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ITER Vacuum Handbook
Appendix 7

Guide to the Supply of All Metal Vacuum Valves for the ITER Project

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7 Requirements for the Supply and Modification of All-Metal Ultra High Vacuum Valves for use on the ITER Project

This Appendix is written as a guide for the manufacture and supply and modification of all metal ultra high vacuum vacuum valves for use on ITER vacuum systems. It is intended that the *suppliers* of such vacuum valves should follow the guidance in this Appendix to achieve the requirements of the ITER Vacuum Handbook.

The *supplier* is at liberty to utilise other techniques not described in this Appendix provided that the components manufactured comply with the requirements of the ITER Vacuum Handbook.

"Supply" includes the design, manufacture, testing and delivery of bellows and flexibles as described in the specifications

7.1 Design

ITER is responsible for specifying the interface between ITER systems and the valves.

The supplier is responsible for the detailed design of the valves including any modifications as specified by ITER.

Flanges or end fittings shall be specified by ITER and supplied in accordance with the ITER Vacuum Handbook Appendix 8.

Valves used for ITER vacuum vessel isolation (VQC1A) should be bakeable to 250°C in the open and closed positions and, in accordance with the requirements of the ITER Vacuum Handbook, should be of double bellowed design. VQC 1 valves should be able to operate at 250°C and be of all metal construction (seal, body etc). Demountable valves for use on VQC 1A should utilise a metal double seal arrangement conforming with the requirements of the ITER Vacuum Handbook Appendix 8

VQC 2 & 3 valves are not required to operate at elevated temperature but must be of all metal vacuum containment.

There is no requirement for VQC 4 valves to be bakeable or of all metal design.

Pneumatic seals and electrical components for valves used in systems with classification VQC1 should withstand a total radiation integrated dose of 10^8 Gray (TDB)

Where valves require to be remotely handled as a unit rather than as part of an integrated remotely handled assembly, they should be designed in accordance with the requirements ITER Remote Handling Code of Practice.

The design life of valves for use on ITER should be such as to limit intervention for replacement or repair during the operational phase of the ITER Project. Typically valves for ITER vacuum vessel isolation should be designed to operate for a minimum of 5000 cycles without the requirement for intervention. This requirement

applies to all torus isolation valves with the exception of valve sizes larger than DN1500 mm (e.g. Neutral Beam isolation valves)

7.2 Additional requirements for the supply of standard valves with modified ends

The requirements of the ITER Vacuum Handbook and this Appendix should also apply to valves with modified ends. In addition, the following requirements will apply to the modified parts only.

7.2.1 Materials

7.2.1.1 General

All vacuum facing materials for use in the manufacture of bellows should comply with the requirements of the ITER Vacuum Handbook. In particular materials should be taken from the ITER Vacuum *accepted* materials list (ITER Vacuum Handbook Appendix 3) and be consistent with the outgassing requirements of the ITER Vacuum Handbook.

7.2.1.2 Metallic Machined Components and Fittings

All VQC 1A components which are machined from steel, austenitic steel or superalloys and which are of final thickness less than 5 mm, should be made from cross-forged material which is Electro-Slag Remelted (ESR) or Vacuum Arc Remelted (VAR). The use of plate is prohibited. Alternative processes for achieving the required inclusion limits may be *accepted* if successfully validated.

The rate of inclusions in such steels should be checked in accordance with ASTM E-45 Method D (or equivalent) to be within the following inclusion limits:

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

Both halves of demountable flanges using metal seals are normally to be manufactured from cross or upset forged material.

Stainless steel knife-edge sealed flanges of any thickness for all vacuum classifications should be manufactured from cross-forged ESR grade material blanks.

All VQC 1A and 2A demountable vacuum flanges should be made from cross-forged or upset forged material.

7.2.2 Fabrication

Before assembly commences the supplier shall submit to ITER for *acceptance* the documents listed in Section 7.7

Tools used during the manufacture of the valves must not contaminate the vacuum surfaces. Cutting fluids need be *accepted* before use and will be water based, oil free, non-halogenated, sulphur and phosphorus free. Those listed in Appendix 4 are

accepted and, if chosen, should be specified in the quality plan and agreed in advance.

Cleaning operations need to be performed to a procedure *accepted* by ITER in accordance with the ITER Vacuum Handbook Appendix 13. The use of chlorine and other halogen containing fluids (e.g. trichloroethylene) is strictly forbidden.

All assemblies must be individually identified, packaged and shipped to the ITER site in accordance with Section 22 of the ITER Vacuum Handbook.

7.2.2.1 Welding

The qualification, production and testing of welds should be in accordance with the ITER Vacuum Handbook Attachment 1.

In particular:

1. Before fabrication can commence the *supplier* should prepare for *acceptance* a weld plan. The weld plan is a drawing which cross references each welded joint to a supporting Weld Procedure Specification (WPS).
2. All welds should be qualified prior to manufacture.
3. 100% visual examination of production welds should be performed.
4. 100% volumetric examination of production welds should be performed, unless a method of pre-production proof sampling is *accepted*.
5. Dye-Penetrant examination of production welds is only permitted in accordance with the ITER Vacuum Handbook.

7.3 Leak Testing

Prior to shipping all valves should be subject to an acceptance vacuum leak test. Detailed leak testing procedures in accordance with the ITER Vacuum Handbook Appendix 12 should be submitted for *acceptance*.

Helium leak testing should include the following steps:

Valves for use on VQC1 systems should be baked and hot leak tested at 250°C as follows:

1. Valve body
2. Across the valve seat.
3. Valve actuator bellows.
4. Internal pressure element.
5. Double bellows interspace.
6. VQC 1A double seal interspace.

Immediately after bake-out, the same tests must be repeated at ambient temperature. In both cases the acceptance leak rate shall be met with the background reading on the leak detector being at least one order of magnitude below the acceptance leak rate without electronic correction. In each case, the leak test

procedure should include three operating cycles of the valve at each test temperature before leak testing. Leak rates for valve assemblies (including double bellows interspace), and across the valve seat, should not exceed 1 x 10^{-10} Pam^3s^{-1} at 250 °C

Valves for use on VQC 2 systems are subject to the same tests as VQC 1 with the requirement for temperature cycling waived. Leak rates for valve assemblies (including double bellows interspace), and across the valve seat, should not exceed 1 x 10^{-10} Pam^3s^{-1}

It is expected that valves for use on VQC 3 & 4 systems will be delivered to ITER as proprietary items and hence be delivered with a manufacturer's certificate of conformity confirming leak tightness. In this case, proprietary valves may be subjected only to an ambient temperature acceptance test at the ITER site prior to installation. Leak rates for proprietary valve assemblies (including double bellows interspace), and across the valve seat, should not exceed 1 x 10^{-10} Pam^3s^{-1}

All leak tests and test facilities may be the subject of inspection by the ITER Vacuum Responsible Officer or nominated representative and hence the ITER Vacuum Responsible Officer must be notified as of the final timing of tests a minimum of 4 weeks prior to the tests commencing.

7.4 Marking

Each valve should be individually marked with a unique identification which is traceable to the valve document package. The use of dyes, paints, pens and other such markers that transfer marking material into any window assembly surface must not be used for the marking of window assemblies. Scribing with a clean sharp point and vibro-etching are acceptable marking processes.

Each valve shall be marked with an arrow clearly identifying the seal face direction of the valve.

7.5 Documentation

Valve data sheets are to be supplied for all valves.

A suppliers' certificate of conformity is required confirming that the valves supplied conform to the valve data sheet as revised and accepted by ITER.

Leak test reports and / or Certificates of Conformity must be supplied in accordance with the relevant requirements of the ITER Vacuum Handbook.

7.6 Packaging & Delivery

The packaging and delivery of valves to the ITER site should be in accordance with ITER Vacuum Handbook.

Valves should be entirely enclosed in heat sealed polyethylene and backfilled with a suitable dry gas. Nitrogen is preferred but other gasses may be *accepted*. All valve assemblies must be shipped dry internally and externally irrespective of final acceptance testing at the manufacturer's site.

The use of adhesive tape for the protection and packaging of components must be limited to prevent the risk of contamination from the tape. In particular tape used on austenitic stainless steel should meet leachable chloride and fluoride limits of 15 ppm and 10 ppm, respectively. Where used, tape should be fully removable without residue, using isopropyl alcohol or acetone as the solvent if necessary.

All valve assemblies should be transported in rigid packing cases or containers which are lined with waterproof material. Components should be packed with adequate protection from thermal and mechanical stresses which may adversely affect the operation of the valves. All packing case joints should be sealed and cases marked with individual valve specific identification. Handling instructions should also be clearly marked on the outer packaging. Any chemical or radiological hazards, etc., must be identified on the packaging. All packaging markings should be in English and French and include the VQC of the valve.

7.6.1 Incoming inspection at ITER Site

In addition to the inspection detailed in this Appendix, window assemblies will be subject to an incoming inspection on delivery to the ITER site. This will include, as a minimum, dimensional inspection for compliance with the technical specification and helium leak testing in accordance with the ITER Vacuum Handbook Appendix 12.

7.7 Documentation

Valve data sheets should be supplied for all valves.

A suppliers' certificate of conformity is required confirming that the valves supplied conform to the valve data sheet as revised and *accepted* by ITER.

Leak test reports and / or Certificates of Conformity must be supplied in accordance with the relevant requirements of the ITER Vacuum Handbook.

The following documents should be accepted before pre-manufacture activities commence:

- Weld Plan
- Quality Plan (including test plan /schedule)
- Welding Procedures and Welder Qualifications
- Dimensional Drawings

On completion of manufacturing, two sets of the following documents should be supplied as data books:

- Signed-off Quality Plan
- Welding Procedures and Welder Qualifications
- Radiographic Reports (if applicable)
- Production Proof Sample Reports (if applicable)
- Material Certificates, traceable to assemblies, in accordance with EN 10204 2.2 ,3.1 or 3.2

- Dimensional drawings identifying welds
- Test reports
- Dimensional inspection report