



Framework Contract for Preliminary Design of the ITER Plasma Control System

Technical Specifications

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1 Purpose

The purpose of the Framework Contract is to complete the Preliminary Design of the ITER Plasma Control System (PCS). The duration of the Contract will be 2 years from the date of the signature or until the completion of the PCS Preliminary Design.

2 Background

The PCS Conceptual Design is based on the documents in the PBS-47 Plasma Control System Technical Documentation folder in IDM (<https://user.iter.org/?uid=94HN3D>). The purpose of this contract is to extend that design to complete the Preliminary Design of the PCS, which should clearly define the PCS architecture and how the PCS will operate within CODAC and Machine Operations and develop the preliminary control algorithms that will be required for 1st plasma and for early plasma operation. These algorithms will be based largely on well-developed algorithms that already work well on existing tokamaks. Any changes in the requirements for future high performance operation should also be included in the deliverables of this contract if recent R&D indicates that such changes are required, but there will be no attempt to develop detailed control algorithms for high performance operation through this contract.

3 Scope of Work

This contract includes a major part of the technical input for preparation of the Preliminary Design documents for the ITER Plasma Control System and presentations at the PCS Preliminary Design Review, presently scheduled for the week of 20 July 2015. The technical content for the PCS Preliminary Design includes refining the PCS architecture creating a more precise definition of basic plasma control functionality, interdependencies between control functions, pulse supervisory functions, conflict resolution strategies, shared actuator management, control layer management, and exception handling as part of a real-time control framework. The high-level PCS functions include Actuator Management, Axisymmetric Magnetic Control, Basic Control Functions, Disruption and Runaway Electron Control, Event Detection and Exception Handling, Kinetic Control, MHD and Error Field Control, Support Functions, and some Wall Conditioning and Tritium Removal techniques. The PCS Preliminary Design should provide any updated information that requires a change in the conceptual design based on recent R&D for any of these control functions, but in contrast to the PCS Conceptual Design, this design phase should concentrate on the detailed description of the plasma control algorithms for 1st plasma and early H/He plasma operation. Since this phase of ITER operation will be similar to the operation of existing tokamaks, the plasma control algorithms and support functions required for the Preliminary Design will be largely based on those that work well on existing tokamaks.

The tasks required as part of this Framework Contract for the Preliminary Design include:

- 1) Integration of basic actuator control and the management of shared actuators with the rest of the PCS architecture;
- 2) Basic actuator control of the Electron Cyclotron Heating (ECH) system including operational limits;
- 3) Basic actuator control of the Gas Injection System including operational limits;
- 4) Plasma initiation and burn through – preparation of the poloidal field null, ECH control for breakdown at low loop voltage, vertical and radial field evolution for initial current rise, ECH control for burn through;
- 5) Kinetic control of the initial neutral gas pressure and electron density rise with gas fuelling in a mixture of H and He;
- 6) Runaway electron detection and amelioration in the current rise or flattop;

- 7) Initial disruption and runaway electron prediction, avoidance, and mitigation;
- 8) Error field topology calculations and assessment from magnetic measurements;
- 9) Initial plasma equilibrium reconstruction for early plasma operation beyond 1st plasma not yet including kinetic and MSE constraints.

The amount of work concerning each of these tasks will be detailed in "Task Order(s)". It shall be noted that the Framework Contract may be extended after year one by option release, only after a funding appropriation has been granted by the Council of ITER Organization. Only a Task Order(s) signed by both parties will be a legally binding agreement.

4 Estimated Duration and Timetable

The duration of the Contract will be 2 years from the date of the signature.

Estimated starting date of the Contract: October 2013

Completion date of the all Task Orders is expected at least three weeks prior to the PCS Preliminary Design Review (PDR) scheduled for the week of 20 July 2015 unless there is a formal change to the PCS design review schedule. Some additional modifications to design documents may be required following the PDR before formally closing this framework contract.

5 Work Description and Experience

The present technical specification defines only the basic outline of the envisioned tasks. Details of each task will be developed within each Task Order.

Depending on the preliminary results and on the current needs for the ITER detailed design, some variation in the specification of tasks may be required during the course of the various Task Orders. Frequent communications between the IO-TRO and the C-TRO are therefore envisaged to discuss and agree on details of the tasks and priorities.

The Contractor must have substantial recent experience in the control, modelling, and operation of existing tokamaks including, but not limited to, axisymmetric magnetic control for plasma initiation, burn through, plasma current, vertical and radial position, and shape control, kinetic control of gas fuelling, electron density, and auxiliary plasma heating systems, particularly ECH.

6 Responsibilities

ITER:

ITER will provide the needed information and access to relevant ITER files for executing this work when needed.

In particular, ITER will make available any technical information and references needed for the Contractor to perform the work.

Contractor:

The Contractor will provide results according to the technical specification outlined above and will fulfil the implementation plan and conditions of the present contract.

7 List of Deliverables and Due Dates (proposed or required by ITER)

The deliverables are reports, presentations, and databases describing the scope of each task, input data, and approximations used in the studies and the results obtained (e.g. Microsoft PowerPoint, Word documents, EXCEL tables, and a database format to be agreed). The implementation details of deliverables and priorities of the studies will be agreed between the Contact Persons under each separate Task Order. For all deliverables submitted in electronic format the Contractor shall ensure that the release of the software used to produce the deliverable shall be the same as that adopted by the ITER Organization.

The following reports should be produced for each Task Order:

- 1) Intermediate reports: no later than 6 months following each Task Order
- 2) Final reports: at least 3 weeks prior to PCS PDR

8 Acceptance Criteria (including rules and criteria)

The deliverable is considered acceptable if it fulfils the requirements of the Task Order.

The Contractor shall submit a draft of the deliverables foreseen in the Task Specification at completion of the work.

The IO-TRO shall review the deliverables and reply, within the time specified in the 15 following days, a commented version of the deliverables.

The Contractor shall perform all the necessary modifications or iterations to the deliverables and submit a revised version.

Each Task Order will be considered complete after ITER has accepted the last deliverable associated with that Task Order.

9 Work Monitoring / Meeting Schedule

Regular meetings are expected between the Contractor and IO to coordinate definition of the infrastructure requirements/constraints and delineate responsibilities. Contractor shall propose a list of meetings with ITER for progress monitoring of this contract. At least the following meetings should be foreseen.

Scope of meeting	Point of check/Deliverable
Kick-off Task Order	Work program
Progress meetings at least every 3 months	Checking progress Submission of the Intermediate reports
Closing meeting	Checking of the Final reports

Meetings will take at the ITER Organization, at the Contractor site or by teleconference, to be mutually agreed.

10 Quality Assurance (QA) Requirement

Prior to commencement of any work under a Task Order, a Quality Plan must be provided to IO for approval. This is a separate document which comprises:

- 1) a workplan with proposed time schedule and agreed preliminary dates for progress meetings,

- 2) a statement of those involved in the activity and their approximate role and contribution in time,
- 3) a statement of what work will be subcontracted and who will responsible for checking this.

11 References

- [1] PCS Conceptual Design [Technical Documentation https://user.iter.org/?uid=94HN3D](https://user.iter.org/?uid=94HN3D)
- [2] [PCS CDR https://user.iter.org/?uid=BX6CPC](https://user.iter.org/?uid=BX6CPC) presentations
- [3] [ITER_D_CZ3L69 - Plasma Control System Conceptual Design Review Panel Final Report https://user.iter.org/?uid=CZ3L69](https://user.iter.org/?uid=CZ3L69)

<u>Denomination</u>	<u>Definition</u>	<u>Acronym</u>
ITER Organization	For this Contract the ITER Organization	IO-
ITER Organization Responsible Officer	Person appointed by the ITER Organization with responsibility to manage all the technical aspects of this contract	IO-RO
Contractor	Firm or group of firms organized in a legal entity to provide the scope of supply.	C-
Contractor's Team	The Contractor plus all the sub-contractors/consultants working under its responsibility and coordination for the performance of the contract	C-Team
Contractor Responsible	The person appointed (in writing) by the legally authorised representative of the Contractor, empowered to act on behalf of the Contractor for all technical, administrative legal and financial matters relative to the performance of this contract	C-R
ITER Organization Task Responsible Officer	Person delegated by the IO-RO for all technical matters, but limited to one specific task order	IO-TRO
Contractor Task Responsible Officer	Equivalent to the IO-TRO in the Contractor's team.	C-TRO