Framework Contract for
Remote Handling Engineering Support

1. Background

1.1. The present tender is for the supply of engineering support to the ITER Organization (IO) in the area of Remote Handling.

1.2. A specific call for tender will be organised after the call for nomination.

1.3. The Applicant(s) selected on the basis of the present tender shall provide engineering support to the IO Remote Handling (RH) Section in a range of areas concerned with specification, analysis and design of remote handling systems required for ITER.

2. Scope of Supply

2.1. The engineering support covers the provision of staff as required to suit IO to work in the following areas:

a) IO RH Engineering
- strategy, organisation and methodologies
- standardisation and best working practise policies
- planning
- Quality Assurance
- IO Plant compatibility

b) ITER Maintenance System
- equipment specification and concept development
- assembly, integration and verification
- standardisation and modularity
- best working practise policies
- identification of key technology development requirements

c) RH Operations
- task identification and assessment
- shutdown and intervention planning, logistics and analysis
- mock-up specification and utilisation
- best working practise policies

d) Interfacing
- Internal
- External to DA's
- External to Industry

2.2. The Applicant(s) shall be able to provide the following professional competences:

a) Design analysis using the software tools: CATIA V5, DELMIA V5
b) Integrate the deliverables produced by the ITER Domestic Agencies in the ITER documentation and 3D CATIA models. This activity requires the possibility to receive and deliver CAD files in CATIA/ENOVIA format;

c) Writing of design description documents, interface control documents, functional specifications, test and commissioning procedures for RH equipment and RH operations;
d) Good knowledge and understanding of the ITER device design and of the ITER RH systems.

3. Implementation

3.1. This contract will be a framework contract implemented by means of Work Packages (WP) as and when required and requested by the IO, intended as self-standing engineering design activities.

3.2. Each WP shall be regulated by a Task Order, signed by the Contactor and the IO. It will be specified by the IO and agreement reached between IO and the Applicant(s) as to the following elements:

a) IO responsible officer
b) Applicant(s) responsible officer
c) Technical Scope
d) Start and end dates
e) Applicant(s) person-days to be allocated to the task
f) Work progress monitoring and control
g) Deliverables
h) Charge pattern

3.3. The duration of the framework contract will be **1 year** from the date of the signature by the last of the contracting parties, renewable for a **further 2 years** upon IO decision.

3.4. The Applicant(s) will complete the WP as agreed and will deliver the agreed material on the date specified. If substantive changes are requested or required during implementation of the WP then a change notice will be raised and agreed between the parties before an amendment is made to the WP definition.

3.5. The Applicant(s) will submit an invoice (or invoices) to the IO in accordance with the agreed WP charge pattern for an amount computed according to the person-days worked and the pricing structure specified in this proposal.

3.6. All of the work will be performed by the Applicant(s) staff located at the company's premises. Project progress and delivery meetings will be convened at IO Cadarache and the Applicant(s) offices as required.

3.7. Details of the Applicant(s) staff expected to be available to perform this work (personal profile, professional experience) will be provided ahead of the start of the Contract and at the start of each WP.

4. Utilisation

4.1. As an indication, the anticipated utilisation of the Contractor staff over a 1 year period will need to be agreed prior to the start of the framework contract. It expected that the utilization will vary depending on the Company's staff category and be, on average, around 250 person days.

5. Required level of technical competences and expertise

5.1. Potential Applicants must have excellent and proven competencies in all aspects of technology, operations and management related to the specification, design, implementation and support of complex and time intensive remote handling maintenance applications. The following competencies will be an advantage:

- Remote Handling Operations
- Remote Handling Technologies
- Remote Handling Compatibility of nuclear plant
- Remote Handling Standards
- Remote Handling Training

5.2. Potential Applicants must have experience in planning and executing fully remote maintenance campaigns of 6 months or more.

5.3. The following experience will be an advantage:

- development of remote handling operations concepts taking account of the whole life cycle approach;
- design, development, and operation of electronic tele-manipulation devices;
- design, development, and operation of programmable robotic transporters;
- design, development, and operation of remote environment sensing;
- design, development, and operation of task based tooling;
- remote services supply;
- design, development, and operation of virtual reality systems;
- design, development, and operation of human-machine interfaces;
- design, development, and operation of operations management systems;
- time and resource planning of remote handling operations campaigns;
- estimation of remote operations task feasibility and duration;
- preparation and validation of detailed remote handling operations procedures;
- specification and implementation of physical and digital mock-ups for remote handling task development;
- development of strategies and implementation for recovery of failed remote handling systems in service.

5.4. Previous experience in the field of nuclear fusion remote handling equipment design, development and usage will be considered an advantage.

6. Platforms

As a minimum:

- CAD systems: CATIA V5
- Virtual reality systems: DELMIA V5
- Operations sequence analysis tools

ANNEX 1

DESCRIPTION OF THE ITER REMOTE HANDLING SYSTEM

1. General

Remote handling (RH) is the synergistic combination of technology and engineering management systems to enable operators to safely, reliably and repeatedly perform manipulation of items without being in personal contact with those items. ITER, the world's largest nuclear fusion research facility, will rely heavily on RH operations to accomplish its scientific mission while minimizing the risk of ionizing radiation exposure to its personnel. This mission requires scheduled upgrades of the machine, by means of exchanging internal components, executing scheduled and unscheduled maintenance and/or repair operations. To accomplish such tasks, ITER has adopted a RH maintenance plan (IRHMP). This is based on the maintenance system (IMS) equipment, on the IMS facilities (hot cell, test stand) and on a set of operational procedures.

2. ITER Maintenance System

The IMS relies on the use of RH equipment and tools (briefly described in the six paragraphs below) which will be deployed inside the ITER vacuum vessel, in the hot cell and, depending on the actual radiation levels at the time, inside the cryostat. The current extent of the IMS is based on an ITER machine upgrade plan established some time ago, to be implemented during the lifetime of the machine, to accommodate the scientific and technological development of the ITER experimental program. Parameters positively affecting the IMS functionality, reliability and availability are: a) simple and robust design of the machine components to be maintained, b) simple, staged and perfectly rehearsed RH procedures for each machine component's replacement, requiring a high level of RH equipment testing in RH relevant conditions, under normal and off-normal conditions (requires full size mock up test facilities), c) robust, reliable and proven RH equipment and tools. The IMS includes the following:

- Blanket Handling Equipment
- Divertor Handling Equipment
- Port Systems Handling Equipment
- Neutral Beam Line Components Handling Equipment
- In-Vessel Viewing System Equipment
- Hot Cell Remote Handling Equipment

3. ITER machine operations and maintenance operations

The key aspect to the success of a nuclear fusion reactor is the ability to maintain high plant availability. Plant availability requires that three key, IMS related requirements are simultaneously satisfied: a) the IMS equipment must always be retrievable in case of failure, with no or minimum ionizing radiation exposure to the facility personnel, b) ITER components must be designed to facilitate the maintenance tasks safely, timely and reliably, c) the IMS equipment cost must be acceptable or in any case commensurate to the relevance of the maintenance/upgrade operation to the scientific program success and schedule. Therefore, it is important that the machine design, the machine maintenance/upgrade plan and the IMS must be developed concurrently to guarantee: a) a high degree of machine components' reliability and accessibility, b) a realistic machine maintenance/upgrade plan, c) an IMS equipment deployment and usage readiness for both scheduled and un-scheduled maintenance operations. Scheduled maintenance is addressed by implementing the IMS elements listed in paragraph 2. For unscheduled maintenance the same elements will be used, with additional equipment to be provided at the time, as required. A number of other, generic maintenance tasks will also need to be catered for by the IMS: detection and repair of magnets faults, of vacuum, cryogenic and coolant system leaks, dust cleaning, first wall inspection. Good functional relation between the IMS and the hot cell is essential to ensure smooth RH operations on the machine and inside the hot cell. For this reason, the IMS and, in particular, the hot cell design must be optimized for: a) efficient and reliable exchange of the IMS equipment and tools required during multi-task shutdowns (i.e. when several IMS equipment and tools are deployed), b) systematic and rigorous maintenance and re-testing of the IMS equipment and tools after each maintenance campaign, c) continuous improvement. The hot cell facility design and the type and amount of the hot cell RH equipment depend crucially on the following factors: a) frequency and amount of machine components entering and exiting the hot cell, b) maximum allowable shutdown time, c) maximum amount of component radwaste that can be stored inside the hot cell prior to export to the Host Country radwaste repository site, d) tritium removal efficiency and recovery at the radwaste processing stage (note: this operation will be carried out mostly, but not only, outside shutdown periods). The factor at point a) above is undergoing a re-assessment within the Project; the baseline machine upgrade plan appears to be currently on the limit of the IMS (intended as the RH equipment for the in-vessel operations and the hot cell as a facility) operational capacity originally foreseen, and not entirely compatible with a minimum plant availability requirement (to be confirmed) of ~70%. The role of the hot cell as a support to the RH operations and vice versa can be better understood by noting that for smooth in-vessel RH operations the hot cell must have high functional availability; this in terms of space for in-vessel components' refurbishment, testing and temporary storage. Also, for in-vessel RH equipment/tools operation sequences rehearsal and modification, as expected during complex and sometimes not always fully anticipated shutdowns. Conversely, the hot cell RH equipment/tools (manipulators, cranes, repair tools, RH operations test stand, and radwaste processing equipment) must be readily available so as to accommodate the operations required to refurbish and timely return the components to the vessel, during a given shutdown. One of the biggest challenges of the IMS and hot cell facility designers and operators consists in maximizing these systems' performance (i.e.: readiness for deployment, capacity to operate consistently and reliability) while minimizing the impact on the ITER plant capital and operation costs. When planning the ITER machine operations and maintenance operations, it is important to remember that the time allocated to maintenance (planned or unplanned) must crucially take into account the time for essential, additional parallel/series IMS activities.

4. Conclusions

After more than 10 years of IMS equipment design and R&D, ITER is ready to move forward, consolidating the existing design as well as adapting itself to the evolution of some machine components functional and operation requirements. The realization today is that the IMS cannot be dealt with in isolation; it must be elevated in status to become an integral part of the ITER experimental program. The IMS and the machine design will need to become fully compliant with the guidelines of the IRHMP. A few requirements, such as the extent of the IVVS first wall coverage, must be better clarified. Crucial components' design features need to be improved for better assemble-ability and RH compatibility (blanket modules, port plugs). Further, design and R&D work is still required, in a very short time, before the IMS equipment becomes ready for its first use during initial assembly of the in-vessel components. Other key aspect to be addressed is the global and specific IMS equipment and tools reliability and ability to recover from failure, following postulated failure modes. All this work cannot be done without a strong ITER team and without the help of the ITER Domestic Agencies (DA's). The indications are that the ITER DA's are willing to pick up the above challenges and provide a sustainable effort both during and beyond the construction phase. Finally, it is strongly recommended to keep in mind the JET RH lessons, in particular: a) the ITER RH capability must be considered "holistically" from the outset as an integrating technology rather than a suite of manipulators and tools, b) the ITER RH approach must be from the outset as flexible as possible with minimum reliance on the Tokamak configuration, d) the ITER RH would be facilitated by the definition and control of RH compatible components and features from the early stage. This means that the design of components requiring RH must be significantly influenced by the involvement of RH engineers during their design phases, e) the ITER IMS equipment must be thoroughly proven before being put into service.