly proper tup and hammer is mounted. For miniaturized specimens, pendulum shall be fitted at a lower angle. As per specimen dimensions, anvil and supports shall be mounted on Charpy fixture.
2. For 77K test, specimens are pre-conditioned in by LN2 dipping for 20 minutes
3. Test program template is selected from given list and configured. Specimen dimension etc. shall be entered into appropriate input boxes from machine log-book. Specimen shall be positioned in machine fixture with tongs and safety door shall be closed before test.
4. Actual test shall be performed by manual pressing of buttons on control panel. Detailed test method is as per ASTM E2298 and E2248 (for miniaturized specimens)
5. Data Acquisition: Automatic by machine. Energy Calculation: By software. Data Plotting: by testEXPERT software

6. Post processing of data shall be done after data and plot analysis. Result available from machine shall be saved and print-out to be taken.
7. Strength calculation shall be made manually. Report typing shall be done after verification. Test report will be released after verification and approval.

REFERENCES: ASTM E23, ASTM E2298, ASTM E2248, Machine Operating Manual

DOCUMENTATION/ EXHIBITS: Log Book, Indent Register, AMC Records

Schedule: Test report shall be released within 15 days from date of allotment for normal indents; for urgent indents, within 7 days.

Quality Check (QC): Proper placement of specimen in machine fixture, optical assessment of broken specimen

Acceptance /Rejection Criteria: Against improper test method followed by operator and operator's negligence

Safety Procedure: Apron, gloves and goggles shall be used for 77K testing. Safety door shall be in closed and in a locked condition during testing. Tongs shall be used for positioning specimen.

Work Procedure/Process Document: 19	DOCUMENT NO. MTD/ WP/19

TITLE: Vicker's, Brinell, Rockwell Hardness Testing of metallic materials

PURPOSE: To determine the Vickers, Brinell, Rockwell hardness of metallic materials

SCOPE: For metallic materials. Hardness verification of standard blocks is excluded

PROCEDURE:

1. Test Set-up: Load, indenter, number of indentations, indentation locations on specimen shall be decided / estimated. Specimen flatness and surface finish shall be examined for suitability of test.
2. Proper indenter shall be fitted to machine. Suitable program shall be selected from available list or to be programmed.
3. Item shall be properly mounted based on desired location. Proper fixture/adaptor shall be chosen / fitted as per size and geometry of specimen/product.
4. Actual test shall be performed. Details of test method are available in respective test standards. Indentation size shall be correctly measured / read from dial and recoded. Results shall be recorded in log-book.
5. Report typing shall be done after result verification. Test report will be released after verification and approval.

REFERENCES: ASTM E6, ASTM E10, ASTM E18

DOCUMENTATION/ EXHIBITS: Log Book, Indent Register, AMC Records

Schedule: Test report shall be released within 30 days from date of allotment

Quality Check (QC): Symmetrical shape of indentations for Vicker's and Brinell Test.

Acceptance /Rejection Criteria: Against improper test method followed by operator and operator's negligence

Safety Procedure: Hand gloves and safety shoe shall be used

Work Procedure/Process Document: 20	DOCUMENT NO. QCM/ WP/20

Work Procedure/Process document for mechanical testing of materials and fasteners in QCM Lab

PURPOSE: For carrying out mechanical testing of materials and fasteners.

PROCEDURE:

- Receive the specimens and update the Job movement register and job movement excel log book with sequential MTF Nos.
- Carry out the preparations as required depending on the type of tests on the samples like measurement, marking, cutting, grinding / polishing, visual inspection etc.
- If specimens are acceptable, proceed for testing. Else, return the specimen to the originator for necessary correction /replacement
- Enter all the details of the specimens against relevant MTF No. in test logbook.
- Select appropriate machine and fixtures depending on the type of testing
- Ensure machines / instruments are calibrated
- Switch on machine power, UPS / Stabilizer / PC etc.
- Open the test software and select the appropriate test method
- Save it using 'save as' as a separate file with new MTF number.
- Enter specimen data and test details. All parameters shall be as per relevant international test standards given against each test under details of tests.
- Select appropriate fixtures & hold the specimen/job properly in the grips/ fixtures.
- Start the test and wait for the test to finish, remove the specimen
- Take all measurements as applicable on specimen.
- Verify the test results in accordance with specification requirements. Deviations, if any, in test results shall be discussed with VSSC engineers before proceeding further.
- Save the data and repeat the procedure for all the specimens in the MTF no.
- Log the data with specimen details in the logbook for all specimens
- Once all the specimens are finished, save the file and close the software & computer; switch off machine panel, stabilizer / UPS & main supply.
- Enter status of test in job movement register and excel file
- Prepare the test report and get approval from VSSC engineers.

REFERENCES: ASTM E8, E9, E10, E18, E92, F606, MIL-STD-1312-5, 20, ISO 7481

DOCUMENTATION/ EXHIBITS:

Job Movement register, Job movement excel file, Test Log Book, Test report.

Schedule:

Activity to be completed **within 30 days** from date of allotment.

Quality Check (QC):

Quality check of specimen includes the receipt inspection for sample surface condition, identification and dimensions. After the test, test results shall be as per standard requirements. There shall be no deviation in test procedure which may lead to wrong results.

Acceptance / Rejection Criteria:

- All tests with valid test results without any damage to sample due to error in testing will be considered as acceptable. Some of the examples of unacceptable test results are misalignment of samples, improper setting in machine, improper handling of the specimens etc.

- There shall be no deviation in test procedure which may lead to wrong results.

Safety Procedure:

1. Proper safety shield shall be used in machines for preventing hits from debris.
2. All fasteners shall be tested with proper enclosures to prevent broken samples from falling and causing damage.
3. Emergency switch available in all machines shall be used in case of emergency.
4. Proper PPEs like gloves, safety shoes, goggles shall be used during testing and sample preparation activities.

Work Procedure/Process Document: 21	DOCUMENT NO. SMF/ WP/21

TITLE: Powder milling for hot pressing.

PURPOSE: For proper mixing & mechanical alloying.

DEFINITIONS AND SYMBOLS: Powders, milling

SCOPE:

1. Milling of powders for hot pressing

PROCEDURE:

- Clean the milling jars and balls with water followed by Iso Propyl Alcohol (IPA).
- Dry the jars properly and make sure there is no traces of water/IPA.
- Add the powder in jars and tighten the jars.
- Set the program for the duration of milling as per the job request and run the program in the equipment.

DOCUMENTATION/ EXHIBITS: Log Book, Status Book, Indent File/ Analysis report.

Schedule: Activity to be completed within 30 days from date of allotment.

Quality Check (QC): Quality check includes the verification of test certificates of powders.

Acceptance /Rejection Criteria:

1. The powders with contamination and insufficient time of milling will be rejected.

Safety Procedure: The powder milling operation to be carried out using safety gloves and masks.

Work Procedure/Process Document: 22	DOCUMENT NO. SMF/ WP/22

TITLE: Sample Preparation for Hot Pressing/Diffusion bonding

PURPOSE: Sample Preparation

DEFINITIONS AND SYMBOLS: Samples, Hot pressing, Diffusion bonding

SCOPE: Sample preparation for Hot Pressing/Diffusion bonding

PROCEDURE:

- The sample is belt ground on coarse belt grinder with 80 or 120 grit and emereyed on a series of emery papers starting from 220/280/400/600/800 grit emery papers in a sequence.
- The specimen after obtaining a scratch free surface is thoroughly cleaned with soap and thoroughly dried.
- Measure the dimensions and weight of the samples.
- Carry out the assembly of samples for Diffusion bonding/hot pressing.

DOCUMENTATION/EXHIBITS: Log Book, Status Book, Indent File/ Analysis report.

Schedule: Activity to be completed within 30 days from date of allotment.

Quality Check (QC): Quality check of specimen includes the surface preparation condition of specimens after polishing.

Acceptance/Rejection Criteria:

1. The samples with scratch marks at any place/location in specimen at any stage of polishing will be rejected.

Safety Procedure: Sample preparation to be carried out using safety gloves and apron.

Work Procedure/Process Document: 23	DOCUMENT NO. SMF/ WP/23

TITLE: Powder compaction for hot pressing

PURPOSE: Powder compaction

DEFINITIONS AND SYMBOLS: Powder compaction, Hot pressing,

SCOPE: Powder compaction for Hot Pressing

PROCEDURE:

- Measure the weight of powders.
- Measure the dimensions of die and fixtures.
- Assemble the dies and fixtures and load the powders in the die.
- Measure the powder height.
- Place the full assembly in the press.
- Set the load as per the requirement in job request.
- Start applying the load and provide soaking time as per the job request.
- Release the load and remove the die assembly from the equipment.
- Measure the powder height after loading. Calculate the deformation and switch off the equipment.

DOCUMENTATION/EXHIBITS: Log Book, Status Book, Indent File/ Analysis report.

Schedule: Activity to be completed within 30 days from date of allotment.

Quality Check (QC): Quality check includes the verification of test certificates of powders and deformation.

Acceptance/Rejection Criteria:

1**.** The samples with scratch marks at any place/location in specimen at any stage of polishing will be rejected.

Safety Procedure: The powder compaction operation to be carried out using safety gloves and masks.

Work Procedure/Process Document: 24	DOCUMENT NO. SMF/ WP/24

TITLE: Sieving and Coating of powders for hot pressing

PURPOSE: Sieving and Coating of powders.

DEFINITIONS AND SYMBOLS: Sieving, Coating, Powders

SCOPE: Sieving and Coating of powders.

PROCEDURE:

- Measure the weight of powders.
- Load the powder in sieving machine and carry out the sieving as per mentioned duration in job request.
- After completion, remove the powder.
- With the powder, prepare the water based slurry.
- Coat the fixtures with slurry with brush.
- Dry the fixture and assemble for hot pressing.

DOCUMENTATION/ EXHIBITS: Log Book, Status Book, Indent File/ Analysis report.

Schedule: Activity to be completed within 30 days from date of allotment.

Quality Check (QC): Quality check includes the verification of test certificates of powders.

Acceptance /Rejection Criteria:

1. The coating should be free of cracks and any crack observed in coating will be rejected.
2. The size of sieved powders will be measured and if any variation from the desired size is observed, the powder will be rejected.

Safety Procedure: The powder sieving and coating operation to be carried out using safety gloves and masks.

Work Procedure/Process Document: 25	DOCUMENT NO. SMF/ WP/25

TITLE: Heat treatment of components using oven

PURPOSE: Heat treatment of components using oven

DEFINITIONS AND SYMBOLS: Heat treatment, Oven

SCOPE: Heat treatment of components.

PROCEDURE:

- Measure the dimensions of the components.
- Place the component in the chamber of Oven and close the chamber.
- Set the program in Oven as per the job request.
- Run the program and remove component after temperature is RT.
- Measure the dimensions of the components.
- Carry out visual inspection.

DOCUMENTATION/ EXHIBITS: Log Book, Status Book, Indent File/ Analysis report.

Schedule: Activity to be completed within 30 days from date of allotment.

Quality Check (QC): Quality check includes the verification of heat treatment cycle and any damage to component.

Acceptance /Rejection Criteria:

1. Any damage to component observed due to shoot up in temperature/mishandling will lead to rejection of component.

Safety Procedure: The heat treatment operation to be carried out using safety gloves and masks.

Work Procedure/Process Document: 26	DOCUMENT NO. SMF/ WP/26

TITLE: Weight, thickness & density measurement of samples

PURPOSE: Weight, thickness & density measurement

. **DEFINITIONS AND SYMBOLS**: Weight, thickness, density

SCOPE: Weight, thickness & density measurement of samples.

PROCEDURE:

- Switch on the digital weighing balance and set it to zero.
- Place the sample on weighing balance and note down the weight.
- Measure the dimensions of samples using Vernier calipers/ micrometer and note down the dimensions.
- Place the sample in density measurement equipment.
- Start the equipment and set the temperature to room temperature.
- Measure the weight in air and water. Note down the values.
- Press the density switch and note down the density value.
- Carry out visual inspection of sample.

DOCUMENTATION/ EXHIBITS: Log Book, Status Book, Indent File/ Analysis report.
Schedule: Activity to be completed within 30 days from date of allotment.
Quality Check (QC): Quality check includes the verification of calibration reports of equipments.
Acceptance /Rejection Criteria:
1. Any damage to sample observed due to mishandling will lead to rejection of component.
Safety Procedure: The Weight, thickness & density measurement of samples operations to be carried out using safety gloves and masks.

Annexure-4

Process Team (to be deployed by the Contractor to carry out the activities in GOCO mode).

Table - 13: Process Team (manpower) requirements.

Sl. No.	Category	Qty Nos.	Qualification, Experience & Nature of Work
1	Engineer	4	1) BE / B.Tech in Metallurgy/Mechanical Engg with one-year experience in related Material characterization : **1 No.** [for Technical activities related to Technical activities related to Transmission Electron Microscopy, Scanning Electron Microscopy Specimen Preparation and Analysis (Annexure-1, table 5, Sl no. 24 to 35)] 2) BE / B.Tech in Metallurgy / Mechanical Engg with one-year experience in related Material Testing : **1 No.** [for Technical activities related to Conducting fracture toughness testing, fatigue testing, guiding the technical issues relating to other mechanical testing, review of results, preparation of reports and maintenance of log books of mechanical testing (Annexure-1, table 6, Sl no. 46 to 60)]. 3) BE / B.Tech in Metallurgy / Mechanical Engg with one-year experience in related Material characterization/ testing/Material processing : **2 Nos.** [for Managing and monitoring the day-to-day activities under the Contract and carrying out the activities as per Annexure-1, table 5: Sl no. 1 to 23 & 36 to 45, table 7: Sl no. 61 to 85, table 8: Sl no. 86 to 91.]

2	Scientific Assistant/	3	1) B.Sc Physics with one-year experience in mentioned Material characterization activities: **3 Nos.** [For Technical activities related to Optical Microscopy Specimen Preparation and Analysis & Microhardness Analysis (Annexure-1, table 5, Sl no. 1 to 15)].
3	Technical Assistant	3	1) Diploma in Metallurgy/ Mechanical Engineering with one-year experience in mentioned Material characterization: **1 No.** [For Technical activities related to X-ray Diffraction Specimen Preparation and Analysis & Oxygen, Hydrogen, Nitrogen analysis (Annexure-1, table 5, Sl no. 16 to 23)]. 2) Diploma in Mechanical Engineering with one-year experience in mentioned Material Testing: **2 Nos.** [For Technical activities related to Preparation of specimens, Dimensional inspection of specimens, carrying out the mechanical tests, recording test log book, preparation of test reports, plotting of stress-strain curves. (Annexure-1, table 6, Sl no. 46 to 60)].
4	Technician	8	1) ITI Mechanical/Fitter with one-year experience in mentioned Material characterization activities:**1 No.** [For Technical activities related to Non-destructive in-situ metallography, EBSD specimen preparation, hot/cold mounting, specimen cutting, maintenance of equipments etc., (Annexure-1, Table 5, Sl No.36-45)] 2) ITI Fitter with one-year experience in Mechanical Testing: **1 No.** [For Technical activities related to Preparation of specimens, making test set-up, carrying out the

			mechanical tests, recording test log book, preparation of test reports, cleaning and upkeeping the test machines. Mounting and un-mounting of hydraulic grips, test fixtures, component assembly, specimen policing, test results filing, etc. (Annexure-1, Table 6, Sl No.46-60)] 3) ITI Mechanical trade with one-year experience in Mechanical testing: **3 Nos.** [For Technical activities related to Preparation of specimens, carrying out the mechanical tests of materials and fasteners, Updating job movement register and database management, preparation of test reports and work scheduling (Annexure-1, Table 7, Sl No.61-85)] 4) ITI Mechanical trade with one year experience in operation of ovens/polishing machine/cutting machines/ball mills: **3 Nos.** [For Technical activities related to Mixing/Milling of Powders for hot pressing, sample preparation for hot pressing/diffusion bonding, powder compaction for hot pressing, sieving and coating of powders for hot pressing, heat treatment of components using oven, weight, thickness & density measurement of samples (Annexure-1, Table 8, Sl No.86-91)]

Annexure 5

Price Variation Formula as per GFR 2017

APPENDIX-11

$$P1 = P0 \left[F + a \left[\frac{M1}{M0} \right] + b \left[\frac{L1}{L0} \right] \right] - P0$$

P1: Adjustment amount payable to the supplier (a minus figure will indicate a reduction in the contract price)

P0: is the contract price at the base level

F: is the fixed element not subject to price variation

a: is the assigned percentage to the material element in the contract price

b: is the assigned percentage to the labour element in the contract price

L0 & L1 are the wage indices at the base month & year and at the month and year of calculation respectively

M0 & M1 are the material indices at the base month and year and at the month and year of calculation respectively

In this case, F = 0, a = 0, b = 1

Base month: Month of release of PO / commencement of activity whichever is later

Note: The price variation will be applicable, if the resultant change is higher or lower than 2 % of previous unit price (from base for third year and from third year for fourth year).