
	Manufacturing, testing and supply of vacuum vessels for HNB3 (Beam Line Vessel and Beam Source Vessel) and DNB <i>Annexure-4: Materials – General requirements</i>	INDUS Ref No II-UQRH63G- V1.2
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1. Scope

This document specifies the general requirement pertaining to the raw materials for the manufacturing of DNB Vessel and HNB3 Vessel and its sub-components. These general requirements are applicable for all the sections (See. Clause 2 below) under this annexure.

2. Reference Documents

RCC-MR Section-2 MATERIALS

ITER_Vacuum_Handbook_2EZ9UM_v2_5

ITER Vacuum Handbook: Appendix_3_Materials_27Y4QC_v1_20

3. Structure of this annexure

For the specific requirements of the raw material depending on the product form, following annexures (integral part of the this annexure but separated for the ease of handling and understanding) have to be referred.

Annexure 4A_Materials_Forgings for DNB Vessel
Annexure 4B_Materials_Rolled or forged bars and semi-finished products for DNB Vessel
Annexure 4C_Materials_Plates for DNB Vessel
Annexure 4D_Materials_Seamless pipes for DNB Vessel
Annexure 4E_Materials_Forgings for HNB3 Vessel
Annexure 4F_Material_Rolled or Forged bars and semi- finished products for HNB3 Vessel
Annexure 4G_Materials_Plates for HNB3 Vessel
Annexure 4H_Materials_Pipes for HNB3 Vessel


4. Materials for manufacturing of DNB Vessel and HNB3 Vessel

4.1 All material for use in vacuum have been clearly specified in the engineering drawing. The same have to be certified in accordance with EN 10204 3.1 or 3.2 before being used in manufacturing.

4.2 Metallic Machined Components and Fittings:

4.2.1 Final Thickness < 5 mm:

All VQC 1A components which are machined from steel, austenitic steel or superalloys and which are of final thickness less than 5 mm shall be made from cross-forged material which is Electro-Slag Remelted (ESR) or Vacuum Arc Remelted (VAR). The rate of inclusions in such steels shall be checked in accordance with ASTM E-45 Method D (or equivalent) to be within the following inclusion limits:

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- Inclusion Type A ≤ 1.0 .
- Inclusion Type B ≤ 1.0 .
- Inclusion Type C ≤ 1.0 .
- Inclusion Type D ≤ 1.5 .

These requirements are synopsised in **Table 1** below.

4.2.2 Final Thickness between 5 mm and 25 mm:

VQC 1A components which are machined and are of final thickness between 5 mm and 25 mm shall be manufactured from the material mentioned in the drawing, in the form of stock which has been cross-forged (upset forged).

These requirements are synopsised in **Table 1** below:

Table 1: Specific requirements for metallic machined components and fittings

Nominal Thickness (of vacuum boundary)	Plate / Bar		Forging
	Transverse cross section w.r.t vacuum boundary	Parallel w.r.t vacuum boundary	
Thk ≤ 5 mm	Not Allowed	No special requirements except mentioned in this specification	1. Cross or Upset forged 2. Low inclusion requirement with 4.1 above and ESR / VAR
5mm<Thk \leq 25mm	Not allowed		Cross or Upset forged
Thk >25mm	Low inclusion requirement with 4.1 above and ESR / VAR		No special requirements except mentioned in this specification


4.3 Manufacture of Vacuum Flanges

Both halves of demountable flanges using metal seals are to be manufactured from cross or upset forged material. Stainless steel used for the manufacture of knife-edge sealed flanges of any thickness shall be from cross-forged ESR grade material blanks.

4.4 The sulphur content of the following welding area shall be between 100ppm and 150ppm to achieve a good penetration and to avoid hot cracking


For HNB Vessel: defined by 2.7 mm thickness/ DN200 in the Drawing 046910 – sheet 14 – view BZ-BZ - version H

4.4 Materials for the jigs and fixtures shall be compatible with stainless steel or at least have a cladding at contact surfaces with the component.


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5. General Instructions

- 5.1 All the raw materials, proprietary items and brought out items including materials for trials, qualifications, Production Proof Samples (PPS) and test coupons etc., as required for manufacture of DNB Vessel and HNB3 Vessel shall be procured and tested in accordance with this annexure, its relevant sections and EN standards mentioned therein.
- 5.2 The source of material procurement shall be indicated and approved by the purchaser through quality audit.
- 5.3 All the material used in manufacture shall be new and of specified quality.
- 5.4 MIP, QP, testing procedure, Non Destructive Examination (NDE) procedure etc. submitted by the Supplier of raw materials shall be submitted to the purchaser for approval before procurement of material. Approved MIP and QP shall be strictly followed thereafter during procurement.
- 5.5 Specification for proprietary items and brought items shall be provided to purchaser for review and approval.
- 5.6 Traceability and test certificate of material:
 - 5.6.1 The Contractor shall ensure that each material is properly identified, each block of material being assigned a unique traceable number.
 - 5.6.2 Traceability of each material shall be maintained throughout all manufacturing processes (from reception stage to the delivery including all intermediate steps during manufacturing). Traceability documentation (Test certificate for all material used in manufacturing) which cross-references component parts to material certificates shall be included in the final collective acceptance documentation.
 - 5.6.3 It is the responsibility of Contractor to ensure that all testing and characterization required by this specification are performed and well documented in test certificate.
 - 5.6.4 The material traceability shall be implemented through dedicated procedures **to** be subjected to the ITER-India / IO approval, before starting any manufacturing operations.
 - 5.6.5 PMI testing shall be performed at a point in time that ensures proper material is used in the fabrication of an identifiable assembly. Usually, this is during delivery material acceptance at Supplier's factory, fabrication or immediately prior to fabrication. PMI testing shall not substitute required material test reports and certificates defined in clause 4.1 above.
- 5.7 All the material and items shall be procured under purchaser's inspection. This inspection and testing shall be carried out by the Contractor at his cost in a laboratory approved by the purchaser.
- 5.8 Usage of Stock material:

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- 5.8.1 Stock material from the contractor's own stock / material from stockists can be used provided traceability of the component is established (Stamp on the material and relevant certificate).
- 5.8.2 It is the Contractor's responsibility to check that the certificates of analysis and all test results of the stock material meet the requirements of contract specification. In such situation, where traceability is established and EN 10204 3.1 test certificates are available, MIP or QP from the Raw material manufacturer may not be required to be submitted. In case of unavailability of the tests conducted, the material can be upgraded by performing the necessary tests in accredited laboratory.
- 5.8.3 The Contractor is responsible for the quality of the stock material used. All material shall be free from surface cracks and fissures, forge and other tool marks, burns, delamination and other defects that would make it incompatible with a high vacuum environment.
- 5.9 Usage of standard Items
- 5.9.1 Contractor shall procure standard items from recommended make (if applicable) as suggested in this annexure and its relevant sections.
- 5.9.2 Standard items shall be procured of required size, grade & specification specified in this document.
- 5.9.3 Contractor shall submit Test certificate conforming to EN 10204 Type 3.1 for all standard items procured before initiating the manufacturing.
- 5.9.4 If at the time of procurement by the vendor, it is observed that the off the shelf items prescribed by the purchaser are not available or do not meet the specific requirements / interface needs, the vendor needs to bring this to the notice of purchase and a mutually agreed alternate should be found
- 5.9.10 The dimensions mentioned in the drawings are finished dimensions and the Contractor shall procure the material in sufficient quantities and appropriate size taking into account the necessary allowances required for manufacture, qualification and testing.
- 5.10 Contractor shall issue Purchase order to raw material supplier so as to include the information sought by this annexure. Contractor shall provide the copy of Purchase Order specification (unpriced) for each procurement to purchaser for approval of ITER-India and IO.
- 5.11 Contractor shall arrange for access for purchaser at raw material supplier's place for Progress monitoring, quality audits, production surveillance and inspection activities as agreed in the MIP, during project execution.
- 5.12 Contractor shall ensure that, raw material supplier has submitted the detail manufacturing programme to purchaser prior to start of manufacturing.

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- 5.13 The Raw material supplier shall submit the MIP for Raw material to Contractor. The Contractor shall mark up its intended intervention points on the Raw material supplier's MIP, approves the plan and send it to the purchaser. Purchaser will then mark up its intended intervention point on the Raw material supplier's MIP, accept the plan and send it to IO for acceptance and mark-up of any IO interventions. This is not valid in case of usage of stock material.
- 5.14 Contractor shall ensure that, Raw material supplier has submitted Material Test report after completing all the manufacturing and inspection activity with supporting technical records (like Heat treatment record, NDE reports, Inspection reports, Lab test certificates etc.) to purchaser.
- 5.15 Purchase specification for piping elements that will be used to manufacture cooling and gas systems shall include electro-polishing requirements.
- 5.16 Surface Finish
- 5.16.1 Unless specified otherwise, maximum average surface roughness (defined in accordance with ISO 4278:2000) shall be 6.3 μm Ra for all metallic components.
- 5.16.2 Measurement Technique: Electric Stylus
- 5.16.3 Where the base material is not produced with an acceptable surface finish, such surface finishes may be achieved using techniques including:
- Machining
 - Electropolishing
 - Bead Blasting in a slurry in a water jet with alumina or glass beads.
 - Surface Passivation / Pickling (*as per Annexure 8*).
- 5.16.4 All processes on vacuum surfaces shall be followed by appropriate cleaning of the surface (*as per Annexure 7*).
- 5.17 Quality Requirements pertaining to raw material procurement
- 5.17.1 The Contractor shall develop and operate a management system that is appropriate to the all stage of material procurement and is based on a recognized Quality standard that meets purchaser Quality programme.
- 5.17.2 The Contractor shall prepare a Quality plan for material procurement which states the effective implementation of the contract.
- 5.17.3 The Contractor shall ensure that all material produced is tested and the appropriate certificates issued.
- 5.17.4 The Contractor will, at the request of purchaser, provide objective evidence that the contractual requirements are met.
- 5.17.5 Guidelines for preparation of MIP for procurement of raw material:


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Table 2 describes the inspection milestone recommended for preparation for MIP for procurement of major raw material. Based on these guidelines, Contractor / Raw Material Supplier shall prepare the MIP and submit to purchaser for each procurement for review and approval.

Table 2: Inspection milestone for Raw material

Sr. No.	Activity	Raw material Supplier	Contractor	ITER-India	IO
1.	Melting Method	P	R	R	-
2.	Chemical Analysis (Ladle analysis + Product analysis)	P	R	R	-
3.	Heat Treatment	P	R	R	-
4.	Tensile Test	P	R	R	-
5.	Ferrite content check	P	R	R	-
6.	Non Metallic inclusion (Whenever Applicable) and IGC	P	R	R	-
7.	Technology test (flaring and flattening) for pipes	P	R	R	-
8.	NDE	P	R	R	-
9.	Visual Examination	P	S1	NP	NP
10.	Dimensional Examination	P	S1	NP	NP
11.	Material Identification & Stamping	P	S1	NP	NP
12.	Final Documentation	P	H	H	NP
13.	Issue of Certificate of compliance / EN 10204 3.1 certificate	P	R	R	NP
14.	Issue of Release note	-	-	H	NP

Definitions:

- Raw material supplier – Manufacturer of Raw Material
- Contractor – Manufacturer of DNB Vessel and HNB3 Vessel
- P – Perform the Test activity
- R – Review & Evaluate Test record
- W- Witness the Test activity
- H – Hold Point (Witness the activity and issue compliance report)
- S1 – Activity that requires 100% inspection
- S2 –Activity that requires random inspection
- NP – Notification Point (Activity that must be notified to Purchaser and ITER Organization.)

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6. Material for the standard metallic seals.

- 6.1 All metallic seals except the rectangular ones implemented on the Top lid and on the Rear Lid for HNB3 vessel are defined as standard metallic seals for HNB3 vessel.
- 6.2 All metallic seals except the rectangular ones implemented on the Top lid and on the High Voltage Bushing Flange for DNB Vessel are defined as standard metallic seals for HNB3 vessel.
- 6.2 All such standard off the shelf parts as gaskets, standard Helicoflex® spring energized seals, etc. are defined in the Bill of Material of respective vessels and shall be procured in compliance with their reference.

7. Material for the bolts

The materials of bolts have been defined according to the definition of the Final design. Bolts (nuts, washers, etc.) material and grade are defined in the Bill of Material and shall be procured in compliance with the Code or Standard written in the Bill of Material

- 660 grade steel (under vacuum) according to A3.1B (Section1-Subsection Z-Appendix A3of RCC- MR 2007
- 42CrMo4 (under atmospheric pressure) according to A3.11B (Section1-Subsection Z-Appendix A3of RCC-MR 2007
- Inconel 718 (Superbolts) according to A.B01/S10 of SDC-IC- Appendix A

8. Material for Metallic seal for Top Lid and Rear Lid (only for information) NOT IN THE SCOPE OF SUPPLY

Some seals are Helicoflex® spring energized seals. Their section and materials considered are the same for each flange:

- Spring is made of Inconel 718 alloy
- Inner Jacket is made of 304L stainless steel.
- Sealing lining is made of pure silver.