

TECHNICAL SUMMARY

Framework Service Contract for Manufacturing and Qualification of Specialized Components for the ITER Visible Spectroscopy Reference System

Purpose

The main purpose of this framework contract is to provide the ITER Diagnostics Program, and specifically the Visible Spectroscopy Reference System of this Program, with specialized opto-mechanical and electrical components and associated acceptance and qualification tests to support its manufacturing and construction.

Due to the diversity of the required components, the ITER Organization reserves the right to award this contract to more than one contractor.

Background

The ITER Project 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.

Monitoring and controlling the ITER device using diagnostics is crucial for successful operation. Design, construction and planning for operation of these diagnostics are now well underway. There are about fifty diagnostics systems in ITER which are needed to cover the reliable routine operation, advanced operation and physics exploitation. These diagnostics are divided into several categories, including magnetics, neutrons, bolometer, infrared, optical, ultraviolet, X-ray, microwave and operational systems. The diagnostic system in the scope of the proposed framework contract is the Visible Spectroscopy Reference System (VSRS), which is moving towards its manufacturing phase. The VSRS consists partly of in-vacuum optics (mirrors), Radio-Frequency (RF) electronics and moving parts. Furthermore, it contains also further optics, pneumatics, electronics and moving parts outside of vacuum but still in areas of high radiation and magnetic field. Moreover, some provision is foreseen in this Framework Contract to support other diagnostic systems (such as visible and infrared imaging systems, visible spectroscopy systems, (vacuum) ultraviolet and X-ray spectroscopy and neutron diagnostic systems) with manufacturing and testing resources where there is an overlap regarding the requested experience.

As mentions above the VSRS components located within the ITER Vacuum vessel and subject to high radiation and high magnetic fields. Environmental and Integration constraints as well as diagnostic requirements will impose to develop novel concepts or fit existing concepts to specific ITER conditions. Those will require prototyping and qualification testing in support of manufacturing, which will be a first part of the work covered by the framework contract.

A second part of this framework contract encompasses final manufacturing and acceptance testing of diagnostic components of the actual diagnostic system components installed on the ITER facility for operation.

Nuclear Safety

As mentioned above, ITER is a Nuclear Facility (INB-174) and work within the scope of this framework contract could potentially involve Protection Important Components (and in particular Safety Important Class components (SIC)) or other activities defined as Protection Important Activities (PIA). For those 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 \(AW6JSB v1.0\)](#)).

Scope of Work

ITER Organization Diagnostics Program shall coordinate the manufacture of mechanical components and the achievement of both prototype and final component manufacture and qualification and acceptance tests through Task Orders. Each Task Order shall have a specific technical specification providing detailed requirements on the expected supply. Task Orders are in principle expected to be limited to work for a single diagnostic subsystem, but exceptions might occur whereby the work covers supply to multiple diagnostic subsystems. In general Task Orders would fall into following categories:

- Manufacturing and (qualification) testing of prototype components in support of Final Design Review (FDR) and Manufacturing Readiness Reviews (MRR). These could include some design work or refinement (including engineering verification) on the prototype component specifications and drawings provided as input to the Task Order.
- Manufacturing studies in support of Manufacturing Readiness Reviews (MRR). This would include (but is not necessary limited to) evaluation of final design specifications and drawings with respect to the anticipated manufacturing methods and tooling, update of design (including engineering verification) to ensure compatibility with manufacturing methods and tooling, and reducing manufacturing risks, pre-

qualification of manufacturing methods and tooling This would also include verification of welding requirements, weld designs and planning of non-destructive testing (NDT) of welds. This will also include the possibility to perform assembly test and 1:1 scale mock-up.

- Procurement of ITER grade material, including material certification and potentially material composition tests. These task orders could potentially cover multiple diagnostic subsystems to improve procurement efficiency.
- Manufacturing and assembly, including Factory Acceptance Testing (FAT), of Diagnostic components and/or subassemblies. These could include some design work or refinement (including engineering verification) on the component specifications and drawings provided as input to the Task Order. Also Manufacturing studies work could be combined with actual manufacturing and FAT in a single task order to reduce overhead, especially if the manufacturing studies are expected to have low risk of revealing unforeseen complexity of the manufacturing process.

Manufacturing could include outsourcing the production of very specialized subcomponents to specialized suppliers (potentially contracted separately by IO). In such case, follow-up and technical support to such production shall be part of the Task Order.

The manufacturing and assembly Task Orders would also include all stages up to the Delivery Readiness Review, and organise delivery to the IO site.

The scope of the work requested in this call covers the services of experienced manufacturers in Ultra High Vacuum components, Optical components (including optical coatings) and Mechanical components (including motion in vacuum). The scope of the work includes:

- Supplying of ITER grade materials with (3.1 and 3.2) certification, incl. possibility for testing Co, Ta and Nb content of materials if they cannot be procured with certification of Co<0.05%, Ta<0.01% and Nb<0.01% content.
- Designing (3D and 2D Computer Aided Design model) from CATIA preliminary and final models provided by ITER Organization;
- Design and execution of Welding / Brazing / Diffusion Bonding techniques on multiple materials, incl. tests to qualify weld/braze/diffusion bond;
- Machining (Milling, Cutting, Drilling, Spark erosion, 3D printing, etc.) of Austenitic Stainless Steel (304 or 316), Nickel Based Alloys, Titanium, Copper, etc., incl. high precision machining (<10 micron);
- Permanent or temporary assembly of mechanical components in subassemblies;
- Electrical wiring and installation of electrical connectors (incl. electrical testing for connectivity, resistance, grounding and electromagnetic compatibility ...) both for UHV use (mineral insulated cables junction boxes, setup and weld cable end joints, fabricate braze joints, sealing cables into vacuum test rig) and use outside vacuum;
- Manufacturing of UHV compatible ceramic Printed Circuit Boards (PCBs) for the radio frequency signals (~10-100MHz) (potentially outsourced);
- Vacuum outgassing tests, residual gas analysis and Helium Leak Testing (leak rate < $1 \times 10^{-10} \text{ Pa.m}^3.\text{s}^{-1}$) on welded joints or particular assemblies;
- Cleaning of components to level of vacuum and optical cleanliness;

- Manufacturing, assembly and testing of pressurized circuits (e.g. for water cooling or pneumatic actuators);
- Thermal cycling tests;
- Mechanical testing, incl. vibration table tests (resonance, sine or random), motion in vacuum tests, pulling / pushing tests;
- Radiography, Ultrasonic testing and dye penetration testing of welded joints;
- Metrology and optical alignment (e.g. with laser tracking);
- Manufacturing of custom optical surfaces (e.g. by diamond turning) and optical precision polishing;
- Uniform coating (e.g. by Physical Vapour Deposition) of multiple materials (Copper, Rhodium, Platinum, Aluminium, Zirconium- and Silicon-Oxide, Boron Carbide, Titanium Oxide, Dielectric coatings etc.) with coating thicknesses up to 10 µm, on several substrate materials (Stainless Steel, Copper, Aluminium, Alumina, Aluminium Nitride etc.) of sizes up to 300x300mm² (potentially outsourced).
- Optical testing (transmission, specular/diffuse reflectivity and BRDF¹, contrast, wavefront error, stray light characterization ...) in the infrared and visible (and if possible ultraviolet and X-ray wavelength bands).

Duration of Services

The Contract is expected to come into force by the end of 2024 for a firm duration of four (4) years, with an option to extend for a further period of 2 years.

The indicative Call for Tender milestones are:

Call for Nomination	End of May 2024
Issuing of Prequalification invitations	Beginning of July 2024
Issuing of Call for Tender	End of August 2024
Submission of Tenders	Mid of November 2024

Experience

The selection process will be based on the following past experiences and facilities:

- Supplying of ITER grade materials with (3.1 and 3.2) certification;
- Supplying of Ultra-high vacuum-compatible mechanical components or systems;
- Machining of UHV-compatible mechanical components;
- Supplying and machining of non-UHV mechanical components;
- Supplying of Optical components (mirrors, lenses, coatings, polishing) both UHV compatible and non-vacuum;
- Metallic assemblies using welding, e-beam welding and brazing;
- UHV and non-UHV electrical (Low Voltage and Radio Frequency) circuit manufacturing and assembly;

¹ Bidirectional reflectance distribution function

- Computer Aided Design;
- Machining facilities;
- Test facilities including UHV testing, electrical testing, optical testing, alignment and metrology testing;

Candidature

Participation is open to all legal persons participating either individually or in a grouping (consortium) which is established in an ITER Member State. A legal person cannot participate individually or as a consortium partner in more than one application or tender. A consortium may be a permanent, legally-established grouping or a grouping, which has been constituted informally for a specific tender procedure. All members of a consortium (i.e. the leader and all other members) are jointly and severally liable to the ITER Organization. The consortium cannot be modified later without the approval of the ITER Organization. Legal entities belonging to the same legal grouping are allowed to participate separately if they are able to demonstrate independent technical and financial capacities. Bidders' (individual or consortium) must comply with the selection criteria. IO reserves the right to disregard duplicated references and may exclude such legal entities from the tender procedure.

Reference

Further information on the ITER Organization procurement can be found at:

<http://www.iter.org/org/team/adm/proc>