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Technical Specifications (In-Cash Procurement)

Technical Specification - Staged approach of the Hot Cell Complex

This document aims at specifying two types of transverse activities to be performed for the Hot Cell Complex design activities:

1 – Impact of the Staged approach on the Hot Cell Complex, configuration before the nuclear phase, potential delayed procurement and temporary means for the Beryllium phase,

2 – Functional analysis and System Detailed performances

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1 Purpose

This document aims at specifying two types of transverse activities to be performed for the Hot Cell Complex design activities:

1 – Impact of the Staged approach on the Hot Cell Complex, configuration before the nuclear phase, potential delayed procurement and temporary means for the Beryllium phase,

2 – Functional analysis and System Detailed performances

2 Scope

The scope includes the overall Hot Cell Complex, including the building and the processes, in particular the Hot Cell Complex building, the Radwaste process and the Hot Cell Remote Handling System.

The Hot Cell Facility is described in ITER_D_L9V43M - Functional description of the Hot Cell Building. The Radwaste facility is described in ITER_D_L5G67Y - HCC TF - Functional description of the Radwaste Building. The Personal Access Control Building is described in ITER_D_L5G8Z5 - HCC TF - Functional description of the Personnel Access Control Building.

To be noted that the Hot Cell layout has changed in 2017 (see figures below of 3 specific levels and ITER_D_V5JTMA - HCC - Layout drawings - July 2017).

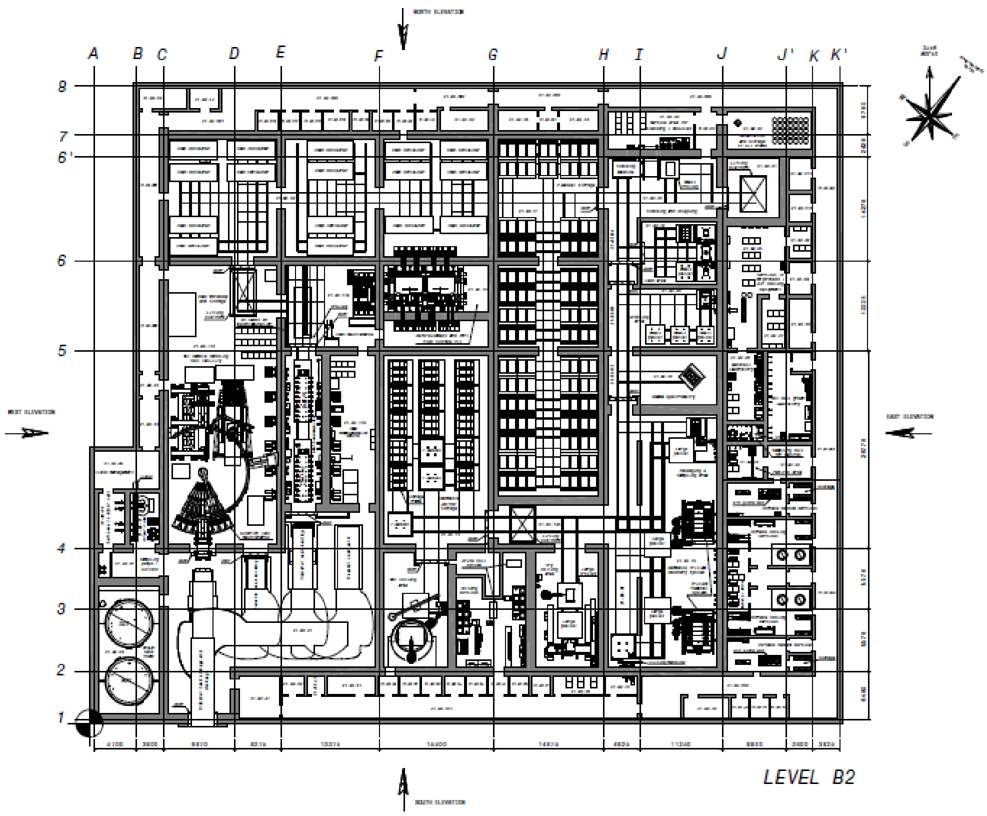

Figure 1 Level B2 of the 2017 Design of the Hot Cell Complex

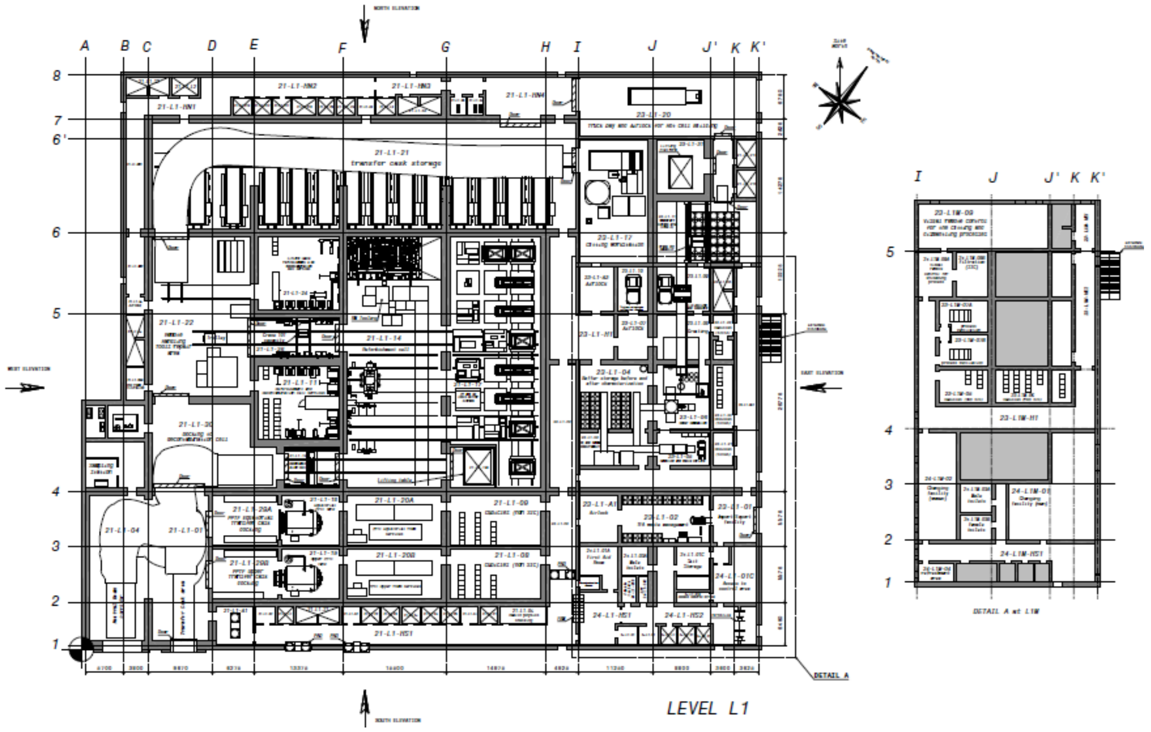

Figure 2: Level L1 of the 2017 Design of the Hot Cell Complex.

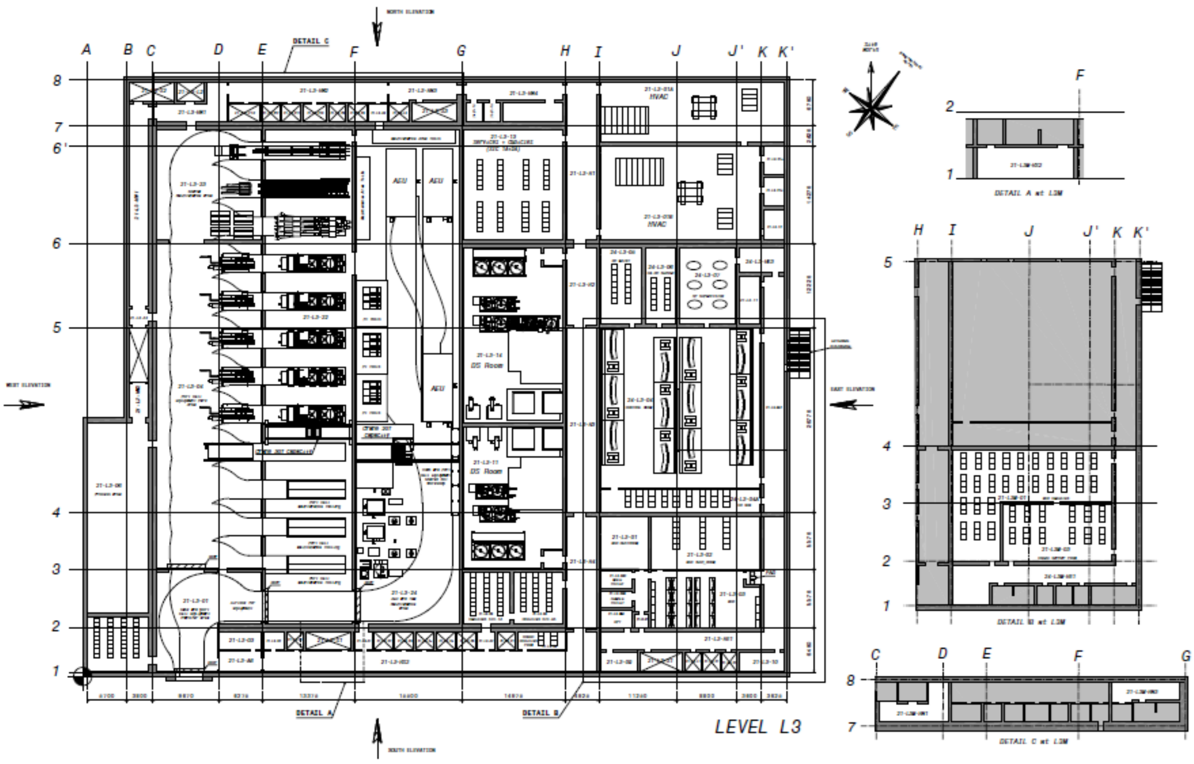

Figure 3: Level L3 of the 2017 Design of the Hot Cell Complex.

The table in appendix summarizes main features of the Hot Cell Complex, illustrating the level of complexity and the required skills for this contract.

3 Definitions

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

4 References

Acronyms:

- Be: Beryllium
- C-R: Contractor Responsible. See Contract specifications for definition of duty.
- C-TRO: Contractor Task Responsible Officer. See Contract specifications for definition of duty.
- HCC: Hot Cell Complex
- IO-RO: ITER Organization Responsible Officer. See Contract specifications for definition of duty.
- IO-TRO: ITER Organization Task Responsible Officer. See Contract specifications for definition of duty
- PBS: Project Breakdown Structure
- PR: Project Requirement
- RH: Remote Handling
- RW: Radwaste

5 Estimated Duration

The contract duration shall be one year and shall commence after the official start date and upon the mutual agreement of both parties.

The services shall be performed on-site at IO.

6 Work Description

6.1 Context

Three types of activities are being performed in 2018 aiming at designing the Hot Cell Complex (HCC) and answering to the French regulator:

- Impact analysis of the staged approach, aiming at minimizing as much as possible the cost of the HCC,
- Elaboration of technical specification for an Engineering contract, aiming at elaborating the preliminary design of the Radwaste and Remote Handling system of the Hot Cell Complex.

This is the reason why this activity is spitted into two parts and two types of deliverables.

6.2 Objective of the contract

The objective of the contract is broken down into 6 deliverables which correspond in fact to two types of activities as described below.

6.2.1 Impact of the staged approach on the Hot Cell Complex

6.2.1.1 Management of the Tokamak maintenance

In the current configuration, the Hot Cell Complex is housing the maintenance activities of the Tokamak and systems located within the Tokamak Complex.

A cost benefit analysis shall be performed as followed:

- Review of the maintenance activities to be managed during operation (Be phase – PFPO-1 and 2 and nuclear phase DD/DT),
- Flow analysis based on the ITER operational schedule and the ramp up of the radioactivity over time,
- Feasibility study of outsourcing the maintenance, including transport and acceptance criteria, in line with French regulation and safety requirements,
- Cost benefit analysis between outsourcing and treatment in situ,
- Proposal of optimized maintenance strategy, aiming at minimizing the investment and operational cost, and being flexible enough to cope with different operational profiles of the Tokamak machine.

This activity aims at investigating different strategies to manage maintenance during ITER operation. Goal is to propose a strategy which minimizes the overall investment and operation cost.

6.2.1.2 Management of Beryllium waste

This activity aims at investigating different strategies to manage Be waste during the first phase of ITER operation. Goal is to propose a strategy which minimizes the overall investment and operation cost, while it can accommodate the risk of schedule slippage.

It shall be structured as followed:

- Review of the Beryllium waste quantity to be managed before the nuclear phase,
- Benchmark of Beryllium waste management:
    - Characterization, buffer storage, treatment and disposal of Be solid waste,
    - Characterization, buffer storage, treatment and disposal of Be liquid waste,
- Feasibility study of outsourcing the Be waste management (solid and liquid), including transport and acceptance criteria, in line with French regulation and safety requirements,

- Cost benefit analysis between outsourcing and treatment in situ,
- Sensitivity study of potential strategies against the risk of an extended duration of the "Be phase",
- Proposal of optimized Be waste management strategy, aiming at minimizing the investment and operational cost, and being flexible enough to cope with the risk of delay during the early stage of the TKM assembly, commissioning and operation.

6.2.1.3 Management of Radioactive waste

This activity aims at investigating different strategies to manage radioactive waste during ITER operation. Goal is to propose a strategy which minimizes the overall investment and operation cost.

It shall be structured as followed:

- Review of the radwaste waste quantity to be managed during operation,
- Flow analysis based on the ITER operational schedule and the ramp up of the radioactivity over time,
- Feasibility study of outsourcing the Be and radioactive waste management (solid and liquid), including transport and acceptance criteria, in line with French regulation and safety requirements,
- Cost benefit analysis between outsourcing and treatment in situ,
- Comparison between two strategies:
    - o Limited buffer storage, waste treatment during operation and temporary storage of waste after treatment before the dismantling phase,
    - o Not Radwaste treatment during operation, larger buffer storage capacity and Radwaste treatment after the end of operation,

  This comparison shall include a cost, schedule and technical analysis, including a preliminary safety impact analysis (e.g. impact on the source term, incidental and accidental scenarios).
- Proposal of optimized Radioactive waste management strategy, aiming at minimizing the investment and operational cost, and being flexible enough to cope with the risk of delay during the early stage of the TKM assembly, commissioning and operation.

6.2.1.4 Functional analysis

Goal is to establish a functional breakdown of maintenance activities, including the waste treatment.

This breakdown shall distinguish the different functions, constraints and requirement during the different phases of ITER operation (see Figure 4):

- The pre-nuclear phase PFPO-1 and 2,
- The nuclear phase DD/DT,
- The deactivation phase (between the end of operation and dismantling),

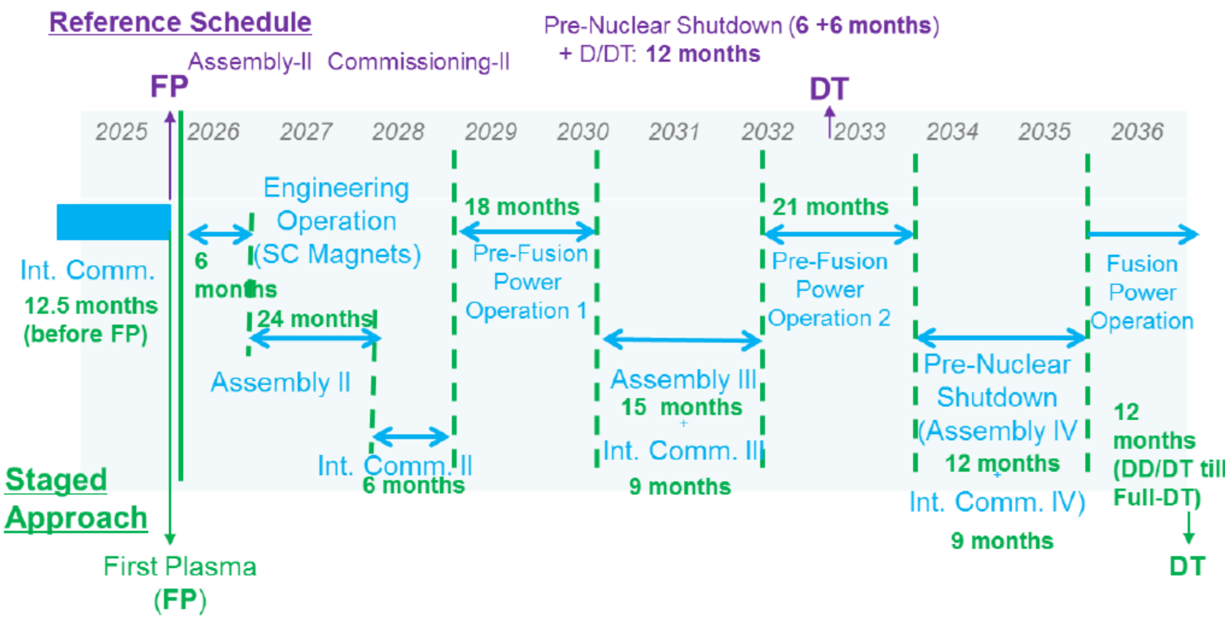

Figure 4 ITER reference schedule – staged approach 2016

In line with the outcome of analyses mention in section 6.2.1.2, 6.2.1.3 and 6.2.1.1, the aim is to identify the functions and systems strictly needed for the PFPO-1 and PFPO-2, then the Nuclear phase DT and the deactivation phase.

At the same time, the current HCC layout shall be reviewed in order to identify any function and system that could be located outside the Hot Cell Complex building.

6.2.1.5 Process flow

For each phase of operation (pre-nuclear, nuclear, deactivation), the functional analysis shall be completed by a process flow that identifies clearly the waste amount and the different steps of the maintenance and waste management in site or outside the INB perimeter: transfer, characterization, buffer storage, treatment, temporary storage, temporary means, export, etc.

Particular attention shall be paid to the first phase of the nuclear operation which corresponds to limited quantity of radioactive waste, limited activation level and limited contamination. For this early phase of nuclear operation, the contract may develop a specific function analysis and specific cost analysis.

6.2.1.6 Proposal of HCC alternative layout

Based on the analyses mentioned above (section 6.2.1.1 to 6.2.1.5) and based on the current Hot Cell Complex layout, the contractor shall propose some alternative layouts, aiming at minimizing the overall investment cost of the Hot Cell Complex.

This work shall necessarily be performed in an iterative way and in close collaboration with IO representative.

A cost estimate shall be established for each proposed layout and a curve of investment cost over time will be presented, based on the schedule given in Figure 4 and based on other scheduling options that will be specified at the Kick off Meeting.

6.2.1.7 Summary and recommendations

For each deliverable D1 to D3, a section shall summarize the outcome of the analysis and the recommendations to move forward.

6.2.2 Functional specification of the Hot Cell Complex

6.2.2.1 Traceability of PR requirements

Based on the HCC functional analysis and the requirements given in the Project Requirement, overall performances given for ITER maintenance activities shall be broken down to performances of each sub-function of the HCC.

As for illustration, the contractor shall ensure a full traceability of requirement, for the following criteria:

The ITER maintenance facilities shall ensure execution of the scheduled remote maintenance tasks (RH Class 1) within the scheduled maintenance time (**Table 6-6**). [PR1082-R]

Table 6-6: Scheduled remote handling maintenance tasks

Task	Maintenance Time (note 1)
Divertor Cassette Exchange (54 units)	6 months
Blanket Replacement of all First Wall Panels	24 months
Test Blanket Modules (3 units)	2 months
NB caesium oven	1 month

Note 1: This time excludes ITER stop/start time. [PR1690-C]

Unscheduled remote maintenance tasks (failures that did not require an unscheduled shutdown or system upgrades) shall be performed during the remaining available time of a scheduled shutdown. The number of unscheduled tasks performed will depend on the time required to perform each task, their priority, and the possibility to carry out parallel remote handling operations (see **Table 6-7**). [PR1084-R]

The remote maintenance systems (PBS-23) shall be capable of processing, in parallel, tasks from the different columns (pools) shown in **Table 6-7**. [PR1087-R]

Table 6-7: ITER maintenance task pools

Pool A Tasks (est. 3 months each)	Pool B Tasks (est. 3 months each)	Pool C Tasks (est. 2 months each)	Pool D Tasks (est. 2 months each)	Pool E Tasks (est. 2 months each)
1× Equatorial Diagnostic Plug maintenance	1 × Upper Diagnostic Plug maintenance	3 × Test Blanket exchange	18 × Divertor cassette exchange	1 × NB caesium oven change
1× Equatorial ECH antenna upgrade	1x Upper port EC antenna upgrade	2 x Diagnostic rack exchange	37 x Blanket module replacements (based on a complete blanket replacement 2-year campaign)	1 × NB Fast Shutter maintenance (unplanned maintenance)
1× Equatorial ICH antenna upgrade		1 x IVVS exchange		1 × NB ion source caesium cleaning
1× Equatorial port limiter upgrade	1 × Torus cryopump maintenance			

For pools A and B, the maintenance systems shall be capable of processing, in series, two tasks in a six-month maintenance period. [PR1089-R]

For pools C, D, and E, the maintenance systems shall be capable of processing, in series, three tasks in a six-month maintenance period. [PR1090-R]

An eight month scheduled down time, including two months for preparatory activities for opening the vacuum vessel and getting the machine back on line, will be allocated on average every two years as major shutdown (long-term maintenance state, LTM) for maintenance and/or upgrades of all the systems. [PR2237-I]

In-vessel activities involving remote handling shall not exceed six months every two years. [PR2236-R]

6.2.2.2 Functional analysis and performances of sub-systems

Based on the outcome of staged approach analysis and the outcome of section 6.2.2.1, the contractor shall propose a detailed functional analysis, aiming at specifying for each sub-functions specific performance (e.g. the IRMS HC Remote Handling system, the Radwaste Type B system).

6.2.2.3 Input data for preliminary design activities

Based in the outcome of the tasks described above and based on the CDR documentation of the RW and RH systems, the contractor shall gather all input data to be considered in order to perform the preliminary design activities of the RW and RH system of the HCC.

7 Responsibilities

7.1 Contractor’s Responsibilities

In order to successfully perform the tasks in this Technical Specification, 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.

7.2 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.

8 List of deliverables and due dates

D #	Description	Due Dates
D1	Staged approach of the Hot Cell Complex - step 1: Draft version of the analysis described in section 6.2.1 - Management of the Tokamak maintenance - Management of Beryllium waste - Management of Radioactive waste - Functional analysis - Process flow - Proposal of HCC alternative layout - Summary and recommendations	T0 + 2 months

D #	Description	Due Dates
D2	Staged approach of the Hot Cell Complex - step 2: Preliminary version of the analysis described in section 6.2.1, taken into consideration the comments made on D1 - Management of the Tokamak maintenance - Management of Beryllium waste - Management of Radioactive waste - Functional analysis - Process flow - Proposal of HCC alternative layout - Summary and recommendations	T0 + 4 months
D3	Staged approach of the Hot Cell Complex - step 3: Final version of the analysis described in section 6.2.1, taken into consideration the comments made on D2 - Management of the Tokamak maintenance - Management of Beryllium waste - Management of Radioactive waste - Functional analysis - Process flow - Proposal of HCC alternative layout - Summary and recommendations	T0 + 6 months
D4	Functional specification of the Hot Cell Complex - step 1: Draft version of the analysis described in section 6.2.2 - Traceability of PR requirements - Functional analysis and performances of sub-systems - Input data for preliminary design activities	T0 + 8 months
D5	Functional specification of the Hot Cell Complex - step 2: Preliminary version of the analysis described in section 6.2.2, taken into consideration the comments made on D4 - Traceability of PR requirements - Functional analysis and performances of sub-systems - Input data for preliminary design activities	T0 + 10 months

D #	Description	Due Dates
D6	Functional specification of the Hot Cell Complex - step 3: Final version of the analysis described in section 6.2.2, taken into consideration the comments made on D5 - Traceability of PR requirements - Functional analysis and performances of sub-systems - Input data for preliminary design activities	T0 + 12 months

To be noted that the priorities between the different Deliverables to be issued could be changed at the KoM or during the duration of the contract, as per IO request and in agreement with the contractor.

9 Acceptance Criteria

These criteria shall be the basis of acceptance by IO following the successful completion of the services. These will be in the form of monthly progress reports as indicated in section 8, table of deliverables and further detailed below:

- Report and Document Review criteria.
- Reports as deliverables shall be stored in the ITER Organization's document management system, IDM by the Contractor for acceptance.
- Technical Responsible Officer is the Approver of the delivered documents.
- The Approver can name one or more Reviewers(s) in the area of the report's expertise.
- The Reviewer(s) can ask modifications to the report in which case the Contractor must submit a new version.
- The acceptance of the document by the Approver is the acceptance criterion.
- The acceptance criteria of the document correspond to:
    - Justified and documented comments,
    - Lessons learned of existing nuclear facilities,
    - Reference to existing technologies and proven solutions used in nuclear field,

10 Specific requirements and conditions

Significant experience in:

- Chemical waste management,
- Radioactive waste management,
- Remote Handling Systems,
- Functional analysis and cost benefit analysis,
- Design, commissioning and operation of nuclear facilities,

At least 20 years' experience is required in these fields of expertise.

The contractor shall present in the offer:

- a resource loaded schedule, in line with the delivery dates given in section **Error! Reference source not found.**,
- a resource estimate for each of the Deliverables,

11 Work Monitoring / Meeting Schedule

The work will be managed by means of Progress Meetings and/or formal exchange of documents transmitted by emails which provide detailed progress. Progress Meetings will be called by the ITER Organization, to review the progress of the work, the technical problems and the planning. It is expected that Progress Meeting will be held weekly or bi-weekly in ITER site. Progress meetings will involve C-R, C-TROs, IO-RO and IO-TROs.

The main purpose of the Progress Meetings is to allow the ITER Organization/RHRM Division and the Contractor Technical Responsible Officers to:

a) Allow early detection and correction of issues that may cause delays;
b) Review the completed and planned activities and assess the progress made;
c) Permit fast and consensual resolution of unexpected problems;
d) Clarify doubts and prevent misinterpretations of the specifications.

In addition to the Progress Meetings, if necessary, additional meetings to address specific issues to be resolved may be requested by the ITER Organization.

For all Progress Meetings, a document (email or Progress Meeting Report) describing tasks done, results obtained, blocking points and action items must be written by the Contractor.

12 Delivery time breakdown

See Section 8 – Deliverables and Due Date

13 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).

14 CAD Design Requirements (if applicable)

No CAD activity is planned in the frame of this contract.

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.

16 Appendix: Main features of the Hot Cell Complex

	Requested experience	Main features of the Hot Cell Complex facilities
Nuclear civil engineering of complex large scale project	High technology project	First-of-a-kind or research construction projects
	Strong links with industry and potential Plant manufactures	Wide range of disparate leading edge/high-tech systems and equipment to be designed, in order to avoid risk of change during suppliers manufacturing design.
	International projects	ITER stakeholders are China, the European Union, India, Japan, Korea, Russia and the United States. It corresponds to 35 different nations.
	Engineering/design	Design and overall integration of : - Building structure. Volume about 300,000 m^3 nuclear concrete building - Approximately 600 rooms within the Hot Cell Complex, - Building systems, e.g. Heating, Ventilation, and Air Conditioning (HVAC), fire protection, electrical distribution, Instrumentation & Control (I&C), liners, red zone cooling, piping, - Mechanical heavy handling, e.g. cranes, doors, trolleys
Hot Cells expertise	Numbers of hot cells / red zones	15 different hot cells in HCB, in total volume of red zones / C4 ventilation class = 26,000 m^3
	Management of irradiated and contaminated components	Contact dose rate = 250 Sv/h due to activation in the Tokamak. Contamination of tritiated and activated dust on In Vessel components and IRMS Constant efforts to prevent spread of dust in red zones (from design stage to operational procedures), ALARA
	Tritiated environment	High level of tritium concentration > 4000 DAC (Derived Atmospheric Contamination) in red zones Red zone / C4 areas fully covered by stainless steel liner, with a gap between the concrete wall and the liner. This gap is maintained under air Detritiation System.
	Nuclear maintenance	10 different hot workshops, 300 m^2 average each, dealing with hands-on maintenance on components after remote decontamination, ALARA
	Remote heavy handling in red zone	Handling of various heavy components, non-exhaustive list: – Equatorial Port Plug (50t, 3.5m length x 2.4 m x 2m), – Upper Port Plug (25t, 6 m length), – Divertor (9t, 3.5m length, 2m high, 0.8m wide), – Vacuum Cryopump (2.9m length, 1.7m diameter),

	Requested experience	Main features of the Hot Cell Complex facilities
		– Oversized Neutral Beam components up to 8m length, 3m high and 3.3m wide Two lines of defence: high reliability of heavy transfer systems and mitigation means in case of unexpected load drop.
	Docking of transfer casks	Transfer and docking of Remote Handing Transfer Cask, large size docking door: 2m x 2.4m, between the TKM and the HCC, and within the Hot Cell Building.
Radwaste management	Treatment of radioactive solid waste	Orders of magnitude during 20 years operation: – 1000 tons of MAVL waste – 100 tons FMA-VC – 100 tons purely tritiated waste – 10 tons TFA
	Treatment of radioactive liquid effluent	Orders of magnitude: 200 m^3 / year
	Radwaste process remotely controlled	Type B radwaste process located in the red zones / C4 areas shall be fully remotely controlled (no man access) and with in situ remote maintenance or hands-on maintenance after remote decontamination.
Hot Cell Remote Handling	Complex remote operation	Port Plug refurbishment, example of tasks to be performed fully remotely: – tilting 90° of 50t port plugs, – removal of subcomponents, – welding and control, – testing.
	Hot Cell Remote Handling	Design and integration of: – Tens of heavy duty long range manipulators, fully powered by electrical motors, – Few telescopic power manipulators, – Shielded windows, – Lighting and viewing systems, – Frames and handling tools, Buffer storage, remote decontamination, hands-on maintenance.
	Centralized control system	Functions such as ventilation management, remote transfers, remote refurbishment of In Vessel Components, remote waste treatment, shall be controlled from a centralized control room located in the Personal Access Control Building
	Seismic requirement	High seismic requirement (2 to 3 g acceleration in different dimensions) on building structure and part of the building system and process which is seismic classified according to the safety analysis