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Technical Specification of Shield Block for the ITER Blanket System

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TECHNICAL ANNEX B1_01

SCOPE OF THE PROCUREMENT ARRANGEMENT

Abstract

This document is prepared based on the Annex B of the ITER Blanket Shield Blocks Procurement Arrangement 1.6.PB1.KO.01 (hereinafter PA) and describes technical specification for the supply of the Blanket Shield Blocks to National Fusion Research Institute (hereinafter NFRI). This document defines the mandatory information to be supplied together with the Tender for the scope of Annex B by potential suppliers.

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1 Extent of Supply

This contract covers the manufacturing of:

- 1) One Full-Scale Shield Block (SB) prototype per manufacturing technology and per manufacturer, which is required for the pre-production qualification, specifically SB 06 to be agreed with Korea Domestic Agency, NFRI (hereinafter IO-DA) and ITER Organization (hereinafter IO-CT) ;
- 2) The deliverable list of documents and data to be submitted by the supplier are defined in section 3 of Annex B1_01.
- 3) Calibration blocks as required for the test campaign including UT testing.
- 4) Handling, support and protection jig and fixtures required during transportation and test as described in section 2 of Annex B1_01.

Table 1 SB Quantities

Poloidal row of SBs	Numbers
SB01	18
SB02	18
SB06	18
SB07	18
SB08	18
TOTAL NUMBER OF	90

The supply shall also include the following items:

- The engineering activities consisting of
 - The manufacturing drawings;
 - The technical specification for the manufacturing process;
 - The technical specifications for tests and inspections;
- The Quality Plan and the Manufacturing and Inspection Plan (one MIP for each manufactured SB) required to follow up on the manufacturing.
- All the necessary equipment for inspection during manufacturing
- Certification of qualified personnel for the manufacturing and examinations.
- All welding and inspection tools, jigs and fixtures, which are needed for the execution of this contract during manufacturing
- The cleaning and packaging and the delivery to the ITER site of the SBs (see APB1_07 and APB1_08)

- The witnessing of the final acceptance tests of the SBs at the ITER site, if and when so wished by the supplier (see APB1_09)

2 Handling, Support and Protection Jig and fixtures for the SB

In order to handle, support and protect the SB during transportation and storage, a support jig shall be manufactured. The jig shall also allow a 4-high stacking of SBs to minimise necessary storage volume. SB are wrapped / packaged in a manner that facilitates the final acceptance tests of the component (APB1_09) with limited removal of wrapping.

The components shall be supplied with all required jigs, fixtures and fittings (end caps, probes etc.) required to perform the final acceptance tests at ITER site.

The detailed design of this component shall be agreed between the Supplier and IO-DA. The agreement on the detailed design of the support jig represents an Authorization-To-Proceed Point.

3 List of PA Deliverable Document

A tentative list of anticipated PA deliverable documents is given hereinafter.

3.1 Pre-production Documents

- Detailed Work Schedule
- Documentation Schedule
- Quality Plan / Quality System Description
- Risk Management Plan
- Inspection Application Plan
- Manufacturing and Inspection Plan (MIP) for the prototype
- MIP Control Procedure
- Detailed design of the handling and support JIG
- General assembly drawings of the SB prototype
- Manufacturing Drawings of the SB prototype
- Description of the Manufacturing Processes and their Qualification Procedures
- Procedures for Manufacturing and Inspection
- Handling and Packaging Procedure
- Marking and Identification Procedure
- Cleaning Procedure
- Non-destructive Testing Protocols (UT, RT, VT, DT, LPT)
- Geometrical Shape and Tolerances Protocol for the SB prototype
- Preliminary Welding Data Package
- Welding Data Package
- Plan of Advanced Manufacturing Technology Development
- Repair Welding Procedure
- Shop Description

- Stress Relieving Procedure

3.2 Process Qualification Documents

- Report of Advanced Manufacturing Technology Development
- Ultrasonic / X-ray examination of welding for the SB prototype
- Acceptance of each weld for the SB prototype
- Confirmation of inspection results “no blocked or partially blocked water channels” for the SB prototype
- Report on the Geometrical Shape and Tolerances for the SB prototype
- Final Welding Documentation for the SB prototype
- Acceptance of Final Cleaning for the SB prototype
- End of Manufacturing Report

3.3 Series Production Documents

- Manufacturing and Inspection Plan for the SBs
- Detailed Design of the Handling and Support JIG for the SBs
- General Assembly Drawings of the SBs
- Manufacturing Drawings for the SBs
- Procedures for Manufacturing and Inspection
- Handling and Packaging Procedure for the SBs
- Welding Data Package for the SBs
- Geometrical Shape and Tolerances Protocol for the SBs
- Cleaning procedure for the SBs
- Ultrasonic / X-ray Examination of Welds for the SBs
- Acceptance of each Weld for the SBs
- Confirmation of inspection results “no blocked or partially blocked water channels” for the SBs of the series production
- Report on the Geometrical Shape and Tolerances for the SBs
- Final Welding Documentation for the SBs
- Acceptance of Final Cleaning for the SBs
- End of Manufacturing Report

3.4 Final Delivery Documents

- Contractor Release Note
- Credit Request Form

TECHNICAL ANNEX B1_02

PROCUREMENT ORGANIZATION

Abstract

This document is prepared based on the Annex B of the ITER Blanket Shield Blocks Procurement Arrangement 1.6.PB1.KO.01 (hereinafter PA) and describes technical specification for the supply of the Blanket Shield Blocks to National Fusion Research Institute (hereinafter NFRI). This document defines the mandatory information to be supplied together with the Tender for the scope of Annex B by potential suppliers.

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1 Overview

The Supplier shall supply the IO-DA with SBs for the following Blanket locations:

- BM 1
- BM 2
- BM 6
- BM 7
- BM 8

2 Procurement Follow-Up

2.1 Notification Points, Authorizations-To-Proceed Points and Hold Points

The Suppliers shall perform a close oversight of the production in accordance with an accepted Manufacturing and Inspection Plan. This monitoring shall include Notification Points, Authorization-To-Proceed Points, and Hold Points at critical steps in the Suppliers' plans. The control points shall be integrated into the agreed Supplier schedule.

A Notification Point (NP) is a milestone where the Supplier is required to notify the IO-DA, who informs the IO-CT, that it has completed a specific task or a specific deliverable and is proceeding to the next task or to the next action on the specific deliverable. A NP is meant to enable IO-DA and IO-CT personnel to follow the progress of the contract and possibly to witness a critical manufacturing step at the Supplier's premises. The Notification shall be sent by the Supplier to the IO-DA at least 10 working days prior to the scheduled manufacturing step. The IO-DA shall inform the IO-CT of the Suppliers' Notification within 4 working days and the IO-DA and the IO-CT shall decide whether or not they want to attend. A NP shall not affect the production flow of the Supplier that shall continue the work even without a reply from the IO-DA and/or IO-CT.

An Authorization-To-Proceed Point (ATPP) is a milestone where the Supplier is required to notify the IO-DA, who informs the IO-CT, that it has completed a specific task or a specific deliverable and must wait for an authorization from the IO-DA before proceeding to the next task or to the next action on the specific deliverable. The IO-DA shall grant the Authorization-To-Proceed on the basis of clearly identified Quality Control data and Acceptance test results to be provided by the Suppliers. The IO-DA shall have 4 working days to review the Supplier's data and to notify the IO-CT of its decision. The IO-CT shall have 3 working days to review the IO-DA decision. Beyond these 3 working days and if there is no IO-CT reaction, the IO-DA shall notify the Supplier of its decision. In case of authorization, the Supplier shall proceed to the next task or to the next action on the specific deliverable. In case of rejection, the Supplier shall develop with the IO-DA a recovery plan that shall be submitted and reviewed by the IO-CT within 5 working days of submission. In case of IO-CT objection, the IO-CT shall detail its motives in writing and the IO-DA shall have 5 working days to answer the IO-CT objection and, whenever suitable, develop a recovery plan with the Supplier. An ATPP shall only affect the specific task or the specific deliverable it is associated with and shall not interfere with the execution of other tasks of the production or other deliverables of the same kind.

A Hold Point (HP) is a milestone where the Supplier is required to notify the IO-DA, who informs the IO-CT, that it has completed a specific task or a specific deliverable and must stop the associated processes until a HP Clearance is issued. The HP Clearance shall be issued on the basis of clearly identified Quality Control, data and acceptance test results to be provided to the IO-DA and the IO-CT at the time of the request. The IO-DA shall have a maximum of 5 working days to review the Suppliers' data and to notify the IO-CT of its decision and the IO-CT shall have a maximum of 5 working days to review the IO-DA assessment and to confirm or reject it. In case of clearance, the Supplier shall resume

its activity. In case of rejection, the Supplier shall develop with the IO-DA a recovery plan that shall be submitted and reviewed by the IO-CT within 10 working days of submission. In case of IO-CT objection, the IO-CT shall detail its reasons in writing and the IO-DA shall have 10 working days to answer the IO-CT objection and, whenever suitable, develop a recovery plan with the Supplier.

The IO-CT list of NPs, ATPPs and HPs to be implemented during the various phases of this PA is given in Table 1. The criteria applied to issue authorizations and clearances are given in dedicated Appendix. Additional Control Points may be identified following review of the MIPs.

Table 1 List of Control Points to be implemented in the PA execution

	NP	ATPP	HP
Responsibility	Supplier informs IO-DA; IO-DA informs IO-CT	Supplier informs IO-DA IO-DA informs IO-CT IO-DA authorizes to Supplier IO-CT may object	Supplier requests to IO-DA and holds related processes IO-DA sends request and assessment to IO-CT IO-CT authorizes IO-DA IO-DA authorizes Supplier
Phase II: Process Qualification		<ul style="list-style-type: none"> - Detailed design of the handling and support Jig - Validation of the cleaning procedures for SB prototype - Ultrasonic / X-ray examination of welding for the SB prototype - Acceptance of each weld for the SB prototype - Confirmation of inspection results "no blocked or partially blocked water channels" for the SB prototype - Acceptance of final cleaning for the SB prototype 	<ul style="list-style-type: none"> - Quality Plan - Manufacturing and Inspection Plan for the prototype - General assembly drawings of the SB prototype - Description of the manufacturing processes and their qualification procedures - Non-destructive testing protocols - Preliminary welding data package - Welding data package - Qualification of all welds - Geometrical shape and tolerances for the SB prototype - Final welding documentation for the SB prototype
Phase III: Series production of SBs		<ul style="list-style-type: none"> - Cleaning procedure for SBs of the series production - Ultrasonic / X-ray examination of welding for the SBs - Acceptance of each weld for the SBs - Confirmation of inspection results "no blocked or partially blocked water channels" for the SBs - Final cleaning for the SBs 	<ul style="list-style-type: none"> - General assembly drawings of the SBs - Manufacturing and Inspection Plan for the SBs - Geometrical shape and tolerances protocol for the SBs of the series production - Geometrical shape and tolerances for the SBs of - Final welding documentation for the SBs

2.2 Data Management

Generally speaking, any document from the Supplier, produced during the execution of this contract, can be sent to the IO-DA for Approval, Acceptance or Information.

The general rule is as follows:

- The IO-DA has responsibility for approving documents related to safety, interfaces, integration and ITER performance.
- The Supplier has responsibility for the documents requested by the contract, therefore the Supplier is responsible to get any such documents approved, before sending them to the IO-DA;
- The IO-DA returns the documents requested by the contract (following the acceptance or approval process);
- Documents sent for information require no further decision (neither acceptance nor approval). Comments can be sent where there is a serious, major issue on the content of the document.

The data generated during the execution of the present contract shall be handled electronically and entered into a database similar to the ITER IDM. Exchange of documentation between the Contractor, the IO-DA and the IO-CT shall comply with the "Procedure on Procurement Documentation Exchange between IO, DA, and contractors" (*Procedure on procurement documentation exchange between IO-CT, IO-DAs and contractors (35BVQR v2.1)*). These engineering data shall be organized according to the "ITER Document Breakdown Structure Overview ([ITER Document Breakdown Structure Overview \(43327Q v1.1\)](#))" and to the document "ITER Plant Breakdown Structure" ([ITER Plant Breakdown Structure \(28WB2P v2.0\)](#)).

The structure of this database shall be defined by IO-CT in agreement with the IO-DA. The Supplier shall use this database to store information related to the contract. All data entered in the database will be kept strictly confidential by Supplier and, under no circumstances, shall be communicated or made accessible to other Suppliers or IO-DAs. Data consistency checks shall be implemented to facilitate IO-DA and IO-CT oversight. Data flow shall be consistent with the following protocol:

- Data flow from the Supplier to the IO-DA: Relevant data shall be made available by the Supplier to the IO-DA through the database each time a control point is requested, or a deviation request, a non-conformance report, or any other document which is part of the PA deliverables is issued by the Contractor.

The exchange of CATIA detailed models, drawings and schematics shall be in agreement with the "DCIF" document.

2.3 IO-CT Reviews

The IO-CT and IO-DA will organise Status Reviews (SRs) and Quality Control Reviews (QCRs). These may be focused on particular areas of production and will be organised by IO-CT as required by the progress and performance. IO-CT will appoint the review group and define its terms of reference. The present schedule for these reviews is as follows:

- Pre-Production Readiness Review, at the issue of the pre-production documentation (i.e. before starting the manufacturing of the prototype(s) in Phase II of Table 1),
- Production Readiness Review, at the end of process qualification (i.e. after Phase II of Table 1),
- Status and/or Quality Control Review as needed during series production upon IO-CT or IO-DA proposal.

The Pre-Production Readiness Review, the Production Readiness Review and the Status and Quality Control Reviews are carried out in parallel to the PA execution and are not Hold Points.

The IO-CT shall organise all the above mentioned Reviews. The Review Panel is chaired by the IO-CT TRO and shall consist of representatives of the IO-DA including those responsible for the procurement being assessed, the IO-CT and external reviewers appointed by the IO-CT with the agreement of the IO-DA. The Review Panel shall submit a report to the ITER Blanket Section Leader for his approval. The outcome of the review shall be presented on the timescales of one week assuming no major issues.

2.4 Documentation review cycle

Unless otherwise mentioned, the standard documentation review cycle shall be:

- IO-DA shall have ten (10) working days from the receipt of Supplier's Documents to review, comment on and/or, as the case may be, accept/approve them;
- The Supplier shall have eight (8) working days from the receipt of commented documents to update and resubmit them to IO-DA; and
- IO-DA shall have five (5) working days from the receipt of the Supplier's submission to review and return the documents.
- On submission of documents for acceptance: if no comments have been received within the defined time frame, the document is deemed to have been accepted by IO-DA.

The Supplier shall provide IO-DA with the documents and data defined in the Section 3 of Annex B1_01. In case the Supplier revises the documents and data submitted to the IO-DA, the Supplier shall immediately submit them to the IO-DA for the same submittal purposes as the originals until the documents and data become "As-Built" status.

3 Blanket Safety Requirements

No safety function is credited to the Blanket. Therefore, it is considered as non-SIC (Safety Importance Class).

Materials composition shall provide As Low As Reasonably Achievable (ALARA) requirements on radioactivity protection for minimisation of radioactive waste, generation of activation corrosion products and contact dose (such as a limit on Co impurities).

4 Quality Class

The SB, including all its parts and materials, is assigned a Quality Class 1 according to the ITER Document [Quality Classification Determination \(24VQES v4.1\)](#).

5 Vacuum Quality Classification and Requirements

The pressure boundary parts and materials of the SB are assigned a Vacuum Classification VQC-1A. The bolt inserts and fittings are assigned a Vacuum Classification VQC-1B.

The SB shall comply with the requirements stated in the "ITER Vacuum Handbook" for this class of components (IDM reference: [ITER Vacuum Handbook \(2EZ9UM v2.3\)](#)). In case of conflict with the requirements of this document, this shall be brought to the attention of IO-DA for resolution.

In particular, it is pointed out in Section 5.3 of the ITER Vacuum Handbook that all VQC-1A components, which are machined from austenitic steel 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). Alternative processes for achieving the required inclusion limits may be accepted if successfully validated.

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: Inclusion Type A, B, C ≤ 1.0 , Inclusion Type D ≤ 1.5 .

Section 5.4 of the ITER Vacuum Handbook includes the requirements for outgassing rates of materials with details and guideline given in Appendix 17 of the ITER Vacuum Handbook.

Section 5.5 of the ITER Vacuum Handbook states that Hot Isostatic Pressing (HIP) of sintered material is allowable for use on all VQC components forming a vacuum boundary, provided that it is demonstrated that the components meet the mechanical and leak rate requirements for the proposed application and the vacuum boundary thickness is greater than 5mm.

Section 5.7 of the ITER Vacuum Handbook describes the use of plate materials: when hot or cold rolled plate material is used, it is recommended for all vacuum classes, that a surface parallel to the direction of rolling forms the vacuum boundary.

Where for VQC1A hot or cold rolled plate material is used with the transverse cross section crossing the vacuum boundary, low inclusion rate material shall be used which meets the inclusion limits as specified in Section 5.3 and shall be made from material which is Electro-Slag Remelted (ESR) or Vacuum Arc Remelted (VAR).

The component shall also be proven by leak testing in an environment which conform as closely as possible to the operating conditions (See Section 25 of the ITER Vacuum Handbook) with due consideration taken of the effects of possible leaks along laminations on the response time for the test.

It shall also be noted that Attachment 1 "Welding" of the ITER Vacuum Handbook details stricter limits on porosity. As regards tungsten or copper inclusions, the requirements specified in EN ISO 5817 standard apply for thickness > 5 mm.

6 Technical Interfaces

For information, the technical interfaces are described in [SRD-16-BS \(Wall-Mounted Blanket Shield\) from DOORS \(28B2Q4 v2.2\)](#).

7 Licensing Requirements

All the Items to be supplied are excluded from the application of the decree on pressurised equipment, n° 99-1046 dated 13 December 1999, and consequently excluded from the ESPN order.

MANDATORY APPENDIX APB1_01

DRAWING

Abstract

This document is prepared based on the Annex B of the ITER Blanket Shield Blocks Procurement Arrangement 1.6.PB1.KO.01 (hereinafter PA) and describes technical specification for the supply of the Blanket Shield Blocks to National Fusion Research Institute (hereinafter NFRI). This document defines the mandatory information to be supplied together with the Tender for the scope of Annex B by potential suppliers.



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1 3D Models and 2D Drawings

The General assembly drawings will cover at least the following information:

- a. Nominal dimensions and geometrical references of procured assemblies
- b. Resulting overall tolerances on the finished surfaces and identified interfaces of the procured assembly
- c. Surfaces roughness on locations and areas where the procured elements have an interface with non-procured elements
- d. Locations and definitions of the fixing and connecting features of the procured assemblies with other ITER components (including remote handling access)

During Phase II "Process Qualification" and, in any case, before starting Phase III "Series production of SBs", IO-DA shall send the 3D models and 2D "General Assembly Drawings" of the minor variants of all the SBs to be procured to Supplier. Delivery schedule of 3D models and 2D General Assembly Drawings could be changed in accordance with consultation between IO-DA and IO-CT. For each minor variant, an assembly drawing will be delivered. This 2D drawing will refer to the main variant 2D drawings so as not to duplicate the main geometry requirement. This general assembly drawing will cover at least the following information:

- a. Reference to 2D covering interfaces and overall geometrical requirement of main variants
- b. Geometrical reference (datum) of procured assemblies in accordance with main variants
- c. Geometrical deviation compared to main one
- d. Specific tolerances concerning the local variation from main variant

MANDATORY APPENDIX APB1_02

MANUFACTURING REQUIREMENTS

Abstract

This document is prepared based on the Annex B of the ITER Blanket Shield Blocks Procurement Arrangement 1.6.PB1.KO.01 (hereinafter PA) and describes technical specification for the supply of the Blanket Shield Blocks to National Fusion Research Institute (hereinafter NFRI). This document defines the mandatory information to be supplied together with the Tender for the scope of Annex B by potential suppliers.



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1 General Requirements

Before manufacturing can start, the general assembly drawings for manufacturing shall be accepted in writing by IO-DA (Hold Point).

A detailed description of all the manufacturing processes shall also be accepted by IO-DA in writing. The acceptance of the specifications for all the manufacturing steps and their qualification procedures represents a Hold Point.

Acceptance of IO-DA for the manufacturing process is only aimed at checking whether the supplier's proposal is ITER relevant and whether it is consistent with the requirements of the SB. The supplier has the sole responsibility in the success or failure of the proposed manufacturing process.

Other equivalent national or international standards than those mentioned in this contract may be acceptable with prior written IO-DA's approval. This approval is subject to the submission of evidence that the alternative standard is equivalent to the proposed one.

The SBs shall be compatible with an operation in an ultra-vacuum environment. After the final cleaning procedure, they shall be handled with care and using appropriate gloves and procedures.

Elements with high vapour pressure, e.g. zinc or cadmium, are not allowed as brazing/filler materials, nor those which form the same elements by neutron transmutation, such as silver or gold.

Unless otherwise specified in the 2D drawings, the finishing of all the external metallic surfaces should be $R_a = 6.3 \mu\text{m}$ (ISO N9) or finer except when non-destructive examinations require better values.

Unless otherwise specified in the 2D drawings, the finishing of all the internal metallic surfaces (including the drilled holes) should be approx. $R_a = 6.3 \mu\text{m}$ (ISO N9) or finer except when non-destructive examinations require better values.

Unless otherwise specified in the 2D drawings, all the dimensions shall satisfy the tolerance Class "c" of ISO 2768-1 and tolerance Class "L" of ISO 2768-2.

Heat treatments, which can lead to sensitization of the stainless steels, are not allowed.

Through-wall welding (i.e. "transparent welding") is not allowed.

Welded joints with permanent backing or extra non-fused lid are not allowed.

The crossing of weld lines assembling the various parts of the steel structure is not authorised.

All welds and joints shall be full-penetration welds and shall be qualified according to the procedure described in APB1_03.

MANDATORY APPENDIX APB1_03

WELDING

Abstract

This document is prepared based on the Annex B of the ITER Blanket Shield Blocks Procurement Arrangement 1.6.PB1.KO.01 (hereinafter PA) and describes technical specification for the supply of the Blanket Shield Blocks to National Fusion Research Institute (hereinafter NFRI). This document defines the mandatory information to be supplied together with the Tender for the scope of Annex B by potential suppliers.

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1 Scope

This Appendix relates to welding. It outlines the procedure to be adopted and documents required to be submitted to, and accepted by IO-DA and IO-CT, before the specified welding fabrication can commence.

2 Abbreviations

EN	European Standard
IO	ITER Organization
ISO	International Standard Organization
SB	Shield Block
NDT	Non Destructive Testing
PA	Procurement Arrangement
LDP	Liquid Dye Penetrant
LPT	Liquid Penetrant Testing
PT	Penetrant Testing
pWPS	Preliminary Welding Procedure Specification
RT	Radiographic Testing
UT	Ultrasonic Testing
WPQR	Welding Procedure Qualification Record
WPS	Welding Procedure Specification
VT	Visual Testing

3 Applicable Code and Standards

The SB shall be manufactured according to the following standards:

- EN 13445-1:2009: Unfired pressure vessels – Part 1; General
- EN 13445-2:2009: Unfired pressure vessels – Part 2; Materials
- EN 13445-3:2009: Unfired pressure vessels – Part 3: Design
- EN 13445-4:2009: Unfired pressure vessels - Part 4: Fabrication
- EN 13445-5:2009: Unfired pressure vessels – Part 5: Inspection and testing

The Supplier can propose similar standards subjected to previous written approval by IO-DA. To this aim, the Supplier shall provide evidence that the proposed code and standard is equivalent to the corresponding one, which is specified above.

The welding procedures shall be qualified according to the following standard:

- EN ISO 15614-nn: Specification and qualification of welding procedures for metallic materials-
Welding procedure test - Part nn

Where “Part-nn” means all the relevant parts for this procurement, e.g.:

Part 1 : arc and gas welding of steels and arc welding of nickel and nickel alloys
Part 7 : overlay welding
Part 11 : electron and laser beam welding

Part 13 : upset resistance butt and flash welding.

The following list of standards is recommended. Other equivalent national or international standards and codes may be acceptable subject to the IO-DA's written approval. To this aim, the supplier shall provide evidence that the proposed code and standard is equivalent to the corresponding one, which is specified below:

- EN ISO 9606-1: Qualification testing of welders – Fusion welding – Part1: Steels
- EN ISO 17639: Destructive tests on welds in metallic materials. Macroscopic and microscopic examination of welds
- EN ISO 14732: Welding Personnel – Approval testing of welding operators for fusion welding and resistance weld setters for fully mechanized and automatic welding of metallic materials
- EN 1435: Non-destructive examination of welds. Radiographic examination of welded joints
- EN 1708-1: Welding – Basic weld joint details in steel – Part 1: Pressurized components
- EN ISO3452-1: Non-destructive testing – Penetrant testing – Part 1: General principles
- EN ISO 3452-2: Non-destructive testing - Penetrant testing - Part 2 : Testing of penetrant materials
- EN ISO 3452-3: Non-destructive testing - Penetrant testing - Part 3 : reference test blocks
- EN ISO 3834-1: Quality requirements for fusion welding of metallic materials – Part 1: Criteria for the selection of the appropriate level of quality requirements
- EN ISO 3834-2: Quality requirements for fusion welding of metallic materials – Part 2: Comprehensive quality requirements.
- EN ISO 3834-5: Quality requirements for fusion welding of metallic materials – Part 5: Documents with which it is necessary to conform to claim conformity to the quality requirements of ISO 3834-2, 3834-3 or ISO 3834-4
- EN ISO 5817: Welding - Fusion-welded joints in steel, nickel, titanium and their alloys (beam welding excluded) - Quality levels for imperfections
- EN ISO 6520-1: Welding and allied processes – Classification of geometric imperfections in metallic materials – Part 1: Fusion welding
- EN ISO 8249: Welding - Determination of Ferrite Number (FN) in austenitic and duplex ferritic-austenitic Cr-Ni stainless steel weld metals
- EN ISO 9712: Non-destructive testing – Qualification and certification of NDT personnel – General principles
- EN 10204: Metallic products - Types of inspection documents
- EN 12062: Non-destructive examination of welds. General rules for metallic materials
- EN ISO 13919-1, Welding. Electrons and laser beam welded joints. Guidance on quality levels for imperfections. Part 1: steel
- EN 14532-1: Welding consumables - Test methods and quality requirements - Part 1: Primary methods and conformity assessment of consumables for steel, nickel and nickel alloys
- EN 14532-2: Welding consumables - Test methods and quality requirements - Part 2: Supplementary methods and conformity assessment of consumables for steel, nickel and nickel alloys
- EN ISO 15607: Specification and qualification of welding procedures for metallic materials – General rules
- EN ISO 15609 – n: Specification and qualification of welding procedures for metallic materials – Welding procedure specification – Part NN
- EN ISO 17637: Non-destructive examination of fusion welds - Visual examination
- EN ISO 17640: Non-destructive testing – Ultrasonic examination – Part 1: General principles
- EN ISO 22825: Non-destructive testing – Ultrasonic testing – Testing of welds in austenitic steel and nickel-based alloys

4 Welding Procedure Requirements

4.1 Welding and Inspection Plan

This is IO-DA approved drawing, which cross-references each welded joint to a supporting weld procedure specification.

The format of the Welding and Inspection Plan will be left to the supplier's discretion, but must contain all the necessary information in order that the correct controls are exercised.

4.2 Supplier's Responsibility

In order that the requirements of this specification can be met, the supplier shall prepares a Welding and Inspection Plan as described above.

This Welding and Inspection Plan in conjunction with the following documents

- a. Preliminary Welding Procedure Specifications.
- b. Welding Procedure Qualification Records.
- c. Welding Procedure Specifications.
- d. Welder Certificates.

will require IO-DA's acceptance prior to the commencement of any welding. Subsequent to the submission and acceptance by IO-DA of these documents, the Supplier shall establishes and maintains a list of qualified welders.

4.3 Preliminary Welding Procedure Specification

The supplier shall prepare a pWPS and shall ensure that it is applicable for the actual production, using experience from previous productions and the general fund of knowledge of welding technology.

Each pWPS shall be used as a basis for establishment of a WPQR qualified according to one of the welding methods which will be used.

4.4 Welding Procedure Specification

A Welding Procedure Specification (WPS) is a document, which gives the welder or operator specific instructions on how to complete a welded joint. The qualification of a WPS is performed in accordance with this specification and test results are documented on a form titled "Welding Procedure Qualification Record" (WPQR). A WPS should contain the information according to the standard EN ISO 15607: *Specification and qualification of welding procedures for metallic materials – General rules* and standards series EN ISO 15609 for individual welding process: for example EN ISO 15609-1: *Specification and qualification of welding procedures for metallic materials – Welding procedure specification – Part 1: Arc welding*.

4.5 Welding Procedure Qualification and Welding Procedure Qualification Record

The Welding Procedure Qualification (WPQ) is intended to provide proof of weldability of a metal with a particular process, using the parameters stated in the WPS.

The WPQR is a record of the parameters used during the WPQ. The relevant items listed for the WPS in the relevant part of EN ISO 15609 shall be included, together with the details of any features that would be not acceptable by the requirements of EN ISO 15614.

5 Preparation of Qualification Tests

5.1 Filler Material

The Supplier shall define the filler material to be used in welding the SB. The filler material shall fulfill the requirements stated hereinafter and the ferrite content requirement, which in the weld metal shall be between 5 - 12 %, preferably less than 10%.

The filler material shall have a cobalt content less than 0.2 wt. %.

The Supplier shall ensure that the manufacturer of the welding consumables provides inspection documents demonstrating compliance with the specification by providing a test report "2.2" in accordance with the standard EN 10204: *Metallic products - Types of inspection documents*.

The Supplier shall perform appropriate examinations to ensure that the selected filler material meets the required specification (e.g. according to standard series EN 14532). Suitable certification of the filler material can be given as alternative.

Inspection documents of the filler material should provide:

- The chemical composition of welding filler metal or all-weld metal as appropriate
- The tensile properties of all-weld metal: tensile and yield strength, elongation at room temperature
- Impact properties of all-weld metal at temperature according to designation. Test results are based on non-specific inspection and testing. They can be given for example as typical values based on quality control tests.
- Analysis of delta ferrite content

The technical delivery conditions for welding consumables shall be in accordance with EN 13445-2: *Unfired pressure vessels – Part 2; Materials*.

5.2 Preliminary Welding Procedure Specification (pWPS)

For each joint to be welded in the SB, the supplier shall present the preliminary welding procedure specification (pWPS) for qualification tests. All pWPS should be made with the information according to the standard EN ISO 15607: *Specification and qualification of welding procedures for metallic materials – General rules* and standards series EN ISO 15609 for individual welding process: for example EN ISO 15609-1: *Specification and qualification of welding procedures for metallic materials – Welding procedure specification – Part 1: Arc welding*.

Using pWPS for any other operation than for qualification test is strictly prohibited. pWPSs will be qualified with suitable welding procedure qualification tests.

5.3 Plan of Welding Procedure Qualification Tests

Preliminary welding procedure specifications (pWPS) shall only to be qualified by welding procedure tests according to the standard series EN ISO 15614: *Specification and qualification of welding procedures for metallic materials- Welding procedure test*. For example for arc welding EN ISO 15614-1: *Specification and qualification of welding procedures for metallic materials- Part 1: Arc and gas welding of steels and arc welding of nickel and nickel alloys*.

The welded joint to which the welding procedure will relate in production shall be represented by making a standardized test piece as specified in EN ISO 15614.

5.4 Test Plates

The dimensions of the Test Plates shall be as follows:

minimum length = 350mm
minimum width = 150 mm.

5.5 Welding Position

There are occasions during the course of fabrication when welding may be extremely difficult due to the local conditions.

Under such conditions the quality of welding could be adversely affected. It is required that the WPQ is to be completed in the most difficult position, together with an assimilation of any prevailing physical restrictions.

5.6 Plan of Welder and Operator Qualifications Tests

The Supplier shall use skilful and qualified personnel in welding operations. Welders should be qualified according to the *EN ISO 9606-1: Qualification test of welders – Fusion welding – Part 1: Steels*. Welding operators should be qualified according to the *EN ISO 14732: Welding Personnel – Approval testing of welding operators for fusion welding and resistance weld setters for fully mechanized and automatic welding of metallic materials*.

The qualification process must take place prior to any fabrication work of SB welding in order to verify that the welders and operators have the necessary skill to properly execute welds using qualified welding procedures.

5.7 Plan of Testing Personnel Qualifications Tests

The testing and inspection personnel as well as their supervisors must possess the necessary skill and competence, which are proved by qualification made according to the standard *EN ISO 9712: Non destructive testing – Qualification and certification of NDT personnel – General principles*.

5.8 Plan of Stress Relieving

In order to fulfil the tight tolerance requirements in the final stage of SB, the supplier shall undertake necessary measures for stress relieving after welding operations in the manufacturing procedure. The stress relieving can be done by various procedures like: optimal welding sequence, heat treatment or mechanically (i.e. Shot Peening, Ultrasonic or Vibratory treatment, etc.

In the case of heat treatment the following applies (as per RCC-MR, Sect. 5, RF-8410 "*Dimensional Stabilization Treatment on Austenitic Stainless Steel Components*"):

- Before heat treatment, the part is thoroughly degreased and all the products likely to modify the resistance to corrosion (products containing halogen or carbon) shall be thoroughly removed

- The atmosphere of the furnace shall be vacuum or inert gas
- The temperature at which the part is introduced into the furnace shall in no case exceed 120°C and, during heating, the temperature difference in the part shall not exceed 55°C
- The treatment temperature shall not exceed 425°C
- Furnace cooling should be carried out after the heat treatment and the temperature difference in the part shall not exceed 55°C
- The heat treatment procedure has to be recorded and presented in the final welding data package

5.9 Preliminary Welding Data Package

The preliminary welding data package gathers together all the essential elements defining the welding operations for the SB and pipes. During Phase II of the procurement (Pre-production Documentation), the supplier shall present the preliminary welding data package.

The preliminary welding data package shall include at least the following:

- A preliminary Welding and Inspection Plan of all joints: for each welded joint, the following shall be provided:
 - o A dimensional sketch, for allowed groove geometries the following applies
 - EN 13445-3: *Unfired pressure vessels – Part 3: Design*
 - EN 1708-1: *Welding – Basic weld joint details in steel – Part 1: Pressurized components*
 - o Preliminary welding procedure specification, pWPS
 - o The type and scope of non-destructive examinations to be used
- A list of production control test coupons needed according to EN 13445-4: *Unfired pressure vessels – Part 4: Fabrication*
- Plan of stress relieving
- Plan of weld identification/markings during the welding operations
- Plan of welding procedure qualification tests
- Plan of welder qualifications tests
- NDT personnel qualifications or plan of qualifications tests

This document requires IO-DA's acceptance and IO-CT's acceptance prior the starting of any qualification activity (Hold Point).

6 Qualifications, Examination and Testing

6.1 Execution of Welding

Preparation and welding of the test piece shall be carried out in accordance with the pWPS and under the general conditions of welding in production which they shall represent. If tack welds are to be fused into the final joint they shall be included in the test piece also.

If stress relieving is to be carried out in production of the SB, the welded test pieces shall undergo the same treatment before examinations and tests.

6.2 Examination and Testing

Examination and testing shall be made in accordance with the standard series EN ISO 15614-n. In addition determination of ferrite content and microscopic examination shall be done according to EN ISO 8249: *Welding - Determination of Ferrite Number (FN) in austenitic and duplex ferritic-austenitic Cr-Ni stainless steel weld metals*, EN ISO 17639: *Destructive tests on welds in metallic materials. Macroscopic and microscopic examination of welds* and EN ISO 5178: *Destructive tests on welds in metallic materials*.

6.3 Welding Procedure Specification (WPS)

The pWPS is qualified to be as a WPS if the imperfections in the test piece are within the specified limits of **quality level B** according to standard EN ISO 5817: *Welding - Fusion-welded joints in steel, nickel, titanium and their alloys (beam welding excluded) - Quality levels for imperfections* or for beam welding standard EN ISO 13919-1: *Welding. Electrons and laser beam welded joints. Guidance on quality levels for imperfections. Part 1: steel*.

For other properties, the following applies:

- Transverse and longitudinal tensile strength shall not be less than parent material
- In impact test the absorbed energy shall be in the accordance with the parent material standard

6.4 Range of Qualification

Standard series EN ISO 15614-n applies with following provision:

Joint between two 316 L(N)-IG plates does not qualify dissimilar joint between 316 L(N)-IG and XM-19 and vice versa.

6.5 Welder and Operator Qualification

6.5.1 Welder

In case of arc welding standard *EN ISO 9606-1: Qualification test of welders – Fusion welding – Part1: Steels* applies with following provisions:

- Any change in the procedural conditions (manual, part mechanized, mechanized, automatic, etc), shall require the welder to be re-qualified
- If using partially mechanized welding process, the welder should have a corresponding qualification
- For a full-penetration T-Butt joint in plate, the range of approval for thickness applies to the thickness of the bevelled plate
- Each qualification test coupon with full-penetration butt welds shall be subjected to radiographic examination

6.5.2 Operator

Welding operators shall be qualified according to the *EN 1418: Welding Personnel – Approval testing of welding operators for fusion welding and resistance weld setters for fully mechanized and automatic welding of metallic materials* using approval based on welding procedure tests, 4.2.1 in EN ISO14732.

The operator is qualified if the weld fulfils **quality level B** according to the EN ISO 5817 or EN ISO 13919-1 in the welding procedure qualification test made in accordance in standard series EN ISO 15614.

6.6 Testing Personnel Qualification

Standard EN ISO 9712: Non-destructive testing – Qualification and certification of NDT personnel – General principles applies.

6.7 Welding Data Package

During Phase II of the procurement (Process Qualification), the supplier shall present a detailed welding data package, which gathers together all the essential elements defining the welding operations.

The welding data package shall include at least following:

- A Welding and Inspection Plan of all joints: for each welded joint, the following shall be provided:
 - o A dimensional sketch
 - o The welding processes to be used and relevant, qualified WPSs with WPQRs
 - o The type and scope of non-destructive examinations
- A list of production control test coupons needed according to the EN 13445-4
- Qualification certificates of welders, operators and testing personnel
- Qualification of filler material
- Description of welding sequence
- Description of weld identification/markings during the welding operations
- Description of examinations during welding operation
- Description of stress relieving

This document requires IO-DA's acceptance and IO-CT's acceptance prior to the start of any welding activity of the SB (Hold Point).

7 Execution of Production Welds of SB

7.1 Documents Required for Welding Operations

All welding operations shall be carried out in accordance with the requirements of a set of duly identified documents, which shall satisfy the requirements of the welding data package.

A detailed Welding and Inspection Plan shall be fulfilled during the welding and testing operations.

7.2 Storage, use and identification of Welding Materials and Welds

All welding consumables shall be stored and handled with care and used in accordance with the conditions specified by the welding consumable manufacturer. Electrodes, filler wires, rods and fluxes that show signs of damage or deterioration, such as cracked or flaked coating, rusting or dirty electrode wire, shall not be used.

The supplier shall have and maintains an identification system for welding materials used in fabrication so that all welding materials can be traced to its origin. The identification system shall satisfy the requirements of EN 13445-4.

All the welds shall be identified with a unique number and shall be traceable back to the welder/operator, testing personnel and results, and WPS used.

7.3 Joint Preparation and Examination

The surfaces to be welded shall be thoroughly cleaned of oxide, scale, oil grease or other foreign substance and shall be free of defects such as inclusions, cracks and laminations to avoid any detrimental effect on weld quality. If any indication is foreseen the Supplier shall perform LDP testing of weld surfaces according to the EN 3452-1: *Non-destructive testing – Penetrant testing – Part 1: General principles*.

7.4 Dimensional Accuracy of the Joint

The edges to be welded shall be kept in the position, either by mechanical means, temporary attachments or by tack welding or by a combination. The tack welds shall be removed or fused again in the weld bead, depending on the WPS. The procedure of welding of tack welds, attachments, supports and stiffeners shall be qualified and welder of tack welds shall also be qualified.

During the whole welding operation, the edges to be welded shall be held so that the alignment tolerances are satisfied.

Temporary attachments shall be removed using a technique which does not affect the properties of the metal of the pressure part to which they are welded. Care shall be taken that the area of the removed attachment is free of surface cracks.

7.5 Execution of welds

The welder or operator shall have available the applicable WPSs and detailed work instructions based on the accepted WPSs and defining all the essential variables under direct control by the welder.

Arc strikes on parts outside the weld preparation shall be avoided. Where arc strikes occurs accidentally the affected area shall be repaired in accordance of standard EN 13445-4 point 11.1.

During welding operations, the welds shall be subjected to visual in-process inspection for the fit-up, soundness of the weld passes and chip back of second site of sound metal stages.

8 Final Testing

8.1 General

The minimum required testing, the testing procedures and the acceptance criteria are given hereinafter. They shall be carried out by experienced and qualified personnel. The supplier shall envisage all the additional examinations he deems to be necessary to detect possible non-conformities at an early stage of the manufacturing process and thus to be able to perform suitable and timely corrective actions.

Following any non-destructive testing in which testing materials are applied to the piece, the piece shall be thoroughly cleaned in accordance with suitable procedures which do not degrade or introduce impurities in the examined surface. The applicable standards are those specified below for each testing.

Other equivalent national or international standards may be acceptable with prior written IO-DA's acceptance.

8.2 Weld surface finishing

After welding and heat treatments the surfaces of the welds and adjacent areas shall be finished so that the required NDT can be performed. This means removing of spatters, slag, scaly oxides, grease etc. liable to interfere with the inspections and NDT.

For LPT testing, weld surfaces at the final or intermediate stage (root of filler passes) shall be left as welded. Cleaning for the LPT testing should be made in a way that it doesn't mask discontinuities by plastic deformation or clogging from abrasive materials.

For radiographic testing of butt welds with penetration > 50 mm, outside and accessible inside shall be made flush with the base material using a suitable mechanical method. Inside weld surfaces are not required to be flush when the first penetration weld run has been made by TIG and when such a run does not contain irregularities liable to hinder radiographic interpretation.

8.3 Visual Testing

8.3.1 General

Visual testing (VT) of the welds shall be made according to the EN ISO 17637: *Non-destructive examination of fusion welds - Visual examination*.

8.3.2 Time of Execution

Visual testing shall be made after possible heat treatment and before any machining or grinding operations of weld surfaces.

8.3.3 Extent

Visual testing shall cover all the welds and both weld and root surfaces when accessible. Areas from where temporary attachments have been removed shall also be inspected.

8.4 Liquid Penetrant Testing

8.4.1 General

The use of LPT is generally not permitted for the inspection of welds or in the inspection of weld preparations used in the fabrication of VQC 1 & 2 components, due to the ability of the dye-penetrant to block leaks temporally.

If LPT can not be avoided, only the use of the ITER vacuum qualified LDP is permitted.

If LDP is used, then cleaning must be performed to procedures qualified and approved by the IO-DA.

8.4.2 Time of Execution

PT shall be made after visual testing and before any machining or grounding operations of weld surfaces.

8.4.3 Extent

All the welds over their entire length shall be tested. Testing shall also cover adjacent base metal of 15 mm of both sides from weld. In case of full penetrated welds, both weld and root surfaces shall be tested when accessible.

Areas from where temporary attachments have been removed shall be inspected.

8.4.4 Report

The testing report shall be made according to the standard EN 3452-1 with following amendments:

- Identification of the part, weld, material and fabrication process
 - Designation of the testing document used
 - Testing procedure
 - Unacceptable indications. Any indications initially considered unacceptable but interpreted as non characteristic of an unacceptable defect, and therefore not taken into account, shall be recorded.
- Identification of subcontractor conducting the testing, where applicable

8.5 Radiographic testing

8.5.1 General

For volumetric testing of the welds of the SB, radiographic testing is preferred, but in the case where it is not possible due any reason, also US examination can be used, subject to the IO-DA's acceptance.

Radiographic testing (RT) shall be made according to the standard EN 1435: *Non-destructive examination of welds. Radiographic examination of welded joints*, using examination techniques B and preferably X-ray technique.

8.5.2 Time of Execution

RT shall be made after heat treatment and surface finishing.

For some welds RT could be done during welding operations if the final state of the SB is incompatible with the testing technique.

8.5.3 Extent

All the welds over their entire length shall be tested. Testing shall also cover adjacent base metal over a distance of:

- At least 10 mm in relation to the actual groove when $e > 30$ mm

At least 5 mm in relation to the actual groove when $e \leq 30$ mm

8.5.4 Report

The testing report shall be made according to the standard EN 1435 with following amendments.

- Stage of testing
 - Film classification and commercial brand name of film
 - Film processing conditions
 - Diameter of the smallest visible hole or wire
- Identification of subcontractor conducting the testing, where applicable

8.6 Ultrasonic testing

8.6.1 General

For volumetric testing of the welds of the SB, radiographic examination is preferred, but in the case where it is not possible due any reason, and in case of inspection of pipe weldings also US examination can be used, subject to the IO-DA's acceptance.

Ultrasonic examination shall be made according to the standard EN ISO 22825: *Non-destructive testing – Ultrasonic testing – Testing of welds in austenitic steel and nickel-based alloys* with using of reference block and EN 583-1: *Non-destructive testing – Ultrasonic examination – Part 1: General principles*.

8.6.2 Time of Execution

Ultrasonic testing shall be made after heat treatment and surface finishing.

For some welds ultrasonic testing could be done during welding operations if the final state of the SB is incompatible with the testing technique.

8.6.3 Extent

All the welds over their entire length shall be tested. Testing shall also cover adjacent base metal over a distance of:

- At least 10 mm in relation to the actual groove when $e > 30$ mm
- At least 5 mm in relation to the actual groove when $e \leq 30$ mm

8.6.4 Report

The testing report shall be made according EN ISO 22825.

8.7 Acceptance criteria of NDT

Acceptance criteria is **level B** according to the standard EN ISO 5817: *Welding - Fusion-welded joints in steel, nickel, titanium and their alloys (beam welding excluded) - Quality levels for imperfections* and for

beam welds EN ISO 13919-1, *Welding. Electrons and laser beam welded joints. Guidance on quality levels for imperfections. Part 1: steel.*

9 Repairs

In the case of need of repair for surface defects of parent material or weld defects, repairing procedure shall follow the point 11 of standard EN 13445-5. An NCR shall be raised prior to any repair activities.

The inspection of repairs shall follow point 6.5.3 of standard EN 13445-5.

10 Final Welding Documentation

Detailed welding data package, which include at least following:

- An overall or outline drawing of the steel structure of the SB, marking the position of all welded joints
- A test coupon schedule showing the test coupons and welding sequences together with inspections
- A Welding and Inspection Plan of all joints: for each welded joint, the following shall be provided:
 - o A dimensional sketch of the joint
 - o Number of the weld
 - o The welding procedure specification (WPS) used
 - o Welder/operator and the date of welding
 - o The NDT procedures used and checked
- All the Welding Procedure Qualifications Records (WPQRs)
- The qualification records of welders or operators
- The record of cumulated heat treatments
- The properly referenced qualification test coupon or coupons which validate the welding procedure
- A recapitulatory list of qualification test coupons for the whole component with, for each test coupon, the welding procedure data sheet from which the area of validity of the qualification is derived
- A list of production control test coupons
- All the Non-conformance reports

This document will be reviewed by IO-DA before each delivery.

MANDATORY APPENDIX APB1_04

EXAMINATIONS

Abstract

This document is prepared based on the Annex B of the ITER Blanket Shield Blocks Procurement Arrangement 1.6.PB1.KO.01 (hereinafter PA) and describes technical specification for the supply of the Blanket Shield Blocks to National Fusion Research Institute (hereinafter NFRI). This document defines the mandatory information to be supplied together with the Tender for the scope of Annex B by potential suppliers.

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1 General Requirements

All surfaces to be examined shall be clean and free from all foreign matter, which may adversely affect evaluation of the test results.

Following any non-destructive examination in which materials are applied to the piece, the piece shall be thoroughly cleaned in accordance with suitable procedures which do not degrade or introduce impurities in the examined surface. The applicable standards are those specified for each examination.

The minimum required examinations, the examination procedures and the acceptance criteria are given hereinafter. They shall be carried out by qualified personnel. The supplier is recommended to envisage all the additional examinations it deems to be necessary to detect possible non-conformities at an early stage of the manufacturing process and thus to be able to perform suitable and timely corrective actions. The non-destructive examinations to be applied shall be performed in accordance with a written procedure (non-destructive testing protocol) that shall include, as a minimum, the following information in addition to the requirements of the applicable standards:

- Scope of examination and stage of manufacture at which it is conducted;
- Surfaces on which examination will be performed: drawings may be used to indicate areas of examination for each procedure, and any limitations due to size, shape or other physical characteristics;
- Data to be recorded.

The acceptance of all the non-destructive testing protocols represents a Hold Point.

The supplier or his sub-contractor shall prepare a report for each non-destructive examination carried out to be included in the given documentation. All reports shall, as a minimum, contain the following information in addition to the requirements of the applicable standards:

- All procedural, equipment and calibration parameters shall be identified sufficiently to provide a basis for comparison with later examinations;
- A marked up drawing or sketch indicating the weld or part examined, the item or piece number, the datum points and co-ordinate conventions used for location, and other identification information necessary;
- An acceptance or rejection statement on the detected defects.

2 Examinations of SB cooling channels

This examination is aimed at demonstrating that none of the parallel coolant channels are blocked or partially blocked. 100% visual inspection by endoscope shall be performed on cooling channels before the cover plate welding is performed.

Alternative methods, which could detect blocked or partially blocked coolant paths, can be proposed and subject to IO-DA's acceptance.

The demonstration that none of the parallel coolant channels are blocked or partially blocked represents an Authorization-To-Proceed Point.

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3 Examinations of Welds in the SB

The examinations required for the welds in the steel structure are those specified in APB1_03.

4 Forming of Materials

Forming and bending of material shall follow the requirements given in EN13445-4 for austenitic steels. These requirements are applicable to all forming and bending processes such as the coolant pipes, plates, etc.

To avoid problems of stress corrosion cracking for deformed materials, and assure a margin for cold work effects (including uncertainties), the following maximum target value is recommended:

Hardness HV < 300,

If the hardness exceeds the above value, then the solution annealing of austenitic steel shall be implemented.

5 Examinations of Materials

The examinations required for the materials are those specified in the corresponding material specifications.

6 Archival and Witness Samples

Sections of welded joints, as well as material samples, shall be submitted to the IO-DA by supplier after final acceptance tests at the ITER site.

MANDATORY APPENDIX APB1_05

FACTORY ACCEPTANCE TEST

Abstract

This document is prepared based on the Annex B of the ITER Blanket Shield Blocks Procurement Arrangement 1.6.PB1.KO.01 (hereinafter PA) and describes technical specification for the supply of the Blanket Shield Blocks to National Fusion Research Institute (hereinafter NFRI). This document defines the mandatory information to be supplied together with the Tender for the scope of Annex B by potential suppliers.

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1 Geometrical Shape and Tolerances

1.1 Introduction

The geometrical shape and tolerances shall be measured on each final component, including the full-scale prototype, after the completion of the manufacturing process. The geometrical shape and tolerances shall be measured according to a testing protocol agreed with IO-DA and IO-CT and compliant with the [ITER Dimensional Metrology Handbook \(46FN9B v2.1\)](#). The dimensional metrology shall be carried out at room temperature with the component in its operational position.

The ITER Dimensional Metrology Handbook (IDMH) outlines the mandatory requirements for dimensional control of the components, assemblies and systems for the ITER machine. In addition the handbook provides significant guidance and helpful information on best practice for large volume metrology applications.

The IDMH is issued as a supplement to project requirements documents, since it is necessary that the requirements contained within it are followed by the IO-CT, the IO-DAs and their suppliers to ensure the successful construction and operation of ITER.

The agreement on this testing protocol represents a Hold Point.

The demonstration of meeting the requirements on the geometrical shape and tolerances represents a Hold Point.

1.2 General Tolerances

Unless otherwise specified, the dimensions shall satisfy the tolerance Class “c” of ISO 2768-1 and tolerance Class “L” of ISO 2768-2. General tolerances do not require a specific check unless there are doubts that they have been met.

The above tolerances also apply to the maximum deviation from the straightness and flatness of straight lines and flat surface, respectively.

1.3 Specific Tolerances

The conformity with the required specific tolerances shall be demonstrated and reported in an appropriate table. The format of this table will be left to the Supplier's discretion, but must contain all the necessary information in order that the correct controls can be exercised.

Specific tolerances are shown in the provided 2D Assembly drawings from IO-DA.

MANDATORY APPENDIX APB1_06

LABELLING AND TRACEABILITY

Abstract

This document is prepared based on the Annex B of the ITER Blanket Shield Blocks Procurement Arrangement 1.6.PB1.KO.01 (hereinafter PA) and describes technical specification for the supply of the Blanket Shield Blocks to National Fusion Research Institute (hereinafter NFRI). This document defines the mandatory information to be supplied together with the Tender for the scope of Annex B by potential suppliers.

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1 Component Labelling and Traceability

IO-CT and IO-DA shall agree to a permanent identification and numbering system, which comply with the IO-CT official numbering system, according to the document [ITER Numbering System for Components and Parts \(28QDBS v2.0\)](#). All components and the main subcomponents shall be clearly marked by supplier in a permanent way and in a visible place with the IO-CT official numbering system. All fabrication historical data will be electronically archived following the IO-CT requirements and templates.

MANDATORY APPENDIX APB1_07

CLEANING

Abstract

This document is prepared based on the Annex B of the ITER Blanket Shield Blocks Procurement Arrangement 1.6.PB1.KO.01 (hereinafter PA) and describes technical specification for the supply of the Blanket Shield Blocks to National Fusion Research Institute (hereinafter NFRI). This document defines the mandatory information to be supplied together with the Tender for the scope of Annex B by potential suppliers.



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1 Cleaning

During assembly and cleaning, particular attention shall be given to the removal of weld spatter, debris and other foreign matter from the coolant passages.

Final cleaning shall ensure effective cleaning without damage to the surface finish, material properties or metallurgical structure of the materials.

Final cleaning of the metallic parts of the final components will be done manually, using Scotch-Brite™ hand-pads, cotton hand-scarf and isopropyl alcohol.

The Supplier shall submit the proposed cleaning procedure for acceptance in accordance with the ITER Vacuum Handbook Section 24. The IO-DA may, if they consider it necessary, instruct the Supplier to repeat or carry out a special cleaning process on any item. The use of incompatible cleaning materials with vacuum conditions shall be avoided.

The SB shall be properly cleaned and dried before packaging to ensure cleanliness of the components for the ITER machine.

The demonstration of meeting the cleaning requirements represents an Authorization-To-Proceed Point.

MANDATORY APPENDIX APB1_08

PACKAGING AND DELIVERY

Abstract

This document is prepared based on the Annex B of the ITER Blanket Shield Blocks Procurement Arrangement 1.6.PB1.KO.01 (hereinafter PA) and describes technical specification for the supply of the Blanket Shield Blocks to National Fusion Research Institute (hereinafter NFRI). This document defines the mandatory information to be supplied together with the Tender for the scope of Annex B by potential suppliers.

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1 Packaging of the SBs and Delivery Reports

The SBs shall be properly packed, in accordance with the ITER Vacuum Handbook Section 29, in order to prevent any kind of damages and to limit the spread of contamination onto vacuum facing surfaces.

The SBs shall be “double bagged” in sealed transparent envelopes in a dry atmosphere or inert gas or under vacuum.

The SB shall be properly mounted into the handling and support jig described in ANB1_01, which is in turn fixed inside a wooden box. This box shall be rigid enough in order not to deform appreciably under the component weight and should be possible to re-close it, after the final acceptance test in ITER site described in APB1_09. The supports have to avoid extra loading on the components due to sudden movements or accidental drop, in this respect a shock absorbing material shall be used.

The SBs shall be enclosed just after the ultra-vacuum treatments in a sealed envelope in dry atmosphere or under vacuum. Tube ends shall be closed and tightly sealed with suitable non-metallic covers or plugs.

At least two accelerometers per each direction shall be rigidly fixed onto each SB and shall be capable to record the acceleration along three perpendicular directions.

Prior to packing each SB row, a “Delivery Report” shall be prepared by the Supplier, stating as a minimum:

- The packaging date
- The full ITER site address and the name of the IO-CT person responsible to receive the package as well as the sender's name and full address
- The number and type of components and samples contained in the package
- The enclosed documentation
- The declaration of integrity of the package
- The declaration of integrity of the components and samples
- Any additional relevant information on the status of the components and samples.

The Delivery Report shall be signed by a representative of the Supplier and/or of the IO-DA. It shall be countersigned by a representative of IO-CT.

Upon receipt of the package at IO-CT site, the representative of IO-CT shall open the package and make a visual inspection of its content to check

- The integrity of the package
- The number and type of components and samples contained in the package
- The enclosed documentation
- The reading of the accelerometers

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Packaging and Delivery**

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- The integrity of the components and samples

Any additional relevant remark on the status of the components and samples will be recorded.

If the accelerometers record shocks above 5g, a visual examination of the SB for signs of damage, will be performed. A decision on acceptance will be made by mutual agreement between IO-CT and the IO-DA.

In the case when everything is in order, the Delivery Report shall be signed for the preliminary acceptance of the delivery by the representative of IO-CT. A representative of the Supplier of the components and samples and/or the IO-DA shall be allowed to witness this acceptance protocol, if he/she so wishes.

The original of the Delivery Report is kept by the IO-CT and a copy of it is given to the IO-DA.

MANDATORY APPENDIX APB1_09

FINAL ACCEPTANCE

Abstract

This document is prepared based on the Annex B of the ITER Blanket Shield Blocks Procurement Arrangement 1.6.PB1.KO.01 (hereinafter PA) and describes technical specification for the supply of the Blanket Shield Blocks to National Fusion Research Institute (hereinafter NFRI). This document defines the mandatory information to be supplied together with the Tender for the scope of Annex B by potential suppliers.

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1 Final Acceptance

The SBs shall be subject to the following final acceptance tests by IO-CT at the ITER Site (carried out outside the scope of this contract)

- Cold He leak test (as described in Appendix 12 of the ITER Vacuum Handbook)
- Geometrical shape and tolerances.

The final acceptance by IO-CT shall be granted after the successful completion at the IO-CT site of these acceptance tests and provided that the following accompanying documentation for each SB has been accepted by IO-CT:

- The material list, traceability, and documentation of the SBs;
- The “as-built” drawings of the SBs;
- A comprehensive description of the manufacturing process including qualification of the SBs;
- The test certificates and reports.

A “Final Acceptance Document” is signed by IO-CT and sent to the IO-DA after the definitive acceptance of each SB and its related documentation.