



Technical Specification and Statement of Work

Contract for Slow ICS Performance Analysis

Abstract

This is a contract to provide technical support for the validation, analysis and improvement of the solutions selected during the R&D phase of the ITER slow interlock system.

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1 INTRODUCTION

1.1 Purpose and Scope of the Document

This document describes the current status of the ITER Central Interlock System (CIS) design and prototyping activities and the tasks required for completing the R&D campaign of the slow interlock architecture. It provides the required information for potential bidders to supply a tender.

1.2 Document scope and structure

Throughout this document, mandatory rules (or requirements) are enumerated and prefixed with R. Table 1-1 provides a list of paragraph identifiers used in this document.

R	Rule / Requirement
RD	Reference Document

Table 1-1 Paragraph identifiers

1.3 Glossary

N/A

1.4 Acronyms

CIN	Central Interlock Network
CIS	Central Interlock System
CODAC	Control, Data Access and Communication
CSS	Central Safety System
ICS	Interlock Control System
ITER-IO	ITER International Organization
PCDH	Plant Control Design Handbook
PIN	Plant Interlock Network
PIS	Plant Interlock System
FAT	Factory Acceptance Tests
SAT	Site Acceptance Tests

Table 1-2: Abbreviations and acronyms

1.5 Related Documents

1.5.1 Applicable Documents

N/A

1.5.2 Reference Documents

The following documents are referenced in this document:

- [RD1] ITER plant description. PD - Plant Description (2X6K67 v1.1)
- [RD2] CIS Conceptual Design (2PMJPV v1.1)
- [RD3] Plant Control Design Handbook – PCDH v.5.2 (27LH2V v.5.2)
- [RD4] CIS Protection functions candidates - functional description (496Z25 v1.0)



2 TECHNICAL CONTEXT

The investment protection at ITER is provided by the Interlock Control Systems. These are the systems in charge of implementing all the instrumented protection functions of the tokamak and its associated plant systems. These functions are divided into:

- Local interlock functions, which are limited to one plant system and have no effect on the rest of the machine. The interlock event and the mitigation action are performed within the same plant system.
- Central interlock functions, which involve two or more plant systems.

The local functions are implemented by the different Plant Interlock Systems (PIS) while the central actions are implemented by the Central Interlock System (CIS) via the PIS of each plant system involved [RD2].

The ITER Interlock Control System is therefore formed by:

- One Central Interlock System (CIS).
- One or more Plant Interlock System (PIS) for each plant system involved in one or more investment protection functions (around 50 PIS expected at the final ITER configuration)
- The interlock networks:
 - o Central Interlock Network (CIN) connects the different PIS with the CIN.
 - o Plant Interlock Networks (PIN) connects the PIS with the different elements of its plant system (i.e. sensors, actuators and other controllers)

During the past two years, an R&D campaign has been carried out to develop the design of the slow and fast architectures for the Central and Plant Interlock Systems.

The prototypes of the slow architecture of the interlock control system together with their test tools will be completed and delivered to ITER IO by the end of 2011. During the preliminary design phase of the CIS (2012), these prototypes will be used as test bench for demonstrating the capability of the selected technologies for implementing the local and central slow interlock functions.

Using as input real ITER interlock functions, the contractor will use the existing hardware and software to configure the prototype cubicles (based on S7 Siemens 400FH technology) and the different plant system simulators to study the real performance, limitations, constraints and potential improvements of the different interlock architectures under evaluation

2.1 CIS Conceptual Design

ITER operation requires coordinating the activity of the Plant Systems, procured "in kind" from the Domestic Agencies (e.g. cryoplant, vacuum, power supplies, cooling water system, plasma external heating, plasma diagnostics, etc.) This coordination is guaranteed by three clearly separated tiers. These three tiers are: CODAC and Plant System conventional I&C, the Interlock Control Systems (ICS) and the Safety Control Systems (SCS).

The design of these three systems shall follow the Plant Control Design Handbook (PCDH) [RD3], this are a set of rules and guidelines provided by ITER IO in order to ensure coherency between plant system and ease the integration, maintenance and operation of all the I&C systems at ITER. The CIS shall follow the PCDH [RD3].



It is important to notice that while the SCS implements of the functions related with personnel and environmental safety the CIS focuses on the investment protection functions only.

At its present stage of development the CIS will be based on three independent parts depending on the required integrity level and performance of the implemented central functions:

- Slow high integrity architecture:
 - o Integrity: SIL 3
 - o Performance: > 100 ms
 - o Technology: Siemens S7 PLC
- Fast high integrity architecture:
 - o Integrity: SIL 2-3
 - o Performance: 10 μ s – 100 ms
 - o Technology: TBD
- Hardwired high integrity loops:
 - o Integrity: SIL 3
 - o Performance: 100 μ s – 100 ms
 - o Technology: optical and/or electrical loops

Although the PCDH imposes that direct communication between PIS belonging to different plant systems, for some exceptional cases a direct hardwired linked will be allowed (e.g. quench loops). These links will be also considered part of the Central Interlock Networks and will fall under the CIS responsibility.

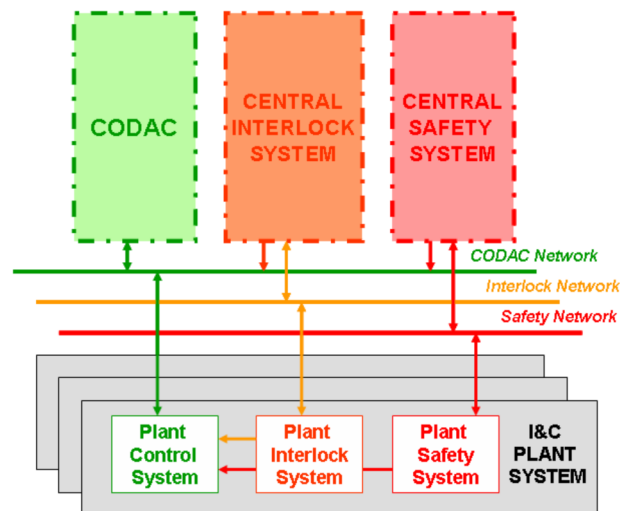


Figure 1: three-tier and two-layer general architecture of the ITER I&C



3 SCOPE OF THE SERVICES

The scope of the services requested in this specification covers the analysis of the performance, possibilities and limitations of the selected solutions for the slow interlocks and the demonstration of their capability to implement real functions required by the ITER project using the existing prototypes.

The contractor will be also required to use the prototypes to answer to the different technical questions which will be encountered during the preliminary design phase of the Central Interlock System.

3.1 Services

3.1.1 Study of CIS and PIS slow architecture performance

Using as input real ITER interlock functions, the contractor will use the existing hardware and software to configure the prototype cubicles (based on S7 Siemens 400FH technology) and the different plant system simulators to study the real performance, limitations, constrains and potential improvements of the different interlock architectures under evaluation.

All studies and their conclusions will be described by the contractor in different technical reports.

3.1.2 Implementation of proposed modifications to the prototypes

In parallel with the development of the preliminary design of the CIS, modifications of the selected solutions may be required. The contractor will modify the prototypes using the hardware provided by ITER IO.

3.1.3 Study of the software solutions for interfacing the prototypes with CODAC via EPICS.

Some non-critical functions of the prototypes (e.g. diagnostics, reset, configuration) will be performed in the final facility using the CODAC infrastructure which is based on EPICS. The contractor will use the prototypes to find technical solutions the open issues concerning the communication (based in EPICS) between the conventional part of the ITER I&C and the interlocks.

3.2 Deliverables

All tasks defined in the different task orders shall be executed in close collaboration with the CODAC IO team and take into account other activities, internal and external, with any relevance to this contract (i.e. CIS prototyping, machine protection functions identification, preparation of the CIS preliminary design, etc.).

The deliverables will be detailed in each Task Order and will consist on:

- Technical reports describing the hardware tests and their results
- Software deliverables
- Electrical and I&C drawings





4 CONTRACT EXECUTION & ORGANISATION

4.1 Contract Schedule

The Contract is scheduled to come into force in February 2012 with an initial duration of one year with an option for a one year extension. The period of provision of services may be extended only with the express written agreement of the parties before such period elapses.

4.2 Contract Follow-up

4.2.1 Periodic meetings and Progress Reports

Day-to-day management of the work will be performed by ITER CIS RO. In addition, contractor personnel will be expected to attend regular Group Progress Meetings as requested, and to the formal exchange of documents transmitted by emails required. Progress Meetings will be called by the ITER Organization, to review the progress of the work, the technical problems, the interfaces and the planning. Where necessary or appropriate, off-site contractor managers may be invited to participate in some progress meetings via videoconference.

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

- Summary of the work carried out for all on-going Task Orders;
- Description of any problems encountered for all on-going Task Orders;
- References to any produced deliverables for all on-going Task Orders;
- Status and schedule of all on-going Task Orders;
- Definitions of new Task Orders;

In addition to the Progress Meetings, if necessary, the ITER Organization and/or the Contractor may request additional meetings to address specific issues to be resolved.

It is expected that on occasion the Contractor will be required to make a presentation to Topical Technical Meetings. For all Progress Meetings, a document (the Progress Meeting Report) describing tasks done, results obtained, blocking points and action items must be written by the Contractor. Each report will be stored in the ITER IDM in order to ensure traceability of the work performed.

4.3 Premises

The prototypes and their test tools will be shipped to the contractor premises after the signature of the first task order. The technical work will be performed in the contractor premises. SVN and Bugzilla tools will be used to ensure that ITER keeps the intellectual property of the developed software.

The Contractor shall have and maintain the necessary equipment and licenses to run the software tools required to carry out the engineering analyses and produce the deliverables in accordance with the tools adopted by the IO. ITER will grant access for the Contractor's staff to the development setups and test beds at ITER site when appropriate. It is the Contractor's responsibility to provide all required equipment at its premises.

To facilitate good communication between ITER site and Contractor's back office, the Contractor shall have access to screen sharing tools, i.e. H322 compatible video conferencing system and MS Live Meeting, and the necessary equipment compatible with ITER IO facilities.



4.4 Payment schedule

The Contractor shall be paid after each successfully completed Task Order.

Payments will be processed subject to IO confirmation of work carried out satisfactorily in accordance with the scope of work in section 3 of the technical specification ITER_D_6M348N.

Payments will be made upon receipt of an IO approved and appropriately signed report and a correctly rendered invoice.

4.5 Results Dissemination

All results obtained in the frame of the work described in this document together with the software packages and licenses shall become the property of IO and as such will be available for use either partially or fully in the future development of the project.



5 INFORMATION REQUIRED WITH OFFER

5.1 Bidder information

The bidder shall provide the following information:

- The address of the principal office serving this Contract and the name of the person at the office charged with supervising this Contract;
- Details of internet connectivity and development facilities available at the Bidder's premises;
- Details of the availability of the staff offered for this Contract;
- Detailed CVs for each of the staff offered for this Contract. The qualifications and experience of each expert must clearly match the requirements indicated in the Technical Specifications.

5.2 Bidder experience

The bidder is expected to have:

- A solid experience working with research institutions and facilities especially with ITER and/or other tokamak projects.
- Capability to understand the processes involved in the protection of the ITER machine.
- Experience in hardware integration of conventional industrial control systems (> 5.000 inputs/outputs);
- Experience in hardware integration of interlocks and/or safety control systems (> 1.000 inputs/outputs);
- Experience in the field of instrumentation and signal interfacing;
- Experience in EMI effects on I&C components and EMC rules to apply in harsh environment.
- Knowledge NI cRIO technologies
- Knowledge on FPGA based data acquisition systems and their signal interfacing;
- Knowledge of installing and interfacing Siemens Step 7-400FH series PLCs and their input/output modules;
- Experience of installing industrial rack mounted systems, D-rails, patch panels and such;
- Experience of manufacturing and configuring batches of similar I&C cubicles;
- Experience working with EPICS

5.3 Management Plan

The Bidder must be able to demonstrate to the satisfaction of IO that the chosen human resources have the professional skills to provide the services required by the technical specification.

As part of the technical offer, the Bidder shall provide a management plan explaining how it will ensure the Contract will be managed to the satisfaction of IO. The management plan shall include a complete organizational chart (every team member must be present) of the proposed team. In addition, the Bidder shall provide a description of the support facilities that the team of experts will have from the Contractor during the execution of the Contract.

Where the contractor proposes to replace an existing team member ITER reserves the right to reject any proposed new team member.

The organizational chart shall include the positions described in the following paragraphs:

5.3.1 Contract Management

The Contract Manager shall be the principle point of contact between IO and the Contractor on contractual matters.



The Contract Manager is considered solely responsible for all the aspects of the work given to the Contractor by ITER.

The Contract Manager acts also as a **Senior Expert Professional**.

The Contract Manager is expected to have the following qualifications and experience:

- The Contract Manager shall have been employed by the Contractor for at least two years;
- The Contract Manager shall have a university degree (MSc or equivalent) in Electrical Engineering, Computer Science, experimental Physics or similar;
- The Contract Manager shall have experience with protection systems of large scale scientific facilities for at least five years;
- The Contract Manager shall have a complete command (oral, writing, reading) of English;
- The Contract Manager shall have demonstrated organization and communication skills to coordinate a team and interface to clients.

5.3.2 Contractor Team

The contractor team shall support the Contract Manager to carry out the work.

The contractor team is expected to have the qualifications and experience as required for the bidder (see section 5.2).

6 QUALITY ASSURANCE (QA) REQUIREMENT

The organization conducting these activities should have an ISO 9001 accredited quality system.

The general requirements are detailed in ITER document [ITER Procurement Quality Requirements \(22MFG4\)](#)

Prior to commencement of the task, a Quality Plan [Quality Plan \(22MFMW\)](#) must be submitted for IO approval giving evidence of the above and describing the organization 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.

Prior to commencement of any manufacturing, a Manufacturing & Inspection Plan [Manufacturing and Inspection Plan \(22MDZD\)](#) must be approved by ITER who will mark up any planned interventions.

Deviations and Non-conformities will follow the procedure detailed in IO document [MQP Deviations and Non Conformities \(22F53X\)](#)

Prior to delivery of any manufactured items to the IO Site, a Release Note must be signed [MQP Contractors Release Note \(22F52F\)](#).

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 modeling, etc. shall be reviewed and approved by the IO prior to its use, it should fulfill IO document on Quality Assurance for ITER Safety Codes [Quality Assurance for ITER Safety Codes \(258LKL\)](#).

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