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Technical Specifications (In-Cash Procurement)

RAMI Analysis for the Diagnostics systems

The contract covers the following tasks (see details in Section 7 and 9):
Determination of the electronics Quality Class (QC) and RAMI-based mitigation to achieve QC-3 for the electronics;Update of the RAMI analyses of ITER diagnostic systems, ports, port components and integrated assembly;Resolution of the RAMI-related design review chits; Creation of the RAMI analyses of ITER diagnostic systems, ports, port components and integrated assembly;Update of the report on the global ITER ...

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1 Background

The ITER machine is an international effort aimed at demonstrating the scientific and technological feasibility of fusion energy. ITER is specified as a Nuclear Facility INB-174. It has to be highly reliable, efficient and safe device built to produce a predefined output quantity and quality of scientific data.

A typical tool needed for assessing that this requirement is fulfilled is the RAMI analysis. RAMI is defined as: Reliability: continuity of correct operation, Availability: readiness for correct operation, Maintainability: ability to undergo repairs and modifications and Inspectability: ability to undergo visits and controls.

ITER is the fusion device for which a RAMI approach is formally implemented before its construction and operation. The RAMI analysis aims to handle technical risks that have an impact on the availability of the ITER machine operation. Project management risks such as schedule and cost risks are usually not be considered in the RAMI analysis. The RAMI Analysis Program at the ITER Organization (IO) is detailed in [1].

2 Purpose

This document represents the Technical Specifications for a Contract to perform RAMI analysis for systems managed by the ITER Port Plug and Diagnostics (PPD) Division.

3 Scope

The contract covers the following tasks (see details in Section 7 and 9):

(1) Determination of the electronics Quality Class (QC) and RAMI-based mitigation to achieve QC-3 for the electronics;
(2) Update of the RAMI analyses of ITER diagnostic systems, ports, port components and integrated assembly;
(3) Resolution of the RAMI-related design review chits;
(4) Creation of the RAMI analyses of ITER diagnostic systems, ports, port components and integrated assembly;
(5) Update of the report on the global ITER Diagnostics RAMI analysis document [2];

4 Definitions

For a complete list of ITER abbreviations see ITER Abbreviations (2MU6W5 v1.16).

5 References

The documents referred to below are provided in the Annex of this Technical Specifications. These documents are provided as background information to the Technical Specifications for the sole purpose of allowing bidders to evaluate the offers. These documents shall not be divulgated to any third party without prior agreement by the ITER Organization.

[1] ITER RAMI ANALYSIS PROGRAM (28WBXD v4.3)

[2] Global Diagnostics Analysis Report by PWC - May 2015 (RTVB3K v1.0)

[3] Final report (S7KGHJ v1.0)

[4] Management of Local Interlock Functions (75ZVTY v5.0)

[5] Annex 2, Risk table, to DDD of flux loops (55.A7-AI) (4HXDKB v2.0)

6 Estimated Duration

The duration shall be 14 months from the kick-off meeting (KOM).

7 Work Description

7.1 RAMI expertise to diagnostic systems, ports, port components and integrated assembly

This task includes the creation (for the Conceptual Design Review) and update (Preliminary and Final Design Reviews) of the RAMI analyses, as well as the resolution of RAMI-related design review chits. This work includes the creation or update of the RAMI analyses of ITER diagnostic systems, diagnostic ports and diagnostic/port generic components, the resolution of the RAMI-related design review chits. The work is detailed in Section 9 and concerns the Deliverables D03-D05 and D07-D14.

7.2 Electronics QC determination and RAMI-based mitigation to achieve QC-3 for the electronics

This task concerns investment protection electronics in radiation environment. Deliverables D01 and D02 are associated to this task.

Background: Many diagnostics systems have a primary role for measuring parameters with investment protection roles and they have electronics in port cells or galleries, which is an area with an elevated radiation level:

55.B4 Neutron Flux Monitors - preamplifiers
55.BC Divertor Neutron Flux Monitor – preamplifiers
55.D1 Bolometers – preamplifiers
55.E2 H-Alpha – cameras (TBC)
55.E3 VUV Survey – cameras (TBC)
55.E4 Divertor Impurity Monitor – cameras (TBC)
55.EC Edge CXRS – cameras (TBC)
55.ED Edge X-ray crystal Survey – cameras (TBC)
55.EG X-ray crystal Spec Survey – cameras (TBC)
55.EG Divertor VUV Spectroscopy – cameras (TBC)
55.EH VUV Edge imaging – cameras (TBC)
55.G1 Midplane Vis/IR – cameras
55.G8 Erosion Monitor – cameras (TBC)
55.G9 Dust monitor – cameras (TBC)
55.GA Upper Vis/IR – cameras
55.GC Tritium Monitor – cameras (TBC)

According to the proposed ITER policy/handbook on electronics in radiation environment ITER Policy on electronics exposed to radiation v.1.35.docx the question on whether these electronics can conform to this policy depends on the quality class which is attributed to them.

If the electronics were identified as quality class 2 (QC-2), they would have to be removed from the port-cell and gallery or they would have to be fully radiation qualified, both of which are difficult and/or expensive if not impossible. If they are only classified as QC-3 their approximate radiation hardness may be inferred by radiation testing of COTS sample systems made of COTS components which are not radiation qualified and the electronics can be installed in port-cells and galleries behind appropriate local shielding. This is generally speaking the present default situation for the above mentioned systems. Up-to-date background on the diagnostics situation with regards to electronics in radiation environment can be found here (and the references therein): [3].

The objective of this task is to make for each of the systems and each of the measurement parameters the decision which QC to use for the electronics in the presently foreseen configuration and to make recommendations how to achieve QC-3 status (e.g. through higher redundancy or software frequently resetting the electronics etc.) if this is possible and not yet the case. This shall be made on the basis of the guidelines provided in [4] by assessing in each case the severity of the machine unavailability and the failure cost that are likely to occur through radiation effects on the corresponding electronics.

7.3 Update report on the global ITER Diagnostics RAMI analysis.

The objective of this task (Deliverable D06) is to re-asses the report [2] and to provide details about the architecture of the Reliability Block Diagrams (RBDs) in this report. It should be explained whether the RBDs in [2] represent a simplified model of the MP and BC systems analysed in [2]. If the RBDs represent a simplified model of the Machine Protection (MP) and Basic Control (BC) systems, it should be justified that the RBD models in [2] provide the correct (i.e. reasonably conservative) estimates of the MP and BC system availabilities. If this is not the case, the RBDs in [2] shall be updated.

8 Responsibilities

8.1 Contractor's responsibilities

The Contractor shall ensure the compliance with the followings provisions:

- The Contractor shall guaranty that all input information provided to perform the task remain property of IO and shall not be used for any other activity than the one specified in this specification.
- The Contractor shall be in charge of the training and coaching of all its resources.
- The Contractor shall provide an organization suitable to perform the work as described in this specification;
- The Contractor shall work in accordance with the QA plan approved by IO;
- The Contractor shall provide support to IO Design Reviews (e.g. presentations, remote participation at the Design Review) related to Deliverables in Section 9 within the duration of this Contract;
- The Contractor shall perform the activities accordingly to this Technical Specification;
- The Contractor shall take into account all relevant additional documents and IO processes into account (hand books, export control, intellectual properties, etc.).

Prior to the start of work on each Task, the Contractor shall review the input technical information provided to it by IO for completeness and consistency, and shall advise the

Contract sub-TRO (see Section 8.2) of any deficiencies it may find. The Contractor shall appoint a responsible person, the Contractor-Responsible (C-R), who shall represent the Contractor for all matters related to the implementation of this Contract. The Contractor shall provide results according to the scope of the work outlined in this Specification and shall fulfil the implementation plan and conditions of the present Contract. The C-R shall have necessary experience, time allowance and authority to manage the Contract. The C-R shall:

- Coordinate the planning and performance of the technical work, including work assigned to subcontractors (if any);
- Act as a liaison officer with the IO;
- Keep time schedules;
- Any change of the C-R shall be subject to the IO's prior written acceptance.

The Contractor acknowledges and accepts that all received information from IO is confidential and that, therefore, they cannot be used outside the scope of this Contract and they cannot be divulgated to any third party, unless authorized by IO in writing. The same restriction applies to the documents referred to in Section 5 and provided as Annex to this Technical Specifications.
The Contractor shall be fully responsible for quality with respect to all services. The Contractor shall be responsible for imposing all technical and quality requirements as applicable to all the Subcontractors furnishing services in accordance with all applicable specifications. The technical and quality requirements of all applicable specifications shall be passed down to all levels of Subcontractor.
QA and QC activities by IO shall not relieve the Contractor and their Subcontractors from responsibility to perform all inspections and tests required by the contract and governing codes and standards.

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.

It is the contractor's responsibility to have all necessary software licences (e.g. ReliaSoft BlockSim) needed for completion of the work specified in Sections 7 and 9.

8.2 IO's responsibilities

IO shall assign one IO representative, namely the Technical Responsible Officer (TRO), to work as Contractor's interface for all technical matters related to this Contract. For each Deliverable, the TRO will assign sub-TRO, to work as sole Contractor's interface for all technical matters related to a given Deliverable. The sub-TRO will assess the performance and quality of the work. The sub-TRO shall be responsible for checking the Deliverables against requirements and schedule and for organizing and recording the Progress Meeting(s) as specified in Section 12. The sub-TRO will be assigned at the beginning of the work on each Deliverable.

IO shall make available to the Contractor all technical data and documents which the Contractor requires to carry out its obligations pursuant to this specification in a timely manner. IO will provide the needed information and access to the adequate ITER documents for executing this work, when needed, following the implementation plan.

IO shall specify the diagnostic system for Deliverable D13 at T_0 + 12m at the latest and the diagnostic port components / integrated assembly for Deliverable D14 at T_0 + 13m at the latest.

9 List of deliverables and due dates

The deliverables are provided as follows (T_0 – KOM date):

D#	Description	Due Dates
D01	**Electronics QC determination.** Make for each of the diagnostic systems and each of the measurement parameters the decision which QC to use for the electronics in the presently foreseen configuration. See details in Section 7.2.	T_0 + 1m
D02	**RAMI-based mitigation to achieve QC-3 for the electronics.** Make recommendations how to achieve QC-3 status for the electronics (e.g. through higher redundancy or software frequently resetting the electronics etc.) for the systems that would be a higher QC class in the present configuration. See details in Section 7.2.	T_0 + 1m
D03	**Update of the RAMI analysis for the Hard X-Ray Monitor (55.EE).** Provide update of RAMI analysis carried out during the CDR. The CDR design has changed significantly and the RAMI analysis for the HXR-monitor was done with RXC-system (combined analysis). A new dedicated analysis is needed for the HXR-Monitor.	T_0 + 2m
D04	**RAMI support to Windows (55.NW).** RAMI support for the resolution of one CAT 1 chit raised during the PDR of the window assemblies: "55.NW-Cat1-01 - Chit 64 - Window failure rate and foreseen operations". The actions proposed to solve this chit, is first to propose realistic maintenance, inspection and mitigation plans showing compliance with RAMI requirements, and secondly to establish the allowable down time for repair consistent with RAMI requirement. RAMI support shall firstly consist in identifying any inconsistencies between the RAMI requirements and the existing maintenance and inspection plans. Secondly a proper assessment of allowable down time for repair shall be achieved. The deliverable will be a chit resolution report.	T_0 + 3m
D05	**RAMI analysis for Continuous Flux Loops (55.A7) for FDR.** A global RAMI analysis was done for the magnetics and was used for the Flux Loops PDR [5]. Update of this analysis is needed for the FDR (foreseen ~March 2017) to take into account latest development that occurred between PDR and FDR (choice	T_0 + 4m

	of SC stud welding technique, access to A7 wipers through ports, etc.).	
D06	**Update report on the global ITER Diagnostics RAMI analysis [1].** Provide details on the architecture of the RBDs. In case the RBDs represent a simplified model of the MP and BC systems, provide justification that the RBD model gives correct (i.e. reasonably conservative) estimates of the MP and BC availability or update the RBD model. See Section 7.3.	T_0 + 6m
D07	**RAMI analysis of the Tokamak Structural Monitoring (55.GT).** A complete CDR level RAMI analysis including FMECA and RDB analysis, summary report, functional breakdown, etc. based on the current TSM operational plans and concepts.	T_0 + 7m
D08	**RAMI analysis for TNS (55.BE).** A complete CDR level RAMI analysis including FMECA and RDB analysis, summary report, functional breakdown, etc.	T_0 + 8m
D09	**RAMI analysis for the Neutron Test Facility (55.BT).** A complete CDR level RAMI analysis including FMECA and RDB analysis, summary report, functional breakdown, etc.	T_0 + 9m
D10	**RAMI analysis for the In Vessel Neutron Calibration (55.BV).** A complete CDR level RAMI analysis including FMECA and RDB analysis, summary report, functional breakdown, etc.	T_0 + 10m
D11	**LP14** A complete PDR/FDR level RAMI analysis including FMECA and RDB analysis, summary report, functional breakdown, etc.	T_0 + 11m
D12	**RAMI analysis of the Halo Rogowskis (55.AN, 55.AP) for PDR.** A complete PDR level RAMI analysis including FMECA and RDB analysis, summary report, functional breakdown, etc.	T_0 + 12m
D13	**RAMI analysis for a diagnostic system.** A complete CDR/PDR/FDR level RAMI analysis including FMECA and RDB analysis, summary report, functional breakdown, etc. of a diagnostic system to be specified – see Section 8.2.	T_0 + 13m
D14	**RAMI analysis for diagnostic port components/integrated assembly.** A complete PDR level RAMI analysis including FMECA and RDB analysis, summary report, functional breakdown, etc. of components to be specified – see Section 8.2.	T_0 + 14m

10 Acceptance Criteria

The Deliverables listed in Section 9 shall comply with ITER QA requirements and shall be reviewed by the IO sub-TRO. The deliverables will be posted in the Contractor's dedicated folder in IDM. The IO sub-TRO will review the draft version of the deliverables and will provide a commented version of the Deliverables. The Contractor shall perform all the necessary modifications or iterations to the Deliverables. The acceptance of the Deliverable shall be the basis of successful completion of the services.

11 Specific requirements and conditions

As the RAMI analysis will have to be done in close collaboration with the IO sub-TROs, it is required that the expert(s) in charge of this contract will visit the ITER Organization Headquarter for a period of one week for at least four times during the execution of this contract. The first visit shall take place during the date of the kick-off meeting. The dates for the following visits will be agreed between the Contractor and IO TRO according to the organization of the work on Deliverables from Section 9.

Experience in fusion and high-temperature plasma diagnostics areas would be an advantage but is not mandatory.

12 Work Monitoring and Control Points

12.1 Kick-off meeting (KOM)

A KOM at the IO Headquarter shall be organized within one month from the signature of the Contract. During the meeting, the work plan on the first Deliverables will be defined and the sub-TROs will be assigned for these Deliverables. At the KOM, the Contractor provides working plan, including QA plan. At the same time, during the KOM visit, the Contractor will have the opportunity to discuss with the sub-TROs the work plan on the Deliverables and agree with the sub-TROs on RAMI process to be used and the work schedule.

12.2 Progress Meetings

At least one Progress Meeting shall be held for each Deliverable to ensure that the analysis progresses according to the schedule. These meetings will be held between the Contractor and the sub-TRO. The progress meetings can be either remote or take place during the visit of the Contractor at IO premises (see Section 10). The meeting minutes shall be uploaded on IDM by the sub-TRO together with the meeting presentations (if any).

13 Delivery time breakdown

See Section 9 “List Deliverables section and due dates”.

14 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).

15 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.

16 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)).