

CONTRACTS TECHNICAL SPECIFICATION

Contract Title:

Metrology Engineering Services

Technical Specification

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1 Abstract

This document specifies the requirements for the provision of a Metrology Engineer to carry out services relating to metrology activities for ITER machine assembly.

2 Background and Objectives

The ITER machine consists of many components, assemblies and associated systems which must be accurately and precisely aligned for the machine to operate. The Machine assembly and Installation (MAI) section is responsible for all aspects of dimensional control from acceptance testing of the constituent parts through to their final operational alignment.

Large volume metrology typically utilises optical measurement systems for dimensional control and alignment. ITER currently plans to use laser trackers, total stations and photogrammetry systems for data capture, interfacing with appropriate software packages for data manipulation and reporting. Currently Spatial Analyzer is the metrology software being used on the project.

Survey networks will be designed, installed, measured and monitored, providing the datum for alignment activities in the various ITER buildings. These networks will enable measurement systems to book into a common coordinate system for alignment tasks anywhere within the applicable building.

The components for ITER are large, heavy and therefore difficult to manipulate. In addition, the restrictive space allocated for their assembly and the exacting tolerances to which they need to be installed puts metrology challenges into perspective.

For the major ITER components, each alignment task shall be carefully studied to develop and qualify the measurement and alignment process. Component reference points will be defined that provide coordinate values linked to the key functional features of the item. Survey geometry shall be defined and registered within the configuration models and measurement simulations will be used to ensure that the process meets the required specification.

3 Scope of Work

The Metrology Engineer will work on studying requirements for alignment of various components and assemblies for the ITER machine. The Engineer will develop and qualify procedures, select suitable measurement systems and compile data packs for execution of the measurement process.

In support of procurement arrangements the work will cover development of inspection techniques, preparation of procedures and technical specifications and interfacing with technical responsible officers (TRO) to define the scope of the inspection activity. It will also require participation in design reviews and document review processes.

4 Estimated Duration

The duration for the contract shall be 24 months with provision for a further 12 months extension.

5 Work Description

The metrology engineer shall be expected to take ownership of the alignment/measurement tasks allocated to them, to agree the scope of the activity with the ITER TRO for Metrology and to define a plan for its execution. In consultation with the TRO for the system under study, they shall identify the requirements and develop a strategy for implementation.

In many cases the environment in which the measurement tasks are to be carried out will be extremely congested and lines of sight for optical measurement systems very restrictive. The metrology engineer, supported by the design office will evaluate the state of plant foreseen at the time the measurement process will be implemented and develop a process tolerant of the conditions pertaining.

For qualification purposes, where tolerances are very tight or where measurement geometry is difficult, it will be necessary to simulate the measurement process and determine the measurement uncertainty. Spatial Analyzer software is available at ITER to carry out this function representing a wide selection of survey and metrology instruments. This simulation will form part of the design study report.

On completion of the study and qualification work it will be necessary to prepare a procedure to convey the measurement process to the technician carrying out the activity. The procedure shall identify all necessary hardware and software for the task, processes to be followed and outputs required. It will identify all reference data; models, drawings, control files, measurement plans, safety documents etc. collating all data relevant to the task.

For some tasks, bespoke tooling will be required for targeting the component or stationing the metrology instruments. Where this is the case the metrology engineer will manage the design process, prepare technical specifications for procurement and when necessary oversee the manufacturing activity.

For factory acceptance of key tokamak components it is planned to place contracts with company's local to the factories to carry out dimensional control surveys. For this activity the metrology engineer will be required to prepare a technical specification for the work package to facilitate tendering and contract placement. The scope of the inspection will need to be defined with the TRO and a data pack detailing processes, datum key features and tolerances shall need to be compiled.

Examples of typical work packages that the metrology engineer could be allocated are detailed below:

5.1 As-built building survey

The first task in the tokamak building shall be to establish the as-built dimensions of the tokamak pit, port cells, key penetrations and embedment's, so as qualify the construction and to establish the origin and orientation of the PIT datum system. Anticipated deliverables for this study are:

- Design specification detailing tolerance requirements, measurement point density, survey instrument selection, software selection, data format
- Dimensional control procedure
- Reverse engineering procedure
- Best-fit processes and weighting parameters
- Acceptance documentation

5.2 Preparatory studies and document preparation for tokamak components

Tokamak components are mainly located in the tokamak pit however; some items like the feeders for example span adjacent areas passing through large concrete walls. Typical activities to be carried out in preparation for the assembly of these items are listed below:

- Design specification detailing setting out, dimensional control and alignment requirements, state of plant during alignment activity, schedule etc.
- Dimensional control, pre-alignment and alignment procedures
- Inspection report template

5.3 Dimensional control for factory acceptance, example: vacuum vessel sector

Each vacuum vessel sector weighs approximately 420 tonnes and is 14m tall. Seven of the sectors are to be manufactured in Korea and 2 in Europe from where they shall be shipped to ITER, aligned using bespoke tooling and welded together. Dimensional control of these items is essential to ensure that they can be assembled compliant with code requirements and meet the very demanding tolerances specified. Some interaction with the Domestic Agencies (DAs) responsible for the procurement arrangement is likely to be required. The deliverables for this study shall be:

- Design specification detailing key characteristics and their tolerances plus configuration of component for inspection
- Preparation of key characteristics model supported by the design office
- Inspection procedure and measurement simulation for qualification
- Tooling design and tech spec for procurement
- Technical specification for tender of measurement task

5.4 Metrology Lab – specification for supply and installation

The metrology lab shall be constructed within the Assembly Hall to provide a temperature controlled environment for dimensional control activities. The lab shall contain a coordinate measuring machine large enough to accommodate a blanket shield module plus a selection of metrology instruments to provide a metrology service during the construction of the ITER machine. The deliverables for this study shall be:

- Design specification detailing the requirements for the lab i.e. environmental conditions, measurement tasks, typical volumes, access requirements, lifting requirements etc.
- Design review documentation
- Technical specification for procurement

5.5 Sector sub-assembly

The sector sub-assembly consists of a vacuum vessel, 2 TF coils and a thermal shield. Each of these items shall need to be aligned and a number of auxiliary surveys carried out to facilitate customisation at the joint between adjacent TF coils. Various diagnostic systems shall need to be added during this process but they are outside of the scope of this study. The deliverables for this study shall be:

- Design specification detailing dimensional control and alignment requirements, state of plant during alignment activity, schedule etc.
- Dimensional control, pre-alignment and alignment procedures for vacuum vessel, TF coils and thermal shield
- Survey and customisation procedure for
 - Inner Leg Intercoil Structure (ILIS)
 - Inner Intercoil Structure (IIS)
 - Outer Intercoil Structure (OIS)
 - Intermediate Outer Intercoil Structure (IOIS)
- Inspection report templates

International travel may be required in the execution of some tasks listed above.

6 Responsibilities (including customs and other logistics)

Contractor:

The Contractor warrants that all personnel supplied under the contract have the necessary qualifications and experience to carry out their work. All short-listed candidates proposed will be interviewed.

The work is mainly related to establishing and assessing feasibility of measurement and alignment concepts plus associated infrastructure systems. The work shall be performed on the ITER site because daily exchanges and periodic meetings are foreseen.

ITER:

The contractor will work under the technical instruction of an ITER nominated engineer.

ITER will provide the required information-access to the respective ITER files for executing the work when needed to follow the implementation plan during execution of the work package.

In particular ITER will make available any technical information needed for the contractor to perform the work. All issued / requested documents containing this information must be returned to ITER on completion of the contract.

ITER shall provide a computer with network access rights, an email account and access to Spatial Analyzer software for survey simulation tasks.

7 List of deliverables and due dates (proposed or required by ITER)

Section 5 details typical deliverables for a selection of task types. The generation of these deliverables shall be monitored by the IO engineer during execution of the contract and reviewed at the end of each work package.

8 Acceptance Criteria (including rules and criteria)

Typical deliverables as described in section 7 shall be regularly reviewed by IO. The contractor shall update his reports in order to take into account any comments.

9 Specific requirements and conditions

The following attributes are required to carry out the typical work packages identified in this specification:

- University degree in mechanical engineering or surveying, or a combination of qualifications and experience acceptable to IO
- Minimum of 10 years' experience in the application of industrial measurement techniques appropriate to precision alignment
- Familiarity with Spatial Analyzer:
 - Online interfacing with measurement instruments
 - Offline reporting, data manipulation and survey simulation
- Demonstrated ability to develop innovative solutions to complex survey and metrology tasks.

- Familiarity with the application and operation of portable 3-dimensional measurement systems utilising instruments such as theodolites, total stations, levels, laser trackers, photogrammetry etc.
- Knowledge of Quality Assurance systems and their practical application
- Fluent in English both written and oral
- Ability to communicate effectively and to write clear and concise reports in English
- Proficient in the use of Microsoft Office suite of software
- Good interpersonal, communication and organizational skills
- Ability to work independently when required
- Good planning, organisation, communication and negotiation skills
- Good computer skills, usage of databases would be an advantage
- Excellent team player while capable of working independently
- Ability to work effectively in a multi-cultural environment

The metrology engineer shall have survey and alignment experience gained within the field of large scale assembly processes ideally related to a large physics project where alignment requirements are critical. Experience in both construction surveying and industrial metrology would be a distinct advantage.

10 Work Monitoring / Meeting Schedule

The official language of the ITER project is English.

Generally, the work shall require the presence of the Contractor's personnel at the site of the ITER Organization.

Each work package shall commence with a kick-off meeting.

- A weekly progress meeting shall take place.
- A short review shall take place at the completion of each work package.
- Other regular meetings will take place on an ad-hoc basis as deemed necessary

The Contractor shall prepare short minutes of each kick-off, weekly and milestone progress meeting

11 References / Terminology and Acronyms

DA	Domestic Agency
IO	ITER Organisation
MAI	Machine Assembly and Installation
TRO	Technical Responsible Officer