Hot Cell Complex Building Engineering Contract (REVISED)

Call for Nomination

<u>It is important to note that participation in this tender process will NOT cause a conflict of interest (and hence exclusion) regarding further tenders relating to the Hot Cell Building Complex. This current tender is essentially for a Conceptual Design only.</u>

1 Purpose

ITER is a first of a kind mega-project with a wide range of disparate leading edge/high-tech systems to be assembled and installed into buildings at its site in Saint Paul lez Durance, Cadarache, in the south of France.

The ITER Organization (IO) is the nuclear operator, complying with the relevant French Laws and regulations, authorization, codes and standards applied to Basic Nuclear Installation (INB). IO is responsible for integrating the activities from the early stage of design, to the procurement, the assembly, commissioning and operation.

IO and Fusion For Energy (F4E), called "Owner" in this document, have been charged with the design and the procurement of the Hot Cell Building (HCB), the Radwaste Building (RWB), the Personal Access Control Building (PACB) with the Radwaste process for the management of very low, low and medium radioactive waste, and the Remote Handling system of the Hot Cell. About 10% of the building floor surface is used for miscellaneous systems which will be designed and procured by other participant countries (Domestic Agencies), in particular the Detritiation System (DS) and the Port Plug Test Facility (PPTF).

IO shall provide to the French Nuclear Regulator a description and a safety analysis of these three nuclear facilities. At this point, in addition to design activities being performed on the process, building design activities are needed, knowing that the Hot Cell Complex Buildings are nuclear buildings, therefore they are "Protection Important Component" (PIC).

Based on the safety and functional requirements, starting from existing layout and existing safety analyses, the first step of the Hot Cell Complex Building Engineering Contract (HCC-BE) is to perform a Value Engineering analysis of the current design, aiming to reduce the building cost, in particular, by having the three buildings on the same slab. During this phase, input data shall be consolidated when needed and detailed safety requirement shall be defined.

Then, design activities shall be performed for the Civil Work structure and the building systems (e.g. cranes, doors, trolleys, ventilation system). The design effort corresponds to a conceptual detailed level. After this design stage, a safety analysis shall be made in order to demonstrate that the safety requirements are met, that safety risks are properly prevented and mitigated.

The outcome shall be an integrated building design, providing evidence that safety and functional requirements have been met, while the overall cost of the facility has been reduced as much as reasonably possible. Design activities on the process are out of the scope.

It must be noted that part of the expected documentation will be used as support documentation to answer to the French nuclear regulator.

This Call for Nomination is to seek companies interested in participating in the tender for the Hot Cell Complex Building Engineering contract.

Abbreviations are given in appendix 1.

2 Requirements, main features of plant and buildings

2.1 Maintenance and Radwaste process

The Hot Cell and the Radwaste facilities and the PACB shall provide the following functions:

- **Refurbishment and storage of In-vessel components**: It means that the Hot Cell will be the place where activated and/or contaminated In-vessel components go after their removal from the Tokamak. These In-vessel components will be refurbished, maintained, and for some of them buffer stored in this facility.
- **Test of In-vessel components after refurbishment**: Thermal cycling and functional tests are required on the repaired/refurbished Port Plugs (PP) using PP test facilities located in the HCB,
- **Port Cell equipment storage and maintenance**;
- **IRMS storage, decontamination and maintenance**: IRMS equipment will be decontaminated, maintained, refurbished, tested and stored between the shutdowns in the HCB,
- **Radwaste processing and storage of**:
  - Solid Radwaste type B, also called "MAVL" (corresponding to "Medium Activity, Long Life Radionuclide"), which are mainly the discarded part of the In Vessel component,
  - Solid Purely Tritiated Waste,
  - Solid Radwaste type A, also called FMA-VC (corresponding to "Low and Medium Activity, Short Life Radionuclide"):
  - Solid Radwaste TFA (corresponding to Low Level Waste),
  - Buffer storage and treatment of radioactive effluent after accidental event in TKM,
  - Liquid Radwaste type A,
  - Suspect liquid effluents from radiological controlled zones that turn out to be radioactive,
- **Characterization, chemical analysis, packaging and export of Radwaste.**
- **Health physics facilities, access control of personnel, changing rooms** for personnel working in radiological controlled areas of the Tokamak Complex (TKM), the HCB or RWB,
- **Control rooms** for Remote Handling operations performed inside the nuclear facilities (TKM and HCB) and back-up control room for the safety systems

2.2 ITER project lifecycle

The design of the Hot Cell, the Radwaste Facility and the Personal Access Control Buildings shall accommodate different phases of operations, with related constraints and objectives:

- The operational phase where plasma will be perform in TKM, with negligible activation but production of Beryllium dust. In this configuration, there shall be man access into the hot cells,
- The operational phase without Tritium but with non-negligible activation level of In Vessel components,
- The operational phase with Deuterium-tritium Plasma producing activated and contaminated components, in particular with activated dust and tritium,

- The deactivation phase for which the HCB and RWB shall support, in particular, the removal, the treatment and the buffer storage of In-vessel component,
- The decommissioning of the TKM and later the decommissioning of the HCB and RWB themselves.

2.3 Main building features

The main features of the three buildings are given here only for information because the first activity of this contract will be the redesign of the Civil Work, based on updated "functional" General Arrangement Drawings, provided by the owner, aiming at having the HCB, RWB and PACB on the same slab. Therefore, the overall volume and the complexity will be likely similar but the features of the current buildings are going to change.

The Hot Cell Building (HCB, Building 21), the Radwaste Building (RWB, Building 23) and the Personal Access Control Building (PACB, Building 24) are located adjacent to the Tokamak Complex, north side. They are connected to the Tokamak through a cargo lift located in the TKM Complex for the transfer of equipment and through a personal access corridor for operators (see Figure 1).

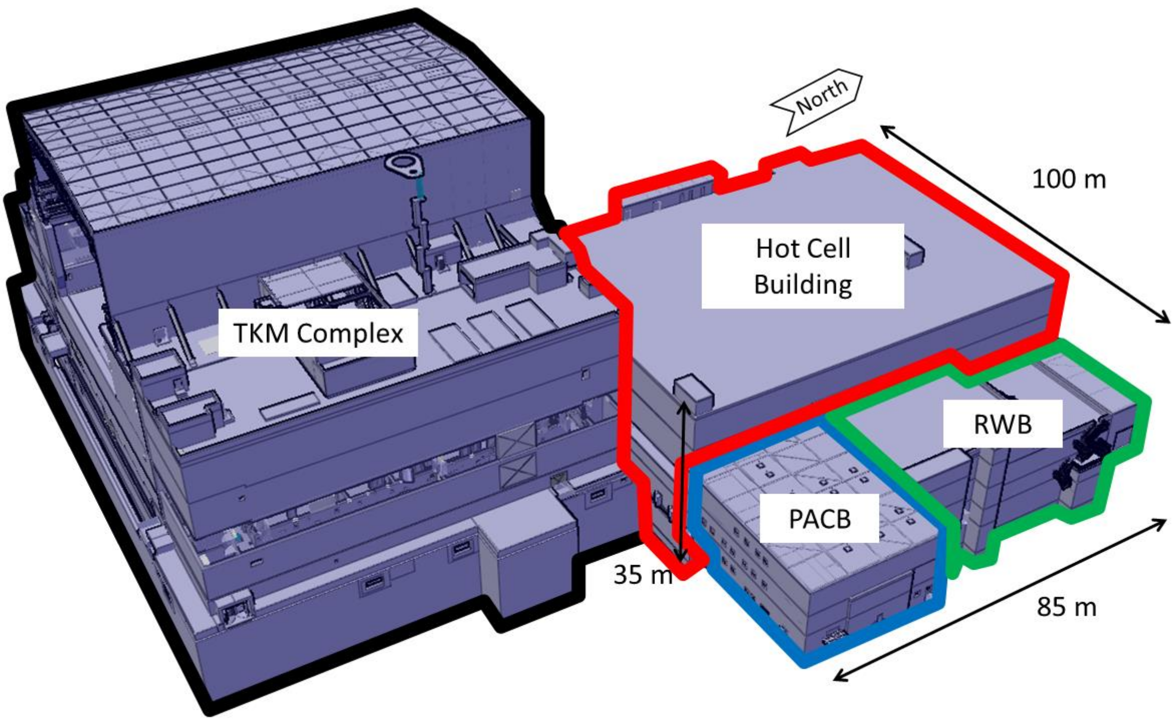

Figure 1 : Overview of the Hot Cell Complex

The three nuclear buildings HCB, RWB and PACB correspond to the Hot Cell Complex (HCC).

The table in paragraph 5.1 gives some main features of the HCC in order to illustrate the level of complexity.

It must be noted that the construction of the HCC (B21, B23 and B24 in the figure below) will occur while the construction of the TKM and the adjacent buildings will be on-going, or at least, during the assembly phase of the TKM Complex. It is a strong constraint which shall be considered at an early stage of design, in term of technical feasibility, cost, functional and physical interfaces.

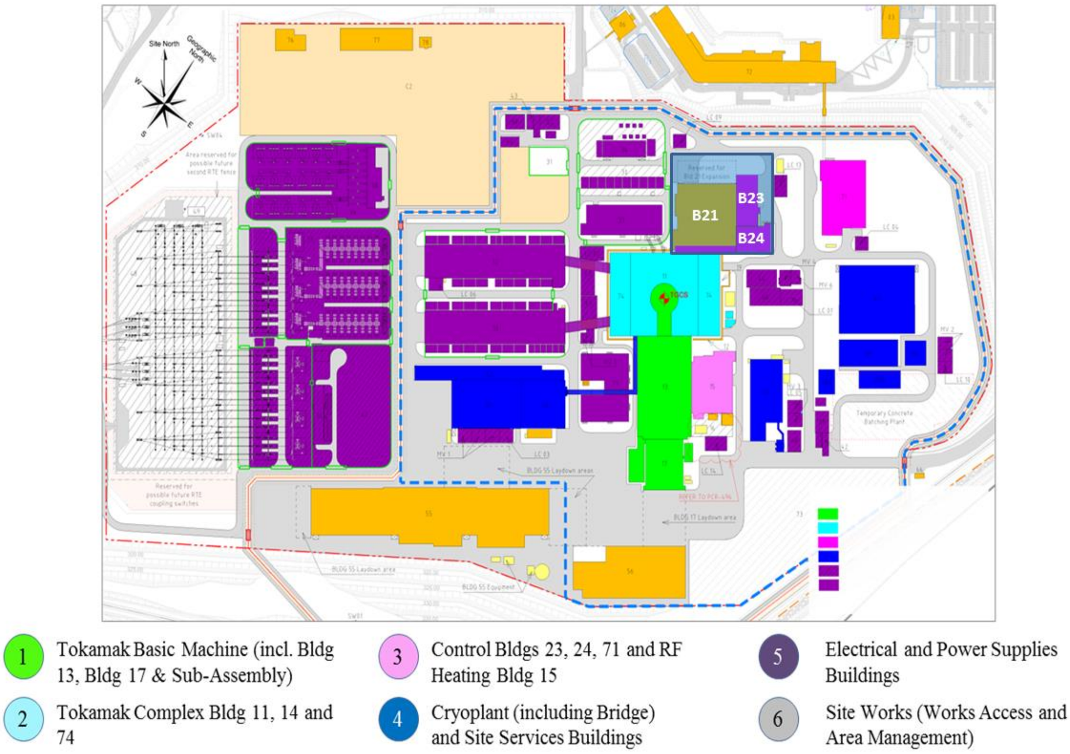

Figure 2 : Site master plan

3 Scope

This contract covers building design activities needed to answer to the Nuclear French Regulator, including related safety analysis. It covers the Civil Work and the building systems (e.g. cranes, doors, trolleys, HVAC, red zone cooling, Stainless Steel Liner covering the surface of the contaminated rooms, fire prevention and mitigation).

Many analyses and related documentations already exist, but:

- At the start of the contract, the owner will provide a new “functional” layout for the three buildings. The civil work structure will have to be readjusted to ensure the strength of the building and reduce its cost. Design activities on building systems will have to be adapted and refined in order to have a sufficient level of confidence on the internal arrangement, the Civil Work structure, and to get the proper input data for the safety demonstration,
- Some technical solutions have been defined according to functional and safety requirement, but trade off studies shall be performed in order to evaluate alternatives and to select the most optimized ones (trade off studies as described in “Systems Engineering Fundamentals – DOE January 2001”).

The scope does not include design activities of the Remote Handling, the Radwaste, the Port Plug Test Facility and the Detritiation System. Nevertheless, the skills of the contractor in Remote Handling, Waste management and Tritium management will be an advantage as it will help the integration work and the decision making.

4 Schedule outline and task summary

The duration of the contract is expected to be 12 months.

It is expected to have 5 phases, with overlaps between them, as illustrated in Figure 3:

1. Review and completion of input data:
    - Review of input data, in particular the “Safety Requirements” (QD),
    - Review of building loads (weight, fire, heat, etc),
    - Identification of missing items,
    - Technical assumptions approval for data not provided,

2. Value Engineering:
    - Challenge input data, cross check and consolidation,
    - Trade studies and benchmarking,
    - Review and consolidation of the new HCC layout,
    - Review and consolidation of the Civil Work structure and building systems, aiming to reduce complexity and cost,
    - Integration of lessons learned from the TKM complex (e.g. constructability),
    - Recommendations and supports of decision.

3. First step of safety analyses, aiming at defining the “Detailed Safety Requirements” (ED) versus the “Safety Requirements” (QD), according to the French Order 7th February 2012, in particular regarding the following items:
    - Confinement function,
    - Shielding function,
    - First step of hazard analysis:
        - Fire risk,
        - Thermal releases,
        - Internal flooding,
        - Overpressure risk,
        - Explosion risk,
        - Load drop risk,
        - External risk (e.g. seismic, external flood, external overpressure, airplane crash),

    To be noticed that “Detailed Safety Requirements” (ED) shall be justified, for some of them based on trade studies, studying different options, aiming at minimizing the cost, without jeopardizing the functional requirements.

4. Building design activities, which correspond to a conceptual design maturity level:
    - To demonstrate compliancy with Safety Requirements,
    - Integrated design of doors, cranes, trolleys,
    - Red zone cooling system, Heating, Ventilation, and Air Conditioning
    - Fire prevention and mitigation means,
    - Overpressure mitigation systems,
    - Flood mitigation systems,
    - Transfer of heavy loads, load drop mitigation,
    - I&C of the building systems,

    - Shielded penetrations,
    - Stainless Steel Liner covering the surface of the contaminated rooms,
    - Building configuration during Be phase,
    - Building configuration during deactivation phase,
    - Maintenance activities,
    - Concrete outline drawings,
    - 3D model of the building and building systems,
    - Structural Analysis (loads and load combinations), in particular in seismic event, load drop and airplane crash,
    - Risk and opportunity analysis,
    - Construction schedule and cost assessment,

5. Safety demonstration:
    - Operation and control, ALARA approach,
    - Safety zoning and justification of the safety zoning: radiological, ventilation, anti-deflagration, Beryllium, magnetic, fire zoning and waste zoning,
    - Update and completion of "Detailed Safety Requirements" (ED) versus "Safety Requirements" (QD),
    - Hazard analysis for internal and external risks: identification, prevention, detection and mitigation means for each type of risk.

ITER is a Nuclear Facility identified in France by the number-INB-174 ("Installation Nucléaire de Base"). As a consequence, the Contractor 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, if any,
- the activities for supervision purposes are also subject to a surveillance done by the Nuclear Operator.

To be noted that:
- Maintaining the schedule is crucial to the timely release of a key project stage gate by the French nuclear regulator. The Building Engineering contractor shall make an additional provision of 6°months (option) for the different design and nuclear safety reviews/meetings with a limited core team, and to continue to work with IO to integrate the safety documentation.
- The key personnel forming the core of the contractor team will be continuously located at ITER in order to integrate the design with other stakeholders and ensure an efficient design process which meets requirements, in particular safety and trade studies. This shall include the overall design manager and discipline design leads.
- The contractor will carry out Value Engineering (VE) exercises and trade off studies at the most beneficial points in the schedule expected to be in Phase 1 to 3 in the list from the task summary list above. This VE will be based on total expenditure and risk for the entire facility (process and buildings). The Contractor will lead and facilitate this exercise utilising staff experienced in design and operation of major Hot Cell facilities.
- As much as possible, technical solutions shall be based on existing and proven techniques, aiming at reducing risks and minimizing cost.
- The sequence of activities corresponds approximately to the schedule below:

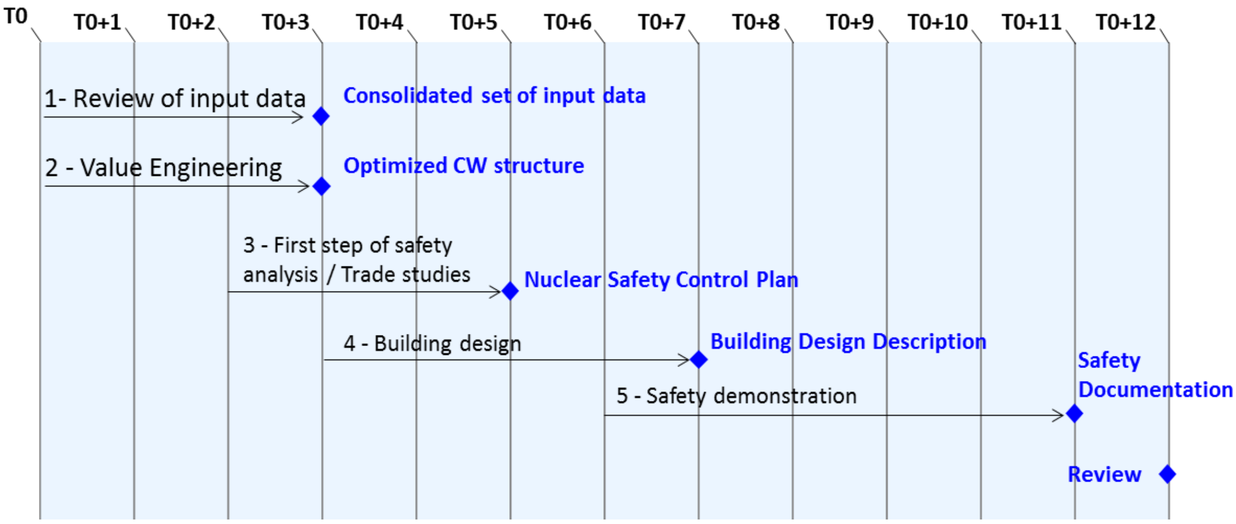

Figure 3 : Illustration of the sequence of activities – illustration only

At T0+7 months, the level of design and related justification shall be sufficient to be able to freeze the layout of the Hot Cell Complex and to start transverse calculation and safety analyses.

At T0+11 months, the set of documentation shall be issued for a review carried out by the owner.

5 Contract tender

5.1 Skills and experience

The Hot Cell Complex Contractor shall provide a well-organized, highly skilled team, with in-depth knowledge and experience of ALL the following topics:

	Demonstrable skills and 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 for in the Preliminary and Construction Design stages 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. The project language is English and safety documentation to be delivered to the French safety authority shall be in French and English.
	Engineering/design	Design and overall integration of : - Building structure. Volume HCB 190,000 m^3 nuclear concrete building and RWB 30,000 m^3, PACB 16,000 m^3 - Approximately 400 rooms within the HCB, 130 rooms in the RWB and 110 rooms in the PACB, - Building systems, e.g. Heating, Ventilation, and Air Conditioning (HVAC), fire protection, electrical distribution, Instrumentation & Control (I&C), liners, red zone cooling, - Mechanical heavy handling, e.g. cranes, doors, trolleys,
	HVAC and fire protection	2 air change per hour in accessible areas, switch to Detritiation System if tritium above threshold detection (safety function) Management of heat loads, fire loads, air conditioning, fire protection and mitigation
	Network routing (e.g. cabling, piping, HVAC), management of penetrations and anchorage	About 400 Control Cubicles and 100 Electrical Distribution Boards located in the HCB and RWB. Routing of HVAC, cable trays, DS piping in peripheral corridor. Segregation of routing for PIC functions (e.g. power supply, instrumentation)

	Demonstrable skills and experience	Main features of the Hot Cell Complex facilities
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 in red zones Red zone / C4 areas fully covered by stainless steel liner, with an gap between the wall and the liner
	Nuclear maintenance	10 different hot workshop, 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), – 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
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).
Hot Cell Remote	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.

	Demonstrable skills and experience	Main features of the Hot Cell Complex facilities
	Hot Cell Remote Handling	Design and integration of: – Tens of heavy duty long range manipulator, 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
Safety	Safety demonstration	Full traceability of safety requirement, from the “high level” safety requirement to the detailed safety requirement and the related reference documentation Exhaustive list of prevention, detection and mitigation means for each internal and external safety hazard (deterministic approach).
Safety	ALARA	Implementation of the “As Low As Reasonably Achievable” approach into design activities, in particular regarding shielding calculation and hot workshops.
Safety	Human Factor	Human factor integration, definition and tracking of Human Factor requirements, development of virtual mockup and Human Machine Interfaces for the centralized control room.
Safety	French Nuclear Regulator licencing process	Safety analysis of the HCB and RWB based on the outcome of the consolidation / value engineering phase. Then continuous support to the licencing process: answer to ASN request, data and safety analysis for the update of the RPrS.

Table 1: Demonstrable skills and experience

The primary selection criteria for the Hot Cell Complex Contract shall be demonstrated experience, knowledge and skills with criteria given in table above and ensuring safe, timely and cost efficient management of large scale first-of-a-kind and nuclear projects.

The candidates shall have sufficient experience, resources and financial capacity to manage such a large scale project. Key skills are building design activities of large scale nuclear projects, in particular hot cells, and safety analysis, being familiar with the approach of the French Authority. Skills in Remote

Handling, Radwaste management and tritium management are also necessary to support safety and trade analysis.

The Owner will seek to incentivise the Hot Cell Complex Contractor to reduce the overall investment and operational cost. It will be required to contribute to open communications & teamwork with the Owner.

5.2 Procurement Schedule

A tentative timetable is outlined as follows:

Procurement Schedule	**Tentative Dates**
Call for nominations	20th April 2016
Receipt of nominations	16th May 2016
Issue call for tender	20th May 2016
Tender submission due date	30th June 2016
Estimated Contract Award date	August 2016
Estimated Contract Start Date	September 2016

Table 2: Timetable of the tender

Appendix 1: Abbreviations

ALARA	As Low As Reasonably Achievable
ASN	« *Autorité de Sûreté Nucléaire* » - French Safety Authority
Be	Beryllium
C4	Ventilation Classification C4 according to ISO 17873
DAC	Derived Atmospheric Contamination
DS	Detritiation System
ED	Detailed Safety Requirement (former "Exigence Définie")
F4E	Fusion For Energy, European Domestic Agency
FIDIC	International Federation of Consulting Engineers
FMA-VC	Low and Medium Activity, Short Life Radionuclide
HCB	Hot Cell Building
HCC	Hot Cell Complex
HCC-BE	Hot Cell Complex Building Engineering Contract
HVAC	Heating, Ventilation, and Air Conditioning
I&C	Instrumentation & Control
INB	« *Installation Nucléaire de Base* » - Nuclear Facility
IRMS	ITER Remote Maintenance System
MAVL	Medium Activity, Long Life Radionuclide
PACB	Personal Access Control Building
PIA	Protection Important Activity
PIC	Protection Important Composant
PP	Port Plug
PPTF	Port Plug Test Facility
PT	« *Prescription Technique* » - Technical Prescription
QD	Safety Requirement (former "Qualité Définies")
RPrS	« *Rapport Préliminaire de Sûreté* » - Preliminary Safety report
RWB	Radwaste Building
TFA	Low Level Waste
TKM	Tokamak
VE	Value Engineering