

Technical Specifications (In-Cash Procurement)

Technical Summary for a Feasibility Study on RPC&HF Stage 2.

This Technical Summary intends to give an overall view of the scope of a Feasibility Study to explore and analyse the Reactive Power Compensation and Harmonic Filtering system upgrade architectures (RPC&HF-St2) to function and perform in parallel with the existing system (RPC&HF).

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1 Background

The ITER Organization (IO) is a joint international research and development project for which the initial construction activities are underway. The seven members of the IO are the European Union (represented by F4E), Japan, the People's Republic of China, India, the Republic of Korea, the Russian Federation and the USA.

The project aims to demonstrate the scientific and technological feasibility of fusion power for peaceful purposes and to gain necessary data for the design, construction and operation of the first electricity-producing fusion plant. It will also test a number of key technologies, including the heating, control, diagnostic and remote maintenance that will be needed for a full-scale fusion power station.

The ITER electrical network is divided in two parts: Steady State Electrical Network (SSEN) and the Pulsed Power Electrical Network (PPEN). The SSEN provides distribution from the grid to the balance of plant of the Iter consumers and has an average load of 120 MW and 48 MVAR.

The PPEN represents the part of the grid devoted to the supply and distribution of the energy from the French grid to the power converters. These converters are connected to the inductive magnets that will sustain and control the plasma operation during each pulse. The 400kV French grid Transmission system provides up to 500MW and 200 Mvar for the pulsed loads. PPEN is composed by three main busbars at 400 kV, each one with a three power transformer with secondary and tertiary voltage level of 66 kV and 22.5 kV respectively.

The above referred power converters absorb a large amount of reactive power. The Reactive Power Compensation and Harmonic Filtering System (RPC&HF) is installed in order to compensate this reactive power absorbed by the converters. This system is rated 750 Mvar, 250 Mvar connected to each 66kV busbar. The technology is SVC with Thyristor base converters, Thyristor Control Reactors (TCR) and Harmonic Filters (HF).

However, and in the basis of escalation of power conversion to reach from SRO to a Deuterium-Tritium phase, the RPC&HF system power will not be enough to compensate the additional power. A new system, referred from now as RPC&HF Stage 2, will be necessary. This system is preliminary rated at 250 Mvar.

A feasibility study to analyse, simulate different scenarios, help to select the technology (between SVC and STATCOM), and prepare the Conceptual Design Review (CDR) is necessary and is the object of this service contract.

2 Purpose

This Technical Summary intends to give an overall view of the scope of a Feasibility Study to explore and analyse the Reactive Power Compensation and Harmonic Filtering system upgrade architectures (RPC&HF-St2) to function and perform in parallel with the existing system (RPC&HF).

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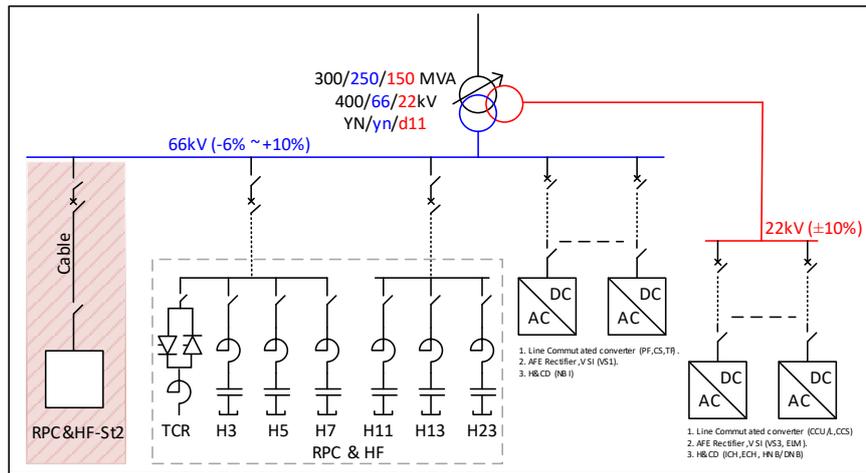


Figure 1 : ITER PPEN Power Distribution Configuration (bay1)

During the analysis, simulations, descriptions, benchmarking... performed during the Feasibility Study, it will provide results and conclusion on the performance requirements, selection of technology, conceptual engineering design and definition of required interfaces.

It is intended to study three alternative systems, with the goal of enabling ITER to select the most suitable solution. The architectures under consideration are:

- Thyristor Switched Capacitor (TSC)
- Static Var Compensator (SVC)
- Static Synchronous Compensator (STATCOM)

Each architecture shall be developed and assessed independently as a complete and fully functional system.

The present study shall explore different RPC&HF St2 system schemes to enhance reactive power compensation in coordination with the existing RPC&HF system, and to improve the overall response time.

In addition to the above architecture studies, the analysis will also include a detailed assessment of low-order harmonic distortion—particularly low-order non-characteristic and inter-harmonic components—arising from the dynamic operation of the converters in response to commands issued by the Plasma Control System and shall propose appropriate mitigation measures to effectively compensate these harmonics.

It also includes support for preliminary civil engineering, such as developing indicative layouts, preparing preliminary routing for power and control cables, loads and weights definitions for foundations, and defining interfaces with the existing plant.

Present contract does not cover supply, installation, acceptance of equipment/components, construction and testing of prototypes.

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3 Scope of Feasibility Study

3.1 Scope of work

The scope of work is organized into the following sequential technical activities:

- 1) The feasibility study will begin with preliminary simulation studies and system analysis of the existing ITER plant electrical network under the selected plasma scenarios, to size the rating of the RPC&HF-St2 system and evaluate voltage regulation, harmonic behaviour (including characteristics and non-characteristics components -especially low order even and inter harmonics)), and active/reactive power dynamics. This phase concludes with the definition of the main system parameters and performance criteria, considering coordinated operation with the existing RPC&HF system.
- 2) Based on the results of the simulation studies, the next phase focuses on the identification and technical and economical evaluation of suitable reactive power compensation technologies, with specific focus on TSC, SVC and STATCOM solutions. Each technology will be evaluated in terms of functional requirements, control capabilities, dynamic response, harmonic performance, system integration aspects, and operational flexibility. The Proposals also will include mitigation measures for low order and inter harmonics as part of the overall architecture recommendation.
- 3) This is followed by a technical and performance-based comparison of TSC, SVC and STATCOM solutions, considering system behaviour, response speed, interaction with existing equipment, footprint, expandability, and economical aspects. The comparison leads to the selection of the most suitable technology for the ITER project.

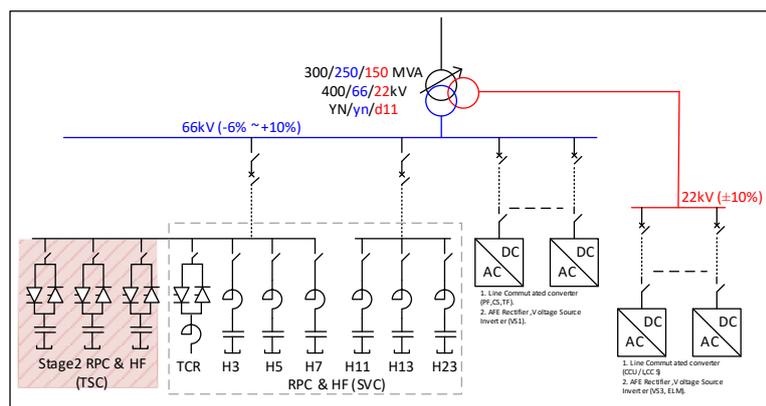


Figure 1. RPC&HF-St2 TSC Configuration

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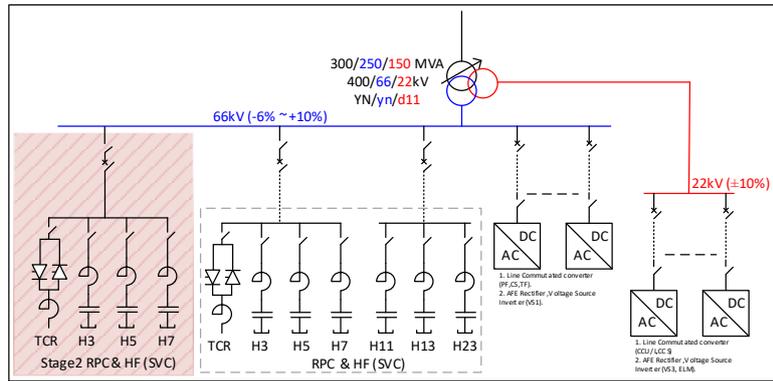


Figure 2. RPC&HF-St2 SVC Configuration

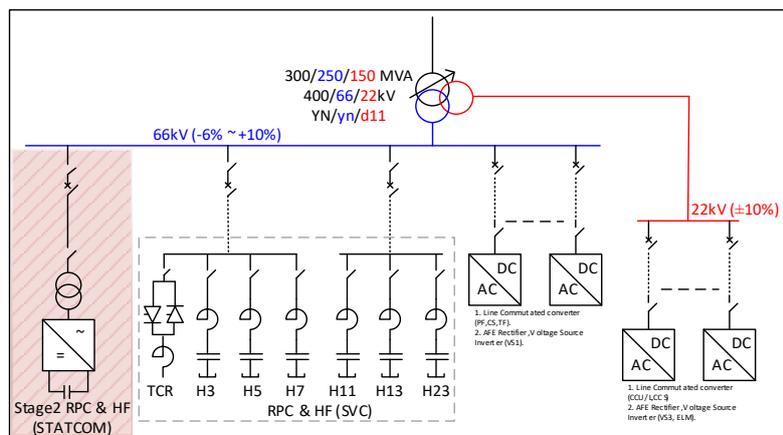


Figure 3. RPC&HF-St2 STATCOM Configuration

- 4) Once the technology is selected, the scope advances to detailed analysis and engineering, including refined modelling, control and protection philosophy, electrical and I&C interfaces, layout and auxiliary system considerations, and verification of compliance with applicable standards and grid requirements. The results of these activities are consolidated into a comprehensive technical report.
- 5) The final stage of the scope involves the preparation of the documentation to serves the Conceptual Design Review of the system.

3.2 Schedule

Table 1 provides a proposed schedule for reference only. The Supplier shall produce a detailed Schedule showing all phases of the Contract. The duration of the full contract shall be between 12 to 18 months.

Table 1 General schedule

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Milestones	Deliverable	Key deliverables	Expected Timing (T0+x) *
#0	D0-Quality Plan	Detailed quality plan (for RPC&HF-St2)	1M
#1	D1-Simulation Analysis and Design	Design models, analysis and simulations reports	4M
#2	D2-Evaluation of Q-compensation technologies	RPC&HF Q-compensation with TSC technology report	7-10M
		RPC&HF Q-compensation with SVC technology report	
		RPC&HF Q-compensation with STATCOM technology report	
		Low order harmonic mitigation solution report	
#3	D3-Technology selection	Technology comparison and selection report	
#4	D4-Detailed analysis and engineering of selected solution	Detailed simulation and analysis report	10-14M
		Detailed engineering and interface report	
		Preliminary civil works report	
#5	D5- CDR documentation	Conceptual Design Review deliverables	12-18M

* TO = Contract signature date.

* Each milestone indicates the accomplishment of the contract phase.

3.3 Requirements and Qualifications to execute work

3.3.1 Skill Profiles

Proposed work should be executed by a team of personnel having expertise on design and development of high current- high power industrial grade power converters, STATCOM /SVC. They must be having adequate proficiency in design / development / analysis of power converter, high and medium voltage electrical power system, advanced electronics and control engineering concepts as well as mechanical engineering aspects too. Team also should be having ability to develop an appropriate technical solution from technical specifications and requirements.

3.3.2 Software tools requirements

The proposed work should contain analysis part and IO prefer to use Matlab Simulink/Simscape Power System, the contractor must be having valid MATLAB Simulink license or other equivalent simulation tool. The team also should be having proficiency to use same. The

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Contractor shall guarantee, that all personnel executing part of this contract shall have all the necessary hardware and software tools required to perform their duties.

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Appendix I – List of Deliverables

List of technical documents and data to be provided by the Supplier:

Deliverable	Deliverable number	Key Deliverables	Documentation
D0- Quality plan	D0	Detailed quality plan (for RPC&HF-St2)	Detailed quality plan
D1- Simulation Analysis & Design	D1.1	Design models, analysis and simulations reports	*Simulation and power flow Analysis for SRO & DT scenarios (Phasor & Transient models): <ul style="list-style-type: none"> - Reactive power demand report - Harmonic filtering report (characteristics and non-characteristics) - Active/reactive power dynamics report - ESCR, resonance and flicker analysis report
D2- Evaluation of Q-compensation Technologies	D2.1	RPC&HF Q-compensation with TSC technology report	Simulation analysis and verification with TSC technology and report submission
	D2.2	RPC&HF Q-compensation with SVC technology report	Simulation analysis and verification with SVC technology and report submission
	D2.3	RPC&HF Q-compensation with STATCOM technology report	Simulation analysis and verification with STATCOM and report submission
	D2.4	Low order Harmonic mitigation solution report	Low order harmonic mitigation solution report submission
D3- Technology selection	D3.1	Technology comparison and selection report	<ul style="list-style-type: none"> - Technology comparison evaluation - Technology selection
D4- Detailed analysis and Engineering of selected solution	D4.1	Detailed simulation and analysis report	Detailed simulation and analysis report.
	D4.2	Detailed engineering and interface report.	Technology and System description: <ul style="list-style-type: none"> - Detailed Interface Assessment report, Interface requirement (PPEN, SSEN, CCWS) - Earthing requirements - HVAC assessment and requirements - Circuit breaker sizing, CT, PT selection, Cable routing. - Cable Analysis report.

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	D4.3	Preliminary civil works report	<p>Civil works report submission.</p> <ul style="list-style-type: none"> - Layout. - CW calculations and drawings. - Foundation report, cable trenches - Building specifications and drawings - Fences arrangement - Others
D5- CDR documentation	D5.1	Conceptual Design Review deliverables	- List of CDR deliverables (Refer below table IDP)

Note:

* Indicates: The initial version simulation models will be provided by IO.