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Technical Specifications (In-Cash Procurement)

Technical specification for nuclear analysis support

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1 Purpose

This document defines the technical requirements for a support contract for nuclear analysis for the ITER Facility.

2 Scope

This specification covers the support to be provided to the Nuclear Integration Unit (NIU) [1] in the area of nuclear radiation transport modelling and activation calculations. The NIU is undertaking work in the following areas:

- Preparation of models of tokamak components and buildings
- Preparation of source terms
- Radiation transport simulations
- Activation calculations

Support will be provided in these or similar areas depending on priorities set by the ITER Responsible Engineers. The contract will be carried out at the ITER site.

3 Definitions and Abbreviations

For a complete list of ITER abbreviations see: ITER_D_2MU6W5 - ITER Abbreviations

DCIN Design and Construction Integration Division

PBS Plant Breakdown structure (or element thereof)

NIU Nuclear Integration Unit [1]

4 Objectives

The objectives of the tasks are to provide support in the areas of nuclear analysis. They are defined more specifically below.

4.1 Preparation of models of tokamak components and buildings

The required models are:

- Equatorial, upper, and lower port plugs with specific port interspace structures
- Detailed TF coil model (outboard segments)
- Heterogeneous models of blanket rows
- Bio-shield plugs
- Contents of port cells
- Assembly building
- Hot cell building
- Rad-waste building
- Local shielding
- Detailed models of penetrations

4.2 Preparation of source terms

The following source terms are to be defined:

- Hydrogen plasmas
- Deuterium plasmas
- Spallation neutrons

- Activated in-vessel components including:
  - 1st wall modules
  - Divertor cassette
  - Diagnostic plugs
  - ICH plug
  - ECH plug
  - TBM plugs
- Activated ex-vessel components including those located between outer shell of vacuum vessel and bio-shield
- Activated corrosion products
- Activated dust
- Calibration sources
- 6MeV photon test source
- Neutron test source

4.3 Radiation transport simulations

Radiation transport calculations are continuously needed to assess proposed design changes or to support design finalisation. The work includes the assessment of the impact of radiation on components (e.g. heating, damage, gas production etc.), the prediction of radiation fields (fluxes, fluencesetc.), and the assessment of shielding capabilities.

The following radiation transport calculations are required:

- Radiation streaming through ports and characterisations of radiation fields up to bio-shield.
- Radiation streaming through bio-shield plugs and characterisation of radiation field in port cells.
- Assessment of the effect of penetrations close to TCWS
- Assessments of the effect of penetrations through the B11 walls
- Full characterisation of sky-shine from B11
- Assessment of shielding capacities of shielding doors

4.4 Activation calculations

Activation calculations are required for the specification of source terms and for the assessment of the generation of radioactive waste. The source terms are in turn used in shielding design analyses and occupational radiation exposure estimates.

4.5 Other Categories

The contractor shall be required to carry out miscellaneous tasks of the following type:

- Document review
- Data technical checking
- Recording of meeting minutes

5 Duration

The contract will have 3 phases. A firm phase of 12 months duration with option phases of 12 months duration each. The phases will run sequentially.

6 Location of Services

In general, services provided under this technical specification will be performed at ITER site using ITER IT hardware, with contractor's staff intended to work full time and at IO the duration of the contract. Management support may be provided by contractor's staff working part time on this scope and/or not at the ITER site as required.

7 Work Description

Refer to sections 4 and 10. Details on specific work unit scope shall be defined when the work unit is launched.

The ITER Organization shall only launch Work Units as per its needs within the assigned scope. Quantities estimated in section 11 do not represent a commitment on IO to use all estimated Work Units during the foreseen period. Work Unit quantities are indicative; the estimated quantities will serve as a budget limit, but the number of any given Work Unit that can be ordered is not limited by the quantity estimates.

Certain items will be considered "activities". An activity generally involves regular or reoccurring delivery of work. Examples of activities include maintenance of Excel status tables, punctual support to another contractor based on individual experience, and meeting attendance not otherwise related to a current deliverable (most likely related to a previous deliverable). Management support is not considered a separately billable activity; rather it should be incorporated into Work Unit rates.

If there is any change in scope after the Contract is signed, it shall be formalized by the parties as an amendment to the Contract.

8 Methodologies

8.1 Model Design

Model design will use approved CMM models of the tokamak machine and the building, and other components as supplied by DCIN or PBS Responsible officers. In some specific circumstances these models may be conceptual designs to be used in assessments.

MCNP models will be prepared using SpaceClaim and MCAM. The contractor is expected to be experienced in the use of these packages.

The deliverables will include simplified CAD models based on input data provided by IO, MCNP models, complete documentation describing simplifications, definitions of materials etc. in accordance with Instructions on Nuclear Analysis [3] and other relevant quality control documentation

8.2 Source Specification

Several calculation steps are required to determine characteristics of radiation sources. This area of activity is that related to taking the output of these analyses to create descriptions of radiation sources suitable for further radiation transport simulations.

The methodologies specified in [3] shall be respected.

8.3 Radiation Transport Calculations

Radiation transport calculations will be performed using MCNP primarily. This does not exclude the use of other radiation transport code if appropriate and feasible.

The methodologies specified in [3] shall be respected.

The reference model for radiation transport calculations within the tokamak will be supplied as appropriate.

8.4 Activation Calculations

Activation calculations shall be performed using FISPACT. (This does not exclude the use of other inventory codes if appropriate and feasible.) The contractor is expected to be experienced in the use of this package. Instructions on reference input data such as SA2 irradiation scenario [2] will be supplied by IO.

9 Responsibilities

All responsibilities are defined and agreed by all stakeholders and then described in the sections below.

9.1 IO Responsibilities

a) IO shall assign one technical IO representative (TRO), to work as the Contractor interface for administration of the contract;
b) Responsible Engineers (REs) will work directly with contractor staff to define and clarify work;
c) The TRO will assess the performance and quality of the work;
d) The TRO shall be responsible for checking the deliverables against requirements, schedule the processes (including CAD);
e) 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. Generally, data will be available in IDM for documentation and in ENOVIA for CAD models.
f) IO shall provide office space, office furniture, computer hardware and some software required for the work of full time contractor staff at ITER site.
g) IO will **not** provide copies of software with restricted licences e.g. MCNP

9.2 Contractor's responsibilities

The Contractor shall ensure the compliance with the provisions of the Framework Contract. Particular attention is drawn to the following:

a) The Contractor shall guarantee that all input information provided to perform the task remain property of IO and shall not be used for any other activity different from those listed in this specification;
b) The Contractor shall be in charge of the training & coaching of all its resources;
c) The Contractor shall provide an organization suitable to perform the work as described in this specification;
d) The contractor shall work in accordance with the QA plan approved by IO;
e) The contractor shall perform the activities according to this specification, taking into account all relevant additional documents and IO processes (hand books, export control, intellectual properties, …);

f) The Contractor shall be responsible to produce and manage, using the ITER software platform, all the required documents;
g) The contractor shall have licenced copy of MCNP.
h) For delays in providing technical data and documents that has an impact on delivery for any given work unit, the Contractor shall advise IO representative of the potential impact on the delivery of the work unit(s), to agree and define all the correction actions to take in place.
i) The contractor shall draft meeting minutes and report delivered work using item reporting procedure (reference).

Prior to the start of work on each activity, the Contractor shall review the input technical information provided to it by IO for completeness and consistency, and shall advise the IO representative of any deficiencies it may find. The contractor shall not be responsible for errors in the input technical information which may not be reasonably detected during such a review.

10 Schedule and Work Monitoring

10.1 Work Plan

10.1.1 Subtask: Reference Model updates

The first sub-task will be to provide updates to the ITER radiation transport models (currently the C-model and the Tokamak Complex model). This subtask involves the creation of simplified CAD models and MCNP models of components as the designs are updated suitable for incorporation into the reference models. This will include materials specifications derived from CAD models and information gathered from system ROs. Full traceability shall be maintained.

10.1.2 Subtask 2 Calculations of nuclear responses

The second subtask is to perform neutron and radiation transport simulations. This involves calculations using existing models and source specifications. All of the analyses will conform to the instructions in [3], this includes methodologies, approximations, checking and reporting. The priorities shall be provided by the NIU.

10.1.3 Subtask 3: Activation calculations and source specifications

The third subtask is to perform activation calculations using FISPACT and the production of source specifications. This involves calculations using existing models and irradiation scenarios some circumstance further irradiation scenarios may be developed. The task will include calculations to determine the source strength, energy spectrum, and geometric and angular distributions as required. It will also involve the production of source descriptions which can be used directly in radiation transport simulations. All of the analyses will conform to the instructions in [3], this includes methodologies, approximations, checking and reporting. The priorities shall be provided by the NIU.

10.2 Categories

All subtasks will be divided into work units, which will fall into one of nine categories. The categories form a matrix of time and complexity as follows:

Complexity/Skill			Best IO Estimated Timeframes
Low	Medium	High	
A1	B1	C1	1-day (8 working hours)
A2	B2	C2	1-week (5 working days)
A3	B3	C3	1-month (20 working days)

The duration required to complete a deliverable will be agreed between Contractor and IO. At start of each launched task, Work Unit arrangements (Type and number) shall be agreed with the Contractor based on complexity and expected deliverables.

Shorter work units will sometimes be used to assess the workload of a longer service. For example, IO may request a 1-day work unit to assess the scope of work for a longer service (conceptual tool design, assembly study, etc.)

More detailed descriptions of the categories follow.

10.2.1 Category A – Low Experience and Skill Work Units

Work units requiring a low level of skills or experience include simple scoping calculations (e.g. interpolation or extrapolation of existing results, 1-D attenuation calculations etc.) and the building of simple models and execution of small scale radiation transport simulations. Use of the word “low” does not implies inferior, substandard or unskilled work; all work is to meet ITER quality standards and shell be performed by qualified Contractor employees.

10.2.2 Category B – Medium Experience and Skill Work Units

Work units requiring a medium level of experience would include model building which involves the use of SpaceClaim and/or MCAM; activation calculations requiring the developments of specific scenarios and/or post processing of large results files; radiation transport simulations requiring variance reduction and the definition of several tallies.

10.2.3 Category C – High Experience and Skill Work Units

Work units requiring a high level of experience would include model making from complex CAD geometries requiring significant simplifications, and more than a few hundred different components and/or complex mathematical representations of surfaces; radiation transport calculations with very large models (e.g. C-model), variance reduction, significant post processing of results and coupled radiation transport and activation calculations; source specifications with a few or more levels of parameter dependence and time varying sources.

11 List of Deliverables / Outputs

11.1 Deliverables

11.1.1 Subtask 1: Reference Model updates

- Simplified CAD models
- MCNP models
- Models reports describing simplifications

11.1.2 Subtask 2: Calculations of nuclear responses

- Quality Plan
- Report on calculations of Nuclear Responses
- Input Files
- Output files

11.1.3 Subtask 3: Activation calculations and source specifications

- Quality Plan
- Report on calculations of Activation Calculations
- MCNP input cards describing sources
- Input Files
- Output files

11.2 Category Quantity Estimations

The tables in the following sections show the estimated number of work units to be consumed during each contractual phase. The work unit quantities listed below are estimates only. However, actual work unit consumption can be divided into other durations and complexities as long as maximum contract value is not exceeded.

11.2.1Subtask 1Reference Model Updates

Complexity-Low A	Complexity-Medium B	Complexity-High C	Time frame
			1 day
	4		1 week
	1	2	1 month

11.2.2Subtask 2 Calculations of nuclear responses

Complexity-Low A	Complexity-Medium B	Complexity-High C	Time frame
10			1 day
2			1 week
	3	1	1 month

11.2.3Subtask 3: Activation calculations and source specifications

Complexity-Low A	Complexity-Medium B	Complexity-High C	Time frame
			1 day
			1 week
	1	3	1 month

12 Acceptance Criteria (including rules and criteria)

Monthly reports describing the work, including the breakdown the work in each skill category shall be provided by the contractor.

All reports describing the results of all analyses and the models shall be reviewed by NIU and final reports shall incorporate changes to the draft deliverables as requested by ITER (these changes will not constitute substantive changes to the scope of the subtask.) These reports must conform to the requirements described in Quality Assurance section.

13 Payment Conditions, Amendments and Liquidated Damages

Interim monthly payments shall be made upon completion and acceptance by ITER RO of the deliverables stated in Section 11.

14 Quality Assurance (QA) requirement

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

Prior to commencement of the work, a Quality Plan which complies with Procurement Requirements for Producing a Quality Plan (ITER_D_22MFMW) shall be submitted to IO for approval with evidence of the above. The Contractor's Quality Plan shall describe the organisation for tasks; roles and responsibilities of workers involved in; any anticipated subcontractors; and giving details of who are the independent checkers of the activities. Where any deviation is requested or non-conformity has happened from the Technical Specification, Contractors Deviations and Non Conformities the ITER Requirements Regarding Contractors Deviations and Non Conformities (ITER_D_22F53X) shall be followed.

Documentation developed as the result of this task shall be retained by the Contractor of the task for a minimum of five (5) years and then may be discarded at the direction of the IO. IO will monitor implementation of the Contract’s Quality Plan. Where necessary, IO will assess the adequacy and effectiveness of the quality system specified in the Quality Plan through surveillance or audit. Where condition adverse to quality is found during monitoring, IO may request to the Contractor to take corrective action.

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). Where applicable, Software Qualification Policy (KTU8HH v1.2) shall be taken into consideration to ensure quality and integrity of software prior to application.

15 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 [20] (Please refer to ITER_D_4EUQFL - Overall supervision plan of external interveners chain for Protection Important Components, Structures and Systems and Protection Important Activities).

16 References

[1] ITER_D_SK72EB - Terms of Reference for Nuclear Integration Unit
[2] ITER_D_2V3V8G - Recommendation on Plasma scenarios
[3] ITER_D_R7XRXB - Instructions for Nuclear Analyses