Government of India  
Bhabha Atomic Research Centre  
Electromagnetic Applications & Instrumentation Division  

Ref : BARC/EmA&ID/KS/2021/61861  
Date : 28.04.2021  

Sub : Minor fabrication job of “Fabrication, machining and qualification of high conductivity copper and aluminium sheets for thermal contacts”  

Dear Sirs,  

1. Quotations are invited for the minor fabrication job of “Fabrication, assembly and qualification of thermal shield assembly for vacuum vessel for magnet test facility specifications TSP/KS/2021/30.  
2. Bidder shall quote for the machining and fabrication along with raw materials involved in the technical specification. Taxes shall be quoted separately.  
3. The quotation must reach Head, EmA&ID by due date 11.05.2021 and must be sent in a sealed envelope super scribed with the reference number & the due date given above.  
4. The address on the envelop should read:  
   Head,  
   Electromagnetic Applications & Instrumentation Division,  
   RCnD Building  
   BARC, Trombay,  
   Mumbai - 400 085.  
   (Kind Attn: Smt Kumud Singh)  
5. Any modification required during the fabrication process shall be made after approval from our engineer.  
6. The bidder shall complete the same within 15 weeks from the date of firm work order issued to the bidder.  
7. Head, EmA&ID reserves the rights to accept / reject any or all quotations without assigning any reason.  
8. Delivery charges if any must be clearly mentioned in the offer.  
9. Quotation must also indicate the validity of offer.  
10. Quotation should be submitted on printed format along with PAN, GSTIN. Computer generated format and without PAN & GSTIN, the quotation will be rejected.  

Encl.:  
   01) Technical specification : TSP/KS/2021/30  

Kumud Singh,  
SO(F), EmA&ID
Technical Specifications for minor fabrication job of “Fabrication, machining, annealing and qualification of high conductivity copper and aluminium sheets for thermal contacts”

<table>
<thead>
<tr>
<th>Specification no.</th>
<th>Revision no.</th>
<th>Date of Issue</th>
<th>Total Number of pages</th>
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<td>TSP/KS/2020/30</td>
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<td>28.04.2021</td>
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</table>

1.0 INTRODUCTION

OFE-Cryogenic grade copper plates/sheets and Al-5N purity sheets are required with RRR (Residual-resistivity ratio) of 250 – 450. These plates shall be machined and finished as per specifications stated below.

2.0 SCOPE OF SUPPLY

The successful bidder shall deliver the “Fabrication, machining, annealing and qualification of high conductivity copper and aluminium sheets for thermal contacts” and all relevant documentation as defined in this technical specification.

2.1 Supplier’s Responsibility:
Following shall fall under scope of fabrication and machining
(a) A complete manufacturing file, containing detailed information about the design, the production and quality control;
(b) The procurement of raw materials and subcomponents as per para 4.0
(c) The design and construction of all necessary tooling for the manufacture, assembly, and qualification.
(d) Jigs and fixture for machining and fabrication.
(e) Factory acceptance tests on the as per para 7.1;
(f) The Quality Control Records (QCR), Inspection and test plans records (ITP) as per para 5.1;

2.1 Deliverables included in the supply:

<table>
<thead>
<tr>
<th>Sr. No</th>
<th>Job description</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Cu 5N Purity Sheets. 0.04” x 12&quot; wide x 48” long</td>
<td>30 No.s</td>
</tr>
<tr>
<td>2.</td>
<td>Al 5N Purity Sheets. 1 mm x 400 mm wide x 1000 mm long</td>
<td>400 No.s</td>
</tr>
</tbody>
</table>

2.2 Free Issue material
No free issue material is involved. Raw material shall be arranged by the supplier.
3.0 TECHNICAL REQUIREMENTS

3.1 Technical specification
Fabrication and Supply
a) Fabrication, testing, supply of plates as per specifications and safe delivery to Purchaser’s site.
b) Geometrical inspection and qualification.
c) Electrical and thermal conductivity qualification on sample plates.
c) Transportation and safe delivery to purchaser’s site including protection for all machined and sealing surfaces to mitigate any damage during transportation.

4.0 RAW MATERIALS

4.1 High purity copper plates
Chemical Composition:
- Copper (inclusive of silver) min % Min 99.995# (copper purity 4N or higher)
- Oxygen (max %) Max 0.0010

# Copper will determined by the difference of total impurities from 100

Physical Properties:
- Density (nominal) 8.94 g/cm3
- Specific heat [J/(kg.K)] 385
- Melting temperature 1083

Electrical and thermal Properties
- Electrical Conductivity @200C %IACS ≥ 100%
- Thermal Conductivity @200C %IACS ≥ 391 W/m-K

High purity Aluminium sheets:
Mechanical Properties
Property Value
- Proof Stress 85 Min MPa
- Tensile Strength 105 - 145 MPa
- Hardness Brinell 34 HB
- Elongation A 12 Min %

Property Value
- Density 2.71 kg/m3
- Melting Point 650°C
- Modulus of Elasticity 71 GPa
- Electrical Resistivity 0.282 x 10-6 Ω.m
- Thermal Conductivity 222 W/m.K
- Thermal Expansion 24 x 10-6/K
5.0 PERFORMANCE OF THE CONTRACT

5.1 Fabrication and Delivery Schedule
Delivery of all five Helium vessels is expected in **about fifteen (15) weeks after the contract is awarded**. Container and packaging design is subject to review and approval by Purchaser, but approval shall not relieve Manufacturer of any responsibility for damage to the assemblies during transit due to improper packaging or handling.

5.2 Manufacturing Plan
The Subcontractor shall submit a manufacturing plan to the purchaser for approval. The plan shall identify and describe all aspects of work to be executed from the point of design work through delivery of the plates.
In cases where the Subcontractor modifies the design and/or develops its own tooling, an approval of the purchaser would be necessary to proceed to the next step of the manufacturing phase.

The Purchaser must accept the Manufacturing Plan prior to use. Sections of the Manufacturing Plan may be submitted earlier for acceptance. This will allow the Subcontractor to commence some fabrication tasks earlier.

5.3 Progress Report
The Subcontractor shall submit a monthly progress report to the purchase representative. The progress report shall be submitted within the 15th day of the month following the one for which progress is reported.

5.4 Quality Assurance Plan
The Subcontractor shall submit a Quality Assurance (QA) Plan to the Purchaser for approval before the fabrication process starts. The plan shall ensure that each item offered for acceptance conforms to the requirements herein. As a minimum requirement the QA plan shall include:
- Description of manufacturing traceability.
- Proposed layout of Travelers. Details of each step of the fabrication process must be well described in a traveler-type document, which must be made available to the Purchaser before the fabrication starts.
- QA plan must include methods for inspection and dimensional control of mechanical parts and subassemblies including description of the measuring equipment, sequence and frequency of inspection, methods for defect/flaw determination, criteria for rejection of parts including corrective action and plan for record keeping.
- QA plan must include a description of the welding equipment and welding procedures for each weld joint.
- QA document must include Non-Conformance reporting. Discrepancies shall be reported in the Subcontractor's Non-Conformance Reports and submitted to the Purchaser for acceptance. Work shall be placed on hold until the corrective action has been accepted by the Purchaser.

5.5 Identification marking
The Subcontractor shall transfer identification information and alignment information according to the method of labelling and referencing developed by the Subcontractor.
and accepted by the Purchaser. Each vessel assembly is to be given a unique serial number and labelled according to the corresponding assembly drawing. The identification marking shall be legible, and shall be applied by engraving on the outside of the vessel flange. The marking shall have no deleterious effect upon the lens intended performance and shall not deteriorate in the cryogenic environment.

6.0 INSPECTION BY THE PURCHASER

6.1 Hold points
In addition to any hold points identified by the Subcontractor in the normal course of QC, Test, or Fabrication operations, the Purchaser may specify in the subcontract hold points in the processing and fabrication of the finished product covered by this Specification. The purpose of all hold points shall be to determine conformance of products to the requirements of this Specification before continuation of further processing and/or fabrication. The Purchaser may elect to witness and sign off any mandatory hold points.

6.2 Purchaser right to inspection
- The Purchaser reserves the right to have its designated representative witness, at the place of manufacture, processing/fabrication operations agreed upon by the Purchaser and Subcontractor and specified in the Subcontract.
- The Purchaser reserves the right to have its designated representative witness, at the place of manufacture, the inspections, analyses, and tests established under the Subcontractor's QA Program to demonstrate compliance with the Specification.
- The intent of the Purchaser in witnessing inspections, tests, and/or processing/fabrication operations is to gain confidence that developed helium vessel meet all the requirements.

6.3 Corrective action
In the event that any lens assembly or a portion thereof is rejected by the Purchaser as a result of poor workmanship or nonconformance to this Scope of Work, the Subcontractor shall take corrective action on the material or process, or both as necessary, on all items or portions thereof which were similarly manufactured which are subject to the same cause for rejection. Acceptance shall be withheld until inspections and tests have shown that the corrective action was successfully implemented and the solenoid or any portion thereof conforms to the requirements of this Specification.

7.0 CONFORMANCE TESTS

7.1 Responsibility for testing and inspection
The Subcontractor shall be responsible for performing all required inspections, analyses, and tests designated as factory acceptance tests herein. The Subcontractor shall provide space, personnel, and test equipment to meet all inspection requirements. All testing and inspection shall be performed at the Subcontractor's facilities, or at the facilities of a mutually acceptable Designated Test Agency (including Purchaser's site). The Subcontractor shall notify the Purchaser 15 calendar days in advance of scheduled
commencement of any tests and inspections required by this Scope of Work to allow the Purchaser to arrange for witnessing the inspection, if elected. Results of inspections, analyses, and tests performed by the Subcontractor shall be reported in the Traveler. Inspections specified herein are not intended to supplant any controls, examinations, inspections, or tests that the Subcontractor shall perform to assure the quality of the final product.

Purchasers are responsible for performing site acceptance tests and communicate to the supplier of any modification required in series vessel assembly. The conformance tests required to be performed are as stated below:

<table>
<thead>
<tr>
<th>Sr. no</th>
<th>Qualification</th>
<th>Acceptance criteria</th>
<th>Scope</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Visual inspection</td>
<td>Visual signs of damage, deterioration and oxidation shall not be present on any component of the assembly,</td>
<td>Purchaser Representative shall inspect the vessel assembly at suppliers premises</td>
</tr>
<tr>
<td>2.</td>
<td>Electrical Qualification</td>
<td>Supplier/fabricator shall measure electrical conductivity of the sample coupons</td>
<td>Purchaser Representative shall inspect the vessel assembly at suppliers premises</td>
</tr>
<tr>
<td>3.</td>
<td>Thermal conductivity</td>
<td>Supplier/fabricator shall measure thermal conductivity of the sample coupons</td>
<td>Supplier shall carry out these inspection tests and a report shall be given for approval. Purchaser reserves the right to be present during these tests.</td>
</tr>
<tr>
<td>4.</td>
<td>Geometrical inspection</td>
<td>Parts and final assemblies shall be measured by coordinate measuring machine (CMM) to check the geometrical properties of the objects and their adherence to released drawings</td>
<td>Supplier shall carry out these inspection tests and a report shall be given for approval. Purchaser reserves the right to be present during these tests.</td>
</tr>
</tbody>
</table>
7.2 **Test Certificates**
Supplier shall carry out and arrange for the following test certificates for the raw materials:

<table>
<thead>
<tr>
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<th>Test Certificate</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Mill test certificate - Mill test certificate containing heat no., batch no., chemical composition, size etc.</td>
</tr>
<tr>
<td>2.</td>
<td>Mechanical test certificate - Mechanical and other physical properties of the plates &amp; sheets shall conform to the requirements</td>
</tr>
<tr>
<td>3.</td>
<td>Chemical test certificate - Chemical composition shall be as per specifications. The chemical composition shall be recorded separately for each thickness of material.</td>
</tr>
<tr>
<td>4.</td>
<td>Dimensional inspection report - Dimensional inspection report containing drawing dimension, measured dimension, deviation if any, within tolerance limit or not, rectification needed etc</td>
</tr>
</tbody>
</table>

8.0 **GENERAL DESCRIPTION**

- Supplier shall quote with material; no free issue material is involved in this tender.
- Overall cost will be compared and include packaging, forwarding and safe delivery to BARC at RCZ stores.
- Suppliers shall give complete details of their product, facilities, winding machine details, list of users and compliance certificates form users for technical evaluation. Quotations submitted with incomplete details are viable for rejection. A technical committee will visit the facilities.
- Vendors with test facilities for qualification of welding (radiography tests on test specimen), leak test, Pressure testing and basic metrology equipment’s for dimensional checks will be given preference. In case vendor plans of subcontracting the job, same shall be clearly brought out in quotations. The subcontracting can only be carried out only after prior permission of the purchaser. In all circumstances the responsibility of completion of job up to the satisfaction of the purchaser lies with the supplier. Vendors shall list down the details of qualification checks performed on the fabricated parts by self or in collaboration with other laboratories.
- Supplier Qualification: (Requirements of Supplier Qualifications)
  - **Human resources**
  - The supplier must give the details of qualified human resources including draughtsmen, welding technicians, Quality control personnel.
  - **Infrastructure:**
  - The supplier must give the details of infrastructure suitable for this job such as Floor Space availability, welding equipment’s, leak check and pressure testing equipment’s etc.
  - **Past experience:**
  - The supplier must give their past three year turnover and similar jobs executed by them with reference, volume of work and completion schedule, present commitments and anticipated commitments inside and outside India. Vendors who have in past executed similar projects for similar applications will be given preference. Vendors should have in past
executed, should have knowledge about superconducting magnets and cryogenic materials.

- **Sub-contractors:**
  - Supplier should list the jobs, which they want to sub-contract. They should also produce the list of sub-contractors and their infrastructures and facilities.