Annex II

Technical Specifications

"FEA simulation of welding processes Specialist in the manufacturing design of DFWs for equatorial Port Plugs #11"

ITER_D_U9HU6X v. 1.0, dated 28 November 2016

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1 Purpose

This document describes technical needs of for specialist work relating to FEA simulation of welding processes in support of the manufacturing design of DFWs for equatorial Port Plugs #11.

2 Scope

The work comprises welding distortion and residual stress FEA analysis to determine an optimum seal welding sequence that minimizes the risks of failure in the brazed joints of DFW panels and the welding distortions on the piece.

A typical DFW is formed by front wall which is brazed to a forged block forming the coolant channels circuit of the component. This wall is welded in its whole perimeter to seal the coolant circuit with respect to primary the vacuum boundary.

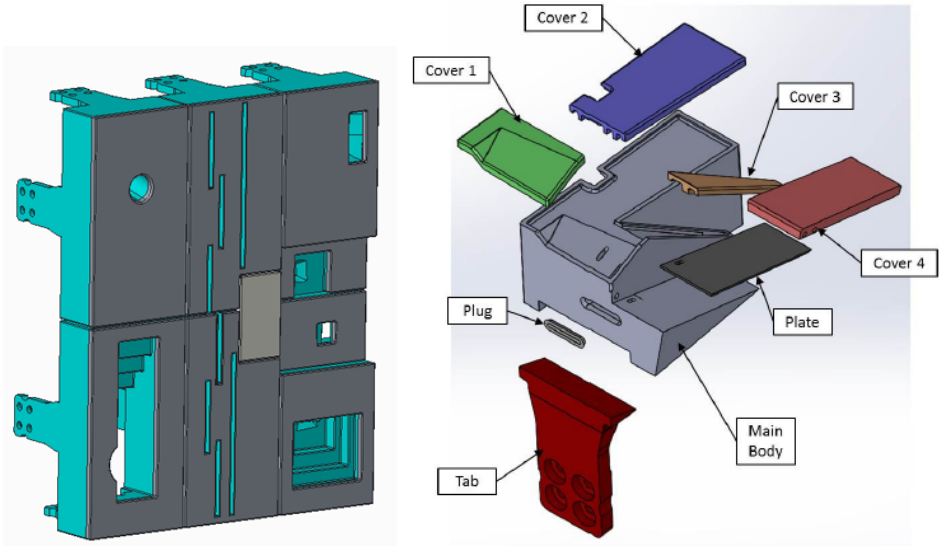

Figure 1: Typical set of 6 DFWs and demonstrator for DFWs where the cover plates (1 to 4) to be brazed to the forged block are shown.

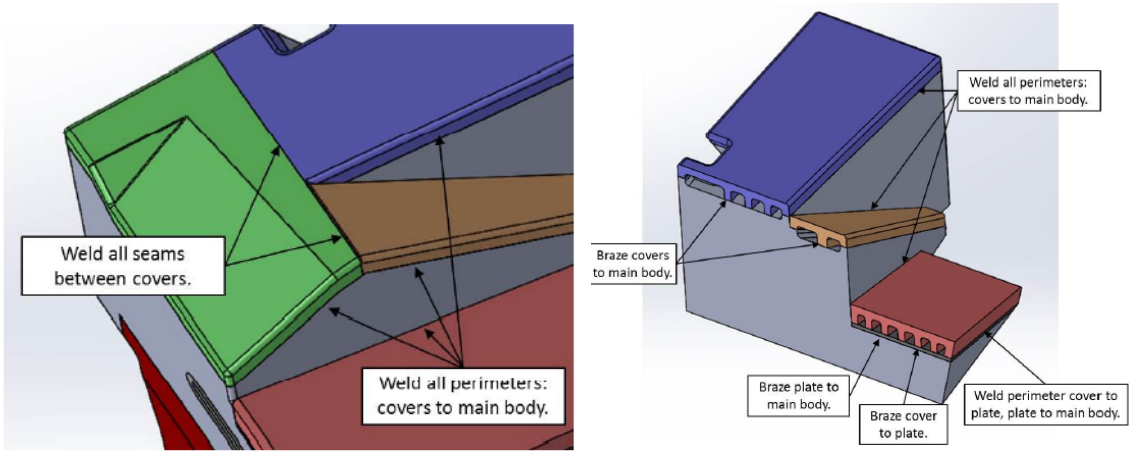

Figure 2: Perimeter seal weld and brazed joints (cut view).

It has been experimentally observed that the seal welding distortions and residual stresses may develop failures in the brazed joints. Therefore, the optimization of a welding sequence that minimizes this risk has been identified as a key point to mitigate this risk.

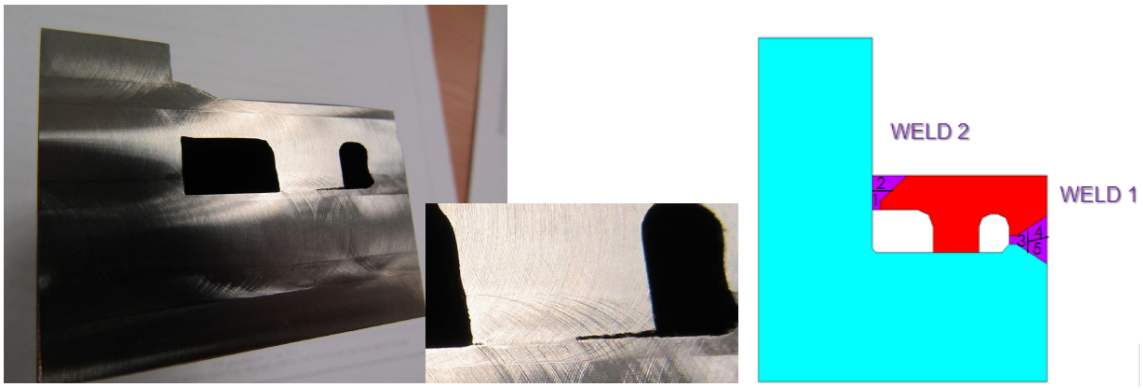

Figure 2: Failure in the brazed joint due to the residual stresses / welding distortions of perimeter seal welds

3 Definitions

ADP: Acceptance Data Package
APDL: ANSYS Parametric Design Language
CPPE: Common Port Plug Engineering
DFW: Diagnostics First Wall
DSM: Diagnostic Shielding Module
FEA: Finite Element Analysis
IO: ITER Organization
IO-TRO: ITER Organization Technical Responsible Officer
IPR: Intellectual Property Rights

For a complete list of ITER abbreviations see: ITER Abbreviations (ITER_D_2MU6W5).

4 Estimated Duration

The duration shall be for 12 months from the starting date of the task order. Services may be provided off-site under the full supervision of CPPE staff.

5 Work Description

The work involves technical involvement on the analysis activities aimed to perform welding distortion analysis to support the manufacturing design of 4 DFWs for Equatorial Port Plug #11 that includes:

- To develop the FE models that implement the welding design and the mathematical model of the brazed joints in order to characterize the possible impact on their integrity due to the welding distortions and residual stresses generated during the process.

- To carry out the thermal-mechanical non-linear transient analyses to simulate the welding process following different sequences in order to determine the optimum one, understood as the one that minimizes the risk of failure in the brazed joints.
- To produce explicative presentations and reports explaining the analyses details, the quality tests that guarantee the correctness of the analyses, the analysis results and the conclusions reached.

Travel to the IO premises may be required to carry out the work.

6 Responsibilities

6.1 Contractor's Responsibilities

In order to successfully perform the tasks in these Technical Specifications, the Contractor shall:

• Strictly implement the IO procedures, instructions and use templates;

• Provide experienced and trained resources to perform the tasks;

• Contractor's personnel shall possess the qualifications, professional competence and experience to carry out services in accordance with IO rules and procedures;

• Contractor's personnel shall be bound by the rules and regulations governing the IO ethics, safety and security IO rules.

6.2 IO's Responsibilities

The IO shall:

• Nominate the Responsible Officer to manage the Contract;

• Organise a monthly meeting(s) on work performed;

• Provide offices at IO premises.

7 List of Deliverables and due dates

The main deliverables are provided in the table below.

D #	Description	Due Dates
D01	Production of FE model implementing the detailed geometrical configuration of the Upper DFW of DSM 1 in EPP#11 as well as the mathematical implementation of the brazed joints and seal welds to conduct the analysis. A detailed presentation of the model built together with the model itself will constitute the ADP of this deliverable.	T0 + 2 months
D02	Nonlinear thermal mechanical simulation of the welding process for the Upper DFW of DSM 1 in EPP#11 with optimization in sequence as described above. A detailed report of the analysis describing the findings and the final sequence chosen together with the analysis results will constitute the ADP of this deliverable. The ADP will include all the inputs,	T0 + 4 months

	models and macros that are not subject to IPR included in a background declaration.	
D03	Production of FE model implementing the detailed geometrical configuration of the Lower DFW of DSM 1 in EPP#11 as well as the mathematical implementation of the brazed joints and seal welds to conduct the analysis. A detailed presentation of the model built together with the model itself will constitute the ADP of this deliverable.	T0 + 5 months
D04	Nonlinear thermal mechanical simulation of the welding process for the Lower DFW of DSM 1 in EPP#11 with optimization in sequence as described above. A detailed report of the analysis describing the findings and the final sequence chosen together with the analysis results will constitute the ADP of this deliverable. The ADP will include all the inputs, models and macros that are not subject to IPR included in a background declaration.	T0 + 7 months
D05	Production of FE model implementing the detailed geometrical configuration of the Upper DFW of DSM 2 in EPP#11 as well as the mathematical implementation of the brazed joints and seal welds to conduct the analysis. A detailed presentation of the model built together with the model itself will constitute the ADP of this deliverable.	T0 + 8 months
D06	Nonlinear thermal mechanical simulation of the welding process for the Upper DFW of DSM 2 in EPP#11 with optimization in sequence as described above. A detailed report of the analysis describing the findings and the final sequence chosen together with the analysis results will constitute the ADP of this deliverable. The ADP will include all the inputs, models and macros that are not subject to IPR included in a background declaration.	T0 + 10 months
D07	Production of FE model implementing the detailed geometrical configuration of the Lower DFW of DSM 2 in EPP#11 as well as the mathematical implementation of the brazed joints and seal welds to conduct the analysis. A detailed presentation of the model built together with the model itself will constitute the ADP of this deliverable.	T0 + 11 months
D08	Nonlinear thermal mechanical simulation of the welding process for the Lower DFW of DSM 2 in EPP#11 with optimization in sequence as described above. A detailed report of the analysis describing the findings and the final sequence chosen together with the analysis results will constitute the ADP of this deliverable. The ADP will include all the inputs, models and macros that are not subject to IPR included in a	T0 + 12 months

	background declaration.	

8 Acceptance Criteria

The deliverables will be posted in the Contractor's dedicated folder in IDM, and the acceptance by the IO will be recorded by their approval by the designated IO TRO. These criteria shall be the basis of acceptance by IO following the successful completion of the services. These will be in the form of reports as indicated in section 7, Table of deliverables.

9 Specific requirements and conditions

Since the analyses developed will be complemented by other analyses performed in-house, the preferred tool for developing the contract is ANSYS (classic).

To provide a sound ANSYS based analysis strategy/methodology for conducting non-linear thermal – mechanical transient analysis of welding distortions and residual stresses of assemblies (any Intellectual Property on the Contractor's side will be protected according to the ITER IPR policy prior inclusion in the background declaration).

Application examples of the methodology to real manufacturing of components involving high number of welds for which qualification of the methodology has been carried-out.

Good and demonstrable skills in welding distortion analysis using ANSYS (classic): analysis pre-processing, solution setting-up and post-processing procedures.

Demonstrable experience in ANSYS APDL programming and use of advanced analysis features.

Experience in Welding Engineering.

Monitoring and reporting of status of projects.

Generation of technical, administrative, and managerial documents.

Communication with international local and remote teams in context of nuclear fusion research or similarly complex research and engineering environment.

Organization, taking minutes and action tracking of international meetings.

10 Work Monitoring / Meeting Schedule

Work is monitored through quarterly reports (see List of Deliverables section) and at monthly project meetings for each of the four projects.

11 Delivery time breakdown

See Section 8 "List Deliverables section and due dates".

12 Quality Assurance (QA) requirements

The organisation conducting these activities should have an ITER approved QA Program or an ISO 9001 accredited quality system.

The general requirements are detailed in ITER Procurement Quality Requirements (ITER_D_22MFG4).

Prior to commencement of the task, a Quality Plan must be submitted for IO approval giving evidence of the above and describing the organisation for this task; the skill of workers involved in the study; any anticipated sub-contractors; and giving details of who will be the independent checker of the activities (see Procurement Requirements for Producing a Quality Plan (ITER_D_22MFMW)).

Documentation developed as the result of this task shall be retained by the performer of the task or the DA organization for a minimum of 5 years and then may be discarded at the direction of the IO. The use of computer software to perform a safety basis task activity such as analysis and/or modelling, etc. shall be reviewed and approved by the IO prior to its use, in accordance with Quality Assurance for ITER Safety Codes (ITER_D_258LKL).

13 CAD Design Requirements (if applicable)

For the contracts where CAD design tasks are involved, the following shall apply:

The Supplier shall provide a Design Plan to be approved by the IO. Such plan shall identify all design activities and design deliverables to be provided by the Contractor as part of the contract.

The Supplier shall ensure that all designs, CAD data and drawings delivered to IO comply with the Procedure for the Usage of the ITER CAD Manual (2F6FTX), and with the Procedure for the Management of CAD Work & CAD Data (Models and Drawings 2DWU2M).

The reference scheme is for the Supplier to work in a fully synchronous manner on the ITER CAD platform (see detailed information about synchronous collaboration in the ITER GNJX6A - Specification for CAD data production in ITER Contracts.). This implies the usage of the CAD software versions as indicated in CAD Manual 07 - CAD Fact Sheet (249WUL) and the connection to one of the ITER project CAD data-bases. Any deviation against this requirement shall be defined in a Design Collaboration Implementation Form (DCIF) prepared and approved by DO and included in the call-for-tender package. Any cost or labour resulting from a deviation or non-conformance of the Supplier with regards to the CAD collaboration requirement shall be incurred by the Supplier.

14 Safety requirements

ITER is a Nuclear Facility identified in France by the number-INB-174 (“Installation Nucléaire de Base”).

For Protection Important Components and in particular Safety Important Class components (SIC), the French Nuclear Regulation must be observed, in application of the Article 14 of the ITER Agreement.

In such case the Suppliers and Subcontractors must be informed that:

- The Order 7th February 2012 applies to all the components important for the protection (PIC) and the activities important for the protection (PIA).
- The compliance with the INB-order must be demonstrated in the chain of external contractors.
- In application of article II.2.5.4 of the Order 7th February 2012, contracted activities for supervision purposes are also subject to a supervision done by the Nuclear Operator.

For the Protection Important Components, structures and systems of the nuclear facility, and Protection Important Activities the contractor shall ensure that a specific management system is implemented for his own activities and for the activities done by any Supplier and Subcontractor following the requirements of the Order 7th February 2012 (PRELIMINARY ANALYSIS OF THE IMPACT OF THE INB ORDER - 7TH FEBRUARY 2012 (AW6JSB v1.0)).