
	Manufacturing, testing and supply of vacuum vessels for HNB3 (Beam Line Vessel and Beam Source Vessel) and DNB <b><i>Annexure 6E: Welding_Production welds</i></b>	<b>INDUS Ref No</b> <b>II-</b> <b>EYPZ7M5-</b> <b>v1.1</b>
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## 1. Scope

This section covers the welding operations carried out during the manufacturing of DNB Vacuum vessel. By "welding operations" are meant:

- The preparation of the surfaces to be welded
- The use of the filler materials
- The use of the welding processes for:
  - The production welds
  - Equipment repairs
- The finishing of production welds and repairs
- The associated heat treatments (preheating, postheating, stress-relieving heat treatments)
- The conditions governing the preparation of production weld test coupons

## 2. Reference Documents

ITER\_Vacuum\_Handbook\_2EZ9UM\_v2\_5


ITER\_Vacuum\_Handbook\_Attachment\_1\_-\_Weld\_2FMM4B\_v1\_5

RCC-MR 2007: Section 4: RS 7000 Production welds

## 3. Documents Required

3.1 All welding operations (joints, repairs) shall be carried out in accordance with the requirements of a set of duly identified documents, which shall satisfy the requirements of the technical specification. All welding related quality assurance documentation shall form part of the delivery to ITER, and shall include:

- Welding Procedure Specification (WPS) used,
- Various instructions prepared by the Manufacturer for the workshop personnel and in particular the welders and welding operators, for the successful completion of the welding operations.
- After the execution of a welding operation, a production Weld Data Sheet (WDS) shall be issued (Clause 7.6 of this section).
- Weld plans
- WPQR's and test reports
- Welder qualification's and test reports
- Weld Data Sheets
- PPS test reports
- Production weld test reports
- Reports on weld repairs
- Non-Conformance Reports

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#### 4. Preliminary Verifications, Qualifications, Acceptances for Welding and distortion management

4.1 Before using a welding procedure, the following qualifications and acceptances shall be achieved:

- Preliminary verification weldability of materials
- Acceptance / Qualification of filler material lots (**Annexure 6\_Welding\_Section 1\_Acc. and Qual. of Filler mat.**)
- Qualification of welding procedure (**Annexure 6\_Welding\_Section 2\_Welding Procedure Qualification**)
- Qualification of welders and operators for the welding procedure in question (**Annexure 6\_Welding\_Section 3\_Qual. of welder and operators**)
- Workshop qualification (**Annexure 6\_Welding\_Section 4\_Tech. qual. of prod. workshops**)

Production welds shall be performed to qualified procedures by qualified welders.

The WPS shall be available for reference by welders or welding operators, by the responsible welding engineer and by the authorised inspector.

The contractor must also demonstrate that the welding equipment and plant is properly maintained and calibrated in accordance with the relevant operation and maintenance schedules.

#### 4.2 Distortion management

Distortion assessment (through simulation in suitable software) shall be performed to establish the welding sequence and need of proper fixtures in order to meet the dimensional requirements provided in the BtP drawings. This shall be basis for the manufacturing design.


Suitable devices (jigs and fixtures) shall be used to prevent welding distortions.

If jigs and fixtures are used to limit welding distortions, design and manufacturing drawings (including their material) developed by Bidder shall be submitted to ITER-India / IO for acceptance.

Welding process shall be developed in order to minimize distortions, leading to the fulfilment of all the tolerances requirements.

Welded attachments of jigs shall not cross or cover pressure retaining welds.

Welded attachments of jigs shall be compatible with the performance of required NDE.

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## 5. Storage and Use of Welding Materials

### 5.1 Storage condition

5.1.1 The storage conditions shall be such that the properties of the materials are preserved. For this purpose, the materials shall be stored in an enclosed dry place, heated if necessary. The Manufacturer is responsible for fixing the minimum temperature and the maximum relative humidity required. The requirements of the qualification data sheet, as provided by the filler material manufacturer, shall be fulfilled.

### 5.1.2 Entry into Store

Each package of acceptance-tested materials shall be adequately identified (e.g. with a stamp) on entry in storage. By "package" is meant the package of electrodes (or a larger package containing several individually packaged units), a coil or spool or bundle of wire. Materials acceptance-tested after entry into store shall be identified following such acceptance-testing.


### 5.1.3 Storage Period

If the same place is used for the storage of acceptance-tested products and those awaiting acceptance-testing or other materials, a physical separation shall be made between these products. A sufficient space may be deemed to constitute a separation.

During storage, products shall remain in their original intact package (Clause 7.2.1 of this section). Any product which has deteriorated or whose identity has been lost shall be discarded. Particular care shall be taken when handling covered electrodes to prevent any possible damage to their coating.

### 5.1.4 Stock Control

The stock control of acceptance-tested products shall provide the following details of each product lot or batch:

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- Designation
- Dimensions
- Acceptance-tested quantity taken into store
- Date of acceptance test
- Where applicable, the expiry date (**Annexure 6\_Welding\_Section 1**\_Acc. and Qual. of Filler mat.)
- Lot number of the associated product (e.g. wire-flux couple)
- Date of removal from store
- Quantity removed
- Reference of the stores release document or note of materials discarded

#### 5.1.5 Release from Store

Products shall only be released from store on presentation to the store-man or his assistant of a document which shall contain at least the following information:

- Designation
- Dimensions
- Quantity
- Number of the lot or lots (or Manufacturer's code number, provided the code number allows the lot number to be clearly identified)
- Assignment of the products to a given component or weld

Note: if the documents do not satisfy these requirements, the Quality Control procedure relating to the removal of products from store shall provide a source for all this information.

## 5.2 Use of Welding Materials


### 5.2.1 Drying and Conservation

5.2.1.1 The Manufacturer's attention is drawn to the fact that he must specify the maximum quantities of material which may be removed from the store depending on conditions of application and the methods of storage and distribution used so that the material loses none of its properties.

5.2.1.2 The drying conditions shall be as indicated by the Supplier (temperature and holding time) in the product qualification data sheet.

5.2.1.3 When specified (**as per 5.2.1.2 above**), the user shall ensure that covered electrodes and fluxes are dried in ovens reserved for acceptance-tested products.

The covered electrodes are dried after removal from the package, or placed in metal boxes allowing air to circulate through both ends.

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A panel shall be attached to each oven indicating: the grade, lot number and drying conditions of the product contained.

An oven should only contain products of one grade at a time.

However, more than one grade may be placed in the same oven, provided:

- their drying conditions are identical
- there is a physical separation between them (a space not being considered as a physical separation)

5.2.1.4 After drying, the electrodes and fluxes are stored in heated containers or cabinets until use. Electrodes and fluxes in use which have been left for more than 4 hours at room temperature shall be redried. This operation may only be repeated the number of times indicated in the qualification data sheet.

5.2.1.5 Each welder shall have a portable container allowing him to keep his electrodes dry.

5.2.1.6 Electrodes and fluxes which have been unpacked and not used may only be put back into store subject to the above requirements, in particular of RS 7211, and according to a procedure which specifies the means of identification and the new packaging.

## 5.2.2 Recycling of fluxes

5.2.2.1 Recycling of fluxes is not recommended, particularly for agglomerated fluxes containing metallic elements (Cr).

5.2.2.2 However, if this technique is used, the following conditions must be satisfied:


- The recycled flux must be mixed with new flux from the same lot, in a proportion not exceeding 50% of the final mixture,
- Before mixing, the recycled flux must have all particles of slag and fines removed by any appropriate method,
- the Manufacturer must be able to show that the grain size characteristics of the mixed flux remain within the limits specified in the flux qualification data sheet.

## 5.3 Identification of the Products During Welding

All products shall be identified at all times during use; for this purpose, the following requirements shall be respected.

5.3.1 Covered electrodes: each rod shall be marked in accordance with **Annexure 6\_Welding\_Section 1**\_Acc. and Qual. of Filler mat.

5.3.2 Spools of wire: each spool shall have a clearly visible label indicating at least the grade, the diameter and the lot number of the wire. Any spool without a label shall be discarded. Re-utilization of a spool shall be subject to presentation, to ITER-India, of all indications allowing re-identification of the spool.


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5.3.3 Wire rod: The grade shall be identified on each rod:

- either by cold stamping a reference code
- or by marking one end of the wire with a reference colour

If this second method is used, a panel indicating the conventional colour and their meaning shall be placed alongside each place of work and welders shall be required to begin welding with the uncoloured end.

5.3.4 Coils of wire and electrode: A label indicating at least the grade and the lot number shall be attached to one end of the product and shall remain in position for the duration of the welding operations.

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## 6. Preparation and Examination of Edges and Surfaces for Welding

### 6.1 Bevels

6.1.1 The Manufacturer shall choose the shape of the bevels in consultation with ITER-India and the same shall be reflected in the welding procedure qualification tests.

6.1.2 At the supply boundaries it is necessary, in equipment specifications, to notify the various component Manufacturers of the shape of the bevels to be prepared. This shall be done in agreement with the manufacturer who has to carry out assembly welding.

6.1.3 The fairing between two adjacent parts of different thicknesses shall be as per the Engineering Drawings. It shall be compatible with the execution of the non-destructive examinations required for these joints and any additional requirements given in the equipment specification, as well as with the use of in-service inspection equipment.

### 6.2 Beveling methods

6.2.1 The main joints shall preferably be prepared by machining or by thermal cutting and/or by grinding, in accordance with the requirements of “Annexure 5\_Fabrication”; shearing is allowed subject to the reservations of “Annexure 5\_Fabrication”

6.2.2 Pipe bevels shall normally be executed by mechanical machining. However, grinding may be used for trimming purposes when aligning components on site and for the beveling of small diameter pipes. If the inside diameters are machined, the wall thickness and the joint profile shall satisfy the engineering drawing requirements.

### 6.3 Air Carbon Arc Gouging

The air carbon arc process shall be prohibited.

### 6.4 Conditions of Surfaces and edges to be welded and of Adjacent Areas


6.4.1 The condition of the surfaces and edges to be welded shall be compatible with the welding procedure and with the non-destructive examination methods required by this clause 6.

6.4.2 The areas adjacent to the surfaces and edges to be welded shall have over a sufficient width a surface finish compatible with the execution of the non-destructive examinations required for the joints.

### 6.5 Repairs to Surfaces and Edges to Welded

The inspections performed before alignment may reveal one or more unacceptable indications (Clause 6.6 of this section) requiring repairs with or without welding.



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#### 6.5.1 Repair without welding (also see “Annexure 5\_Fabrication “)

Defects may be eliminated by the removal of material (grinding or other mechanical process) without altering the geometry of the groove in such a way, according to the process used, as to upset the normal performance of the welding operation.

Such removal of the material, shall not be considered as a non-conformance report. The examination and acceptance criteria applied after the removal of material are those specified for bevels and surfaces to be welded (clause 6.6.3.4 of this section).

#### 6.5.2 Repair by welding (also see Clause 9 of this section)

In this case, the Manufacturer shall issue a non-conformance report. The welding procedure shall satisfy the same requirements as those for production welds.

According to the content of the repair, the following non-destructive examinations shall be performed:

- Liquid penetrant examinations
- Ultrasonic examinations for weld metal thicknesses greater than 5 mm

Moreover, if the repaired area is not within the examinations area of the joint, it shall be recorded and tested after heat treatment as specified in Clause 10 of this section, for welds of the same type.

The locations and dimensions of the repairs shall be recorded, and included in the non-conformance report.

### 6.6 Inspection Before Alignment

#### 6.6.1 Dimensional Check

##### 6.6.1.1 Method: To be defined by the Manufacturer.

##### 6.6.1.2 Extent of the check: Shape of the groove, fairing, thickness, search for shape defects (ovality, roundness, straightness, etc.).


##### 6.6.1.3 Time of examination: Preferably to be carried out before the other surface examinations specified in this technical specification.

##### 6.6.1.4 Acceptance criteria: The geometrical and dimensional tolerances specified in the fabrication drawings shall apply. It should be recalled that final shape tolerances specified in “Annexure 5\_Fabrication” must be complied with.

##### 6.6.1.5 Report: Prepared only in case of non-conformance. The non-conformance report may replace this report.

#### 6.6.2 Visual Examination

##### 6.6.2.1 Method: In accordance with the requirements of RMC 7100 and RMC 7200.

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6.6.2.2 Extent: All surfaces to be welded and adjacent areas.

6.6.2.3 Time of examination: Preferably to be performed before the other non-destructive surface examinations.

6.6.2.4 Acceptance criteria: The surface finish tolerances specified in the drawings. The surfaces to be welded shall have no defect liable to adversely affect the quality of the weld.

6.6.2.5 Report: Noted on the routing sheet. A separate report is prepared only in case of non-conformance.

#### 6.6.3 Liquid Penetrant Examination

6.6.3.1 Method: These examinations shall be performed in accordance with the requirements of RMC 4000 for liquid penetrant examination.

6.6.3.2 Extent: 100% of all the surface to be welded.

6.6.3.3 Time of examination: To be performed after surface preparation.

6.6.3.4 Acceptance criteria: The following are unacceptable:

- (1) linear indications (see RMC 4200 for definition)
- (2) rounded indications > 2 mm
- (3) 3 or more indications in a line, less than 3 mm apart (edge to edge)
- (4) groups of 5 or more indications, on a rectangular area of 100 cm<sup>2</sup> chosen in the most unfavourable manner in relation to the indications and with its longest dimension not exceeding 20 cm

Unless otherwise specified, only indications > 1 mm shall be considered recordable conditions


#### 6.6.3.5 Report

Noted on the routing sheet. A report is prepared only in case of non-conformance. The non-conformance report may replace this report.


#### 6.6.4 Other Examination

In the case of plates an US examination limited to 50 mm on each side of the welded joint can be performed, in order to delimit defective areas according to RMC 2000.

#### 6.7 Alignment of Weld Edges

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- 6.7.1 The parts to be joined are aligned in such a way as to achieve the tolerances specified in “Annexure 5\_Fabrication” after welding. In the case of pipes, machining or sizing of the ends may be necessary.
- 6.7.2 For alignment and retaining of parts during welding, devices such as clamps, clips, temporary attachments, tack welds, etc. are used. However, wherever possible, mechanical devices are to be preferred, particularly in the case of pipework.
- 6.7.3 The mechanical or welded devices shall satisfy the requirements of Clause 7.2 for the welding and “Annexure 7\_Cleaning and Cleanliness” for the cleanliness criteria.
- 6.8 Inspection after Alignment
- 6.8.1 Dimensional checks of ready-to-weld assembly
- 6.8.1.1 Method: To be defined by the Manufacturer.
- 6.8.1.2 Extent: At intervals, at least 4 in number, along each joint.
- 6.8.1.3 Time of inspection: To be carried out immediately before welding and after any tack welding.
- 6.8.1.4 Acceptance criteria: The edge dimension and gap width tolerances specified in the welding procedure or in the fabrication drawings. The maximum admissible offset in level necessary to satisfy the criteria defined in “Annexure 5\_Fabrication” for welds.
- 6.8.1.5 Report: Required
- 6.8.2 Visual examination of the ready-to-weld test coupon
- 6.8.2.1 Method: The visual examination shall be performed in accordance with the requirements of RMC 7100.
- 6.8.2.2 Extent:
- All surfaces to be welded and their adjacent areas on the front and back sides of the joint, when this back side is accessible.
- The tack welds when they are to be incorporated in the final weld (Clause 7.1 of this section).
- 6.8.2.3 Time of examination: To be carried out immediately before welding and after any tack welding.
- 6.8.2.4 Criteria

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- Identification and coding: Possible presence of marking, coding and other means used for the purpose of identifying the joints on the component and for relating to them the results of subsequent inspections to be performed on the weld.
- Cleanliness: Absence of water, grease, oil, oxides and other materials liable to impair the welding.
- Appearance of incorporated tack welds: Absence of shrinkage and end craters, cracks, porosity, furrows or other imperfections liable to impair the welding. This examination can be complemented by liquid penetrant examination particularly in case of doubt.

6.8.2.5 Report: Required

## 7. Execution of Production Welds

### 7.1 Tack Weld Requirements

#### 7.1.1 General

Tack welds do not form part of the joint. They shall be removed before or during the welding of the joint, and their complete removal shall be ensured.


However, for certain welds without backing runs, tack welds may be incorporated in the joint subject to the following reservations:

- The tack welds shall form part of welding procedure for that joint and the corresponding qualification tests,
- The ends of these tack welds shall be tapered to facilitate back side penetration if there is a gap at the root face.

#### 7.1.2 Execution

Tack welds are made according to a procedure which complies with the following requirements:

##### 7.1.2.1 They are made:

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- either by welders qualified in accordance with RS 4000 for production welds (this condition is mandatory if the tack welds are incorporated in the joints as per a) above),
- or by welders or fitters who have demonstrated their ability to execute such welds by the following test:
  - execution, **in the presence of a Surveillance Agent**, of a series of:
    - Five tack welds in the flat position
    - Five tack welds in the vertical position
  - the length of these welds being:
    - that obtained by the continuous fusion of an electrode in the case of manual shielded metal arc welding,
    - At least 50 mm.
  - These welds are carried out on a surface of a type used during manufacturing, on a base metal of the same grade, and with the filler materials used during these manufacturing operations.
  - Criteria
    - Assessment of operator skill.
    - Appearance of the beads, which shall be continuous, without unacceptable undercutting at the junction with the base metal and with no cracking at the ends.

7.1.2.2 The filler materials used shall be taken among those acceptance-tested for the manufacturing operations concerned, in accordance with “**Annexure 6\_Welding\_Section 1**\_Acc. and Qual. of Filler mat.”

7.1.2.3 If preheating is required for welding operations, the base metal shall be preheated to the prescribed temperature.


7.1.2.4 The preheating is carried out and monitored according to the provisions of **Clause 8** of this section.

7.1.2.5 The preheated zone shall extend to a sufficient distance around the zone to be welded (the minimum preheating temperature shall be reached at least 50 mm from the location of the beads).

## 7.2 Welding of Permanent and Temporary Attachments

### 7.2.1 General

Any part welded to the inner or outer walls of the components or bevels is called an "attachment". Permanent attachments such as supports, brackets, stiffeners, etc., are part of the equipment.

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Temporary attachments consist of parts welded to the component, intended to facilitate manufacturing, handling or erection and subsequently removed.

Branch pipes, nozzles, opening reinforcements, etc., are not considered as attachments.

## 7.2.2 Welding Requirements

7.2.2.1 Welds of permanent and temporary attachments to components shall be made according to the same requirements (in particular preheating, postheating, etc.) as the main joints of the component concerned **(Clause 7.3 of this section)**.

7.2.2.2 The welds of permanent or temporary accessories are all executed before final stress-relieving heat treatment. When it is not possible, the welding of permanent attachments is allowed without subsequent stress relieving heat treatment. This is allowed only where there is no risk of affecting again a base metal which requires a stress relieving heat treatment.

7.2.2.3 Welds of permanent and temporary attachments on walls of pressure retaining components shall be continuous and of the full penetration type.

## 7.2.3 Qualification for the Welding Attachments

Welds of permanent and temporary attachments on the vessel walls shall satisfy the same qualification requirements (welding procedure, welders or welding operators, filler materials) as the other production welds.

## 7.2.4 Bridges and Clamps


7.2.4.1 Clamps, bridge-pieces and the welds attaching them to the components shall be of sufficient dimension, so that the stresses to which these attachments are subjected cannot cause tearing of materials or cracking of the component walls.

7.2.4.2 For formed vessels with wall thicknesses in excess of 50 mm, fitting bridges and clamps are not welded directly to the skin of the pressure vessel but to plates welded to the surface.

7.2.4.3 The plates, bridge-pieces and clamps used for alignment of austenitic stainless steel components shall also be of austenitic stainless steel.

## 7.2.5 Removal of Temporary Attachments

7.2.5.1 In no case shall a temporary attachment be removed by a method liable to cause the tearing of material from the surface of the wall of the component (e.g.: removal with a hammer).

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7.2.5.2 No thermal cutting for the removal of a temporary attachment may be carried out within 5 mm of the surface of the equipment. The remaining material shall be removed mechanically.

7.2.5.3 Temporary attachments shall be removed before the final heat treatment of the component or part thereof. If, for technical reasons, they are removed after this treatment, particular care shall be given to the application of requirements 7.2.5.1 and 7.2.5.2 above.

#### 7.2.6 Inspection after removal of Temporary Attachments

After removal of temporary accessories, their locations on the component shall be subjected to non-destructive examination methods as specified in clause 10 of this section.

In the case of temporary fit-up attachments welded to the bevel with filler materials acceptance-tested for manufacture, only visual examination is required after they have been removed by grinding.

### 7.3 Execution of Welds

#### 7.3.1 General Requirements

Production welding operations may only be undertaken if the following requirements are met:

7.3.1.1 The workshop and personnel satisfy the requirements of “Annexure 6\_Welding\_Section 4\_Tech. qual. of prod. Workshops” and “Annexure 6\_Welding\_Section 3\_Qual. of welder and operators”.


7.3.1.2 the qualification data sheet is available and the acceptance-testing of the filler materials have been carried out in accordance with “Annexure 6\_Welding\_Section 1\_Acc. and Qual. of Filler mat.”

7.3.1.3 The welding procedures have been qualified in accordance with “Annexure 6\_Welding\_Section 2\_Welding Procedure Qualification”

7.3.1.4 All the necessary documents (manufacturing sequences, Manufacturer's working instructions, etc.) are available at the place where the welding is to be performed,

7.3.1.5 The welding procedure is in accordance with the welding procedure qualification and the relevant report, in particular as far as the permitted limits of the variables are concerned.

7.3.1.6 The edges to be welded shall be prepared in accordance with Clause 6 of this section. The surfaces shall be dry and it is forbidden to weld on wet surfaces.

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7.3.1.7 It is forbidden to weld if the room temperature is below - 10°C. The part must be kept at a temperature of at least + 5°C and cooling after welding shall be sufficiently slow to avoid cracking due to internal stress.

7.3.1.8 All welding operations shall be performed under cover from bad weather.

7.3.1.9 If welding is carried out using a shielding gas, the work area shall be draught free. Back shielding gas confinement can be performed on pipes using soluble paper or temporary plugs.

7.3.1.10 During and after welding operations, the filler materials shall be used and handled in accordance with **Clause 5** of this section.

7.3.1.11 The associated heat treatments (preheating, postheating, stress-relieving) shall be carried out in accordance with **Clause 8** of this section.

7.3.1.12 Other operating precautions:

- During welding, each pass shall be visually examined, after complete removal of the slag, if necessary.
- Any visible defect liable to affect the correct execution of the next pass, shall be removed.
- Cracks or cavities visible on the surface shall be removed by chipping and by grinding and/or milling.
- Grinding shall be carried out with care to avoid overheating zones, particularly with austenitic steels.
- For strength welds, stringer beads are recommended (sweeping not more than three times the diameter of the electrode core).
- The surface of the weld beads must be continuous, of uniform thickness and continuously joined to the adjacent surfaces


7.3.2 Special Requirements for low thickness welds carried out with an automatic welding machine

The same welding parameters as those used during performance of the welding procedure qualification coupon shall be recorded. This record shall be carried out by sampling if the production welds are subjected to a full volumetric examination.

7.3.3 Checking of Instrument used for measuring welding Parameter

The calibration of the measuring instruments used for setting electric parameters and checking the welding parameters shall be mandatory. They shall be recalibrated according to a schedule at no longer than 6 monthly intervals.



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This verification shall be covered by a report indicating the number of the machine and the measuring instrument calibrated, the readings taken on the measuring instrument and on the calibration instrument.

#### 7.3.4 Verification of Welding Parameters

The energy parameters (I in the case of manual welding, I, U and V in the case of automatic welding), the polarity and the preheating, interpass and postheating temperatures shall satisfy the requirements of the welding procedure.

For automatic equipment, the voltage is checked at the arc, or as close as possible to it. In this case, the difference between the voltage measured and the voltage at the arc shall be evaluated.

The interpass temperatures are measured using one of the means specified in **Clause 8.2** of this section.

#### 7.3.5 Backing strip and Consumable Inserts

The use of backing strips and consumable inserts is covered by the welding procedure qualification. The use of permanent backing strips is forbidden for the vessel manufacturing

The backing strip material shall be compatible with that of the joint (chemical composition in particular). Nickel-free copper backing strips shall not be used. The weld shall be subjected to non-destructive examinations after complete removal of the backing strip.

Consumable inserts require special preparation of the weld edges. Their design allows them to be incorporated in the welded joint without creating an irregular surface finish. Their ends are welded together to avoid any discontinuity. The material of which they are made shall be acceptance-tested in accordance with RS 2000.


#### 7.3.6 Weld Pool Protection

##### 7.3.6.1 Gas shielding

Care shall be taken to ensure observance of the shielding gas flowrates specified in the welding procedure.

##### 7.3.6.2 Root protection

If the root passes are made by the TIG process, the back side of the weld is protected from oxidation by an inert shielding gas which, for austenitic grades, shall be argon or another rare gas, or a rare gas/neutral gas mixture containing over 50% of rare gas.

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This protection shall be maintained, whatever the welding procedure, until a sufficient thickness - at least 4 mm - has been deposited to prevent any back side oxidation.

By analogy, when welding on the surface of an austenitic stainless steel part less than 5 mm thick, the back face shall be protected against oxidation by an inert shielding gas. The thickness in the question may be increased according to the welding process.

#### 7.3.7 Various surface alterations of the base metal

Arc strikes on the surface of equipment are forbidden and the Manufacturer shall take all necessary precautions to avoid them. For this purpose, the equipment (cables, earth clamps, etc.) shall be kept in good condition.

In TIG welding, it is forbidden to strike the arc on copper plates. TIG welding equipment shall preferably be equipped with remote striking devices (high frequency, etc.).

If traces of arc strikes are detected, these shall be removed and their location carefully examined by liquid penetrant examination to ensure that no cracking has occurred.

For the welding of austenitic stainless steel, care shall be taken to avoid direct contact between copper and parts to be welded: earth clamps, electric cable lugs, etc.

#### 7.3.8 Welds with removal of root passes – Weld with backing run

##### 7.3.8.1 Welding procedures with removal of root passes


If the root zone is not taken into account in the welding procedure qualification (in accordance with “**Annexure 6\_Welding\_Section 2**\_Welding Procedure Qualification”) , the root passes and the corresponding heat-affected zones shall be totally removed by grinding, chipping, machining or thermal gouging, followed by grinding.

##### 7.3.8.2 Welding procedures with backing runs

Before making the backing run, all traces of defects such as lack of fusion, incomplete fusion, slag, etc., shall be removed, if necessary, by grinding, chipping or machining followed by grinding.

##### 7.3.8.3 After removal of the root passes or before making the backing run, an examination shall be performed in accordance with **Clause 10** of this section.

#### 7.3.9 Cleanliness

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During welding and according to the cleanliness classification of the component or part concerned (for the production stage on the basis of which this classification is applied), precautions shall be taken to prevent pollution by arc fumes or slag, in order to satisfy the requirements of “**Annexure 7\_Cleaning and Cleanliness**”. the Manufacturer's attention is drawn to the fact that this requirement may influence the choice of the welding process.

#### 7.4 Weld Surface Finish


- 7.4.1 After welding, the surface of the welds shall be finished so that the required non-destructive examination can be performed.
- 7.4.2 The surface shall display a finish compatible with the non-destructive examination requirements of “**Annexure 5\_Fabrication**” for manufacture, and any additional requirements of the equipment specification.
- 7.4.3 Weld reinforcements exceeding the tolerances shown in the drawings shall be ground or machined within these tolerances. In any case, the reinforcement shall not exceed the values given in tables Table-1 below.

**Table-1:** Maximum permitted reinforcement for butt welds.

*Table RS 7461 : classes 1 and 2 – maximum permitted reinforcements for butt welds.*

	maximum permitted reinforcements on the front side	maximum permitted reinforcements on the back side
Welds with backing run	1/10 of the bead width + 1 mm (1) with a maximum of 5 mm	1/10 of the bead width + 1 mm
Welds without backing run	1/10 of the bead width + 1 mm (1) with a maximum of 5 mm	e/20 + 0.5 with a max of 1.5 mm (2)
(1) For non-flush welds on pipes, the maximum permitted reinforcements shall not exceed the following values: <ul style="list-style-type: none"> <li>1.5 mm for <math>e \leq 5</math> mm</li> <li>2 mm for <math>5 &lt; e \leq 10</math> mm</li> <li>2.5 mm for <math>e &gt; 10</math> mm</li> </ul> (2) For butt welds on pipes, the permitted back reinforcement shall be: <ul style="list-style-type: none"> <li>1.5 mm for <math>e \leq 5</math> mm</li> <li>2.5 mm for <math>5 &lt; e \leq 10</math> mm</li> <li>3 mm for <math>e &gt; 10</math> mm</li> <li>e : nominal thickness of the pipe</li> </ul>		

- 7.4.4 The weld surfaces and adjacent surfaces shall be cleaned to remove spatter, slag, scaly oxides, grease, etc., liable to interfere with the inspections and non-destructive examinations.
- 7.4.5 The grinding wheels or belts, tools and products used for finishing welds for austenitic stainless steel welds, shall satisfy the requirements of “**Annexure 5\_Fabrication**” .

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7.4.6 Precaution shall be taken to prevent the contamination of austenitic stainless steel parts by ejected particles from finish-grinding carbon steel or low-alloy steel welds in the vicinity.

## 7.5 Visual and Dimensional Examination

### 7.5.1 Non-destructive examination methods

Dimensional examination as per “Annexure 11\_Dimensional Inspection”.

According to the requirements of RMC 7100 and RMC 7200, for the visual examination.

### 7.5.2 Extent

All weld joints


### 7.5.3 Time of examination

Before the execution of the other non-destructive examinations required by this specification.

### 7.5.4 Acceptance criteria for the appearance and dimensions of welds

The dimensions and surface condition of the front and back surfaces, where the latter is accessible, shall comply with the requirements indicated on the relevant drawings and, as regards the weld, with the following criteria, unless otherwise specified in the drawings and equipment specifications.


- Maximum permitted reinforcements: For butt welds, these shall not exceed the values given in the Table-1.

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- Offset: According to the requirements of “**Annexure 5**\_Fabrication”.
- Overlap: No overlap of a weld reinforcement over the edge of a part shall be acceptable.
- Incompletely filled groove: Insufficient throat due to gravity not exceeding 0.5 mm is acceptable for welds executed in the overhead position. In all other cases, this type of defect is unacceptable.
- Lack of penetration: Lack of penetration shall not be acceptable.
- Undercut: Undercut shall not be acceptable (defects No. 5011 undercut and No. 5013 shrinkage groove, as defined in standard NF **EN ISO 6520-1**)
  - If such defects exist, they shall be completely removed by grinding and repaired, if necessary, by welding. In the case of discontinuities between the weld and the adjacent surfaces in the form of a smooth-profiled depression along the weld, where it would not be possible to detect undercuts, as defined above, by visual examination alone, the following steps shall be taken:
    - In the case of welds to be trimmed by grinding, these imperfections shall be removed during the course of these operations,
    - In the case of welds which may be left in the as-welded condition, only those imperfections which may lead to unacceptable indications during subsequent liquid penetrant or magnetic particle examinations shall be removed by trimming.
- Other defects: Incompletely filled grooves, weld collapse, shrinkage, undercuts and spongy formations at the root of the weld shall not be acceptable.

## 7.6 Production Weld Data Sheet (WDS)

7.6.1 Following the completion of a welding operation (welded joints, repairs), a production weld data sheet shall be prepared for each operation or group of operations involving the same welding procedure. This production weld data sheet shall indicate:

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- The equipment reference number to which the joint or the repair belongs
- The reference number of the joint, the group of joints or repair
- The reference of the welding procedure used
- The reference number of the lot or lots of filler materials used
- For each operation, the name (identifying symbol) of the welding operator(s) responsible
- For automatic welding, the reference of the machine used.

## 8. Weld related heat treatments

### 8.1 Preheating

Austenitic stainless steels are not preheated.

### 8.2 Interpass temperature

Regular checks shall be made to ensure that the interpass temperature remains within the range required by the welding procedure.

The specified temperature shall be monitored by means of:

- thermocouples (RF 8140a),
- pyrometers or contact thermometers,

The use of heat-sensitive pens is forbidden for welding austenitic stainless steels in order to prevent the introduction of low-melting point products.

The points of measurement shall be chosen so as to ensure that the specified temperature is reached throughout the whole thickness and over the whole area to be welded.

### 8.3 Postheating

Austenitic stainless steels are not post-heated.


## 9. Repair by Welding

### 9.1 General

No weld repair shall be performed without qualification of the welding procedure. Welding procedures used for welding repair shall be qualified in accordance with this document.

All repair welding operations on welds, on parts or products shall meet the same requirements as those applied to production welds.

Two repair welding operations may be performed at the same point. The Manufacturer shall not make further welds until he has prepared a report analyzing the cause of these successive repairs. The same applies to repairs which occur too

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regularly or to the detection of defects which might invalidate the conditions of application of the procedure, or the qualification itself of the welding procedure.

If the extent of the repairs to be carried out on a weld performed by an automatic process is likely to exceed one fifth of its length and half of its thickness, the weld shall be carried out a second time and retested.

In case of pipe, if a defect in the root area of a joint welded on one side only using an automatic process cannot be repaired from the inside then the weld shall be redone.

## 9.2 Special Case of Repairs by Welding Exempted from Subsequent Heat Treatment

In general, Repair by welding after final heat treatment is forbidden. However, repairs may be carried out, subject to the approval of the ITER-India and provided that the welding procedure has been covered by a special qualification test and satisfies all the requirements of **Clause 9.2.1 and 9.2.2** below.

### 9.2.1 Operating procedure requirements

- The welding procedure defines the minimum dimensions of the repair. The repair procedure shall indicate the number, size and relative location of the excavations.
- The steel shall be as defined in the Engineering Drawing.
- The repair shall be carried out to a qualified arc welding procedure **whereby a low hydrogen weld metal is deposited in stringer beads.**
- The base metal and the weld metal used for the qualification test shall be taken from materials purchased for manufacture.
- The metal shall be removed by mechanical means.
- The preheat temperature of the area to be overlaid shall not be less than that of the qualification test.
- The energy parameters prescribed in the welding procedure shall be continuously monitored during the entire welding operation.
- The second layer of weld metal shall be deposited in order to ensure tempering of the heat affected zone in the base metal. Similarly, after filling, additional beads shall be deposited on top of the last layer without overlapping the base metal in order to ensure tempering of the heat affected zone in the base metal caused by the last layer to be deposited **(Figure 1)**.


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Figure RS 7620a: Successive first layers of repair welds

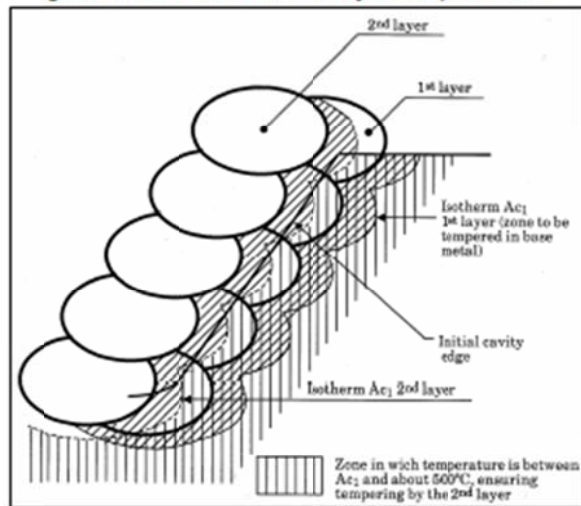


Figure RS 7620b: Repairs by welding exempted of subsequent heat treatment.

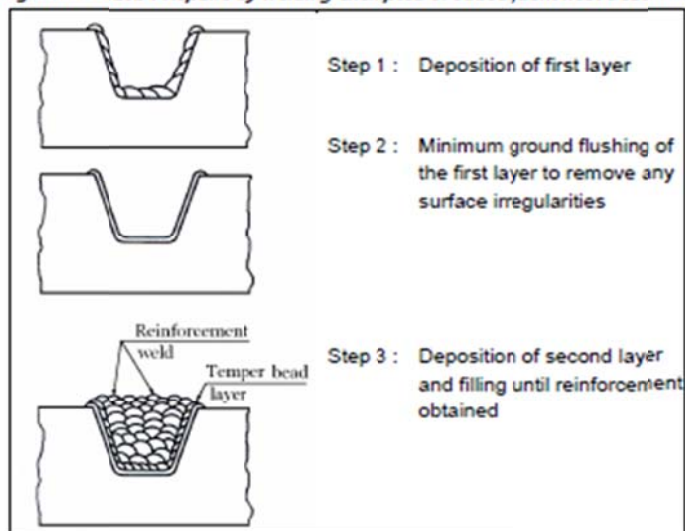


Figure-1 : Methodology for repair

## 9.2.2 Non-destructive examinations of the repaired zone


9.2.2.1 The repaired zone shall be examined at least 48 hours after cooling.

9.2.2.2 The following are performed:

- The examinations specified in **Clause 10** of this section.
- Additional examinations comprising:
  - The examination which revealed the original defects.
  - Any additional examinations needed to check the quality of the repaired zone.

## 9.2.3 Supporting calculations



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The Contractor may require a stress analysis of the equipment in service. This shall take account of the effect of the repairs. The methods used for these analyses shall be agreed between manufacturer and ITER-India.

## 10. Non-Destructive Examination of Production Welds

### 10.1 Methods

#### 10.1.1 Liquid Penetrant Examination for Surface Examination

These examinations shall be performed in accordance with the requirements of **RMC 4000** for liquid penetrant examination.

Inspection using Photothermal camera is permitted in the case where the manufacturer has qualified the method/acceptance criteria prior to the weld

Refer Clause 4 of Annexure 5 for the requirements related to LDP.

#### 10.1.2 Volumetric Examination

Welds shall be subjected to volumetric examination using the radiographic technique. Where there is difficulty in performing the radiographic examination, it may be replaced by ultrasonic examination (for austenitic welds, see the prescriptions of note of **RMC 2610**).


These examinations shall be performed in accordance with the requirements of **RMC 3300** for radiographic examination and **RMC 2600 and RMC 2700** for ultrasonic examination.

Anti-counterfeit measures to be put in place following NF A09-283 “Non-destructive testing - Traceability and securing of radiographic testing” to ensure full reliability of controls. Refer: Template\_Traceability of radiographic control \_Supervision\_Observation\_Report

The results from all these tests shall be included in Manufacturer’s Construction Records. All Radiographic testing records shall be digitalized with a quality allowing full exploitation of the test result as the original (e.g. standard NF\_EN\_14096-1, Non-destructive testing - Qualification of the radiographic films digitalization systems)

**Tables RS 7720** specify the special provisions adopted for certain types of welds for which volumetric examination is not required or cannot be performed.

On welds where it is specified that volumetric examination be performed and radiography or ultrasonic inspection is not possible, Production Weld Test Coupon (Production Proof Sample) is mandatory. **Clause 12** of this section for the requirements related to Production Weld Test Coupon.

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## 10.2 Extent of Examination

### 10.2.1 Butt Welds

These welds shall be examined over their entire length unless otherwise specified in **Tables RS 7720.**

#### 10.2.1.1 Extent of butt welds surface examinations

For surface examinations, submitted areas are the weld metal and adjacent base metal on either side of the joint over a width of at least 15 mm.

This examination is performed on the outer face of the weld and on the inner face when accessible. In the opposite case, the weld root is made with 1 to 3 passes using a welding process with gas protection, with or without filler metal. A surface examination shall be performed each time the welding process changes.

#### 10.2.1.2 Extent of butt welds volumetric examinations

For all VQC 1A welds, 100% volumetric examination of production welds shall be performed.

For volumetric examination of achieved welds, the weld metal and the adjacent base metal, over a distance of:

- At least 10 mm in relation to the actual groove, or excavation cavity in the case of repair, where  $e > 30$  mm,
- At least 5 mm in relation to the actual groove or excavation cavity in the case of repair, where  $e \leq 30$  mm.  
( $e$ =thickness)

Preferred volumetric Examination:


The range of wall thickness (Wt) and preferred volumetric examination method is given in below table:

Wall Thickness	Preferred Volumetric Examination Method
Wt < 12 mm	Radiography
12 mm > wt < 19 mm	Radiography & Ultrasonic
wt > 19 mm	Ultrasonic

**Table 7-1 Range of wall thickness and preferred volumetric examination method**

For radiographic examination, film viewing shall be in accordance with the requirements of **RMC 3312.52b**

Fully penetrated welds are made by welding with back weld **(type I.1, as per RC 3330)** or, for reasons of accessibility, may exceptionally be made by using:

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- A process with protective gas on the back for the bead root (type II.1, as per RC 3330). These joints will be subjected to radiographic examination.

When the joint is made with a penetration pass using a gas shielded process, special volumetric criteria or particular ultrasonic examination modes may be proposed for the root of the weld after testing on a model.

#### 10.2.2 Fillet Welds

These welds shall be examined over their entire length unless otherwise specified in Tables RS 7720.

##### 10.2.2.1 Extent of fillet welds surface examinations

For surface examination, areas of completed welds subjected to examination are the weld metal and the adjacent base metal of parts A and B over a width of at least 15 mm. The examination shall be performed on the outer face of the weld end and, if necessary, on the inner face when accessible.

##### 10.2.2.2 Extent of fillet welds volumetric examinations

For volumetric examination, areas of completed welds subjected to examination are the weld metal and the adjacent base metal of part A for set-on branches, and of part B for set-in branches, over a distance of:

- At least 10 mm in relation to the actual groove, or excavation cavity in the case of repair, where  $e > 30$  mm ( $e$ = thickness of the support part),
- At least 5 mm in relation to the actual groove, or excavation cavity in the case of repair, where  $e \leq 30$  mm ( $e$ = thickness of the support part).


For radiographic examination, film viewing shall be in accordance with the requirements of RMC 3312.52b.

Manufacturer should make provisions with respect to the shape and position of the groove allowing him to ensure that the weld metal is examined in its entirety.

The 10 mm and 5 mm are measured from the actual groove on the surface of the part.

Full penetration angle joints (type III.1) welds are made after back welding or, for reasons of accessibility, may exceptionally be made by using a process with protective gas on the back for the bead root (type III.2, as per RC 3330).

When the radiographic examination cannot be performed, the Manufacturer must carry out: either a 100% ultrasonic examination, the procedures and criteria of which are submitted to the Contractor after testing on a model.

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### 10.2.2.3 Welds for pipe intersections

The corner joints used for pipe intersections are subjected to: **(Table RS 7720b3 Tables RS 7720.**

- liquid penetrant examinations for all pipe diameters,
- radiographic examinations for diameters in excess of 60 mm

For branch connections with diameters between 60 and 114 mm, a film may be exposed per branch connection and a 100% radiographic examination of the branch connection may be performed if the film shows one unacceptable defect.

## 10.3 Time of Examination

### 10.3.1 During Execution of Weld

For welds at the intermediate stage, the examination, when required in **(Table RS 7720b3 Tables RS 7720,** shall be performed after preparation of the surface, as required in **Section 3 of RCC-MR 2007.**

When it is carried out on welds exempted from volumetric examinations after completion, the liquid penetrant examination during execution of the weld is performed with the following frequency:

- Every three layers when  $e \geq 20$  mm
- Every two layers when  $e < 20$  mm

Liquid penetration examination is mandatory after the preparation for the backing run when no final radiographic or ultrasonic examination is required. This examination shall be performed in accordance with paragraphs **RS 7721** for the method to be used and **RS 7363 and RS 7724** for the acceptance criteria.

### 10.3.2 After completion of Weld


For completed welds, the examination shall be performed after finishing and preparation, as required by the examination methods of **Section 3 of RCC-MR 2007.**

In general, when more than one examinations are required, they shall be carried out in the following chronological order; liquid penetrant examination, ultrasonic examination and or Radiographic examination.


Surface Examination and Volumetric Examination shall be carried out after the final heat treatment / stress relieving heat treatment (as and if applicable).

## 10.4 Acceptance Criterion

### 10.4.1 Liquid penetrant examination

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- Only indications > 2 mm are considered recordable conditions. However, any alignment in excess of 20 mm of indications which are close together, even if the latter are of a size less than the recording threshold, shall be the subject of further analysis in order to determine the nature of such indications.
- The following are unacceptable:
  - linear indications,
  - rounded indications whose greatest dimension is > 4 mm,
  - 3 or more indications in a line, less than 3 mm apart edge to edge,
  - groups of 8 or more indications in a rectangular area of 100 cm<sup>2</sup> chosen in the most unfavourable manner in relation to the indications and whose largest dimension shall not exceed 20 cm.

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#### 10.4.2 Radiographic Examination

The following criteria apply to strength welds within the limits defined in **Clause 10 of this section.**

- The following are unacceptable:

Defect Type		Permitted maximum
Planar Defects	Cracks or lamellar tears	Not permitted
	Lack of root fusion	
	Lack of side fusion	
	Lack of inter-run fusion	
	Lack of root penetration	
Solid inclusions	Slag inclusions - individual	20% of t or 2 mm, which ever is smaller
	Slag inclusions - Group	Aggregate length not to exceed t in a length of 12 t, except when the distance between successive indications exceeds 6L where L is the longest indication in the group
	Inclusions – <b><i>Tungsten</i></b> or Copper	Not permitted
Cavities	Isolated pores - round	Diameter <20% t or 2 mm, whichever is smaller
	Gas pore uniformly distributed porosity	1% for single layer (2% for multi-layer) by area where the area of the radiograph to be considered is the length of the weld affected by the porosity times the maximum thickness of the weld
	<b><i>Elongated pores - wormholes</i></b>	<b><i>Not permitted</i></b>
	<b><i>Linear Porosity</i></b>	<b><i>Not permitted</i></b>
	<b><i>Under cut</i></b>	<b><i>Some intermittent undercut permitted. Depth not to exceed 0.5 mm for t &gt; 3 mm or 10% for t &lt; 3 mm. Under cut to blend smoothly with the parent material.</i></b>
Profile defects	Incompletely filled groove, sagging. Root concavity, shrinkage groove	0.05 t or 0.5 mm, which ever is smaller. Weld thickness shall not be less than the parent plate thickness
	Excess penetration - pipe	Not greater than 5% of the pipe internal diameter up to 2 mm max.
	Excess penetration – plate	t = 0.5 to 3 mm: h ≤ 1 mm+10% b t > 3mm: h ≤ 1 mm+20% b max 3mm.
		h=height of excess penetration on backside of plate and b the width
	Excess weld material	Not greater than 10% weld width
	<b><i>Misalignment</i></b>	<b><i>Not greater than 10% of the parent material thickness</i></b>
	Fillet leg length (asymmetry)	Unequal leg length should not exceed 20% of the fillet throat thickness
	Burn through	Not permitted
Other	Root oxidation	Not permitted where a backing purge gas is specified in the WPS



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#### 10.4.3 Ultrasonic Examination

All indications with an echo amplitude > 50% of the reference echo amplitude ( $H_d/H_r > 1/2$ ) shall be recorded.

- The following are unacceptable:
  - Any non-volumetric indication as defined in **RMC 2637 d**
  - Any non-volumetric indication whose length exceeds that specified in the **Table-2** in relation to the  $H_d/H_r$  ratio.

Table-2: Ultrasounds-maximum permitted length of an indication

*Table RS 7724.41 : Ultrasounds- maximum permitted length of an indication*

Value of the maximum amplitude $H_d$ of the defect echo compared with the amplitude $H_r$ of the echo at the hole in the reference block		Maximum permitted length of indication corresponding to a defect or a group of defects
<b>Thickness <math>\geq 50</math> mm :</b>	<b>Thickness &lt; 50 mm :</b>	
$2H_r < H_d$	$1.5 H_r < H_d$	Unacceptable
$1.5 H_r < H_d \leq 2 H_r$	$H_r < H_d \leq 1.5 H_r$	20 mm
$H_r < H_d \leq 1.5 H_r$	$0.75 H_r < H_d \leq H_r$	30 mm
$0.5 H_r \leq H_d \leq H_r$	$0.5 H_r \leq H_d \leq 0.75 H_r$	60 mm
Nota : Individual indications of an amplitude below the specified threshold are not considered as defects needing repair. However, if they are continuous for a length of more than 200 mm, they shall be further analyzed to determine their nature.		

#### 10.5 Repair

If an unacceptable defect is revealed in the course of non-destructive examination of a welded joint, a repair shall be carried out in accordance with a procedure meeting the requirements of RS 7600.

##### 10.5.1 Examination after excavation

10.5.1.1 Method: Liquid penetrant examination.

10.5.1.2 Extent of examination: The entire surface of the cavity.


10.5.1.3 Acceptance criteria: If the cavity is entirely contained within the area of the weld metal any indication > 2 mm is unacceptable. If a part of the adjacent base metal is affected, the criteria applicable to this part shall be those defined in **Clause 6.6 of this section**, taking account of the criteria for edges to be welded

##### 10.5.2 Examination after repair by welding

The method used, the criteria applicable and the documents to be prepared are the same as those required before repair to the type of joint concerned **(Table RS 7720b3 Tables RS 7720)**.

#### 10.6 Report

Report is mandatory for Liquid Penetrant Examination, Radiographic examination and Ultrasonic Examination.

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## 11. Helium Leak Testing of Production Welds

100% of vacuum sealing welds shall be subject to helium leak testing in accordance with the requirements and procedures of the “**Annexure 10**\_Leak Testing”.

Where multi-pass welding is required in the production of components of VQC 1A, it is recommended that leak testing of the root weld pass shall be performed with only this pass completed. However, for multi-pass welding that takes place on the ITER site, this requirement is mandatory.

All repaired vacuum boundary welds shall be subject to full vacuum leak testing with the same procedure and acceptance criteria as that of original weld.

## 12. Destructive Testing of Production Welds: Production Weld Test Coupons

**(This is similar to Production Proof Sample- PPS of IVH.**

**RCC-MR requirements, being more stringent, have been considered)**

### 12.1 Principles

An ITER-India and/or IO representative will witness PPS welding. The representative will also review the destructive and non-destructive examination reports. Operations with witness and hold points to facilitate this must be incorporated in the Work Schedule.

The Manufacturer shall prepare production weld test coupons during manufacture as evidence of the consistency and quality of the production welds and to ensure conformity with the operation requirements determined by the welding procedure qualification test.


The production weld test coupons shall be representative of the production welds to which they refer. The base metals and filler metals shall be in accordance with the requirements of procurement and acceptance specifications.

The base metal or similar shall, in order of preference:

- Be taken from the materials supplied for the manufacture of the component.
- Be taken from the heat from which any products used in this manufacturing process are derived.

If both the above requirements are technically impossible, the Manufacturer shall define the methods used to ensure that the metal is properly representative. For Automatic or Mechanized GTAW (including Hot Wire GTAW), the base material for the Production Weld Test Coupon must be from the same heat as that of the actual component material.



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The direction of primary extension of the base metal test coupon shall be identified, where applicable, and shall correspond to the conditions of the welding procedure qualifications. However, the orientation of the base metal test coupons may differ from the qualification test. The filler materials shall be taken from lots used for the production welds.

The production weld test coupon shall be executed by the welders and/or welding operator who carried out the production welds concerned by the execution of this test coupon.

The same or similar tools or welding equipment as those used for production welds shall be used for the execution of this production weld test coupon.

## 12.2 Number of Production Weld Test Coupon

12.2.1 As a general rule, and subject to the special requirements below, the following shall be executed:

For the all the VQC1A joints of the vessel, one production weld test coupon:

- Per welding procedure qualification
- Per workshop (unless the welding procedure qualification has been transferred in accordance with "Annexure 6\_Welding\_Section 4\_Tech. qual. of prod. Workshops")


12.2.2 Additional requirements for the welds where radiography or Ultrasonic testing is impractical (e.g. welds that are not full penetration butt welds):

- Each Production Weld Test Coupon will only represent a specific type of weld and must use the same materials, thickness and set-up as the production weld.
- The Production Weld Test Coupon must be welded during the same shift as the production welds and by the same welder using the same equipment to be representative of the production welding.
- If more than one welder welds the production welds, each must perform a Production Weld Test Coupon.
- Production Weld Test Coupon are required each shift production welding is being performed to represent the welds performed on that shift.

## 12.3 Welding of Production Weld Test Coupons

Test coupons shall be welded in accordance with the corresponding production welds and whenever geometrically possible in the extension of a longitudinal weld.

The welding of the test coupon shall be carried out under the supervision of the workshop inspection section by welders or welding operators carrying out the corresponding production welds, using the same welding parameters and the same

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type of welding equipment. Readings (or recordings) shall be taken in the same way as in welding procedure qualification tests.

It is forbidden to repair defects detected during the final non-destructive examination. The size and cause of these defects shall be stated in the report.

The dimensions of the production weld test coupons shall satisfy the requirements of the welding procedure qualification test coupon and shall be sufficiently long so that all the tests, retests and repair procedure required for qualification can be performed.

#### 12.4 Examination

The production weld test coupons shall be examined as quickly as possible, and in any case within two months following the end of the welding and heat treatment operations.

#### 12.5 Tests


The production weld test coupon is divided into two parts (if the test coupon is subjected to post-weld heat treatment):

- The first (considered to be the actual test coupon) is subjected to the same heat treatments as the production weld and is heat treated at the same time as the latter, unless this is technically impossible. It shall be sufficiently long so that the specified tests and retests can be performed.
- The second, non-heat treated part (or subjected to simulated stress-relieving heat treatment) is used to detect and correct any deterioration in quality or is retained for retests or repair procedure qualification. According to circumstances and his experience, the Manufacturer shall specify the length of this part, which, in the case of pipes, may consist of off-cuts not used for the tests. This part shall be retained pending acceptance of the production weld test coupon report.

The production weld test coupon shall be subjected to the same non-destructive tests as the production welds and the acceptance criteria shall be same as the production welds.

The test specimens shall be taken from positions outside areas containing defects which are unacceptable according to the criteria of the non-destructive examination.

The series of tests to be performed on the weld test coupons and the results to be obtained are the same as for the welding procedure qualification test coupons ("Annexure 6\_Welding\_Section 2\_Welding Procedure Qualification "). Account shall be taken of the following:

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- The chemical analysis is carried out in a zone free from dilution effect. If non possible, the results of chemical analyses (including ferrite content) obtained in the deposited weld metal for the acceptance of the lot(s) of filler material which was used for the production of the weld test coupon, will be indicated in the weld test coupon report with mention of the reference of the initial filler material test report.
- The longitudinal weld metal tensile tests are not required
- Test piece should be sectioned and macro examined in four places (including one stop/start area). Photographs of the macros giving the date of welding the Production Test coupon, the welder's identity and identifying the production welds it is covering must be included in the final documentation package.

## 12.6 Rejection of the Production Weld Test Coupon

12.6.1 As the Production Weld Test Coupon is a representative sample, rejection of the macro will result in rejection of all welds covered by this Production Weld Test Coupon.

12.6.2 Except for Macro, if the results of the series of tests and retests are not in accordance with the requirements, in order that the component be considered as complying with the requirements of RCC-MR, the Manufacturer shall carry out an investigation and prepare a report. The investigation shall include at least:

- An inquiry into the reasons for these results
- An analysis of their consequences
- Additional findings obtained by studies or direct examinations for the equipment itself demonstrating that its usefulness is not affected.


If, exceptionally, a mistake in the preparation or analysis of a subsequently identified production weld test coupon makes the latter partially or totally unrepresentative, the Manufacturer shall investigate the data which has been lost and their potential consequences, and shall specify measures by which the situation can be remedied.

Test welds which have not be destroyed shall be kept for additional inspection which might be requested under the terms of the Component Specification.

## 12.7 Production Weld Test Coupon Reports

The report shall be prepared by the Manufacturer and shall cover:

- The conditions (required and as recorded) for execution of the test coupon, and in particular the welding sequences, the names of the welders and the lots of filler materials used etc.,

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- The non-destructive examinations performed and the results obtained, the destructive tests performed together with the required values and the results obtained.