	Tender documents [PART-A(ii)]: Scope of Supply, work and Technical Specifications for Phase 2-Driver and Final stage amplifiers for 2 sets of ITER ICRF Sources.- GLOBAL TENDER NOTICE NO: I-I/ET-TPT/25001/25-26	INDUS Ref.
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Tender document for
Phase 2- Driver and Final stage amplifiers for 2 sets of ITER ICRF Sources

TWO PART TENDER

ITER-India, Institute for Plasma Research
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PART – A (ii)

SCOPE OF SUPPLY, WORK AND TECHNICAL SPECIFICATIONS

for

Phase 2- Driver and Final stage amplifiers for 2 sets of ITER ICRF Sources



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Acronyms

A	Ampere
ATTP	Authorization to Proceed
AM	Amplitude Modulation
AC	Alternating Current
CCE	Control Command Embedded
CODAC	Control, Data Access and Communication (ITER subsystem)
COG	Centre of Gravity
COTS	Commercial of The Self
CG	Control Grid
CGPS	Control Grid Power Supply
CW	Continuous Wave
DC	Direct Current
DAE	Department of Atomic Energy
DDC	Digital Down Conversion
DMDI	De-mineralized De-Ionized
DL	Dummy Load
FM	Frequency Modulation
EDR	Engineering Design Review
FDR	Final Design Review
FRR	Fabrication Readiness Review
FAT	Factory Acceptance Test
FPGA	Field-Programmable Gate Array
FPS	Filament Power Supply
GUI	Graphical User Interface
GIP	Generated Intellectual Property
HPA2	Driver Stage Amplifier
HPA3	Final Stage Amplifier
HVPS	High Voltage Power Supply
HP	Hold Point
HPA	High Power Amplifier
Hz	Hertz
ICH&CD	Ion Cyclotron Heating & Current Drive
IO	ITER Organization
IP	Intellectual Property
IIP	Information and Intellectual Property
IPR	Institute for Plasma Research
JIA	Joint ITER Agreement
kV	kilovolt
LCU	Local Control Unit
LoI	Letter of Intent
LPM	Litre per minute
MMTL	Mismatch Transmission Line
MTBF	Mean Time Between Failure
MIP	Manufacturing & Inspection Plan
MRR	Manufacturing Readiness Review

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NP	Notification Point
PM	Pulse Modulation
P&ID	Piping & Instrumentation Diagram
PFD	Process Flow Diagram
PDR	Preliminary Design Review
PON	Plant Operation Network
PSH	Plant System Host
PSM	Pulse Step Modulation
PS	Power Supply (Unit)
ph	Phase
PE	Protective Earth
RAMI	Reliability, Availability and Maintainability Inspection
RF	Radio Frequency
Req	Equivalent Resistor
R&D	Research & Development
RMS	Root mean Square
SAT	Site Acceptance Test
SDN	Synchronous Databus Network
SG	Screen Grid
SGPS	Screen Grid Power Supply
SSPA	Steady State Power Amplifier
TCN	Time Communication Network
TL	Transmission Line
TTL	Transistor-Transistor Logic
VSWR	Voltage Standing Wave Ratio
+Ve	Positive
V	Volt
VAC	AC Voltage
Vref	Reference voltage

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1 Introduction

ITER is a multinational R&D project, which aims to demonstrate scientific & technical feasibility of fusion power. The ITER project is being jointly constructed at St. Paul lez Durance Cedex, France by the 7 Countries (European Union, Japan, China, India, Korea, Russia and USA). The Institute for Plasma Research (IPR) which is an aided scientific institute under DAE, Govt. of India, is nominated as a nodal agency for implementation & coordination of some of ITER-subsystems through its ITER-India empowered body. One of such subsystems is the Ion Cyclotron Heating & Current Drive (ICH&CD) RF source.

The ITER ICH&CD system requires **1 (prototype) + 8 (bulk production) RF sources**, each providing 2.5 MW output power in CW mode (2000s) at 2 VSWR (for any phase of reflection coefficient) in the frequency range 36 – 60 MHz **AND/OR** 3.0 MW / 3600s / 40 - 55 MHz at VSWR 1.5 with any phase of reflection coefficient. However, measuring devices shall have capability to measure RF power up to 3 MW with VSWR 1.5.

Each RF source shall be made with two identical chains, 3dB Hybrid combiner and a local control unit (LCU) controlling the function of RF source. The RF chain shall be tunable for the frequency range of 35-65MHz. However, the operating frequency range shall be 36-60MHz to check the full performance at high power and 1dB bandwidth for ± 1 MHz, as per Section 6.1

Each chain consists of low power RF section, high power tube-based amplifiers, related electrical power supplies.

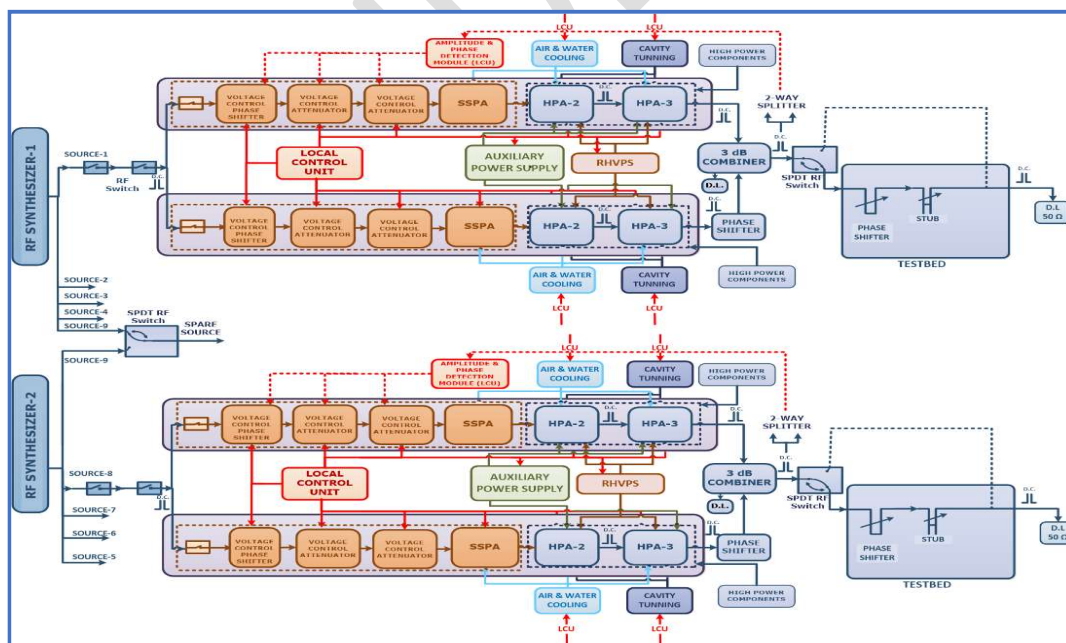



Fig. 1: Block diagram of 2.5 MW RF Source

The different phases of this project are as follows:

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Phase 1: Tube qualification phase using single chain (R&D) experimentation - 1.5 MW / 2000s / 35- 65 MHz at VSWR 2.0 with any phase of reflection coefficient.

Phase 2: Prototype phase (2 no. of RF Source) - 2.5 MW / 2000s / 36 - 60 MHz at VSWR 2.0 with any phase of reflection coefficient **AND/OR** 3.0 MW / 3600s / 40 - 55 MHz at VSWR 1.5 with any phase of reflection coefficient.

Phase 3: Bulk production (3 no. of RF sources) - 2.5 MW / 2000s / 36 - 60 MHz at VSWR 2.0 with any phase of reflection coefficient **AND/OR** 3.0 MW / 3600s / 40 - 55 MHz at VSWR 1.5 with any phase of reflection coefficient.

Phase 4: Bulk production (4 no. of RF sources) - 2.5 MW / 2000s / 36 - 60 MHz at VSWR 2.0 with any phase of reflection coefficient **AND/OR** 3.0 MW / 3600s / 40 - 55 MHz at VSWR 1.5 with any phase of reflection coefficient.

ITER-India has completed R&D phase (**Phase 1**) in March 2019 and presently in a position to initiate the procurement activities related to **Phase 2**. ITER-India is seeking a suitable offer for Driver and Final stage amplifiers for ITER ICRF Sources under Phase 2 from the Bidder who executed the project as per the essential eligibility criteria.

This tender document is for three new sets of Driver Stage Amplifier (HPA2), Trombone & Final Stage Amplifier (HPA3) for three RF chains and modification in existing R&D chain as per new sets for Phase 2.


All other components/sub-systems for all four RF chains for Phase 2 will be provided by ITER-India during the site acceptance testing at ITER-India site.

HPA2 and HPA3 will be identical to phase 1 in terms of RF characteristics. ITER-India do not anticipate any change or modification in design and major components related to cavities of HPA2 & HPA3. Design evolutions compared to phase 1 are requested in the Tender document. These evolutions are done for optimisation of amplifiers operation and do not impact the RF characteristics of the RF amplifiers supplied during phase-1. Evolutions may be considered for cavity-Trombone motorization, sensors for piston end-of-stroke detection, EMC compliance cavity seal, redesign of hydraulic routing for HPA2/HPA3, improve stiffness of mechanical structure, Trombone, Arc detector module, cavity support frame, optimisation in air cooling circuits etc.

During Phase 2, Bidder need to;

- 1) Fabricate, test at factory, test at ITER-India site: two new sets of HPA2, Trombone & HPA3 for first two RF chains, which will be used in prototype RF source.
- 2) Fabricate, test at factory, test at ITER-India site: similar one more new set of HPA2, Trombone & HPA3. This set will be used as a part of one RF chain of Unit 1 RF source
- 3) Modification of existing set of HPA2, Trombone & HPA3 supplied during Phase 1:
 - Submit evolved/optimized drawings as done in new RF chains of prototype unit.

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- Supply the additional components and carry out necessary modification before SAT of third RF chain at ITER-India site.
 - This set of components will be used as a part of another RF chain of Unit 1 RF source
- 4) All the RF chains will be tested as per technical specifications Table 5: Major specifications for Single RF Chain
 - 5) Implement the suppression methodology of parasitic oscillation in the amplifiers to ensure un-conditionally stable operation during different operating scenarios.
 - 6) Need to participate FDR, FRR and MRR as described below.

Note: Bidder will be responsible to test components supplied by the bidder for individual RF chains (as per Section 6.1). ITER-India will be fully responsible to test full RF source (2.5MW/3MW) by combining such two RF chains.

The fabrication of 1st RF chain of prototype RF source will be initiated only;

- After closure of final Design Review (**FDR**) by ITER Organization
- Go-ahead signal given by ITER-India.

There will be Fabrication Readiness Review (**FRR**) performed for components under this tender, by ITER-India after successful factory acceptance testing of 1st RF chain of the prototype RF source to continue the production of balance RF chains.

There will be Manufacturing Readiness Review (**MRR**) to get formal approval from ITER Organization after successful site acceptance testing of the prototype RF source at ITER-India site to freeze the design of balance RF sources.

Note: As these components are ITER deliverables, the involvement of ITER Organization along with ITER-India during each technical activity of this project is anticipated.

The tender specifications detail, the scope and responsibilities of bidder are given as per these requirements.

2 Contract Execution

2.1 *Kick off meeting*


All technical data related to interfaces or Components supplied by ITER India will be confirmed at the kick off meeting. Schedule, initial quality plan, Manufacture & Inspection Plan with all control points listed will be discussed during this meeting.

This kick off meeting will be held within 1 month from effective date of contract.

2.2 *Optimization in Layout for Design Phase common to Phase 2:*

The design of HPA2 and HPA3 tubes and cavities along with Trombone shall be the same as the one developed during the R&D (ref Phase 1)

The tender document is to provide technical content and scope related to ITER deliverables and shall not be disclosed or used for any other purpose without written permission from ITER-India.

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The main task will consist in optimizing the RF source layout along with ITER-India, especially for components to be supplied by Bidder in order to accommodate two sets of HPA2, Trombone & HPA3 components within a footprint of 3.4 m (w) X 4.9 m (l) X 5 m (h) and a corresponding weight less than 10.5 t. The proposed layout is shown in **Annexure-I: Proposed RF source Layout** for reference.

Furthermore, Bidder need to optimize two sets of water- & air-cooling distribution system, in between main header and HPA2 & HPA3, as per agreed diagrams. The selection of blowers needs to be done considering size constraint (i.e. layout) & overall weight of two sets of HPA2, Trombone and HPA3.

This optimization phase will be ended with the Final Design Review (FDR) [31] that will be held in ITER-India/IO. The main objectives of FDR are to validate this optimization as per specifications (see **section 6**) and integration constraints.

After factory acceptance test of 1st RF chain Fabrication Readiness Review (FRR) [31] [32] will be conducted which is more specifically focus on assembly, integration of component on ITER site


After the site acceptance test of prototype RF source at ITER-India, if minor changes are required they will be implemented in the system and validated again during MRR. Retrofitting action will have to be implemented on the prototype RF source, if required. After completion of MRR, no further change will be allowed.

2.3 *Prototype manufacturing and test*

(A) HPA2, Trombone and HPA3 will be supplied by the Bidder, as explained in section 1. Bidder will test these components up to 1.5MW on matched load at their factory before shipment to ITER-India.

(B) During site acceptance test (SAT) at ITER-India, the following components/sub-systems (see **Annexure-H: Description of items to be provided** by ITER-India) will be provided by ITER-India:

- Complete water-cooling headers from the cooling plant, RF source enclosure, support frame, Base frame, service platform with ladder to accommodate 2 sets of HPA2, Trombone and HPA3 for easy assembly/disassembly etc.;
- Low Power stage: Synthesizer, power divider (s), RF Switch, attenuator, phase shifter, HPA1(~10 kW SSPA);
- Local Control Unit (LCU). All the functionalities of CCE (supplied during Phase 1) will be embedded in ITER-India's LCU;
- Power supplies (PS): Auxiliary and High voltage power supplies;
- Transmission line components (Tx-line): Inter-connecting transmission line components including all directional couplers in between HPA1 to HPA2, HPA2 to

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HPA3 and HPA3 to 3dB Hybrid combiner as well as 3dB Hybrid Combiner output to Test bed;

- 3dB Hybrid Combiner with load at isolation port;
- Test bed: Includes MMTL system (phase shifter + stub combination) and high-power matched load (3MW/50 Ω).

(C) Bidder will take part in assembly, integration and commissioning of components supplied by Bidder for both the RF sources along with ITER-India team at ITER-India site and ITER site.

(D) Bidder will be responsible for performance of their supplied components during site acceptance test at ITER-India/IO site.


(E) Development of HPA2 by ITER-India:

- In parallel, ITER-India will fabricate cavity parts related to HPA2 through Indian industry without Bidder's assistance (which is not a part of this tender).
- Bidder will supply one set of custom-built items as per **Table B1** and tube for HPA2.
- ITER-India is responsible to demonstrate the performance of HPA2. Bidder will review the **Annexure-G: Validation report formats for interfaces at ITER-India/IO** under **section 16.21** and Bidder has to provide details of additional qualification tests to be conducted on Indian make HPA2 for validation purpose to integrate with HPA3 during phase 3 onwards for ITER deliverables.
- ITER-India will test the Indian made HPA2 as per suggested qualification tests and Bidder need to validate/witness the test during site acceptance test of prototype RF source at ITER-India.
- If this development is successful, Indian made HPA2 will be used for next phases of delivery to ITER Organization. This decision will be taken after completion of MRR.

2.4 Overall Time Schedule

The Bidder shall produce a detailed Schedule showing all phases of the Contract and showing how the overall ITER-INDIA Schedule will be complied with the required delivery date defined in **Annexure-E: Delivery Schedule**. This detailed Schedule shall be submitted to the ITER-INDIA for approval/acceptance, before starting any work in relation to the Contract.

It is expected that Bidder should complete the activities up to Site Acceptance Test (SAT) at ITER-India's test facility for Phase 2 as per delivery schedule given in **Annexure-E: Delivery Schedule** (including FDR/MRR with IO), after awarding of contract by ITER-India.

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It is expected that Bidder should complete the activities related to assembly, integration & commissioning of their supplied components/sub-systems at IO site, France for Phase 2 after delivery by ITER-India at IO site as per projected schedule in **Annexure-E: Delivery Schedule**.

3 Main Responsibilities

The main responsibilities between the Parties is summarised in Table 1 (below) and is further detailed out in particular for SAT activities in **Annexure-L: Responsibility sharing matrix during SAT** and in the scope of supply **Section 4**.


R = Responsible for action

A = Review/Comment/Accept/Approve

S = Support during execution of action

Table 1: Responsibilities for Phase 2 between ITER-India/IO and the Bidder

Activity	Bidder	ITER-India	IO
Optimization of the system layout			
Submission of technical report related to optimization, drawings/ datasheets, etc.	R	A	A
Final Design Review (FDR)	S	R	A
Manufacture, FAT and Delivery HPA2+Trombone+HPA3 components.			
Manufacturing.	R	A	A
Factory Acceptance Testing (FAT).	R	A	A
Fabrication Readiness Review (FRR) with ITER-India & IO after FAT of 1 st RF chain	R	A	A
Packing.	R	A	S
Delivery to the ITER-India site.	R (FCA)	R (FCA)	
Receipt & Acceptance of HPA2+Trombone+HPA3 components at ITER-India site			
Receipt and Physical verification of packing box	A	R	
Unpacking and physical inspection of supplied components	R	S	
Integration of HPA2+Trombone+HPA3 as per agreed RF source layout	R	S	A
**Validation of various components/sub-systems provided by ITER-India	A	R	A
Site Acceptance Test (SAT) of HPA2+Trombone+HPA3 for all 4 RF amplifier chains. Generation of SAT report	R	S	A
Integration of the HP components in the full RF source		R	A
Site Acceptance Test of RF source		R	A
Manufacturing Readiness Review (MRR) with IO after site acceptance at ITER-India site	S	R	A
Validation of Indian made HPA2 at ITER-India site			
Test of the HPA2 fabricated by Indian industry	A	R	A
Receipt & Acceptance of HPA2+Trombone+HPA3 at ITER (IO) site			

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Activity	Bidder	ITER-India	IO
Delivery of RF source		R	A
Receipt, Physical verification and unpacking of supplied components	S	R	A
Integration of 2 sets of HPA2+Trombone+HPA3 for each RF source in the amplifier chains as per agreed layout	R	S	A
Validation of various components/sub-systems provided by IO	A	S	R
Integration of RF chain output or RF source output with 3 MW Dummy load	A	A	R
Site Acceptance Test of 2 sets of HPA2+Trombone+HPA3 on amplifier chains	R	S	A
Integration of the RF Source		R	A
Site Acceptance Test of the RF Source		R	A

** Bidder to verify performance by sampling based on the measurements performed by ITER-India. The validation remains under the designer's responsibility.

4 Scope of work and Scope of Supply

In the frame of this tender the Bidder has to perform optimization task for layout & water-air cooling arrangements, supply the hardware components and ensure services. All these activities are associated with generation of specific documentation.

Tables in **Section 4.1** are describing the main items to be delivered (options 1 and 2). The detailed list of components to be delivered by the Bidder in the frame of the contract will be finalized by the Bidder while submitting offer.


The design of HPA2, Trombone and HPA3 components will be as described in section 1. However, some adjustments are required to fit with IO interface and integration requirements (size & weight optimization for instance). The light weight supporting structure, positioning of the water-flow distribution and the air-cooling will be optimized by the Bidder.

The corresponding list of optimization tasks to be performed by the Bidder are described in **section 4.2**.

Analysis tasks are described in **section 4.3**.

Essential services will be provided by the Bidder as described in **section 4.4** for instance assembly, integration of components supplied by Bidder in ITER-INDIA or ITER (IO) facilities and support in acceptance process of the same.

Documents to be delivered by Bidder during the various phases of the tender are described in **section 4.5**.

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4.1 *Hardware supply*

- **Prototype RF source:**

- Two sets of new **HPA2+Trombone+HPA3** shall be supplied by Bidder to make prototype RF source.

- **Unit 1 RF source:**

- One set of new **HPA2+Trombone+HPA3** as one of the RF chains shall be supplied by Bidder
- In parallel modified existing (phase 1) **HPA2+Trombone+HPA3** components (which may be sent by ITER-India to Bidder's factory for modification and FAT) as another chain of RF source shall be supplied by Bidder.
- Both above chains will make Unit 1 RF source.

The resulting hardware list is described in the following tables.

4.1.1 *Information on the tube requirements:*


Information on the quantity of tubes to be supplied within this tender are given in **Table 2**, However, the breakup of delivery of the tubes is given in separate Tables (3&4) of deliverables for Phase 2.

Table 2: Information on the tubes (listed in Table 3: Hardware deliverables as deliverables)

For HPA-2 TH 781	For HPA-3 TH 628L	Place of Delivery	To be used for
02 Nos.	02 Nos.	ITER-India, IPR	Phase 2 – Prototype & Unit 1
02 Nos.	02 Nos.	IO, France	Phase 2 – Prototype
01 No.	-----	ITER-India, IPR	For HPA2 only (within 10 months after placing contact)
02 Nos.	02 Nos.	IO, France	Phase 2- Unit 1 RF Source
01 nos.	01 nos.	TBD before contract closure	FAT of all RF chains and will be kept as spare.
Total: 08Nos.	Total: 07 Nos.		

Note: General instructions

1. The same set of tubes will be used to conduct FAT of all RF chains of prototype and Unit-1 at Bidder's site.
2. The same set of tubes will be used to conduct SAT of prototype and Unit-1 at ITER-India.
3. Bidder shall use the same type of tubes for all RF chains

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4. Bidder shall confirm the similar dispersion characteristics of the tubes to comply with the specifications.
5. Bidder should give documents describing in detail the procedure for the storage (including required storage conditions), handling procedure, shelf life, etc. for the tubes.
6. Technical Datasheet for the tubes shall be fully detailed, with all relevant characteristic curves.
7. In case there is a fault in tubes, those under warranty period, shall be replaced/repared by Bidder free of cost within 6 months.
8. Spare tubes will be used for immediate replacement of faulty tubes. However, the faulty tube (those under warranty period) shall still be delivered/replaced/repared by Bidder free of cost within 6 months.
9. Packing material will stay in ITER-India or ITER organization in order to allow shipping back faulty tube to Bidder's factory.


4.1.2 Deliverables

Contractor need to keep all the components ready for shipment as per IO guidelines [7].

Table 3 & Table 4 describe list of the major items as deliverables for Phase 2 related to Prototype RF Source, however, it shall be detailed out by the Bidder.

Table 3: Hardware deliverables

Sr. no.	Description of item (to be delivered to ITER-India)	Quantity
1	HPA2 and HPA3 Cavity Parts: Includes cavities & other peripheral components of HPA2 (~120kW) and HPA3 (~1.5 MW) along with line stretcher (trombone). Peripheral components include accessories for moving mechanisms in the cavity, electrical safety arrangements, motors & controllers, components for suppression of parasitic oscillation, support structure as defined in Annexure-I: Proposed RF source Layout (HPA2 support, Trombone support & chassis 1, chassis 2, maintenance frame, elevator jack, support for output transformer for HPA3), water- & air-cooling accessories along with instrumentation and cables for monitoring & control purpose, specific jigs, fixtures & lifting arrangement etc.	3 Sets
	– Custom-built items as per Table B1 and Table B2.	3 Sets (Along with 3 sets of HPA cavity parts)
	– High power tubes for HPA2 & HPA3.	2 Nos. for HPA2 & 2 Nos. for HPA3
2	High power Tube for HPA2 & HPA3 (Spare) Note: This sets of tube can be used for FAT of 3 sets of HPA2+HPA3 by bidder	1 No. for HPA2 & 1 No. for HPA3

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3	Hardware along with connectors and cables for monitoring and local protection of components supplied by Bidder for remote operation & control through LCU as per section 15.1 under Annexure-F: Hardware to be delivered by Bidder to interface with LCU.	3 Set (Along with 3 sets of HPA cavity parts)
4	Water- & air-cooling distribution system. (1 Set for HPA2 & HPA3 of R&D chain & 3 Set for newly fabricated HPA2 & HPA3)	4 Sets
5	Additional components required to modify the HPA2, Trombone & HPA3 of Phase 1 including components as per section 15.1 under Annexure-F: Hardware to be delivered by Bidder to interface with LCU	1 Set
Description of item (to be delivered to ITER-Organization)		
6	High power tubes for HPA2 & HPA3 (To be delivered to ITER Organization)	4 Nos. for HPA2 & 4 Nos. for HPA3

Note: During FAT at Bidder site, the service platform along with ladder is not required. The cavity support frames will be directly used by Bidder for the tests.

Table 4: Hardware deliverables (for HPA2 by Indian industry)


Sr. no.	Description of item	Quantity
1	Custom built items for HPA2 as per Table B1.	01 Set
2	High power Tube for HPA2.	01 No.

4.2 Optimization tasks

The following optimization tasks will be performed by the Bidder and submitted to ITER-INDIA for approval.

The main optimization task is focussed on the integration of the component developed as a single RF chain during R&D phase into the full RF prototype source (Phase 2) with two RF chains. It includes checking of the components provided by ITER-INDIA, finalization of the overall layout, optimization of size, weight, water and flow distribution, supporting structure, for both prototype and Unit 1 RF sources. It includes in particular:

- To check and validate the specification/performance of components/subsystems procured by ITER-India (**Annexure-H: Description of items to be provided** by ITER-India). Bidder will validate the design of the power supplies of the tubes based on the design data provided by ITER-India and on tests of this design at factory. Provided integration of Bidder's recommendations to ensure adequate use of the tubes, Bidder can verify before SAT the performance of various components of ITER-India design by sampling, based on the measurements performed by ITER-India. The validation remains under the designer's responsibility. Design interfaces will be mutually agreed between Bidder and ITER-India.

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- To optimize & prepare the water- & air-cooling PFD for HPA2 & HPA3 based on proposed diagrams given in **Annexure-J: PFD diagram for water and Air cooling circuit**.
- To provide the step file of components supplied by Bidder with support structure for HPA2, Trombone & HPA3 as defined in **Annexure-I: Proposed RF source Layout** (HPA2 support, Trombone support & chassis 1, chassis 2, maintenance frame, elevator jack, support for output transformer for HPA3) and air & water-cooling lines. This information is required for structural and seismic analysis of overall RF source, which is to be done by ITER-India.
- To participate in preparation of the final layout along with ITER-India, to optimize the positioning of two sets of HPA2, Trombone & HPA3 within a footprint of **3.4 m (w) X 4.9 m (l) X 5.0 m (h)** and weight shall be less than **10.5 t**. The proposed layout is shown in **Annexure-I: Proposed RF source Layout** for reference.
- To provide technical report describing interface, protection, motor configuration, assembly & dis-assembly plan, test results for components/sub-assemblies/assemblies as per Manufacturing and Inspection Plan (MIP) etc.
- To define & verify the correct operation of the system jointly with ITER-India for safety key management system to protect against electrical hazards during Pre-bid/kick off meeting.

4.3 *Analysis tasks during Phase 2*

- To provide updated MTBF values of components supplied by Bidder to ITER-India, as an input for the RAMI analysis. RAMI analysis will be done by ITER-India.
- To conduct Seismic Analysis as per **section 6.4**.


Note: All drawings and mechanical parts should follow **ISO metric system**.

4.4 *Essential tasks*


The following tasks are required from the Bidder:

4.4.1 *For ITER-deliverables*

- To prepare quality plan as per IO's guidelines [2], [4], which will be shared by ITER-India.
- To participate remotely as a team with ITER-India in Final Design Reviews (FDR) conducted with IO and resolve the queries, if any, including performing necessary modification, re-calculation and submission of report etc. **for the components to be supplied by the bidder.**
- To procure the material and fabricate the deliverable hardware as per **section 4.1.2**.
- To implement the suppression methodology of parasitic oscillation to ensure unconditionally stable operation during different operating scenarios as implemented in Phase 1.

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- To submit the detail drawings and necessary components for the modification of existing HPA2, Trombone and HPA3 supplied during Phase 1 (with modified cooling arrangements and tuning motors) on the new service platform as per agreed layout.
- To conduct Factory Acceptance Test (FAT) of HPA2, Trombone & HPA3 (to meet the specification as per **Table 5**) as per “Conditions for Acceptance at factory” as described in **section 8.1.1**, in presence of ITER-India’s/IO’s representatives.
- To participate remotely as a team with ITER-India, after completion of FAT of chain-1 components, in Fabrication readiness Reviews (FRR) conducted with ITER-India and resolve the queries, if any, including performing necessary modification, re-calculation and submission of report etc. for the components to be supplied by the bidder. **After successful completion of FRR only Bidder can start the fabrication for next sets of components**
- To pack HPA2, Trombone & HPA3 & make ready for shipment to ITER-India, IPR.
- To unpack & assemble of delivered HPA2, Trombone & HPA3 at ITER-India site.
- To verify the compatibility with components/sub-systems (as per **Annexure-H: Description of items to be provided** by ITER-India) provided by ITER-India & submission of validation report as per **Annexure-G: Validation report formats for interfaces at ITER-India/IO** to ITER-India before integration with HPA2, Trombone & HPA3. Bidder can verify before SAT the performance of various components of ITER-India design by sampling, based on the measurements performed by ITER-India. The validation remains under the designer's responsibility. Design interfaces will be mutually agreed between Bidder and ITER-India
- To integrate two sets HPA2, Trombone & HPA3 with water-air cooling distribution.
- To install & commission (to meet the specification as per **Table 5**) of HPA2, Trombone & HPA3 with other components (**Annexure-H: Description of items to be provided** by ITER-India), as per **Conditions for Acceptance** (**section 8.1.2**) at ITER-India lab. The responsibility sharing matrix is given in **Annexure-L: Responsibility sharing matrix during SAT**.
- ITER-India is responsible for the combined RF high power test at 2.5 MW (to meet the specification as per **Table 9**). Bidder’s presence is not mandatory in these tests. Bidder will replace/repair the components supplied by them as under warranty clause.
- To repair/ replace of components / sub-systems etc. related to HPA2, Trombone & HPA3 free of cost, in case of failure during the commissioning phase.
- To participate remotely as a team with ITER-India in Manufacturing readiness Reviews (MRR) conducted with IO, after completion of SAT of full RF source, and resolve the queries, if any, including performing necessary modification, re-calculation and submission of report etc. for the components to be supplied by the bidder. **The date of the MRR will be informed to the Bidder by ITER-India well in advance.**
- To unpack & assemble of delivered HPA2, Trombone & HPA3 at IO site.
- To assemble, integrate and commission (to meet the specification as per **Table 5**) the two sets of HPA2, Trombone & HPA3 related to prototype RF source at IO site as per conditions for acceptance **section 8.1.4**. Demonstration of RF performance as per **Table 5** is under the bidder’s scope and as per **Table 9** is under the ITER-India’s scope. The responsibility sharing matrix is given in **Annexure-L: Responsibility sharing matrix during SAT**.

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Note:

- (i) All components for 4 RF chains for Prototype RF source and Unit-1 RF source will be delivered in staggered manner. Commissioning of each unit will be done as per projected schedule after delivery at IO site, France.


4.4.2 *For Indian make HPA2*

- To submit the details of the additional qualification tests to be conducted for this Indian make HPA2 for validation purpose to use for future ITER deliverables within 2 months after contract signature.
- To procure the material and fabricate the deliverable hardware
- To conduct standard Factory Acceptance Test (FAT) the deliverable hardware & submit the test report to get dispatch clearance certificate from ITER-India.
- To pack the deliverable hardware & make ready for shipment to ITER-India, IPR
- To witness the high-power RF performance of HPA2 fabricated and assembled by Indian industry. The performance will be checked as per Annexure-G: Validation report formats for interfaces at ITER-India/IO under section 16.21. This performance test will be conducted during SAT of prototype RF source at ITER-India site. To verify performance by sampling based on the measurements performed by ITER-India. The validation remains under the designer's responsibility
- To repair/ replace of components supplied by Bidder related to HPA2, free of cost, in case of failure during the commissioning phase as per warranty clause.

4.5 *Documents to be delivered by Bidder*

4.5.1 *General Instruction*

- All the documents shall be in duplicate as hard copy print and soft copy in memory stick.
- The Bidder shall prepare all documents in English only.
- The Bidder shall ensure that all documents and records are uniquely identified and traceable by tender references, including subsequent revisions, and are made accessible to ITER-India and IO authorized individuals [26].
- Bidder shall provide:
 - All documentation necessary to determine the progress and status of the work;
 - All documentation necessary to verify the management of manufacturing and supply within the scope of this tender.
- Day-to-Day correspondence and administration between the Parties (ITER-India & Bidder) need to be documented.
- The Bidder shall issue, manage and control its documents and records in accordance with its own QA Program.
- All units which will be used for execution of this tender shall be in metric only.

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- Bidder shall submit confirmation to Intellectual Property Rights (IPR) provision as per **Annexure-D: Intellectual Property Rights Provisions.**

4.5.2 *During offer*


- Scope Understanding Document (SUD) and compliance matrix for all the sections/sub-sections.
- Bill of material (BOM) with a guarantee to the purchaser that the items/systems/sub-systems/components manufactured by Bidder will be available for next 10 years from the date of delivery. For purchased COTS items, the Bidder shall issue LBO (Last Buy Order) to the purchaser in case of end of production of an item. In case of unavailability within less than 10 years after signature of contract, the OEM suppliers will be requested to offer equivalent items.
- QMP documentation emphasizing the following points for evaluation:
 - Standard factory test procedure and test conditions for Bidder's proposed tube. Detailed Technical Datasheet for the tubes shall be submitted along with tube characteristics curve.
 - Test procedure for components supplied by Bidder at factory as well as ITER-India.
 - Quality & Safety plan along with implementation procedure.
 - Realistic Schedule.
 - Risk Mitigation Plan.
 - Manufacturing & Inspection plan based on management specification (**Annexure-A: Management Specifications**).
 - Packing & transportation plan.

4.5.3 *During execution*

- Technical report for components to be supplied, to support FDR, FRR & MRR, containing the following data/content:
 - Updated detailed part wise 3D model (submission of compatible files as per ITER-INDIA requirement) of components supplied by Bidder (HPA2, Trombone & HPA3) containing assembly, sub-assembly and components, as per agreed layout [25] and confirmation on weight of individual amplifier.
 - Updated Bill of Material.
 - Material procurement documents.
 - Interface Control Document with respect to components supplied by Bidder as provided during Phase 1, considering the evolutions/modifications to meet the tuning / cooling requirements.
 - Detail of peripherals containing:
 - i. Mechanical design and analyses (Motor's configuration, blowers, support structure for components supplied by Bidder as defined in **Annexure-I: Proposed RF source Layout** [i.e. HPA2 support, Trombone support & chassis 1, chassis 2, maintenance frame, elevator jack, support for output transformer for HPA3], grounding, etc.).

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- ii. Seismic analysis as per **section 6.4**.
 - iii. Hydraulic design and analyses (water & air-cooling distribution system along with instrumentation, sensors etc.).
 - iv. Cabling diagram (different types of cables, connectors, cable trays etc.).
- Updated MTBF values of components supplied by Bidder. Tube's MTBF will be derived by operational data from other users of the tubes.
- Necessary signal list (digital as well as analogue) related to monitoring and local protection of components supplied by Bidder for remote operation & control of the system through LCU during SAT at ITER-India lab, based on information given in **Annexure-F: Hardware to be delivered by Bidder to interface with LCU**, which is prepared by ITER-India based on experience gained during execution of Phase 1.
- Requirement for various power supplies & cooling (water & air) along with P&ID, based on information supplied by ITER-India.
- Lookup/conversion tables for measuring parameters for cooling (water & air).
- Tuning positions (in mm) of all the motors for different frequencies of operation.
- Technical Report emphasizing components/system to be supplied by Bidder, which will be part of FDR/FRR/MRR.
- Updated Quality Management Plan (QMP) documentations emphasizing the following points for approval by ITER-India and IO:
 - Updated Manufacturing & Inspection Plan (MIP);
 - Updated Packing & transportation plan;
 - Updated Schedule & Risk Mitigation Plan;
 - Test plan and test procedure for components supplied by Bidder at Bidder site;
- Test plan and test procedure for components to be **supplied by Bidder** and for ITER-India's supplied components/sub-systems at ITER-India site, if any testing required for the protection of the tubes.
- FAT documents:
 - Submission of factory acceptance test report for the components/sub-systems either manufactured by the Bidder or purchased from outside sub-Bidder/sub-vendor during prototyping.
 - Factory Acceptance Test report along with Deviation Request and Non-Conformance Reports, if applicable, for getting dispatch clearance certificate from ITER-India.
 - Codes and standards conformity certificates.
- Contractor release note, delivery report & packaging list should be prepared before shipment. See Contractor Release Note [7].
- SAT Documents at ITER-India site:
 - Site Acceptance Test report for components to be **supplied by Bidder**, along with Deviation Request and Non-Conformance Reports, if applicable, for acceptance of the system by ITER-India.
 - Validation reports of all the interfaces with components supplied by Bidder.
 - Final updated Technical Report emphasizing components/system to be supplied by Bidder, which will be part of Manufacturing Readiness Review – MRR.

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- Operation & service manual including trouble shooting (in English).
 - Assembly & disassembly procedure.
 - Maintenance procedure specifying typical time interval for regular maintenance.
 - Document specifying equipment storage & preservation requirement.
- SAT Documents at IO site, France:
- Site Acceptance Test report at IO site, France for components to be **supplied by Bidder** for acceptance of the system by ITER-India & IO.
 - Validation reports of all the interfaces with components supplied by Bidder.

5 Additional information

- Cost for travel, accommodation, insurance of the persons involved during site works and others which will be necessary for execution of this contract will be borne by respective parties.
- It is to be noted that IP generated through execution of contract (see GIP document attached in **Annexure-C: Generated IP during phase 1**) for Phase 1 is background IP for next phases and belongs to ITER-India's property.
- Related to existing R&D RF chain, after modification at ITER-India site, the FAT & SAT will be conducted as per mutually agreed procedure and new extended warranty will be applicable after final acceptance at ITER-India site.

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6 Technical Specifications


6.1 Technical requirement for single RF chain

Table 5 shows the specifications for one complete RF chain.


Table 5: Major specifications for Single RF Chain

Sr. no.	Specification	Level & Units	Remarks
1	Tunable Frequency Range	35-65 MHz	The system shall be tunable for the frequency band 35 – 65 MHz Supplier shall provide data for tuning in the steps of 2MHz.
	Operating Central Frequency Range	36-60 MHz	The system performance shall be checked for full power, duration & bandwidth requirement as per Sr. no. 4.
2	System tuning	-Desirable is within 180s -Not more than 360s	At any operating frequency to any other operating frequency between 35-65MHz, automatic tuning time shall be less than 360 sec.
3	Frequency deviation over any central frequency (1dB bandwidth point)	±1MHz	1dB bandwidth point shall be demonstrated at 36 MHz, 40MHz, 42 MHz, 53MHz, 55MHz & 60 MHz with full output power of 1.6MW without changing the tube biasing or input RF power. RF power will be checked in 0.25MHz steps from the centre frequency. The stability of RF power during each step will be measured during the shot.
4	Constant output power with specified load conditions with any phase angle of the reflection coefficient Note: Maximum 10 kW input power to HPA2 shall be provided by ITER-India	1.6MW/3600s/ matched load	Matched load condition: 1.6MW constant RF Power shall be demonstrated at 36 MHz, 40MHz, 42 MHz, 53MHz, 55MHz & 60 MHz for 3600s duration without any break.
		1.5MW/2000s/ VSWR 2 & 1.6MW/3600s/ VSWR 1.75	Mismatched load condition: Specified constant RF Power shall be demonstrated at 36 MHz, 40MHz, 42 MHz, 53MHz, 55MHz & 60 MHz for specified duration

The tender document is to provide technical content and scope related to ITER deliverables and shall not be disclosed or used for any other purpose without written permission from ITER-India.

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Sr. no.	Specification	Level & Units	Remarks
		Burn-in test with mismatch load of 1.6MW/3600s/VSWR 1.75	and VSWR conditions with a single pulse without any break Five serial pulses with 25% duty cycle (without any break) shall be demonstrated at specified constant power, for 42MHz & 53 MHz with 5 different phase angles between 0 to 180 degree.
5	Accuracy in output power measurement	Minimum 5%	For full scale power.
6	Max. Output harmonic level	-20 dBc	Measured on matched load.
7	Electrical efficiency	Minimum 65% (Matched) Minimum 45% (Mismatched)	Depending upon load conditions (Matched & Mis-matched).
8	Pulse duration: ON time	Maximum 3600s	Depending upon power & VSWR
9	Duty cycle	25%	5 successive pulses of 3600s at 1.6MW on 42 MHz & 53MHz with a duty cycle of 25% on VSWR 1.75
10	Maximum VSWR	2	With any phase of reflection coefficient for the output power of 1.5MW.
11	Maximum Transient VSWR	2.5 (1s max.)	Output power (1.5MW) may be reduced. Bidder shall specify the limit of the absolute value of reflection power to initiate power down mode of the system.
12	The impedance of the coaxial lines interfacing with the amplifiers.	50 Ω	Input & output impedance of HPA2 and HPA-3 shall be compatible with 50 Ω coaxial lines.
	RF power of HPA2 on matched load	Minimum 120kW/3600s	HPA2 will be tested on matched load in standalone mode.
13	Size of HPA3 output port	12"	
	Size of the HPA3 input port	6"EIA compatible	
14	Size of HPA2 input port	3"EIA compatible	
	Size of the HPA2 output port	6"EIA compatible	
15	Validation of Anode, Screen grid and Control grid power supply	As per tube data sheet	Wire burn test/fuse test is carried out for different power supplies as per tube data sheet to switch off the power supply when OC (over

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Sr. no.	Specification	Level & Units	Remarks
			current) is detected and wire/fuse shall not be burnt.
16	Emergency RF power cut-off response	<10 μ s	Max anode voltage sustainable by the components linked to the overshoot in case of RF cut-off (from full power to zero) with all biasing parameters kept ON for the protection of the amplifier will be specified by the bidder Amplifier supplied by the Bidder shall support this cut-off response.
17	RF radiation limit	<1mW/cm ²	It shall be within the limits recommended by the International Non-Ionizing Radiation Committee (INIRC). European directive 2013/35/UE referring to 1999/519/CE relating to workers' exposure to electromagnetic risks are applicable.
18	Max frequency modulation frequency for change in frequency for \pm 1MHz from the centre frequency	1 kHz (1 mS)	Responsibility of ITER-India, but HPA shall support this requirement.
19	Full Power modulation range at the load	1kW-Full power at 100Hz (Close-loop response time)	Responsibility of ITER-India, but HPA shall support this requirement.
21	Half Power to full power modulation range at the load	Half power-Full power at 1 kHz	Responsibility of ITER-India, but HPA shall support this requirement.
22	Max phase modulation frequency (Close-loop response time)	10 kHz (at fixed reference/any frequency)	Responsibility of ITER-India, but HPA shall support this requirement.

Specific requirement for control system:

The amplitude and phase of each RF source are controlled in a closed control loop and compared with a time variable suitable reference, provided by the associated subsystem controller. ITER-India will provide the modulation characteristics (wave curves). All equipment (Including RF amplifiers) of the HP components shall comply and support with the RF power control requirements. Following **Table 6**, **Table 7** & **Table 8** are specifying the control loop requirements, which are for the information to Bidder.


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Table 6: Output power control specifications per RF chain


Forward power control range (MW)	0.005 to 1.75
Power modulation accuracy of full-scale power (%)	5.0
Power modulation frequency (3dB break) (kHz)	1.0
(3dB break points means, power will be ramped up from half to full for 300 micro sec, then 200 micro sec flat tops of full power, then 300 micro sec ramped down from full to half power and then 200 micro sec flat tops for half power)	
Max RF power rise time (full modulation range) (ms)	200
Response to a trip request (μ s)	< 10
Overshoot	< 5%
Max residual power with RF power source ready (power reference at 0) (kW)	1.0

Table 7: Frequency modulation specifications for the RF source

Output frequency range (MHz) (main centre frequency will be set off-line)	36-60 MHz
Frequency step (kHz)	1.0
Offset frequency (kHz)	0.1
Frequency modulation (MHz) (frequency will be set on-line within 1dB bandwidth)	± 1.0
Closed loop response to a frequency step ($\Delta f < \pm 1.0$ MHz) (μ s)	100
Frequency overshoot (kHz)	< 20

Table 8: Phase modulation specifications of the RF source

Phase control range ($^{\circ}$)	360
Minimum output power level allowing phase control (kW)	5
Absolute phase accuracy, including offset and noise ($^{\circ}$)	3
Closed loop response to a phase step ($\Delta \phi < \pm 90^{\circ}$) (μ s)	20
Phase overshoot ($^{\circ}$)	< 20

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Max time interval to lock (any frequency and phase) (ms)	10
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6.2 Technical requirement for RF Source


After successful final acceptance of single RF chains at ITER-India, the warranty of the supplied components will start. ITER-India will combine two RF chains using combiner by its own and test full RF source as per major specifications shown in **Table 9**.

Table 9: Operation specifications for RF Source

Sr. no.	Specification	Level & Units
1	Tunable Frequency Range	35-65 MHz
	Operating Central Frequency Range	40-55 MHz
2	System tuning	within 180s/360s depending upon choice of the moving mechanism
3	Frequency deviation over any central frequency (1dB bandwidth point)	±1MHz
4	RF output power with specified load conditions with any phase angle	Up to 3MW/3600s/matched load and Up to 3MW/3600s/VSWR 1.5 Measured at load
5	Accuracy in output power measurement	Better than 5%
6	Max. Output harmonic level	Better than -20 dBc
7	Overall end stage electrical efficiency	≥65% and ≥45% for Matched condition and mis-matched condition respectively
8	Pulse duration: ON time	Maximum 3600s
9	Duty cycle	25%
10	Maximum VSWR	1.5
11	Transient VSWR	2.0 (1s max.)
12	The impedance of the coaxial lines interfacing with the RF source.	50 Ω
15	Emergency RF power cut-off response	<10 μs
16	RF radiation limit	<1mW/cm ²

6.3 Interface requirements

Details on interface requirements with components supplied by Bidder are given in **Annexure-G**: Validation report formats for interfaces at ITER-India/IO, **Annexure-H**: Description of items to be provided by ITER-India & **Annexure-I**: Proposed RF source Layout.

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All these interfaces will be discussed & confirmed during kick off meetings to resolve design integration issues before FDR meeting.

The main interfaces with the components to be supplied by Bidder are described in **the following subsections.**

6.3.1 *Mechanical interface*

- The transmission line interface in between:
 - SSPA & HPA2 [19];
 - HPA2 & HPA3 [20];
 - HPA3 & Test bed (Dummy Load + MMTL) [21];
 - HPA3 & 3dB Hybrid combiner [21].
- The Key management system (see **Annexure-H**: Description of items to be provided by ITER-India, section 17);
- The Cable Trays (which will be attached with service platform) for laying power cables and control/monitoring cables.

6.3.2 *RF interface*


Bidder need to verify & validate the performance of RF amplifier/low power RF components/Coaxial transmission line components/bi directional couplers by sampling based on the measurements performed by ITER-India. The performance of these components in integrated mode remains under ITER-India.

6.3.3 *Electrical interface*

- Electrical power for air cooling system (blowers), motors (related to tuning system) and water-cooling equipment.
- Connection of the component's grounding to the global Earthing/Grounding network [17].
- The utility power supplies (~250 kW per RF source) at ITER-India and at IO site are 400V±10% / 3 phase / 50 Hz and 230V±10% / single phase / 50 Hz. Uninterrupted mains power supply for filament DC power supply will not be used as per the outcome of Phase 1.
- The components supplied by Bidder shall interface with Auxiliary power supplies for HPA2 and HPA3 provided by ITER-India as per the protection specifications of the tube data sheet (Filament power supply, Screen Grid power supply & Control Grid power supply) as defined in **Annexure-H**: Description of items to be provided by ITER-India, section 17.

6.3.4 *Water cooling interface*

The components shall be compliant with the water-cooling loop characteristics:

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- Water cooling distribution for HPA2 & HPA3 components with Inlet & outlet flange of main water supply line.
- The water-cooling facility for HP components at ITER-India and at IO site:
 - Inlet pressure 5.5 bar;
 - Maximum inlet temperature 31°C;
 - Flow rate as per **section 19**
 - Maximum pressure drops 3.0 bar.
- See Diagram in **Annexure-J**: PFD diagram for water and Air cooling circuit.
- The water-cooling circuits of the RF sources shall use stainless steel or copper.

6.3.5 *Air cooling interface*

- See Diagram in **Annexure-J**: PFD diagram for water and Air cooling circuit.
- The maximum value of heat exhaust inside the lab environment shall be within 1% of total power of RF source, the bidder shall specify the value of heat exhaust for their supplied HPA component inside the lab environment. Bidder need to provide calculation of air-cooling requirement to know the power dissipated in the air.

6.3.6 *LCU Interface*

- See **Annexure-H**: Description of items to be provided by ITER-India, section 17.
- Each RF power source shall ensure its own protection first of all by reducing the RF output power level, and shall be protected against:
 - Load VSWR variations on the RF output, for any phase of reflection coefficient;
 - All internal malfunctioning (over current, over voltage, over temperature, breakdowns etc.);
 - All abnormal commands (over range signals, non-consistent commands);
 - Water/air cooling interruption;
 - Pressurized air interruption;
 - Electrical power supply interruption;
 - Internal/external arc interruption (Individual arc detection signal shall be provided at critical location of amplifier for protection);
 - Relative humidity sensor at ITER-India and IO site will be implemented as per model number suggested by the Bidder, to monitor humidity under 60% and dedicated procedures will be elaborated mutually during FDR in case of overshoot of humidity criterion.
 - Any other parameters as required by Bidder.
- For safe operation of RF amplifier, no operational parameter shall exceed the pre-established thresholds and nominal values (e.g. electronic tubes grid current, anode power dissipation etc.) during operation. Safety thresholds shall be set as per the requirement and the same shall be managed by Local Control Unit (LCU) supplied by ITER-India.
- In this regard, Bidder's responsibility is limited to provide the associated signals from the equipment supplied by Bidder. Supply of cables & connectors for the same is under

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Bidder's responsibility for Phase 2 (Refer **Annexure-F**: Hardware to be delivered by Bidder to interface with LCU).

6.3.7 *Building interface*

- See **Annexure-I**: Proposed RF source Layout.
- At ITER-India and IO site, 5 t crane will be available with a hook height of 6.5m (max) for assembly/disassembly purpose at 3rd floor at ITER-India lab and level 3 of RF building-15 at IO lab. Overall dimension of one 2.5MW RF source shall be within footprint of **3.4 m (w) X 9 m (l) X 5 m (h)** and weight shall be less than **18 t**.
- Bidder shall accommodate two sets of HPA2, Trombone & HPA3 within a footprint of **3.4 m (w) X 4.9 m (l) X 5 m (h)** and weight shall be less than **10.5 t** (see **Annexure-I: Proposed RF source Layout**).
- The supporting structure of HPA2, Trombone & HPA3 should be compatible with RF enclosure, service platform along with ladder.
- Outside temperature range at ITER-India site is from 20 to 46°C with RH range of 65-95%. However, inside ITER-India lab & IO site temperature ranges from 20-30°C and RH ~55% ± 5%.

6.3.8 *HVPS interface*

See **Annexure-H**: Description of items to be provided by ITER-India, section 17.

At ITER-India and IO site, HPA2 & HPA3 will be interfaced with High Voltage Power supply (HVPS).


Dual output high voltage power supply will be used to bias driver stage (13 kV/20A) and final stage (27kV/170A) amplifiers of each RF chain. For all operating conditions, the anode voltage for HPA2 will be fixed at 13kV, while the same for HPA3 may be varied in between 17kV to 27kV.

6.4 *Seismic Requirements*

Bidder is responsible for supply of HPA3, HPA2 and Trombone with support structures during Phase 2. So, Bidder need to submit simulation results for structural stability of above systems with static loads as well as seismic loads. The floor response spectrum needed to carry out the seismic simulation shall be provided by ITER India.

Bidder shall submit the 3-Dimensional model and the total mass of each supplied items (HPA2, Trombone & HPA3 including cooling distribution), along with support structures and the co-ordinates of their Centre of Gravity (COG).

Bidder shall perform a simulation of HPA2, Trombone and HPA3 behavior under seismic loads (not connected to the other elements of the RF chain).

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The seismic analysis of the full RF source will be performed by ITER-India, based on information or analysis provided by the Bidder. After the analysis performed by ITER-India, some minor modifications on support structure that includes the anchorage point shall have to be implemented by the Bidder.

Annexure M: Reference for seismic analysis is detailing the ITER seismic requirements for information only to Bidder.

6.5 Codes and Standards

The following standards are applicable for the execution of this project. These codes and standards shall be implemented for the components supplied by Bidder, wherever applicable.

6.5.1 Codes and Standards for high power RF Equipment

- IEEE C 95-1-1991 OR European directive 2013/35/UE standard defines the limit of exposure for peoples to the RF electromagnetic fields.
- EN 55011: 2007 OR EN 55011:2011 at system level
- Décret 2016-1074 du 3 août 2016 relatif à la protection des travailleurs contre les risques dus aux champs électromagnétiques (Decree 2016-1074 of 3 August 2016 relating to the protection of workers against the risks due to electromagnetic fields):


www.legifrance.gouv.fr/jo_pdf.do?id=JORFTEXT000032974358

(This decree is taken for transposition of Directive 2013/35/EU of 26 June 2013 into French law) In particular, the radio-frequency exposure for personnel working in areas adjacent to sources of hazard should comply with the limits recommended by the International Non-Ionizing Radiation Committee (INIRC), part of the ICNIRP statement (Guidelines for limiting exposure to time-varying electric, magnetic and electromagnetic fields (up to 300 GHz)). The exposure limit for workers expressed as Equivalent Power density for plane waves is: < 1.0 mW/cm². Requires the application of European directive 2013/35/EU, which refers to directive 1999/519/EC regarding workers exposed to risk

OR updated standards as:

Applicable Standards and directives:

- Electromagnetic Compatibility (EMC): European directive 2014/30/EU
- Machinery: European directive 2006/42/EC
- Pressure equipment: European directive 2014/68/EU
- Restriction of hazardous substances in electrical and electronic equipment (RoHS 2) 2011/65/EU
- Ionizing radiation: European directive 2013/59/EURATOM
- REACH

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6.5.2 Codes and Standards for RF Transmission lines.

High power RF transmission line flanges are the interface between ICRF source system & main transmission line system. No specific standards are indicated in ITER standards. Therefore, same flanges [19] [20] [21] like demonstrated R&D chain shall be used for Phase 2.

Pressure equipment: Directive 2014/68/EU:

- NF EN 13480-1 V1 (December 2017 + A1 April 2019 + AC1 July 2020) Industrial metal piping - Part 1: general.
- NF EN 13480-2 V1 (December 2017 + A1/A2/A3 October 2018 + A7 April 2020+ AC1 July 2020 + A8 October 2021) Metallic industrial piping - Part 2: materials.

6.5.3 Codes and Standards for mechanical components

Commercial material shall conform to the applicable standard (ASTM, JIS, DIN, and Material Handbook of IO) for the definition of their grade, physical, chemical, and electrical properties and related testing. All materials for which a suitable certification from the Bidder is not available shall be tested to determine the relevant properties, as part of the procurement. A complete traceability of all the materials, including welding materials, shall be provided. RF Source system will be built using Cu/SS/Brass/Al/Be-Cu/Teflon etc.

Corrosion-free materials shall be used in the water-cooling pipes. Especially, mild steel, Aluminium and brass fittings & connections are forbidden for DMDI water circuits.

Mechanically welded structures and cooling circuits:

- NF EN 1993-1-1 + NA (black steels), NF EN 1993-1-4 + NA (stainless steels).


The use of any chemical compound or product shall comply with the REACH regulation and shall be approved on the basis of its material safety datasheet

All fasteners shall be ISO metric thread type.

Codes and standards for IC H&CD mechanical components shall follow the General ITER specifications: Codes and Standards for ITER Mechanical Components [33].

In addition, the following codes and standards shall be applied:


- ASME B31.3, process piping
- ASME ANSI B16.25 - pipe, valve, fitting and flange butt weld ends
- ANSI-ASME B16.34 - valves - flanged, threaded, and welding end
- ASME B36.19 - stainless steel pipe
- ASME Section IX - welding and brazing qualification
- Pressure Equipment Directive (PED)

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For bought-out components (such as motors, gearboxes, and bearings), design limits shall beset according to manufacturer's recommendations.

Machinery: directive 2006/42/EC:

- NF EN ISO 12100 (31/12/2010) general principles for design, risk assessment and risk reduction
- NF EN ISO 13849-1 (03/03/2016) safety of machinery-parts of control systems related to safety- part 1: general principles for design
- NF EN ISO 13849-2 (14/10/2012) Safety of machinery - safety-related parts of control systems
- NF EN 60204-1 (14/09/2018) safety of machinery - electrical equipment of machines - part 1: general requirements
- NF EN IEC 60204-11 (January 2019) safety of machinery-electrical equipment of machines - Part 11: requirements for equipment operating at voltages above 1 000 V a.c. or 1 500 V d.c. and not exceeding 36 kV
- NF EN ISO 13857 (October 2019) safety of machinery-Safety distances preventing upper and lower limbs from reaching hazardous areas
- NF EN ISO 14122-1 (01/03/2017) safety of machinery-permanent means of access to machinery-Part 1: selection of a means of access and general access requirements
- NF EN ISO 14122-2 (01/03/2017) safety of machinery-permanent means of access to machinery-part 2: working platforms and gangways
- NF EN ISO 14122-3 (01/03/2017) safety of machinery-permanent means of access to machinery-part 3: stairs, step ladders and guard rails
- NF EN ISO 14122-4 (01/03/2017) safety of machinery-permanent means of access to machinery- part 4: fixed ladders
- NF EN 619+A1 (24 December 2010) safety and EMC requirements for equipment for mechanical handling of insulated loads
- NF EN ISO 13850 (18/12/2015) safety of machinery - emergency stop function - design principle
- NF EN ISO 14120 (16/01/2016) safety of machinery-guards-general requirements for the design and construction of fixed and movable guards.
- NF EN ISO 14119 (06/12/2013) safety of machinery-interlocking devices associated with guards-principles for design and selection
- NF EN ISO 12198-1 (November 2008) safety of machinery-estimation and reduction of risks arising from radiation emitted by machines
- NF EN ISO 12198-2 (November 2008) safety of machinery - estimation and reduction of risks arising from radiation emitted by machines - Part 2: Procedures for measuring radiation emissions
- NF EN ISO 12198-3 (November 2008) safety of machinery - estimation and reduction of risks arising from radiation emitted by machines - part 3 : Reduction of radiation by attenuation or shielding
- NF EN 61010-1 (January 2011+A1 February 2019) Safety requirements for electrical equipment for measurement, control and laboratory use - Part 1: General requirements

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- NF EN 50664 (November 2017) Generic standard for demonstrating compliance of equipment, used by workers, with the limits for human exposure to electromagnetic fields (0 Hz - 300 GHz), at the time of commissioning or on site
- NF EN IEC 62311 (January 2020) Assessment of electronic and electrical equipment in relation to human exposure restrictions to electromagnetic fields (0 Hz - 300 GHz)
- NF EN IEC 61439-1 (May 2021) Low-voltage switchgear and control gear assemblies - Part 1: General rules
- NF EN IEC 61439-2 (May 2021) Low-voltage switchgear and control gear assemblies - Part 2: power switchgear and control gear assemblies
- Decree of December 16, 2011 relating to the special provisions applicable to certain laboratories and test platforms
- NF EN 50191 (February 2011) Installation and operation of electrical test equipment

6.5.4 *Codes and Standards for electrical components:*

All the system components shall be designed, manufactured and tested in compliance with the latest issues of the standards published by IO (Electrical Design Handbook Part 3: Codes and Standards [14] and EDH Guide A: Electrical Installations for SSEN Client Systems [15] and Plant Control Design Handbook [13]) and the International Electro Technical Commission (IEC) and NFC 15-100 and NFC 13-200. Applicable standards shall be listed by the Bidder. They shall be submitted to ITER-INDIA for review and approval/acceptance.

All applicable French local and national rules, regulations and decrees shall be strictly followed.

6.6 *Safety Requirements*


The RF sources are considered as Non-Safety Important Component (Non-SIC) by IO. Therefore, nuclear safety rules/standards are not applicable for this tender.

6.6.1 *Safety design criteria*

The IC H&CD RF sources shall comply with the technical requirements of the French Order dated 29 September 2017 [11] and summarized in [Section-9](#) setting the minimum technical design rules applicable to premises in which electrical equipment emitting X-Ray radiation is installed.

X-ray radiation and RF radiation near the vicinity of the equipment will follow the ITER standards (EN 55011, IEEE C 95-1991), AND radiation protection directive 2013/59/EURATOM (transposed by French Decrees 2018-434 and 218-437) & shall be monitored by ITER-India at Indian test facility and by IO at IO site.

During operation of the ICRF source, RF leakage may be observed at certain locations, which needs to be prevented to avoid hazardous RF exposure to the staff.

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Electronic tubes are high vacuum devices. The insulating parts are made of ceramics; they can break and implode violently, projecting dangerous debris. The RF cavities shall be fabricated to confine such debris.

High power electronic tubes dissipate very large amounts of heat. The cooling liquid can be at very high temperature. The untimely opening or break in a cooling circuit can release very hot water or steam. Sufficient protection shall be ensured for workers.

Access to the RF cavities during operation shall be forbidden by proper enclosures with key management system.

Equipment shall be designed to limit the propagation of fire to adjacent components. The inventory for all solid, liquid and gaseous toxic products for the HP components shall be limited to the maximum extent possible in the design, and their impact maintained As Low As Reasonable Achievable (ALARA) during operation.

The French Labour Code art. R.4226-1 is applicable to any design activity of components to be delivered to ITER site. This relates to the control of a new electrical installation (NFC 15-100, NFC 13-200 Standard, Decrees 2018-434 (codifying French Public Health Code) and Decree 2018-437, [11] & [12]).

6.6.2 *Safety limits*

The dose rate of X-ray should be less than or equal to 0.5 $\mu\text{Sv/hr}$ measured at 0.1 m of any point that can be reached by operator in normal operating conditions [Decrees 2018-434 (codifying French Public Health Code) and Decree 2018-437 (codifying French Labour Code)].


The RF exposure for workers expressed as Equivalent Power density for plane waves shall be: $< 1.0 \text{ mW/cm}^2$ measured at 10 cm from the RF source enclosure. European directive 2013/35/UE referring to 1999/519/CE relating to workers' exposure to electromagnetic risks are applicable.

6.6.3 *Safety monitoring requirements*

Safety monitoring requirements shall be generated & submitted by Bidder for the approval of ITER-India. Bidder shall monitor the same during factory acceptance test.

Monitoring shall be provided by ITER-India and/or IO during site acceptance tests to indicate the status in all operational states and accident conditions to indicate whether the above safety functions and requirements are being met.

X-ray emission will be checked during assembly (see 6.6.4), integration & commissioning and periodic measurement will be required, which is under IO safety division responsibility.

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6.6.4 *On-site Work Regulations/ Assembly-Integration-commissioning at ITER-India Site and IO site*

In the frame of work described under this tender, Bidder shall follow specific rules concerning e.g. safety regulations applicable to works of third parties at ITER-India site as well as at IO site [28], access to and activities on the site, occupational health and safety on the site and special health and safety matters. In particular, the standard n° ISO14122 - “Safety of machinery - Permanent means of access to machinery” shall be applied. For Electrical Safety, as per the French Labour Code art. R.4226-14 (relates to the control of a new electrical installation NFC 15-100 & NFC 13-200 Standard) a regulatory initial inspection of the delivered components will be conducted before getting energizing clearance.

Radio Protection Surveys and verifications will be performed before use (e.g. commissioning) as per French Order of October 23, 2020 relating to measurements carried out as part of risk assessment and verifications of the effectiveness of prevention means put in place as part of the protection of workers against risks due to ionizing radiation as well as Article R1333-139 of French Public Health Code.

All the relevant documents will be accessible to the Bidder after placing of contract.

6.7 *Control and Instrumentation Requirements*

The Instrumentation & Control equipment (I&C) supplied by Bidder shall conform to standards, specifications and interfaces as specified in the document “Plant Control Design Handbook” [13].


6.8 *Manufacturing Requirements*

Detailed Quality Plans, Manufacturing Inspection Plans (MIP) as per template [6], work plans and procedures shall be developed by the Bidder and Subcontractors for each step of fabrication as defined in **Annexure-A: Management Specifications**. They shall be submitted to ITER-INDIA for review and approval/acceptance.

In order to simplify and reduce the cost of integrating, operating and maintaining the systems, the Bidder shall use as much COTS components as possible.

6.9 *CE Markings*

CE Markings shall be implemented in accordance with European directives requirements. The list of European directives concerning CE marking is available on the following web site https://ec.europa.eu/growth/single-market/ce-marking/manufacturers_en. Other useful information can be found in the “Guide of implementation of directives based on the New Approach and the Global Approach”: http://ec.europa.eu/enterprise/policies/single-market-goods/files/blue-guide/guidepublic_en.pdf.

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Applicability of CE marking on Components/sub-systems etc. shall be listed by the Bidder. They shall be submitted to ITER-INDIA for review and approval/acceptance.

If delivery will be a "partly completed machine" then CE marking may not be applicable according to the EU Machine Directive. However, Bidder shall issue a certificate of incorporation of RF chain components along with regulatory technical documentation to substantiate the demonstration of conformity to regulation. COTS integrated in Bidder's delivery shall have CE marking.

There is a requirement in France to have a legal inspection (NFC 15-100 & NFC 13-200) of any electrical equipment before it is energized for the first time. Bidder shall implement all the requirement of such legal inspection during production of items in factory and conduct legal inspection at factory before shipment to ITER-India/ITER, France. Bidder is also responsible for the clearance for Legal inspection of their supplied components at ITER, France.

6.10 Reliability and Maintainability Requirements

The Bidder will provide the Mean Time Between Failure (MTBF value) of the components, as a part of the Bill of Material (BoM).

7 Delivery requirements at ITER Site

7.1 Labelling, Cleaning, Packaging, Handling, Shipment and Storage

7.1.1 Scope of application

The following generic requirements apply for the shipment of equipment from the manufacture/assembly site to the ITER-India and/or ITER Site.


Suitable precautions shall be taken to avoid damage to the equipment. The components shall be fitted with the required accelerometers or other sensors and shall be packed as defined in **section 7.1.4**.

The equipment shall be subject to control and inspection, as defined below.

7.1.2 Labelling and Traceability

All components and the main subcomponents shall be clearly marked in a permanent way and in a visible place with the IO official numbering system according to the document "ITER Numbering System for Components and Parts" [8] and [9]. A detailed 'IO component identification standard' together with printed label templates and tagging standards will be provided by ITER-India [10].

The equipment included in the scope of supply shall be fitted with a rating plate in accordance with the applicable standards. The rating plate shall bear the identification of the corresponding equipment in the project.

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In addition, identification of the equipment and components shall comply with the labelling requirements defined in EDH Guide A [15].

7.1.3 *Cleaning*

During cleaning, particular attention shall be given to the removal of weld spatter, debris and other foreign matter. Bidder shall ensure effective cleaning without damage to the surface finish, material properties or metallurgical structure of the materials.

7.1.4 *Packaging and Handling*

Any special ITER-India or/and IO or regulatory transportation requirements shall be documented and provided to the Bidder prior to shipment.

Subsequent to the Factory Acceptance Test, the components shall be partially disassembled to the optimum size that can be shipped. All components requiring re-assembly at the ITER-India and/or ITER Site shall be clearly labelled and tagged.


The Bidder shall design and supply appropriate packaging, adequate to prevent damage during shipping lifting and handling operations. Where appropriate, accelerometers or other sensors shall be fitted to ensure that limits have not been exceeded. When accelerometers are used, they shall be fixed onto each box and shall be capable of recording the acceleration along three perpendicular directions [30].

As the systems are required to ship from factory to ITER-India for site acceptance test at ITER India and from ITER-India to ITER Organization for site acceptance test at IO, all packing material can be provided as re-usable.

Shock absorbing material shall be used.

Each shipment shall be accompanied by a Delivery Report shall be prepared by the Bidder, stating as a minimum:

- The packing date;
- The full address of the place of delivery and the name of the person responsible to receive the package, as well as of the Bidder's name and full address;
- Bill of Materials;
- Security Measures;
- Release Note [7];
- Packing List;
- Material Safety Sheet;
- The declaration of integrity of the package;
- The declaration of integrity of the components;
- Any additional relevant information on the status of the components.

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The Delivery Report shall be signed by a representative of the ITER-India/IO and the Bidder. The signature by the ITER-India and/or IO of the Delivery Report prior to shipment represents a Hold Point (HP).

7.1.5 *Shipment, Transportation and Delivery*

Before the shipment, a Release Note shall be prepared in accordance with the “Contractor Release Note” [7] and approved by the ITER-India and/or IO.

Upon receipt of the package, the ITER-India and/or IO shall prepare an Inspection Report;

The following points will be checked:

- The integrity of the package, including identifying visible damage;
- The reading of the accelerometers or other sensors;
- The enclosed documentation;
- The number and type of components contained in the shipment from the documentation.

In the case of anomalies, the ITER-India and/or IO shall make any additional relevant remark on the inspection report.

The ITER-India and/or IO will inspect the accelerometers or other sensors mounted on the boxes. If these accelerometers record shocks above 5g, a thorough inspection of the components shall be performed. A decision on acceptance of the delivery of the components will be made by the ITER-India and/or IO.

The boxes will be opened in presence of Bidder’s representative, once moved to the final assembly place. The integrity of the components, including identifying visible damage will be checked by ITER-India/IO.

If the components are in an acceptable condition, the ITER-India and/or IO will sign the Inspection Report. The signature of the Inspection Reports is an ITER-India and/or IO Hold Point.


The original of the Inspection Report shall be kept by the ITER-India and/or IO and a copy of it shall be kept by the Bidder.

8 **Conditions for acceptance**

The following sections described the FAT and SAT processes. Additional details and responsibility sharing matrix for SAT process are given in **Annexure-L**: Responsibility sharing matrix during SAT.

The acceptance tests, to meet the technical specifications given in **section 6** of the components supplied by Bidder shall begin once operational parameters of the system like fixing of the tuning positions and biasing parameters for a particular test are well established by the Bidder.

The tender document is to provide technical content and scope related to ITER deliverables and shall not be disclosed or used for any other purpose without written permission from ITER-India.

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During RF test on matched load of the system, such operational parameters should not be adjusted, if adjustment is needed during the test, then the entire test at particular frequency should be repeated. Only anode voltage may be changed during RF test on mis-matched load, but tuning positions and other biasing parameters (i.e. screen grid & control grid voltage) shall remain same for matched as well as mis-matched load test conditions.

Annexure-K: Acceptance of RF Sources describes about the final acceptance of each RF source by ITER-India and/or IO

Note: Adjustment of any tuning element of amplifier is not allowed during acceptance test.

8.1 *Conditions for Acceptance for Phase 2*

8.1.1 *Factory Acceptance Tests (FAT) for components of RF chains*

Factory acceptance test will be carried out in presence of ITER-India's/IO's representative (s). Bidder shall use their test bed, to check the performance of individual tubes as per standard factory test procedure and HPA2 & HPA3 at **full power (1.6 MW) only on matched load conditions** before shipment to ITER India.

8.1.1.1 **Functional and interface tests**

The following parameters will be physically checked as defined in interface sheets of the respective interfaces

Geometry:

- Overall dimensional Check of the components supplied by Bidder.
- Overall weight of components supplied by Bidder (estimation by summing the different component's weight).


Measurement of envelope dimensions & weight of HPA2 and HPA3 will be done during manufacturing of first RF chain components. Other critical dimensions will be systematically measured during manufacturing process and recorded according to the MIP. For next RF chains Bidder shall give certificate of conformance with respect to first RF chain.

Interface check:

- Various power supplies and their electrical connections.
- Grounding connections.
- Key safety system and protection circuits.
- Water connections.
- Air flow connections.
- Transmission line connections.

Electrical:

- Wire burn test on HVPS as given in tube data sheet.
- Fuse tests on Aux. PS as given in tube data sheet.

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Control and instrumentation:

- Protection and controls of existing test facility for HPA2 & HPA3 will be checked.
- Calibration for directional couplers and other measuring instrument will be checked.
- Test set up for RF & electrical measurement will be checked.

Cooling:

- Water cooling distribution will be tested under operational conditions at rated inlet pressure, flow rate, measurement of pressure drop, inlet-outlet temperature etc.
- Air cooling distribution will be checked under operational conditions at rated inlet flow rate.

8.1.1.2 Performance test

Performances will be checked on Matched load at factory site for 1.6 MW RF power.

Tests to be done on HPA2 at Factory:

Tube: according to regular FAT procedure.

Low power test of HPA2 Amplifier:

Static tests:


- Frequency: to be swept at specified range [35 MHz to 65 MHz] within 180/360 s from lower to higher frequency or vice versa.
- Tuning configuration and bandwidth measurement using Network Analyzer for: 35, 36, 40, 42, 45, 50, 53, 55, 60 & 65 MHz.
- Suppression of Higher Order Mode & Parasitic Oscillation test: To ensure stable operation by standard factory test method for 35, 36, 40, 42, 45, 50, 53, 55, 60 & 65 MHz.

High Power tests of HPA2 on matched load:

- VF, IF, VG1, IG1, VG2, IG2, VA, IA will be measured during FAT.
- Tests will be performed on 6 frequencies: 36, 40, 42, 53, 55, 60 MHz.
- 120 kW, 3600 s duration at each frequency.
- 1dB BW will be checked at 120kW output power during each frequency, keeping all other parameters constant.
- Harmonic/spurious signal will be checked.
- X-ray & RF Exposure will be checked as defined in section 6.6.2.
- Electrical Efficiency & gain will be checked.

HPA2 test report shall include:

- Static curves (S11 & S21).
- Tube factory acceptance test report.

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- Measured parameters during operation with test setup diagram.
- Tuning positions in mm, for respective frequencies.
- Water- & air-cooling parameters.

Tests to be done on HPA3 in Factory:

Tube: according to regular FAT procedure.

Low power test of HPA3 Amplifier:

Static tests:

- Frequency: to be swept at specified range [35 MHz to 65 MHz] within 180/360 s from lower to higher frequency or vice versa.
- Tuning configuration and bandwidth measurement using Network Analyzer for: 35, 36, 40, 42, 45, 50, 53, 55, 60 & 65 MHz.
- Suppression of Higher Order Mode & Parasitic Oscillation test: To ensure stable operation by standard factory test method for 35, 36, 40, 42, 45, 50, 53, 55, 60 & 65 MHz.

High Power tests on matched load for global amplifier chain:


- VF, IF, VG1, IG1, VG2, IG2, VA, IA will be measured during FAT for HPA2 & HPA3.
- Tests will be performed on 6 frequencies: 36, 40, 42, 53, 55, 60 MHz.
- Output RF power: 1.6 MW, 3600 s duration at each frequency.
- 1dB bandwidth at ± 1 MHz shall be checked in 0.25 MHz steps at four central frequencies i.e. 36 MHz, 40MHz, 42MHz, 53 MHz 55 MHz & 60 MHz, with 1.6MW output power, keeping all other parameters constant.
- Harmonic/spurious signal will be checked.
- Burn in test at 60 MHz, 1.6 MW, 3600 s, 5 successive pulses with 25% duty cycle.
- X-ray & RF Exposure will be checked as defined in section 6.6.2.
- Electrical Efficiency & gain will be checked.

HPA3 test report shall include:

- Static curves (S11 & S21).
- Tube factory acceptance test report.
- Measured parameters during operation with test setup diagram.
- Tuning positions in mm, for respective frequencies.
- Water- & air-cooling parameters.

Note: No tests on mismatched load are envisaged in the scope of FAT.

8.1.2 Site Acceptance Tests (SAT) of RF chains at ITER-India, IPR

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At ITER-India site, Bidder will be responsible for unpackaging, reassembly and the connection of Bidder's delivery to the RF chain system (mechanical, water, LCU and power), with the support of ITER-India.

The commissioning and the performance of the components other than the HP components in the assembled RF chain is under the responsibility of ITER-India at ITER-India site.

Bidder will be responsible for the installation & commissioning and for the SAT performance of the components delivered by bidder for the RF chain at ITER-India site.

SAT activities will be carried out by the Bidder along with ITER-India as per the responsibility sharing for Phase 2 described in **Annexure-L: Responsibility sharing matrix during SAT.**

All the subsystems/systems/facilities provided by ITER-India will be ready and site readiness review will be conducted remotely by the Bidder, one month before the initiation of SAT.

8.1.2.1 Functional and interfaces tests

Geometry:

- Overall dimensional check of components supplied by Bidder.
- Overall weight check of components supplied by Bidder (estimation by summing the different component's weight)

Measurement of envelope dimensions of HPA2 and HPA3 will be done during manufacturing of first RF chain components at factory. Other critical dimensions will be systematically measured during manufacturing process and recorded according to the MIP.

Interface (provided by ITER-India) check:


- Various power supplies and their electrical connections;
- Grounding connections;
- Key safety system and protection circuits; Bidder need to check the design of the key management system.
- Water connections;
- Air flow connections;
- Transmission line connections;
- Enclosure, service platform etc.

Electrical:

- Wire burn test on HVPS as given in tube data sheet;
- Fuse tests on Aux. PS as given in tube data sheet.

Control and instrumentation:

- Protection and controls of HPA2 & HPA3 will be checked;
- Calibration of directional couplers (Coupling, directivity etc.) and other measuring instrument will be checked; Calibration of directional couplers is under ITER-India

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responsibility. Before SAT, Bidder will check the performance of various components of ITER-India design by sampling, based on the measurements performed by ITER-India. The validation remains under the designer's responsibility.

Note: In order to ensure 5% of accuracy on RF power measurement, accuracy of less than 3% shall be ensured for the couplers.

- Test set up for RF & electrical measurement will be checked;
- Local operation of the source via its controller (LCU) will be checked. The validation of the LCU design includes not only the validation of monitoring, controls, interlocks and data acquisition but also the validation of the performance of the control loops.

Cooling:

- Water cooling distribution will be tested under operational conditions at rated inlet pressure, flow rate, measurement of pressure drop, inlet-outlet temperature etc.
- Air cooling distribution will be checked under operational conditions at rated inlet flow rate.

8.1.2.2 Validation reports generation

The template for the validation report generation is given in **Annexure-G: Validation report formats for interfaces at ITER-India/IO under section 16.21.**

The following validation report are required:


- LP section and SSPA;
- Directional couplers and transmission line components;
- 3dB Hybrid combiner with dummy load at isolation port;
- Test bed for HPA2 and HPA3;
- LCU;
- HVPS;
- Auxiliary power supplies;
- Grounding;
- Water and air cooling;
- RF power measurement test set up;
- Key management system;
- RF enclosure integrity check;
- HPA2 (If Indian made HPA2 will be used during Phase 3).

8.1.2.3 Performance test

Performance test will be checked on Matched as well on Mis-matched load at ITER-India site.

8.1.2.3.1 Tests on components supplied by Bidder for all RF chains

Site acceptance tests shall be performed on newly fabricated 1.5 MW Single RF Chain, to validate the specifications given in **Table 5.**

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On Matched load

Tests to be done on HPA2:

(a) Low power test (Static tests):

- Hi-Pot test of tube, capacitors etc. will be conducted;
- Frequency: to be swept at specified range [35 MHz 65 MHz] within 180/360 s from lower to higher frequency or vice versa;
- Tuning configuration are tested at 35, 36, 40, 42, 45, 50, 53, 55, 60 & 65 MHz;
- Suppression of Higher Order Mode & Parasitic Oscillation test: to ensure stable operation by standard factory test method for 35, 36, 40, 42, 45, 50, 53, 55, 60 & 65 MHz.

(b) High Power tests:

- VF, IF, VG1, IG1, VG2, IG2, VA, IA will be measured;
- Frequencies: 36, 40, 42, 53, 55, 60 MHz;
- 120 kW, 2000 s duration at each frequency;
- 1dB BW will be checked at 120kW output power, keeping all other parameters constant;
- Harmonic/spurious signal will be checked;
- X-ray and RF Exposure will be checked as defined in section 6.6.2.
- Electrical Efficiency & gain will be checked.

HPA2 test report shall include:

- Static curves (S11 & S21);
- Hi-Pot test results;
- Measured parameters during operation with test setup diagram;
- Tuning positions for respective frequencies;
- Water- & air-cooling parameters.


Tests to be done on HPA3:

(a) Low power test (Static tests):

- Hi-Pot test of tube, capacitors etc. will be conducted;
- Frequency: to be swept at specified range [35 MHz 65 MHz] within 180/360 s from lower to higher frequency or vice versa;
- Tuning configuration: for 35, 36, 40, 42, 45, 50, 53, 55, 60 & 65 MHz;
- Suppression of Higher Order Mode & Parasitic Oscillation test: To ensure stable operation by standard factory test method for 35, 36, 40, 42, 45, 50, 53, 55, 60 & 65 MHz.

(b) High Power tests for HPA3:

- VF, IF, VG1, IG1, VG2, IG2, VA, IA will be measured during SAT for HPA2 & HPA3;
- Tests will be performed on 6 frequencies: 36, 40, 42, 53, 55, 60 MHz;

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- Output RF power: 1.6 MW, 3600 s duration at each frequency;
- 1dB bandwidth at ± 1 MHz shall be checked in 0.25 MHz steps at four central frequencies i.e. 36 MHz, 40 MHz, 42MHz, 53 MHz, 55MHz & 60 MHz, with 1.5 MW output power, keeping all other parameters constant;
- Harmonic/spurious signal will be checked;
- Burn in test at 60 MHz, 1.6 MW, 3600 s, 5 successive pulses with 25% duty cycle;
- X-ray and RF Exposure will be checked as defined in section 6.6.2
- Electrical Efficiency & gain will be checked.

(c) Checking of response time:

The test procedure for checking LCU response time will be developed mutually between Bidder, IO and ITER-India. It is the responsibility of ITER-India to comply response time of LCU for following RF parameters as defined in **Table 5**.

- Open loop response time of changing amplitude
- Response time of changing frequency within BW
- Close loop response time of phase change
- Close loop response time of amplitude change

HPA3 test report shall include:


- Static curves (S11 & S21);
- Hi-Pot test results;
- Measured parameters during operation with test setup diagram;
- Tuning positions for respective frequencies
- Water & air cooling parameters.
- Response time of LCU for RF parameters

On mis-matched load

High power tests to be done on HPA3:

Cavity tuning shall be kept at the same position as set during matched load test.

- VF, IF, VG1, IG1, VG2, IG2, VA, IA will be measured for HPA2 & HPA3;
- Tests will be performed on 6 frequencies: 36, 40, 42, 53, 55, 60 MHz with VSWR 2:1, at output power 1.5MW/2000s, at phase angles 0°, 45°, 90°, 135°, 180°, for each frequency;
- Tests will also be performed on 6 frequencies: 36, 40, 42, 53, 55, 60 MHz with VSWR 1.75:1, at output power 1.6MW/3600s, at phase angles 0°, 45°, 90°, 135°, 180°, for each frequency;
- Burn-in test with mismatch load of 1.6MW/3600s/VSWR 1.75 for five serial pulses with 25% duty cycle (without any break) shall be demonstrated at specified constant output power, for 42MHz & 53 MHz with 5 different phase angles between 0 to 180 degree.
- Harmonic/spurious signal will be checked;

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- X-ray and RF Exposure will be checked as defined in section 6.6.2
- Electrical Efficiency & gain will be checked.

Checking of response time:

The test procedure for checking LCU response time will be developed mutually between Bidder, IO and ITER-India before FDR. It is the responsibility of ITER-India to comply response time of LCU for following RF parameters as defined in **Table 5**.

- Changing amplitude,
- Changing frequency
- Changing phase
- Amplitude control loop
- Phase control loop

HPA3 test report shall include:

- Measured parameters during operation with test setup diagram.
- Tuning positions for respective frequencies.
- Water- & air-cooling parameters.
- Response time of LCU for RF parameters

8.1.2.3.2 Tests on modified HPA2, Trombone & HPA3 supplied during phase 1


Bidder will submit evolved/optimized drawings as done in RF chains of prototype Unit. Supply the components for necessary modifications. ITER-India will carry out necessary modification in the supervision of Bidder during SAT of Unit 1. This component set will be used as a part of another RF chain of Unit 1 RF source

Check the healthiness/performance of HPA2, Trombone & HPA3 which were used during Phase 1, at ITER-India lab at 36 MHz, 40MHz, 42 MHz, 53MHz, 55 MHz & 60 MHz on matched load up to 1.6MW/3600s.

All other systems/sub-systems/components will be provided by ITER-India to conduct healthiness check of HPA2, Trombone & HPA3 supplied during Phase 1.

8.1.2.4 High power test of prototype RF source and Unit 1 RF source by ITER-India without Bidder's participation

Test shall be performed by ITER-India by combining two RF chains along with 3dB Hybrid combiner, as per **Table 9**. ITER-India will operate the system as per the agreed parameters range/boundary and interlock functions set during the FAT and SAT of the individual chains. In this test Bidder's participation is not mandatory. The components supplied by the bidder will be under warranty and bidder will be fully responsible to repair/replace the components if damaged during the test.

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8.1.3 *Witness the performance of Indian-made HPA2*

- Bidder shall witness the RF performance of HPA2 fabricated by ITER-India through Indian industries as per reference conditions for acceptance already established during phase 1 (See **Annexure-G**: Validation report formats for interfaces at ITER-India/IO: **Section 16.21**) for HPA2, which can be reviewed by the bidder.
- Bidder need to review the outcome of suggested additional qualification tests for validation purpose to use for future ITER deliverables (Unit-2 RF source onwards).
- Bidder will witness the tests, provide comments on the test reports but formal acceptance remains under the designer's responsibility or end user's responsibility.


8.1.4 *Site acceptance tests (SAT) for RF chains of prototype RF source and Unit 1 at IO site*

All the subsystems/systems/facilities provided by ITER-India/IO will be ready and site readiness review will be conducted remotely by the Bidder, one month before the initiation of SAT.

- At ITER site, Bidder will be responsible for unpackaging, reassembly and the connection of Bidder's delivery to the RF chain system (mechanical, water, LCU and power), with the support of ITER-India.
- The commissioning and the performance of the components other than the HP components in the assembled RF chain is under the responsibility of ITER-India at ITER site.
- Bidder will be responsible for the installation & commissioning and for the SAT performance of the components delivered by bidder for the RF chain at ITER site.
- Two individual RF chains for the prototype RF source will be tested as per Section 8.1.2 on matched load, Bidder will be responsible for the SAT performance of the components supplied by the Bidder.
- Two individual RF chains for the Unit 1 RF source will be tested as per Section 8.1.2 on matched & mismatch loads, Bidder will be responsible for the SAT performance of the components supplied by the Bidder.
- The responsibility sharing for Phase 2 will be applicable as per **Annexure-L**: Responsibility sharing matrix during SAT

8.1.5 *Site acceptance tests (SAT) for RF Sources at IO site by ITER-India without Bidder's participation*

- ITER-India will be fully responsible to test full RF source (2.5MW/3MW) by combining two RF chains.

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- Prototype RF source (Phase-2) will be tested on matched load only as given in **section 8.1.2**
- Unit 1 RF source (Phase-2) will be tested on matched & mismatch loads as given in **section 8.1.2**


9 Reference Documents

Version of these documents are referenced in the tender document as per their applicability context as on date of tender publication, however, during execution of the contract the latest version of documents at the time of contract signature shall be applicable. Future application of these referenced documents will be addressed case by case mutually. For a better understanding, they are grouped below with some explanation. Further details could be exchanged during the pre-bid meeting.


These reference documents shall be implemented for the components supplied by Bidder, wherever applicable.

Table 10: List of reference documents for this tender

Ref.	Title	No.	Version
These documents describe the quality management in ITER Organization. They are helpful to understand the general context of ITER organization but as well the detailed requirements linked to the quality classification of the IC RF sources. Specific documents on the delivery processes or the ITER numbering system are provided.			
[1]	Order dated 7 February 2012 relating to the general technical regulations applicable to BNI - FR (7GJHSE) translated for guidance in:	ITER_D_7GJHSE	1.3
	Order dated 7 February 2012 relating to the general technical regulations applicable to BNI - EN (7M2YKF) and the subsequent ASN decisions linked to this Order	& ITER_D_7M2YKF	1.7
[2]	ITER Procurement Quality Requirements & ITER Quality Assurance Program (QAP)	ITER_D_22MFG4 & ITER_D_22K4QX	5.1 & 8.5
[3]	Quality Classification Determination	ITER_D_24VQES	5.2
[4]	Requirements for Producing a Quality Plan	ITER_D_22MFMW	4.0
[5]	Procedure for Management of Deviations & Nonconformities	ITER_D_2LZJHB	8.1
		ITER_D_22F53X	9.1
[6]	Manufacturing Inspection Plan (MIP) Template	ITER_D_QV7GQF	1.3
[7]	Requirements for Producing a Contractors Release Note	ITER_D_22F52F	5.0
[8]	ITER function category and type for ITER numbering system	ITER_D_2FJMPY	1.7

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Ref.	Title	No.	Version
[9]	ITER numbering system (for parts/components)	ITER_D_28QDBS	5.0
[10]	Specification for Labelling of Equipment on ITER Project	ITER_D_VYJ7U2	1.4
[11]	Order dated 29 September 2017 approving Nuclear Safety Authority Decision 2017-DC-0591 of 13 June 2017 on the minimum technical design requirements to be met by workplaces in which electrical equipment that emit X-rays is used.	ITER_D_VH8MYG	1.0
[12]	Assessment of French Order of 29 September 2017 on technical requirements to be met by workplaces in which electrical equipment emit X-rays.	ITER_D_WDYTR6	1.1
The following documents provide technical information. Some of them are quite general as the ITER Plant Control Design Handbook and only part of it will be applicable within the Bidder’s scope: for instance, the cable catalogue is mandatory to be used by the Bidder while choosing their components. The list of applicable standards shall be adapted as per the Bidder component characteristics. Some other documents specify the interface requirements.			
[13]	Plant Control Design Handbook	ITER_D_27LH2V	7.0
[14]	Electrical Design Handbook Part 3: Codes and standards	ITER_D_2E8DLM	1.3
[15]	Electrical Design Handbook Guide A: Electrical Installations for SSEN Client Systems	ITER_D_2EB9VT	2.7
[16]	IO cabling rules	ITER_D_335VF9	3.3
[17]	Earthing/grounding at ITER-India lab & IO lab	ITER_D_3V2CUG	1.1
[18]	IO Cable catalogue	ITER_D_355QX2	6.11
[19]	3 1/8 inch EIA Transmission line flange	ITER_D_4FHCF3	1.3
[20]	6 1/8 inch EIA Transmission line flange	ITER_D_4FHGF2	1.3
[21]	12 inch Transmission line flange: fix and swivel	ITER_D_4FJGBX ITER_D_3QT2B6	1.3 1.1
The floor response spectrum needed to carry out the seismic simulation will be provided by ITER India. The following documents provide guidelines for seismic analysis.			
[22]	Instructions for Seismic Analyses	ITER_D_VT29D6	2.0
[23]	EU-DA Report – PA 6.2.P2.EU.02 - Methodology to be Used to Generate the Seismic Floor Response Spectra for Ancillary Buildings at ITER	ITER_D_PN36V6	3.1
[24]	IO Building 15 FRS Data	ITER_D_QPBST4	1.2
[25]	Procedure for the CAD management plan Procedure for the Usage of the ITER CAD Manual	ITER_D_2DWU2M ITER_D_2F6FTX	2.2 1.1
[26]	ITER Document Breakdown Structure Overview	ITER_D_43327Q	1.1
[27]	Risk and Opportunity Management Procedure	ITER_D_22F4LE	6.4
[28]	Health Protection and Safety General Coordination Plan ITER Construction Site - Volume 0 - General Safety Rules	ITER_D_2NUEYG	5.7

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Ref.	Title	No.	Version
	Internal Regulations	ITER_D_27WDZW	3.1
	Environmental requirements	ITER_D_97WRFP	2.2
	Contractor Safety Management Procedure	ITER_D_Q2GBJF	1.4
	Procedure for Occupational Health and Safety Hazard Identification and Assessment	ITER_D_AJLQRF	6.0
	Vehicle Access and Traffic Circulation and Parking on the ITER Site	ITER_D_N3MG3V	1.2
	ITER Site access Procedure	ITER_D_S3893D	3.1
	General Management Specification for Executing Entities at the ITER Site	ITER_D_YX55YY	2.3
[29]	Working Instruction for the Delivery Readiness Review (DRR)	ITER_D_X3NEGB	2.0
[30]	Procedure for Transportation of Components to ITER Site	ITER_D_RY5C6Q	3.1
[31]	Design Review Procedure	ITER_D_2832CF	6.4
[32]	Working Instruction for Manufacturing Readiness Review	ITER_D_44SZYP	5.0
[33]	Codes and Standards for ITER Mechanical Components	ITER_D_25EW4K	4.0

Note: Reference documents may be downloaded and refer from the following link:

<https://owncloud.iter.org/index.php/s/48M2p60eRcOzBMr>

Password: II123


10 Annexure-A: Management Specifications

10.1 *Quality requirements*

Quality Requirements shall be in accordance with the “ITER Procurement Quality Requirements” [2]. The ITER Quality Assurance Program shall be applied to all the work under this Tender. The ITER QA Program is based on IAEA Safety Standard GS-R-3 and on conventional QA principles and integrates the requirements of the INB Order dated 7 February 2012 [1] on the quality of design, construction and operation in Basic Nuclear Installation. For this purpose, the Bidder and Subcontractors carrying out contracts placed under this Tender shall be in compliance with the QA requirements under the relevant ITER QA classifications, the requirements of the INB Order and shall have an IO approved QA Program or an ISO 9001 accredited quality system, complemented with the above-mentioned requirements.

Prior to commencement of any work under this Tender, a “Quality Plan” (QP) [4] shall be produced by the Bidder and Subcontractors and submitted to the ITER-INDIA/IO for approval, describing how they will implement the ITER Procurement Quality Requirements.

The tender document is to provide technical content and scope related to ITER deliverables and shall not be disclosed or used for any other purpose without written permission from ITER-India.

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Prior to the commencement of any manufacturing, a “Manufacturing and Inspection Plan” (MIP) [6] shall be produced by the Bidder and Subcontractors and approved by the ITER-INDIA/IO, who will mark up any intended intervention point. MIPs are used to monitor Quality Control and acceptance tests during the execution of the Contract. It should be noted that interventions additional to those required in this Technical Specification may be included on the MIP by the ITER-INDIA/IO. The right of the ITER-INDIA/IO listed above shall apply in relation to any Subcontractor and in this case the ITER-INDIA/IO will operate through the Bidder. The overseeing of the quality control operation by the ITER-INDIA/IO shall not release the Bidder from his responsibility in meeting any aspect of this Technical Specification.

Documentation developed as the result of this Contract shall be retained by the Bidder for a minimum of 5 years after date of closure of the contract in digital form and then may be discarded at the direction of the ITER-INDIA/IO. The use of computer software to perform a safety basis task activity such as analysis and/or modelling, etc. shall be reviewed and approved by the ITER-INDIA/IO prior to its use. Bidder and Subcontractors carrying out contracts placed under the Tender shall be in compliance with the QA requirements under the relevant QA classifications as defined in “Quality Classification Determination” [3].


The equipment included in the scope of supply shall follow the quality standards corresponding to a quality class 2.

10.2 *Monitoring, evaluation & verification*

ITER-India shall have a close monitoring of the production scheme with Bidder. This monitoring shall include Notification Points, Authorization-To-Proceed Points and Hold Points at critical steps in the Bidder’s Manufacturing and Inspection Plans. The control points shall be integrated into the agreed schedule which will be finalized during kick of meeting.

A Notification Point (NP) is a milestone where the Bidder is required to notify the ITER-India, who informs the IO, that it has completed a specific task or a specific deliverable and is proceeding to the next task or to the next action on the specific deliverable. A NP is meant to enable ITER-India and IO personal to follow the progress of the contract and possibly to witness a critical manufacturing step at the Bidder’s premises. The Notification shall be sent by the Bidder to the ITER-India at least 10 working days prior to the scheduled manufacturing step. ITER-India (and IO) shall decide whether or not they want to attend. A NP shall not affect the production flow of the Bidder that shall continue the work even without a reply from ITER-India (and/or IO).

An Authorization-To-Proceed Point (ATPP) is a milestone where the Bidder is required to notify ITER-India, who informs the IO, that it has completed a specific task or a specific deliverable. The Bidder must wait for an authorization from ITER-India before proceeding to the next task or to the next action on the specific deliverable. ITER-India shall grant the Authorization to Proceed on the basis of clearly identified Quality Control data and of Acceptance test results to be provided by the Bidder. The ITER-India (and IO jointly) shall have 8 working days to review the Bidder’s data and to notify the Bidder of its decision. In case

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of authorization, the Bidder shall proceed to the next task or to the next action on the specific deliverable. In case of rejection, the Bidder shall develop a recovery plan that shall be submitted and reviewed by the ITER-India and IO within 5 working days of submission. An ATPP shall only affect the specific task or the specific deliverable it is associated with and shall not interfere with the execution of other tasks of the production or other deliverables of the same kind.

A Hold Point (HP) is a milestone where the Bidder is required to notify ITER-India, who informs the IO, that it has completed a specific task or a specific deliverable and must stop the associated processes until a HP Clearance is issued. The HP Clearance shall be issued on the basis of clearly identified Quality Control and data and acceptance test results to be provided to ITER-India and the IO at the time of the request. ITER-India (along with IO) shall have a maximum of 11 working days to review the Bidder's data and to notify the Bidder on the assessment and to confirm or reject it. In case of clearance, the Bidder shall resume its activity. In case of rejection, the Bidder shall develop a recovery plan that shall be submitted to ITER-India and reviewed by the ITER-India (IO, through ITER-India) within 10 working days of submission. In case of ITER-India/IO objection, the ITER-India (& IO, through ITER-India) shall detail its reasons in writing and the Bidder shall have 10 working days to answer the ITER-India's objection and, whenever suitable, develop a recovery plan.

NPs, ATPPs and HPs to be implemented during the various phases of execution of this project and will be finalized mutually between Bidder and ITER-India/IO in the updated manufacturing and inspection plan (MIP) during the kick-off meeting; however, part of these hold points are already defined in the Table A1 for implementation.

Table A1: Preliminary hold points (HP)

Description	Deliverable requirements
QA document for components supplied by Bidder to be supplied by vendor approved by ITER-India & IO	QA Documents
FDR, safety & QA documents of components supplied by Bidder for RF Source AND Approval of Production for components of prototype RF source & Unit-1 to be supplied by Bidder.	Final Design Report
Submittal of Material Procurement Document for components of prototype RF source & Unit-1 to be supplied by Bidder.	Material test certificate
FAT for 1 st RF chain to get shipment clearance for components supplied by Bidder for Prototype	FAT report
FRR, updated safety & QA documents (if any) of components supplied by Bidder for RF Source AND Approval of Production for components for the 2 nd chain onward to be supplied by Bidder for Prototype and Unit-1	Fabrication Readiness Review report
FAT for remaining chains to get shipment clearance for components supplied by Bidder for Prototype	FAT report
Acceptance of components supplied by Bidder for both chains of Prototype RF Source in ITER-India Test Facility	SAT report

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Description	Deliverable requirements
MRR, updated safety & QA documents (if any) of components supplied by Bidder for RF Source AND Approval of Bulk Production for components supplied by Bidder for Unit-1	Manufacturing Readiness Review report
Final acceptance of components supplied by Bidder for Prototype and Unit 1 RF Source at ITER site	Test report

Note: Template for FDR, MRR etc. will be provided during kick off meeting.

10.3 Periodic reports & Meetings

Reporting

The Bidder shall submit periodic reports to ITER-India and agree on periodic review meetings with ITER-India in order to monitor contract execution. The Bidder maintains data and documents and makes them available upon ITER-India's request to verify that the Project requirements are satisfied.

Progress meeting

Progress meetings shall be conducted as required by ITER-India upon mutual agreement. The frequency of such meetings shall vary throughout the progress of the project, typically from once per month during the initial phases to once per 3 (three) months at the end, assuming no qualification or production problems arise. The meetings shall be held by video conference, teleconference or physically on the ITER-India premises or on the Bidder's premises.

Meeting minutes shall be prepared by the Bidder and submitted to ITER-India not later than 5 (five) calendar days after the meeting.

The ITER-India shall forward to the Bidder any comments within 7 (seven) calendar days of the receipt of the minutes. If no comments are made within this time frame, the minutes are deemed to be accepted.


IO will be involved in progress meetings and review process of minutes of meetings.

Reviews & Inspection

ITER-India and Bidder will organize Updated Design Reviews and Status / Quality Control Reviews by mutual agreement. They may be focused on the different updated design stages and particular areas of production.

Bidder shall designate a Programme Manager who will:

- Lead the Programme efficiently,
- Have cognisance and full responsibility for overall performance of the Contract,
- Act as primary point of contact with the Purchaser.

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A Programme Team, under the responsibility of the Programme Manager, will be created to provide effective management and control of all aspects of the Programme.

Bidder will maintain a Work Breakdown Structure (WBS) that fully captures and defines the scope of the responsibilities as defined in **section 7**. The process of generating the WBS shall be in accordance with established internal procedures and processes as identified within Bidder's plans. The development of the WBS shall comply with ITER-India WBS and shall be finalized mutually within 1 month after placing of the contract. The major elements of WBS shall have:

- Including system Engineering
- Manufacturing, factory testing and shipment of components supplied by Bidder,
- Assembly, integration and Site Acceptance,
- Programme management and Quality assurance,

The following formal meetings shall be organized between Bidder and the ITER-India throughout the contract period:

- Kick-off meeting,
- Finalisation of overall Layout of RF source and controls through LCU
- Discussion on outcome of Factory Acceptance Tests for of Phase 2
- Discussion on outcome of Site Acceptance Tests at ITER-India, IPR for Phase 2 (prototype and Unit-1)
- Final Design/Manufacturing readiness Review meeting with IO
- Discussion on outcome of Site Acceptance Tests at IO site for Phase-2

Meetings will normally be held at Bidder's premises/remotely (except SAT) and minutes will be written by the Bidder. Actions including responsible person and date for resolution will be agreed during the meeting. The minutes, including the agreed action list, will be distributed for comment no later than 2 working days after the meeting. Representatives of both parties will subsequently sign the formal minutes to validate the decisions and actions agreed during the meeting.


The topics to be covered for each formal meeting, assessment and closure criteria for the action/issues shall be mutually agreed during kick-off meeting.

The main Reviews and Inspections are listed in the following table:

Table A2: Reviews and Inspections lists

Reviews & Inspection	Objectives
Review of Technical report accompanied with Bill of Material and layout of components supplied by Bidder, prior to fabrication of Prototype/Bulk production.	Approval of the report by ITER-India/IO
Material test certificate for the components/systems.	Approval by ITER-India/IO
Factory Acceptance Test of components supplied by Bidder for Prototype/Bulk production.	Technical approval of product by ITER-India/IO

The tender document is to provide technical content and scope related to ITER deliverables and shall not be disclosed or used for any other purpose without written permission from ITER-India.

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Reviews & Inspection	Objectives
Inspection of integrated assembly of components supplied by Bidder at ITER-India site.	Approval of assembled components supplied by Bidder by ITER-India/IO
Inspection of integrated assembly of component/system other than components supplied by Bidder at ITER-India site.	Validation of assembled component/system by Bidder
Site Acceptance Test of components supplied by Bidder at ITER-India site.	Verification of Commissioning by ITER-India/IO
Final Design/Fabrication Readiness Review/ Manufacturing Readiness Review of components supplied by Bidder.	Approval of final design of components supplied by Bidder, including layout by ITER-India/IO
Inspection of inward goods (components supplied by Bidder) at ITER site.	Visual inspection of system/component by ITER-India/IO, to identify any damage occurs during transit
Inspection of integrated assembly of components supplied by Bidder at ITER site.	Approval of assembled components supplied by Bidder by ITER-India/IO
Inspection of integrated assembly of component/system other than components supplied by Bidder at ITER site.	Validation of assembled component/system by Bidder
Site Acceptance Test of components supplied by Bidder at ITER site.	Verification of Commissioning and technical approval of product by ITER-India/IO


In case of concerns regarding the quality of production, it may be required to carry out on-the-spot checks (with prior request by ITER-India), in addition to the checks foreseen in the technical specifications by ITER-India (/IO). In such a case, ITER-India will provide a description of its concerns and the rationale behind such request. The actual date(s) of the on-the-spot checks shall be determined by agreement between the Parties.

10.4 *Right of access*

The Bidder shall inform ITER-India of all locations where sub-contracts are implemented. It shall further ensure that sub-contracts include the rights of on-the-spot access subject to the requirement, as stated above (in **Review & Inspection section**). The material which is already procured by Bidder will be inspected at Bidder's site. The new procurement contracts will be monitored by II/IO under such access.

ITER-India's representative shall have access to the premises of the Bidder (and sub-Bidders of Bidder) in order to witness on-site tests and critical fabrication operations, carry out on-the-spot checks in addition to the tests foreseen in the technical specifications and to participate in periodic review meetings. The COTS items which are procured by Bidder will be witnessed at Bidder's site. The new procumbent contracts will be monitored by II/IO under such activities.

In case of marked up interventions in the Manufacturing and Inspection Plan, IO representative will visit the manufacturing site. The appointed IO representatives will always be accompanied

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by ITER-India’s representatives on their visits to the Bidder’s premises (or sub-Bidders’ premises). The IO representatives shall be bound by appropriate confidentiality obligations to be agreed in advance.


10.5 *Quality assurance*

- i. The Bidder shall ensure the quality of all materials, components and services to meet all the requirements of this tender.
- ii. Should any question whatsoever arise with respect to the requirements defined in this tender, the Bidder shall ask ITER-India for clarification prior to proceeding with the work.
- iii. The Bidder Quality Assurance (hereinafter referred to as “QA”) Programme subject to approval by ITER-India shall be applied to all the work under the tender. Under QA program Bidder shall declare the items under old & new contracts and prepare & shall follow the QA plan accordingly.
- iv. A list of the general documentation associated with ITER-India’s Quality Requirements is given in table below:

Table A3: ITER-India’s Quality Requirements

ITER-India’s Quality Requirements
Prior to contract implementation:
<ul style="list-style-type: none"> Obtain ITER-India acceptance of a dedicated “Quality Plan”.
Prior to start of manufacturing:
<ul style="list-style-type: none"> Obtain ITER-India acceptance and mark up of a “Manufacturing and Inspection Plan (MIP)”.
During manufacture:
<ul style="list-style-type: none"> Notify ITER-India representatives of any Inspection Points as marked up on the “MIP”. Complete the relevant entries in the “MIP” as work progresses.
During contract implementation:
<ul style="list-style-type: none"> Issue “Deviation Request” and “Non-Conformance Reports” as necessary.
Prior to delivery:
<ul style="list-style-type: none"> Complete the “Bidder Release Note”. <p>Delivery readiness review documents:</p> <ul style="list-style-type: none"> Contractor release note (CRN) Delivery report Packaging list Equipment storage & preservation requirement

- v. Quality Plans are produced by the Bidder and its Bidder(s) to describe how they will implement the ITER-India’s Quality Requirements. The Bidder’s and its Bidder Quality Plans will be approved by ITER-India. This will be submitted to IO for acceptance, if required.
- vi. MIP is used to monitor Quality Control and acceptance tests and must be produced by the Bidder and its Bidders and sent to ITER-India for approval and mark-up of interventions. This will be submitted to IO for acceptance, if required.

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- vii. The Bidder shall ensure that its Bidder(s) shall only start implementing any contract with a Quality Plan in place that has been approved by ITER-India. This will be submitted to IO for acceptance, if required.
- viii. ITER-India shall designate appropriate inspector/s to perform inspections of the Bidder and its Bidder(s) to verify compliance with quality related activities. These inspections will be performed in accordance with the MIPs and Quality Plan. The inspector/s may be ITER-India personnel or specialized inspectors contracted for that purpose.

10.6 *Change of Management*

- i. All requirements of this tender and subsequent changes and deviations proposed by either ITER-India or the Bidder during the course of execution of the contract will be controlled with ITER-India's Configuration Change Management System.
- ii. Proposed changes and deviations will be jointly assessed by the ITER-India, IO and the Bidder.
- iii. Proposed changes and deviations will be implemented by the Bidder after getting approval by ITER-India and IO through Deviation Request process described in "Contractors Deviations and Non-conformities Procedure"[5].

10.7 *Risk Management*

- The Bidder shall, within 60 (sixty) calendar days of the entry into force of the contract, draw up and submit to the ITER-India, for information, a plan [27] for managing risks associated with implementing the contract (hereinafter referred to as the "Risk Plan").
- The Risk Plan shall set out a register of the risks which may impinge on the successful execution of the contract following the applicable ITER-India Risk Management system and, for each identified risk, shall provide:
 - a summary assessment of likelihood of the risk materializing and of the potential consequences for the successful execution of the contract,
 - possible measures for risk reduction or mitigation and conditions for triggering such measures,
 - an attribution of responsibility in the structure of the Bidder for managing the risk,
 - a plan, consistent with the Schedule, and arrangements for regular monitoring and review of the risk.
- The Bidder shall implement possible measures for risk reduction and mitigation following a graded approach and shall provide to the ITER-India progress reports on a quarterly basis in accordance with the standard template to be agreed between ITER-India and Bidder.
- If and when conditions to trigger specific risk reduction and mitigation measures occur, the Bidder shall inform the ITER-India promptly. The Parties shall consult on the appropriate actions to be taken and on their consequences for the execution of this contract.

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10.8 *Quality Records*


Quality Control and Acceptance Test records shall be maintained according to the procedures defined below as Data Management process. Availability to the ITER-India of the required data is a pre-requisite for granting Authorizations to proceed and Hold Point clearances.

10.9 *Data Management Process*

The large amount of data generated during the execution of this contract shall be handled electronically and entered into a Database. The structure of this Database shall be defined by the ITER-India in consultation with the Bidder protecting Intellectual Property Right (as per **Annexure-D: Intellectual Property Rights Provisions**), and the same will be communicated to IO for agreement. The Bidder and ITER-India shall use this Database to store information related to this contract. All data entered in the Database shall be kept strictly confidential by the IO, and, in no circumstances, shall be communicated or made accessible to other Bidders or other ITER Domestic Agencies.

Documents and data delivered by bidder in the frame of the contract will be uploaded on a document platform defined by ITER-India (INDUS or IDM). No documentation database will be implemented by bidder for this contract.

Data flow from the Bidder to ITER-India: relevant data shall be made available to the ITER-India through the Database each time a NP, ATPP and HP is issued or a Deviation Request and Non-Conformity Report is filed by the Bidder.

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11 Annexure-B: Proposed custom-built items

Table B1: Proposed list of custom-built items for HPA2


Sr. No	Drawing No	Title	Quantity of Supply (Nos.)
1	040-62743999	POTTED ANODE DECOUPLING	01
2	040-62743412	G1 DECOUPLING CAPACITOR	01
3	040-62746542	HV FILTER	01
4	040-62743486	G2 DECOUPLING CAPACITOR	01
5	040-62748030	FILAMENT CAPACITOR	01

Table B2: Proposed list of custom-built items for HPA3

Sr. No	Drawing No	Title	Quantity of Supply (Nos.)
1	040-63052095	CAPACITOR EQUIPPED	02
2	040-62405349	DECOUPLING, POTTED LOWER ANODE	01
3	040-62746542	HV FILTER	01
4	040- 62411123	DECOUPLING UPPER ANODE	01
5	040-62408855	INT G1 DECOUPLING	01
6	040-62407037	DECOUPLING, INT LOWER G2	01
7	040-62407041	LOWER EXT DECOUPLING G2	01
8	040-63054619	UPPER ARMATURE G2 (UPPER DECOUPLING G2)	01
9	040-62406464	EXT G1 DECOUPLING	01
10	040-62406441	FILAMENT CAPACITOR	01

Notes:


- (1) The proposed items in Table B1 & Table B2 are not exhaustive: Bidder may add any other item(s) to fulfil the project requirement.
- (2) Custom Built items are not part of the main item and these are to be quoted separately in the price bid. The delivery of the Custom Build Items will be supplied along with the HPA2 / HPA3 Cavities, except when no cavities shall be supplied, when the HPA2 cavity development will be done by ITER-India through Indian industry.

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12 Annexure-C: Generated IP during phase 1

Table C1: Generated IP during phase 1, which will be background for this tender scope

Title of GIP	Driver Stage High Power Amplifier (HPA2) and Final Stage High Power Amplifier (HPA3) for RF Power Sources of ITER-India
Type of GIP (patent, know-how, trade secret, trademark, utility model, database/software)	Know-How (Generated)
Description (including details of the intended purpose, programming language, etc.)	<p>Under the framework of contract (Contract No.: I-I/CON/003/TED/ 2012-13 dated 27/06/2012) signed by ITER-India, IPR:</p> <p>For Driver Stage High Power Amplifier (HPA2), cavities have been specifically designed to meet ITER-India's requirements. A preliminary study has been done and further lot of necessary works have been carried out to optimize and finalize the design of the driver stage cavity to meet ITER-India's requirements. The final design was further validated experimentally by ITER-India. These works for optimization; finalization of the design and its experimental validation are part of the foreground i.e. Generated Intellectual Property of ITER-India.</p> <p>For Final Stage High Power Amplifier (HPA3), a preliminary study of the cavity has been made theoretically by TED internally prior to contract signature. Moreover, using this background during the execution of contract between ITER-India and Contractor, lot of necessary works have been carried out to optimize and finalize the design of the final stage cavity to meet ITER-India's requirements. The final design was further validated experimentally by ITER-India. These works for optimization; finalization of the design and its experimental validation is part of the foreground i.e. Generated Intellectual Property of ITER-India.</p> <p>The detailed list of documents covered in the scope of this GIP are outlined in section 12.1.</p>

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12.1 *List of documents as part of GIP*

1. Internal reports in ITER-India Document Management System (INDUS) with references as follows:

- EDR HPA2-II-W7QJOG5-v1_0
- EDR HPA3-II-2PL4MOK-v1_0
- FAT report-II-N5CGM6R-v1_0
- SAT Report TED-II-CYP15ZN-v1_0


2. Documents generated with respect to optimization, finalization of the design and its experimental validation of the following:

(A) For Driver Stage Amplifier (HPA2):

- Simulations and final design of the RF output circuit
- Simulations and final design of the RF input circuit
- Simulations and final design of the anode decoupling capacitors
- Simulations and final design of the screen grid decoupling capacitors
- Simulations and final design of the control grid decoupling capacitors
- Final manufacturing drawings of all cavity components/sub-assemblies/assemblies based on experimental results
- FAT and SAT reports

(B) For Final Stage Amplifier (HPA3):

- Simulations and final design of the RF output circuit
- Simulations and final design of the RF input circuit
- Final manufacturing drawings of all cavity components/sub-assemblies/assemblies based on experimental results.
- FAT and SAT reports

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13 Annexure-D: Intellectual Property Rights Provisions

1. General terms & definitions:

1.1 As defined in Article 1.2 & 1.3 of Annex on Information and Intellectual Property (IIP Annex) of the Establishment Agreement on the of the ITER International Fusion Energy Organization for the Joint Implementation of the ITER Project (ITER Agreement), the following definition applies to information and intellectual property:

1.1.1 Information:

“Information” shall mean published data, drawings, designs, computations, reports and other documents, documented data or methods of research and development, as well as the description of inventions and discoveries, whether or not protectable, which are not covered by the term Intellectual Property as defined in 1.1.2.

“Information” shall also include confidential information like specifications, 3-D models, samples and prototypes.

1.1.2 Intellectual property (IP):

“Intellectual Property” shall have the meaning defined in Article 2 of the Convention Establishing the World Intellectual Property Organization, done at Stockholm on July 14, 1967. It may include confidential information such as know-how or trade secrets provided that they are unpublished, and in written or otherwise documented form, and

- a) have been held in confidence by their owner,
- b) are not generally known or available to the public from other sources, and/or are not generally available to the public in printed publications and/or other readable documents and any form of electronic records,
- c) have not been made available by their owner to other parties without an obligation concerning confidentiality, and
- d) are not available to the receiving party without an obligation concerning confidentiality.


Nothing under these provisions would override the National Laws related to Information and Intellectual Property.

1.1.3 Background Intellectual property:

“Background Intellectual Property” shall mean Intellectual Property that has been or is acquired, developed or produced, before the entry into force of the Contract, or outside of the scope of this Contract. (Entry into force shall be the date of Letter of Intent (LoI), in case the actual contract is signed after the LoI).

1.1.4 Generated Intellectual Property:

“Generated Intellectual Property” shall mean Intellectual Property that is generated or acquired with full ownership by ITER-India or by the Bidder and its subcontractors, pursuant to and in the course execution of this Contract.

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2. Provisions under background Intellectual Property:

2.1 Declaration of background:

- 2.1.1** The Bidder shall declare all Intellectual Property and Information which is held by the Bidder prior to the signature of the Contract or outside its scope and which is needed for carrying out the Contract – this information & Intellectual Property shall be subsequently be referred to as “the background”. The declaration shall provide detailed information on the origin and ownership of the background as well as any legal restrictions relating to its use of which the Bidder is aware. The declaration of the background forms part of the Contract.
- 2.1.2** The Bidder may identify additional background information after the signature of the contract. However, in such a situation, the Bidder needs to justify why such a background was not invoked originally into the contract. The use of this Background information shall be authorized only after discussion with ITER-India.
- 2.1.3** The Bidder must clearly identify the use background information that belongs to a third party for which the Bidder has a license agreement. Further, he must obtain the rights form third party to allow him to use the background in conformity with 2.1.1 and 2.1.2.
- 2.1.4** The Bidder must clearly identify the Background information that is confidential. ITER-India shall preserve (in a manner agreed mutually with the Bidder) the confidentiality of the same. On transfer of component to IO, the Background confidential information so provided shall be communicated to IO and shall be protected by IO in a manner described in clause 2.2.2.
- 2.1.5** The background information provided by the Bidder shall be owned exclusively by the Bidder.

2.2 Access to Background information:

- 2.2.1** The Bidder who has incorporated Background Intellectual Property, except confidential information such as know-how and trade secrets, into the items supplied to the ITER-India and the background information so provided is required:
- to construct, operate, use or integrate technology for research and development in relation to the IO facilities,
 - to maintain or repair the item provided, or
 - when deemed necessary by ITER-India, in advance of any public procurement, shall grant on an equal and non-discriminatory basis an irrevocable, non-exclusive, royalty free license to use such Background Intellectual Property to ITER-India, other Members (of IO) and to the IO either directly or through ITER-India, with the right of the IO to sub-license and the right of the ITER-India and other Members (of IO) to sub-license to their research institutes and institutes of higher education within their

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respective territory for the strict purposes of publicly sponsored fusion research and development programmes.

2.2.2 The Bidder who has incorporated background confidential information into the items provided to ITER-India and the background confidential information is required:

- to construct, operate, use or integrate technology for research and development in relation to the IO facilities,
- to maintain or repair the item,
- when deemed necessary by ITER-India in advance of any public procurement, or for safety, for quality assurance and quality control reasons as required by regulatory authorities, shall ensure that ITER-India and the IO have an irrevocable, non-exclusive, non-transferable, royalty-free license available to use for their own needs and to the exclusion of rights to disclose, publish or sublicense, such background confidential information including manuals or instructional training materials for the strict purposes of construction, operation, maintenance and repair of the IO facilities.

The confidential information shall be transmitted maintaining the protection for confidentiality in accordance with section 2.1.4. The recipient for such information shall use it only for the provisions identified above. IO guarantees this protection and compensation for damages arising from the misuse of the background confidential information shall be the responsibility of IO.


2.2.3 The Bidder's attention is drawn to Article 4.2.4 and 4.2.5 of the IIP Annex of ITER Agreement, whereby the Bidder shall use its best efforts to either grant licenses to the background incorporated into the goods supplied under the Contract or to supply such goods to IO Members under the conditions established in Article 4.2.4 and 4.2.5 of the IIP Annex of JIA.

2.2.4 The Bidder is encouraged to make its background incorporated into the goods supplied under the Contract available for commercial purposes under the conditions established in Article 4.2.6 of the IIP Annex of ITER Agreement.


2.2.5 The Bidder shall grant on fair and reasonable conditions a license to use the background information & Intellectual Property, applicable to this contract to any third party nominated by ITER-India for the purpose of fulfilling the contract with ITER-India in case of Bidder's default.

3. Provisions under Generated Intellectual Property:

3.1 All Information (defined in 1.1.1 above) provided by or on behalf of ITER-India to the Bidder shall remain the property of ITER-India. These shall not be shared without permission from ITER-India.

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- 3.2** The background intellectual property provided by ITER-India will continue to be the property of the ITER-India. Any further extension of the IP during the course of execution of the contract will also belong to the ITER-India.
- 3.3** If, during the process of execution of the contract, any improvement, refinement or technical changes and modifications are affected by the Bidder to the background Information and IP owned by ITER-India and given to the Bidder for execution, such changes shall not affect the title to the property of the ITER-India and it shall continue to own the modified Information and IP. ITER-India shall have absolute rights to assign, transfer, sublet, use and transmit all such Information and IP to its consultants, agents and Bidder. Bidder shall not have any claim or right whatsoever in respect of the above Information and IP.
- 3.4** Any information and Intellectual property generated during the course of execution of the contract including those generated at the sub-Bidders end working for this contract shall be communicated to ITER-India immediately and ITER-India shall have the first right to protect such generated intellectual property on its name. The Bidder shall take the appropriate legal and administrative measures to enable ITER-India protect it in its own name.
- 3.5** In specific cases ITER-India may waive its right to take protection. In such a situation, the Bidder can take the protection of IP in its name and solely at its cost after reimbursing costs incurred by ITER-India (if any) on such a protection. At all times ITER-India shall be entitled to a royalty-free, non-exclusive, worldwide, irrevocable license with the royalty-free right to grant sublicenses on the resulting registered right.
- 3.6** If the Bidder or its employees desires to claim rights on the generated intellectual property, it shall be ensured that the same is possible, subject to compatibility with the Bidder's obligations under the contract and also ensuring that the rights of ITER- India remain unaffected.
- 3.7** The Bidder shall be permitted to use the generated Intellectual Property for his own needs. For this, he needs to obtain license from ITER-India. The terms shall be mutually agreed.
- 3.8** The Bidder is made aware of the fact that ITER-India may at its discretion, decide to seek protection of a generated intellectual Property, outside India.
- 3.9** For generated IP where ITER-India, decides to seek protection, the inventors will assign their rights to ITER-India.
- 3.10** ITER-India will seek protection through DAE-IPR Cell.
- 3.11** Should the Bidder wish to seek protection of IP generated on the subject matter on the contract within a period of 24 months after conclusion of the contract, the same shall be conveyed to ITER-India. It may be noted that the subject of these IPs shall be considered to be a part of the Generated Intellectual Property (and subject to provision 3.3 above),

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unless the Bidder demonstrates that these have been created outside the scope of the contract.

4 Indemnities, repair rights and copyrights:


- 4.1** In case the Bidder needs to use the intellectual property belonging to a third party, the Bidder shall indemnify ITER-India from any action for infringement associated with the third-party intellectual property.
- 4.2** The Bidder shall have the first right to attend to repairs for proprietary supplies which incorporate background intellectual property owned by him. However, should the contract not be successful in effecting repairs for such supplies in the first instance, ITER-India shall have the right to effect repairs by whomsoever it may think fit.
- 4.3** The Bidder shall be responsible for obtaining all permits, license and copyrights required for the implementation of the contract, as per laws applicable to the place where the contract is executed. In case of inability to seek the necessary permits, licenses and copyrights, the contract shall inform the same to ITER-India and ITER- India shall decide whether to acquire the rights at costs payable by the Bidder or effect a decision to discontinue all or some part of the work.

Project Director
ITER-India, Institute for Plasma Research
Block A, Sangath SKYZ,
Bhat-Motera Road, Koteswar,
Ahmedabad - 380 005, Gujarat, India

Bidder

(Official Seal)


(Official Seal)

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14 Annexure-E: Delivery Schedule

Table E1: Tentative Delivery Schedule for Phase 2


Sr. No.	Activity	Completion (month)	Probable Hold Points (HP)
1	Signature of the contract.	T0	
2	To check and validate the specifications provided by ITER-India for all the power supplies & cooling (water & air) requirements.	$T_{1P2}=T0+1$	
3	To submit QMP documentation as per management specification.	$T_{2P2}=T0+1$	
4	To check and validate the layout and diagrams of water & air cooling submitted by ITER-India and to generate mutually agreed layout.	$T_{3P2}=T_{2P2}+3$	Hold Point
5	To provide updated MTBF values of components to be supplied by Bidder to ITER-India, as an input for the RAMI analysis.	$T_{4P2}=T_{2P2}+3$	
6	To provide final list of necessary hardware along with connectors and cables for monitoring and local protection of components to be supplied by Bidder for remote operation & control through LCU.	$T_{5P2}=T_{2P2}+3$	Hold Point
7	To participate remotely/in-person as a team with ITER-India in Final Design Review (FDR) conducted with IO and resolve the queries, if any.	$T_{6P2}=T_{5P2}+2$	
8	a. Material Procurement as per requirement. b. To fabricate one set of components for 1 RF chain of prototype along with self-support to be supplied by Bidder including custom-built items & tubes identical to Phase 1 c. To fabricate single set of water & air-cooling distribution system as per agreed diagrams.	$T_{7P2}=T0+12$	Hold Point for submission of material procurement documents.
9	To conduct Factory Acceptance Test (FAT) of chain-1 of prototype.	$T_{8P2}=T_{7P2}+1$	
10	To submit FAT report of chain-1 of prototype for getting dispatch clearance certificate from ITER-India.	$T_{9P2}=T_{8P2}+0.5$	Hold Point

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Sr. No.	Activity	Completion (month)	Probable Hold Points (HP)
11	To participate remotely/in-person as a team with ITER-India in Fabrication Readiness Review (FRR) conducted with II/IO and resolve the queries, if any.	$T_{frr}=T_{8p2}+0.5$	
12	To deliver the chain-1 of prototype fabricated by Bidder at ITER-India.	$T_{10p2}=T_{9p2}+1.5$	
13	To initiate manufacturing of long-lead items components like tube, capacitors, cavities, etc.	$T_{11p2}=T_{9p2}+7.5$	
14	a. To unpack & assemble delivered components supplied by Bidder at ITER-India site. b. To verify the compatibility with components/sub-systems provided by ITER-India by generating validation report.	$T_{12p2}=T_{10p2}+1.5$	Note: All the components / sub-systems provided by ITER-India will be ready to validate at this time.
15	a. To conduct high power RF test of chain-1 of prototype on matched & mismatched load supplied by Bidder. b. To prepare & submit site acceptance test report by bidder to II c. To check healthiness of HPA-2, Trombone & HPA-3 supplied during R&D phase-1 d. To disassemble, & pack HPA-2, trombone & HPA-3 supplied during R&D phase-1	$T_{13p2}=T_{12p2}+4$	
16	To deliver HPA-2, trombone & HPA-3 supplied during R&D phase-1	$T_{13'p2}=T_{13p2}+2.5$	
17	To participate remotely/in-person as a team with ITER-India in Manufacturing Readiness Review (MRR) conducted with IO and resolve the queries, if any.	$T_{14p2}=T_{13p2}+1$	
18	a. Additional material Procurement if required. b. To fabricate chain-2 of prototype to be supplied by Bidder including custom-built items & tubes. c. To fabricate single set of water & air-cooling distribution system as per agreed diagrams.	$T_{15p2}=T_{13p2}+4$	Hold Point for submission of material procurement documents.
19	To conduct Factory Acceptance Test (FAT) of chain-2 of prototype.	$T_{16p2}=T_{15p2}+1$	

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Sr. No.	Activity	Completion (month)	Probable Hold Points (HP)
20	To submit FAT report of chain-2 of prototype for getting dispatch clearance certificate from ITER-India.	$T17_{P2}=T16_{P2}+0.5$	Hold Point
21	To deliver the chain-2 of prototype fabricated by Bidder.	$T18_{P2}=T17_{P2}+1.5$	
22	To unpack & assemble delivered components supplied by Bidder at ITER-India site.	$T19_{P2}=T18_{P2}+1$	
23	a. Validation of components supplied by ITER-India. b. To conduct high power RF test of chain-2 of prototype on matched & mis-matched load supplied by Bidder. c. To prepare & submit site acceptance test report by bidder to ITER-India	$T20_{P2}=T19_{P2}+3$	Hold Point
24	To combine two chains & test Prototype RF source on matched & mis-matched load condition by ITER-India without bidder's participation	$T21_{P2}=T20_{P2}+3.5$	
25	To prepare & submit site acceptance test report for combine RF test to IO by ITER-India	$T22_{P2}=T21_{P2}+1$	
26	a. Additional material Procurement if required. b. To fabricate chain-3 of Unit-1 to be supplied by Bidder including custom-built items & tubes. c. To fabricate single set of water & air-cooling distribution system as per agreed diagrams.	$T23_{P2}=T17_{P2}+4$	
27	To conduct Factory Acceptance Test (FAT) of chain-3 of Unit-1.	$T24_{P2}=T23_{P2}+1$	
28	To submit FAT report of chain-3 of Unit-1 for getting dispatch clearance certificate from ITER-India.	$T25_{P2}=T24_{P2}+0.5$	Hold Point
29	To deliver the chain-3 of Unit-1 fabricated by Bidder.	$T26_{P2}=T25_{P2}+1.5$	
30	To unpack & assemble delivered components supplied by Bidder at ITER-India site.	$T27_{P2}=T26_{P2}+1$	
31	a. Validation of II supplied components.	$T28_{P2}=T27_{P2}+3$	Hold Point


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Sr. No.	Activity	Completion (month)	Probable Hold Points (HP)
	b. To conduct high power RF test of chain-3 of Unit-1 on matched & mis-matched load supplied by Bidder. c. To prepare & submit site acceptance test report by bidder to ITER-India		
32	a. Material Procurement as per requirement for chain-4. b. To deliver the components required for the modification of chain-4 (R&D Chain) c. To modify chain-4 (components of R&D chain) of Unit-1 by ITER-India under the supervision of bidder at ITER-India site d. To modify single set of water & air-cooling distribution system by ITER-India as per agreed diagrams.	$T29_{p2} = T25_{p2} + 4$	
33	a. To conduct high power RF test of chain-4 (components of R&D chain) of Unit-1 on matched & mis-matched load supplied by Bidder. b. To prepare & submit site acceptance test report by bidder to ITER-India	$T30_{p2} = T29_{p2} + 3$	
34	To combine two chains & test Unit-1 RF source on matched & mis-matched load condition by ITER-India without bidder's participation	$T31_{p2} = T30_{p2} + 3.5$	
35	To prepare & submit site acceptance test report for combine RF test for Unit-1 to IO by II	$T32_{p2} = T31_{p2} + 1$	


Assembly & Integration at IO

Sr. No.	Activity	Completion (month)	Probable Hold Points (HP)
1	To deliver the prototype RF source to IO (Under ITER-India's Scope)	$T33_{p2} = T22_{p2} + 2.5$	
2	a. To unpack & assemble the delivered components by Bidder for prototype RF source at IO site, France. b. To verify the compatibility with components/sub-systems provided by IO by generating validation report.	$T34_{p2} = T33_{p2} + 3$	HP: A legal inspection of electrical equipment prior to energization

The tender document is to provide technical content and scope related to ITER deliverables and shall not be disclosed or used for any other purpose without written permission from ITER-India.

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Sr. No.	Activity	Completion (month)	Probable Hold Points (HP)
3	To check the high-power RF performance of two sets of HPA2 and HPA3 on matched load & to submit test report by bidder.	$T35_{P2}=T34_{P2}+4$	
4	To conduct high power RF test of prototype source on matched load by ITER-India without bidder's participation	$T36_{P2}=T35_{P2}+2$	
5	To prepare & submit site acceptance test report by ITER-India.	$T37_{P2}=T36_{P2}+1$	
6	To deliver Unit-1 RF source (Under ITER-India's Scope)	$T38_{P2}=T37_{P2}+2.5$	
7	a. To unpack & assemble the delivered components by Bidder for prototype RF source at IO site, France. b. To verify the compatibility with components/sub-systems provided by IO by generating validation report.	$T39_{P2}=T38_{P2}+3$	
8	To check the high-power RF performance of two sets of HPA2 and HPA3 on matched & mis-matched load & to submit test report by bidder.	$T40_{P2}=T39_{P2}+4$	
9	To conduct high power RF test of Unit-1 on matched and mis-matched loads by ITER-India without bidder's participation	$T41_{P2}=T40_{P2}+2$	
10	To prepare & submit site acceptance test report by ITER-India.	$T42_{P2}=T41_{P2}+1$	

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15 Annexure-F: Hardware to be delivered by Bidder to interface with LCU

15.1 Phase 2


The deliverable quantity for Phase 2 needs to be at least the same number as written in the **Table F1 & Table F2** i.e. for one RF chain. Bidder needs to verify and finalize the list considering various failures and protections for the components supplied by Bidder. If any additional item is finalised by the bidder to fulfil the requirement, the Table F1 & F2 shall be updated accordingly. Three sets of all the components shall be supplied by the bidder along with 3 sets of HPA components. One set of all the components shall be supplied to ITER-India for modification/upgradation of existing R&D chain at ITER-India under the supervision of bidder. This R&D chain will be used as a second chain of unit-1.

15.1.1 Sensor/transmitter


Sensor/transmitter for water-cooling and air-cooling distribution system are tabulated below based on existing RF chain.

Table F1: Sensor/transmitter

Component	Quantity per RF chain	Signal name/Status	Make/Reference
Water cooling system:			
Isolation Valve	HPA2: 2 No.	Manual valve1 High	EBRO Z011 A GGG40 MSK 03 A
		Manual valve1 Low	
		Manual valve2 High	
		Manual valve2 Low	
Motorized Valve	Inlet & outlet of main water-cooling line: 2 No.	Motorized valve1 High	EBRO Z011 A GGG40 E65 24VDC
		Motorized valve1 Low	
		Motorized valve2 High	
		Motorized valve2 Low	
Pressure Indicator with switch	HPA2-2 No.	HPA2 PSL1 low	WIKA 2 contacts NC/NO
		HPA2 PSH1 High	
		HPA2 PSL2 low	WIKA 2 contacts NC/NO
		HPA2 PSH2 High	
	HPA3- 2 No.	HPA3 PSL1 low	WIKA 2 contacts NC/NO 0-10 bar ½’’G
		HPA3 PSH1 High	
		HPA3 PSL2 low	WIKA 2 contacts NC/NO 0-10 bar ½’’G
		HPA3 PSH2 High	
Flow switch	HPA-2: 2 No.	HPA2 Flow alarm1 Low	ELETTA low flow switch PN16 SST

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Component	Quantity per RF chain	Signal name/Status	Make/Reference
	HPA-3: 9 No.	HPA2 Flow alarm2 Low	ELETTA flow switch low V15GSS25C
		HPA3 Flow alarm1 Low	ELETTA flow switch low DN80 PN16
		HPA3 Flow alarm2 Low	ELETTA low flow switch ½” PN16 SST DN15 2
		HPA3 Flow alarm3 Low	ELETTA flow switch low DN80 PN16
		HPA3 Flow alarm4 Low	ELETTA flow switch low DN80 PN16
		HPA3 Flow alarm5 Low	ELETTA flow switch low DN80 PN16
		HPA3 Flow alarm6 Low	ELETTA flow switch low DN80 PN16
		HPA3 Flow alarm7 Low	ELETTA flow switch low DN80 PN16
		HPA3 Flow alarm8 Low	ELETTA flow switch low DN80 PN16
		HPA3 Flow alarm9 Low	ELETTA low flow switch ½” PN16 SST DN15 2
Temperature switch	HPA2: 2 No.	HPA2 Temp inlet high	THERMOEST
		HPA2 Temp outlet high	THERMOEST
	HPA3: 2 No.	HPA3 Temp inlet high	THERMOEST
		HPA3 Temp outlet high	THERMOEST
Temp sensor & transmitter	HPA-2: 2 No.	HPA2 inlet Temperature Transmitter 1	THERMOEST SI600-0 à 120°
		HPA2 outlet Temperature Transmitter 2	THERMOEST SI600-0 à 120°
	HPA-3: 2 No.	HPA3 inlet Temperature Transmitter 3	THERMOEST SI600-0 à 120°
		HPA3 outlet Temperature Transmitter 4	THERMOEST SI600-0 à 120°


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Component	Quantity per RF chain	Signal name/Status	Make/Reference
Flow sensor & transmitter	HPA-2: 1 No.	HPA2 Flow Transmitter1	ELETTA flow meter D5GSS25B 24-120 l/min
	HPA-3: 1No.	HPA3 Flow Transmitter1	ELETTA D5FSS80F 240-1200 l/min
Air cooling system			
Differential pressure switch	HPA2: 3 No.	HPA2 DPSL1	HUBA 6049500001W
		HPA2 DPSL2	HUBA 6049500001W
		HPA2 DPSL3	HUBA 6049500001W
	HPA3: 9 No.	HPA3 DPSL1	HUBA 6049500001W
		HPA3 DPSL2	HUBA 6049500001W
		HPA3 DPSL3	HUBA 6049500001W
		HPA3 DPSL4	HUBA 6049500001W
		HPA3 DPSL5	HUBA 6049500001W
		HPA3 DPSL6	HUBA 6049500001W
		HPA3 DPSL7	HUBA 6049500001W
		HPA3 DPSL8	HUBA 6049500001W
		HPA3 DPSL9	HUBA 6049500001W
Blower	Space need to be optimized by the bidder to comply with space reserved for HPA2, Trombone & HPA3 as per Annexure-I: Proposed RF source Layout	HPA2 blower# run	
		HPA2 blower# fault	
		HPA3 blower# run	
		HPA3 blower# fault	
		HPA2 Blower# start command	
		HPA3 Blower# start command	

15.1.2 Arc detector, Motor & Driver/controller requirement

Table F2: Arc detector, Motor & Driver/controller


Component	Quantity per RF chain	Bidder's deliverable	Make/Comments
Arc detector	HPA2: 2 Arc detectors	<ul style="list-style-type: none"> – Arc detector headers with lamp – Lamp energizing cable – FOC for Arc light transmitting from Arc detector header – Arc detector module 	
	HPA3: 6 Arc detectors		
Motor & driver/controller	HPA2: 8 sets of motor & driver/controller	<ul style="list-style-type: none"> – Moving mechanism with motor 	ITER-India prefers Siemens make servo motor of

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Component	Quantity per RF chain	Bidder's deliverable	Make/Comments
	and 1 set of motor & driver/controller for trombone (phase shifter)	– Motor's driver/controller having profinet connectivity – Cables & connectors required to connect motor with motor driver/controller	SIMOTICS S-1FK2 HD series & controller of SINAMICS S210 series instead of Nanotech motor & PHYLOGIC controller
	HPA3: 9 sets of motor & driver/controller		

General Note:

- Supplied cables shall be selected from cable catalogue of ITER, attached as IDM reference document [18] "IO cable catalogue" and [16] IO cabling rules.
- All cables used in the project shall be non-flammable, low-smoke, halogen free type.

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16 Annexure-G: Validation report formats for interfaces at ITER-India/IO

16.1 Interface Title: Water cooling

ITER-India contract no.	
Contract title	
Bidder	
Person Involved in Validation:	Date:
Major Technical Specifications	
Water Cooling Facility	

Description	Requirements	Observations	Remark
Type of water			
Main line inlet water conductivity			
Main line inlet water temperature			
Main line inlet pressure			
Main line flow			
HPA-3; Inlet pressure			
HPA-3; Outlet pressure			
HPA-3; Flow rate			
HPA-2; Inlet pressure			
HPA-2; Outlet pressure			
HPA-2; Flow rate			

Performance evaluation criteria	
Visual evaluation	Accepted [] Rejected []
Technical evaluation	Accepted [] Rejected [] with standalone Accepted [] Rejected [] with HPA3 Interface Accepted [] Rejected [] with power test
Comments (if any)	
Attachments (if any)	
Filled by Bidder's Representative	Filled by ITER-India's/IO's Representative
Name:	Name:
Date:	Date:
Signature	Signature:


	Tender documents [PART-A(ii)]: Scope of Supply, work and Technical Specifications for Phase 2-Driver and Final stage amplifiers for 2 sets of ITER ICRF Sources.- GLOBAL TENDER NOTICE NO: I-I/ET-TPT/25001/25-26	INDUS Ref.
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16.2 Interface Title: Air cooling

ITER-India contract no.	NA
Contract title	NA
Contractor	NA
Person Involved in Validation:	Date:
Major Technical Specifications	
<i>Air Cooling Facility</i>	

Description	Requirements	Observations at ITER-India	Remark
HPA-2			
Input circuit			
Primary output circuit			
Secondary output circuit			
HPA-3			
Filament circuit			
Input RF circuit			
Input RF transformer			
Output RF transformer: (back wall side)			
Output RF transformer: (front side)			
Bottom anode (back wall side):			
Bottom anode (front side)			
Top anode (back side)			
Top anode front side			

Performance evaluation criteria	
Visual evaluation	Accepted [] Rejected []
Technical evaluation	Accepted [] Rejected [] with standalone
	Accepted [] Rejected [] with HPA3 Interface
	Accepted [] Rejected [] with power test
Comments (if any)	
Attachments (if any)	
Filled by Bidder's Representative	Filled by ITER-India's/IO's Representative
Name:	Name:
Date:	Date:
Signature	Signature:


	Tender documents [PART-A(ii)]: Scope of Supply, work and Technical Specifications for Phase 2-Driver and Final stage amplifiers for 2 sets of ITER ICRF Sources.- GLOBAL TENDER NOTICE NO: I-I/ET-TPT/25001/25-26	INDUS Ref.
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16.3 Interface Title: LP section and SSPA

ITER-India contract no.	PO:
Interface Title	LP section and SSPA
Supplied by	
Person Involved in Validation:	Date:
Major Technical Specifications	
Pre-driver (HPA-1): Solid State Power Amplifier (SSPA)	

Parameters	Requirements	Observations	Remark
Frequency (MHz)	36, 42, 53 and 60MHz		
Output power	10 kW on matched load		
Pulse duration	2000 s		
Harmonic and spurious (on matched load)	$\geq -20\text{dBc}$		
Gain Flatness ($\pm 4\text{MHz}$)	1dB		
Interface for remote control	Analog mode		
Cooling water parameters (pressure/flow/Inlet temperature)	5bar/ 28 LPM/21°C		
Control & protection	RF power, over drive, over VSWR, water cooling		

Performance evaluation criteria	
Visual evaluation	Accepted [] Rejected []
	Accepted [] Rejected []
	Accepted [] Rejected []
Test for performance evaluation	Accepted [] Rejected []
Comments (if any)	
Attachments (if any)	
Filled by Bidder's Representative	Filled by ITER-India's/IO's Representative
Name:	Name:
Date:	Date:
Signature:	Signature:

	Tender documents [PART-A(ii)]: Scope of Supply, work and Technical Specifications for Phase 2-Driver and Final stage amplifiers for 2 sets of ITER ICRF Sources.- GLOBAL TENDER NOTICE NO: I-I/ET-TPT/25001/25-26	INDUS Ref.
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16.4 *Interface Title: Directional coupler*


ITER-India contract no.	
Contract title	
Contractor	
Person Involved in Validation:	Date:
Major Technical Specifications	
<i>Calibration of directional coupler</i>	

Frequency (MHz)	FWD Coupling (dB)	RFL Coupling (dB)	Directivity (dB)	Remark
36				
42				
53				
60				

Calibration for harmonics

Frequency (MHz)	Fundamental (dB)	H1 (dB)	H2 (dB)	H3 (dB)
36				
42				
53				
60				

Performance evaluation criteria	
Visual evaluation	Accepted [] Rejected []
Technical evaluation	Accepted [] Rejected [] with standalone Accepted [] Rejected [] with HPA3 Interface Accepted [] Rejected [] with power test
Comments (if any)	
Attachments (if any)	
Filled by Bidder's Representative	Filled by ITER-India's/IO's Representative
Name:	Name:
Date:	Date:
Signature	Signature:

	Tender documents [PART-A(ii)]: Scope of Supply, work and Technical Specifications for Phase 2-Driver and Final stage amplifiers for 2 sets of ITER ICRF Sources.- GLOBAL TENDER NOTICE NO: I-I/ET-TPT/25001/25-26	INDUS Ref.
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16.5 Interface Title: RF power measurement test setup for HPA2 & HPA3


ITER-India contract no.	
Contract title	
Contractor	
Person Involved in Validation:	Date:
Major Technical Specifications	
<i>Calibration of RF power measurement test setup with cable, filter and attenuator</i>	

Frequency (MHz)	Offset Value for forward power measurement (dB)		Offset Value for Reflected power measurement (dB)		Remark
	HPA2	HPA3	HPA2	HPA3	
36					Total offset: DC coupling+Attenuator loss +Filter loss +Cable loss
42					
53					
60					

Measurement of harmonics

Frequency (MHz)	Fundamental (dB)	H1 (dB)	H2 (dB)	H3 (dB)
36				
42				
53				
60				

Performance evaluation criteria	
Visual evaluation	Accepted [] Rejected []
Technical evaluation	Accepted [] Rejected [] with standalone Accepted [] Rejected [] with HPA3 Interface Accepted [] Rejected [] with power test
Comments (if any)	
Attachments (if any)	
Filled by Bidder's Representative	Filled by ITER-India's/IO's Representative
Name:	Name:
Date:	Date:
Signature	Signature:


	Tender documents [PART-A(ii)]: Scope of Supply, work and Technical Specifications for Phase 2-Driver and Final stage amplifiers for 2 sets of ITER ICRF Sources.- GLOBAL TENDER NOTICE NO: I-I/ET-TPT/25001/25-26	INDUS Ref.
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16.6 *Interface Title: Transmission line components*

ITER-India contract no.	
Contract title	
Contractor	
Person Involved in Validation:	Date:
Major Technical Specifications	

Frequency (MHz)	Insertion loss (dB)	Return loss (dB)
36		
42		
53		
60		

Performance evaluation criteria	
Visual evaluation	Accepted [] Rejected []
Technical evaluation	Accepted [] Rejected [] with standalone Accepted [] Rejected [] with HPA3 Interface Accepted [] Rejected [] with power test
Comments (if any)	
Attachments (if any)	
Filled by Bidder's Representative	Filled by ITER-India's/IO's Representative
Name:	Name:
Date:	Date:
Signature	Signature:


	Tender documents [PART-A(ii)]: Scope of Supply, work and Technical Specifications for Phase 2-Driver and Final stage amplifiers for 2 sets of ITER ICRF Sources.- GLOBAL TENDER NOTICE NO: I-I/ET-TPT/25001/25-26	INDUS Ref.
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16.7 Interface Title: 3dB Hybrid Combiner with dummy load at isolation port

ITER-India contract no.	
Contract title	
Contractor	
Person Involved in Validation:	Date:
Major Technical Specifications on matched load	

Frequency (MHz)	Insertion loss (better than 0.15 dB)	Return loss (better than 22 dB)	Isolation (better than 22 dB)
36			
42			
53			
60			

Performance evaluation criteria	
Visual evaluation	Accepted [] Rejected []
Technical evaluation	Accepted [] Rejected [] with standalone Accepted [] Rejected [] with HPA3 Interface Accepted [] Rejected [] with power test
Comments (if any)	
Attachments (if any)	
Filled by Bidder's Representative	Filled by ITER-India's/IO's Representative
Name:	Name:
Date:	Date:
Signature	Signature:

	Tender documents [PART-A(ii)]: Scope of Supply, work and Technical Specifications for Phase 2-Driver and Final stage amplifiers for 2 sets of ITER ICRF Sources.- GLOBAL TENDER NOTICE NO: I-I/ET-TPT/25001/25-26	INDUS Ref.
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16.8 Interface Title: Dummy loads 200kW/1.5MW/3MW


ITER-India contract no.	
Contract title	
Contractor	
Person Involved in Validation:	Date:
Major Technical Specifications	
Calibration of dummy load	

Temp. (°C)	S11@ 36MHz	S11@ 42MHz	S11@ 53MHz	S11@ 60MHz	S11@ 100MHz
66					
71					
72					

Temp. (°C)	VSWR @ 36MHz	VSWR @ 42MHz	VSWR @ 53MHz	VSWR @ 60MHz	VSWR @ 100MHz
66					
71					
72					

Temp. (°C)	Impedance @ 36MHz	Impedance @ 42MHz	Impedance @ 53MHz	Impedance @ 60MHz	Impedance @ 100MHz
72					

Performance evaluation criteria	
Visual evaluation	Accepted [] Rejected []
Technical evaluation	Accepted [] Rejected [] with standalone Accepted [] Rejected [] with HPA3 Interface Accepted [] Rejected [] with power test
Comments (if any)	
Attachments (if any)	
Filled by Bidder's Representative	
Name:	Name:
Date:	Date:
Signature	Signature:


	Tender documents [PART-A(ii)]: Scope of Supply, work and Technical Specifications for Phase 2-Driver and Final stage amplifiers for 2 sets of ITER ICRF Sources.- GLOBAL TENDER NOTICE NO: I-I/ET-TPT/25001/25-26	INDUS Ref.
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16.9 Interface Title: Mis-matched Transmission Line (MMTL)

ITER-India contract no.	
Contract title	
Contractor	
Person Involved in Validation:	Date:
Major Technical Specifications	
Calibration of MMTL	

	S11@ 36MHz	S11@ 42MHz	S11@ 53MHz	S11@ 60MHz
Amplitude (dB)				
VSWR Range (1 to 2.5)				
Reflection angle range (0-180 degree)				


Performance evaluation criteria	
Visual evaluation	Accepted [] Rejected []
Technical evaluation	Accepted [] Rejected [] with standalone Accepted [] Rejected [] with HPA3 Interface Accepted [] Rejected [] with power test
Comments (if any)	
Attachments (if any)	
Filled by Bidder's Representative	
Name:	Name:
Date:	Date:
Signature	Signature:

	Tender documents [PART-A(ii)]: Scope of Supply, work and Technical Specifications for Phase 2-Driver and Final stage amplifiers for 2 sets of ITER ICRF Sources.- GLOBAL TENDER NOTICE NO: I-I/ET-TPT/25001/25-26	INDUS Ref.
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16.10 Interface Title: Filament Power Supply for HPA2

ITER-India contract no.	PO No.		
Contract title			
Contractor			
Person Involved in Validation:		Date:	
Major Technical Specifications			
Filament Power Supply for HPA2			
Description	Major Specifications	Observations	Remarks
Rated DC output Voltage			
Operational DC voltage			
Rated DC output Current			
Filament Voltage at the cavity terminal Vf (V)			
Filament current If (A)			
Ramp up and Ramp down rate			Through LCU
Line Regulation			Available equipment will be used
Load Regulation			Available equipment will be used
Output voltage ripple			
Over Voltage Threshold			Through LCU
Over Current Threshold			Through LCU
Fault protections: Over load Over voltage			
Heat run test			
Monitoring of Voltage & Current			Through LCU
Cable type			

Performance evaluation criteria	
Visual evaluation	Accepted [] Rejected []
Technical evaluation	Accepted [] Rejected [] with standalone Accepted [] Rejected [] with HPA2 Interface Accepted [] Rejected [] with power test
Comments (if any)	
Attachments (if any)	
Filled by Bidder's Representative	Filled by ITER-India's/IO's Representative
Name:	Name:
Date:	Date:
Signature	Signature:


	Tender documents [PART-A(ii)]: Scope of Supply, work and Technical Specifications for Phase 2-Driver and Final stage amplifiers for 2 sets of ITER ICRF Sources.- GLOBAL TENDER NOTICE NO: I-I/ET-TPT/25001/25-26	INDUS Ref.
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16.11 *Interface Title: Filament Power Supply for HPA3*

ITER-India contract no.	PO No.
Contract title	
Contractor	
Person Involved in Validation:	Date:
Major Technical Specifications	
<i>Filament Power Supply for HPA3</i>	

Description	Major Specifications	Observations	Remarks
Rated DC output Voltage			
Operational DC voltage			
Rated DC output Current			
Filament Voltage at the cavity terminal Vf (V)			
Filament current If (A)			
Ramp up and Ramp down rate			Through LCU
Line Regulation			Available equipment will be used
Load Regulation			Available equipment will be used
Output voltage ripple			
Over Voltage Threshold			Through LCU
Over Current Threshold			Through LCU
Fault protections: Over load and Over voltage			
Heat run test			
Monitoring of Voltage & Current			Through LCU
Cable type			

Performance evaluation criteria			
Visual evaluation	Accepted []	Rejected []	
Technical evaluation	Accepted []	Rejected []	with standalone
	Accepted []	Rejected []	with HPA3 Interface
	Accepted []	Rejected []	with power test
Comments (if any)			
Attachments (if any)			
Filled by Bidder's Representative		Filled by ITER-India's/IO's Representative	
Name:		Name:	
Date:		Date:	
Signature		Signature:	


	Tender documents [PART-A(ii)]: Scope of Supply, work and Technical Specifications for Phase 2-Driver and Final stage amplifiers for 2 sets of ITER ICRF Sources.- GLOBAL TENDER NOTICE NO: I-I/ET-TPT/25001/25-26	INDUS Ref.
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16.12 *Interface Title: Control Grid Power Supply for HPA2*

ITER-India contract no.	PO No.
Contract title	
Contractor	
Person Involved in Validation:	Date:
Major Technical Specifications	
<i>Control Grid Power Supply for HPA2</i>	

Description	Major Specifications	Observations	Remarks
Rated DC output voltage			
Operational DC voltage			
Rated DC current			
Current in the bleeder			
Fuse test (0.5A)			Fuse test will be conducted with Bleeder & negative current circuit connected with P.S.U.
Line regulation			Available equipment will be used
Load regulation			Available equipment will be used
Output voltage ripple			
Over Voltage Threshold			Through LCU
Over Current Threshold			Through LCU
Heat run test			
Monitoring of Voltage & Current			Through LCU
Cable type			

Performance evaluation criteria	
Visual evaluation	Accepted [] Rejected []
Technical evaluation	Accepted [] Rejected [] with standalone
	Accepted [] Rejected [] with HPA2 Interface
	Accepted [] Rejected [] with power test
Comments (if any)	
Attachments (if any)	
Filled by Bidder's Representative	Filled by ITER-India's/IO's Representative
Name:	Name:
Date:	Date:
Signature:	Signature:


	Tender documents [PART-A(ii)]: Scope of Supply, work and Technical Specifications for Phase 2-Driver and Final stage amplifiers for 2 sets of ITER ICRF Sources.- GLOBAL TENDER NOTICE NO: I-I/ET-TPT/25001/25-26	INDUS Ref.
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16.13 *Interface Title: Control Grid Power Supply for HPA3*

ITER-India contract no.	PO No.
Contract title	
Contractor	
Person Involved in Validation:	Date:
Major Technical Specifications	
<i>Control Grid Power Supply for HPA3</i>	

Description	Major Specifications	Observations	Remarks
Rated DC output voltage			
Operational DC voltage			
Rated DC current			
Current in the bleeder			
Fuse test (0.5A)			Fuse test will be conducted with Bleeder & negative current circuit connected with P.S.U.
Line regulation			Available equipment will be used
Load regulation			Available equipment will be used
Output voltage ripple			
Over Voltage Threshold			Through LCU
Over Current Threshold			Through LCU
Heat run test			
Monitoring of Voltage & Current			Through LCU
Cable type			

Performance evaluation criteria	
Visual evaluation	Accepted [] Rejected []
Technical evaluation	Accepted [] Rejected [] with standalone Accepted [] Rejected [] with HPA3 Interface Accepted [] Rejected [] with power test
Comments (if any)	
Attachments (if any)	
Filled by Bidder's Representative	Filled by ITER-India's/IO's Representative
Name:	Name:
Date:	Date:
Signature	Signature:


	Tender documents [PART-A(ii)]: Scope of Supply, work and Technical Specifications for Phase 2-Driver and Final stage amplifiers for 2 sets of ITER ICRF Sources.- GLOBAL TENDER NOTICE NO: I-I/ET-TPT/25001/25-26	INDUS Ref.
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16.14 *Interface Title: Screen Grid Power Supply for HPA2*

ITER-India contract no.	PO No.
Contract title	
Contractor	
Person Involved in Validation:	Date:
Major Technical Specifications	
<i>Screen Grid Power Supply for HPA2</i>	

Description	Major Specifications	Observations	Remarks
Rated DC output voltage			
Operational DC voltage			
Rated DC current			
Current in the bleeder			
Fuse test (1.0A)			Fuse test will be conducted with Bleeder & external protection circuit
Line regulation			Available equipment will be used
Load regulation			Available equipment will be used
Output voltage ripple			
Over Voltage Threshold			Through LCU
Over Current Threshold			Through LCU
Heat run test			
Monitoring of Voltage & Current			Through LCU
Cable type			


Performance evaluation criteria	
Visual evaluation	Accepted [] Rejected []
Technical evaluation	Accepted [] Rejected [] with standalone Accepted [] Rejected [] with HPA2 Interface Accepted [] Rejected [] with power test
Comments (if any)	
Attachments (if any)	
Filled by Bidder's Representative	Filled by ITER-India's/IO's Representative
Name:	Name:
Date:	Date:
Signature	Signature:

	Tender documents [PART-A(ii)]: Scope of Supply, work and Technical Specifications for Phase 2-Driver and Final stage amplifiers for 2 sets of ITER ICRF Sources.- GLOBAL TENDER NOTICE NO: I-I/ET-TPT/25001/25-26	INDUS Ref.
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16.15 *Interface Title: Screen Grid Power Supply for HPA3*


ITER-India contract no.	PO No.		
Contract title			
Contractor			
Person Involved in Validation:			Date:
Major Technical Specifications			
<i>Screen Grid Power Supply for HPA3</i>			

Description	Major Specifications	Observations	Remarks
Rated DC output voltage			
Operational DC voltage			
Rated DC current			
Current in the bleeder			
Fuse test (1.0A)			Fuse test will be conducted with Bleeder & external protection circuit
Line regulation			Available equipment will be used
Load regulation			Available equipment will be used
Output voltage ripple			
Over Voltage Threshold			Through LCU
Over Current Threshold			Through LCU
Heat run test			
Monitoring of Voltage & Current			Through LCU
Cable type			
Performance evaluation criteria			
Visual evaluation	Accepted [] Rejected []		
Technical evaluation	Accepted [] Rejected [] with standalone		
	Accepted [] Rejected [] with HPA3 Interface		
	Accepted [] Rejected [] with power test		
Comments (if any)			
Attachments (if any)			
Filled by Bidder's Representative		Filled by ITER-India's/IO's Representative	
Name:		Name:	
Date:		Date:	
Signature		Signature:	


	Tender documents [PART-A(ii)]: Scope of Supply, work and Technical Specifications for Phase 2-Driver and Final stage amplifiers for 2 sets of ITER ICRF Sources.- GLOBAL TENDER NOTICE NO: I-I/ET-TPT/25001/25-26	INDUS Ref.
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16.16 *Interface Title: Safety Key Management*

ITER-India contract no.	
Interface Title	Safety Key Management System
Supplied by	
Person Involved in Validation:	Date:

Major Technical Specifications
Logic diagram

Fig: Safety Key Management System

Performance evaluation criteria	
Visual evaluation	Accepted [] Rejected []
	Accepted [] Rejected []
	Accepted [] Rejected []
	Accepted [] Rejected []
Comments (if any)	
Attachments (if any)	
Filled by Bidder's Representative	Filled by ITER-India's/IO's Representative
Name:	Name:
Date:	Date:
Signature:	Signature:


	Tender documents [PART-A(ii)]: Scope of Supply, work and Technical Specifications for Phase 2-Driver and Final stage amplifiers for 2 sets of ITER ICRF Sources.- GLOBAL TENDER NOTICE NO: I-I/ET-TPT/25001/25-26	INDUS Ref.
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16.17 Interface Title: RF enclosure

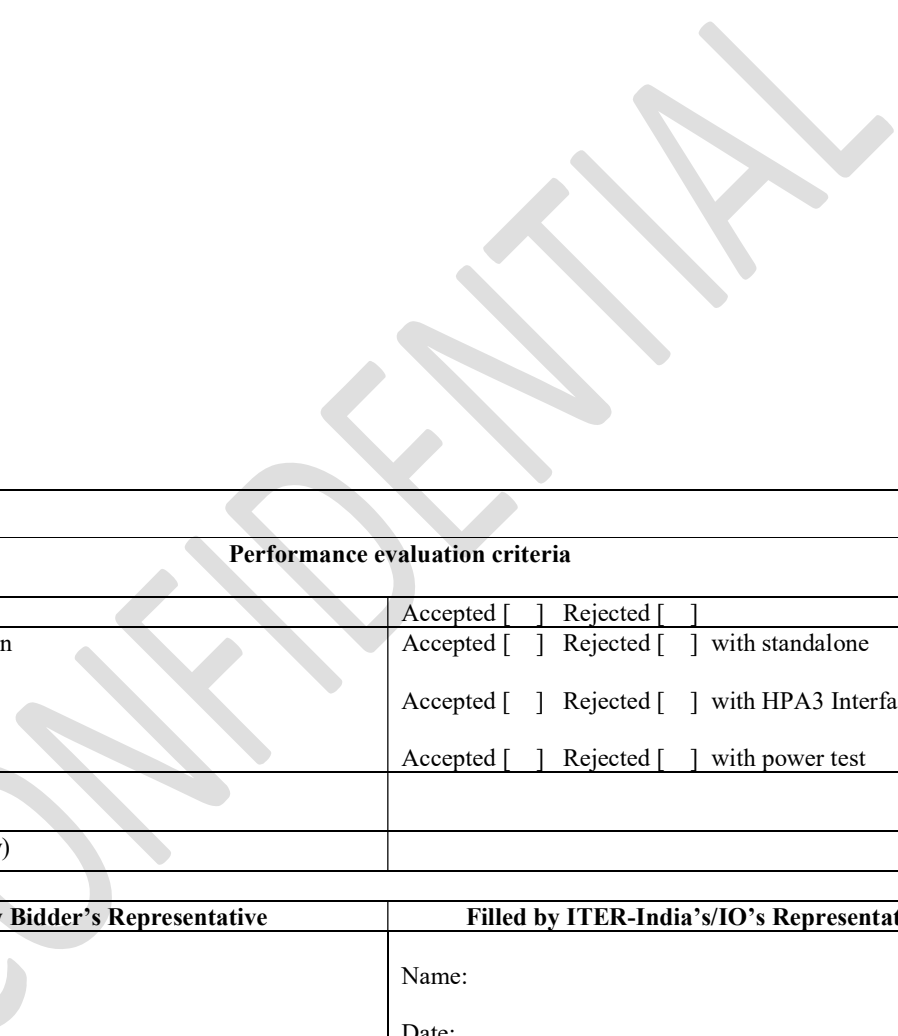
ITER-India contract no.	
Interface Title	RF enclosure
Supplied by	
Person Involved in Validation:	Date:

Major Technical Specifications
Checking as per Layout diagram
<div style="text-align: center; font-size: 2em; opacity: 0.1; transform: rotate(-30deg); pointer-events: none;">CONFIDENTIAL</div>


Performance evaluation criteria	
Visual evaluation	Accepted [] Rejected []
	Accepted [] Rejected []
	Accepted [] Rejected []
	Accepted [] Rejected []
Comments (if any)	
Attachments (if any)	
Filled by Bidder's Representative	Filled by ITER-India's/IO's Representative
Name:	Name:
Date:	Date:
Signature:	Signature:

	Tender documents [PART-A(ii)]: Scope of Supply, work and Technical Specifications for Phase 2-Driver and Final stage amplifiers for 2 sets of ITER ICRF Sources.- GLOBAL TENDER NOTICE NO: I-I/ET-TPT/25001/25-26	INDUS Ref.
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16.18 *Interface Title: Grounding Scheme at ITER-INDIA/IO Site*

ITER-India contract no.	
Contract title	
Contractor	
Person Involved in Validation:	Date:
Major Technical Specifications <i>Grounding Scheme at ITER-INDIA/IO</i>	
<div style="position: relative;">  </div>	


Performance evaluation criteria	
Visual evaluation	Accepted [<input type="checkbox"/>] Rejected [<input type="checkbox"/>]
Technical evaluation	Accepted [<input type="checkbox"/>] Rejected [<input type="checkbox"/>] with standalone
	Accepted [<input type="checkbox"/>] Rejected [<input type="checkbox"/>] with HPA3 Interface
	Accepted [<input type="checkbox"/>] Rejected [<input type="checkbox"/>] with power test
Comments (if any)	
Attachments (if any)	
Filled by Bidder's Representative	Filled by ITER-India's/IO's Representative
Name:	Name:
Date:	Date:
Signature	Signature:

	Tender documents [PART-A(ii)]: Scope of Supply, work and Technical Specifications for Phase 2-Driver and Final stage amplifiers for 2 sets of ITER ICRF Sources.- GLOBAL TENDER NOTICE NO: I-I/ET-TPT/25001/25-26	INDUS Ref.
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16.19 Interface Title: Dual Output High Voltage Power Supply (HVPS)


ITER-India contract no.	
Interface Title	High voltage power supply for RF power source
Supplied by	ITER-India
Person Involved in Validation:	Date:
Major Technical Specifications	
Dual Output High Voltage Power Supply	

Parameters	Major Specifications	Observations	Remark
HPA2			
Note: Driver anode voltage will be kept 13kV to provide less dissipation on driver's tube and a little more margin for Final stage.			
Output voltage	8-14 kVDC		
Output current	20 A		
Output voltage ripple	± 1% of the maximum value		
Overshoot	2kV maximum (during load fault)		
Voltage accuracy	± 1% of the maximum value		
Voltage rise time (10% to 90%)	50ms		
Fast switch OFF (standalone mode)	<10 µs		
Normal ON/OFF time with LCU	5 s		Through reference link
Voltage resolution	± 1% of the maximum value		
Wire burn test	As per data sheet		
Over Voltage Threshold	-		
Over Current Threshold	-		
Time to be ready to restart after fault	200 ms		
HPA3			
Voltage range above driver stage voltage	4-14 kV		
Maximum absolute voltage	27 kV		
Maximum current to one end stage tube	170 A		
Output voltage ripple	± 1% of the maximum value		
Overshoot	2kV maximum (during load fault)		
Voltage Accuracy	± 1% of the maximum value		
Fast switch OFF (standalone mode)	<10 µs		
Voltage rise time (10% to 90%)	50 ms		
Normal ON/OFF time with LCU	5 s		Through reference link
Voltage resolution	± 1% of the maximum value		
Wire burn test	As per data sheet		

	Tender documents [PART-A(ii)]: Scope of Supply, work and Technical Specifications for Phase 2-Driver and Final stage amplifiers for 2 sets of ITER ICRF Sources.- GLOBAL TENDER NOTICE NO: I-I/ET-TPT/25001/25-26	INDUS Ref.
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Over Voltage Threshold			
Over Current Threshold			

Performance evaluation criteria	
Visual evaluation	Accepted [] Rejected []
FAT Report evaluation (see Annexure-I: Proposed RF source Layout)	Accepted [] Rejected []
SAT Report evaluation (see Annexure-I: Proposed RF source Layout)	Accepted [] Rejected []
Test for performance evaluation (see Annexure-I: Proposed RF source Layout)	Accepted [] Rejected []
Comments (if any)	
Attachments (if any)	Detailed information may shall be attached in support
Filled by Bidder's Representative	Filled by ITER-India's/IO's Representative
Name:	Name:
Date:	Date:
Signature:	Signature:


	Tender documents [PART-A(ii)]: Scope of Supply, work and Technical Specifications for Phase 2-Driver and Final stage amplifiers for 2 sets of ITER ICRF Sources.- GLOBAL TENDER NOTICE NO: I-I/ET-TPT/25001/25-26	INDUS Ref.
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16.20 *Interface Title: Local Control Unit (LCU)*

ITER-India contract no.			
Contract title			
Contractor			
Person Involved in Validation:		Date:	
Major Technical Specifications			
<i>Local Control Unit (LCU)</i>			

Description	Observations	Remarks
Sequential control system		
Interfacing and health monitoring system of different sub system		
Data Acquisition system: Acquisition with Normal speed & acquisition with 1 μ s with pre & post data for 100ms w.r.t. fault initiated RF muting		
Fast Protection system		
Offline analysis module		

Performance evaluation criteria	
Visual evaluation	Accepted [] Rejected []
Technical evaluation	Accepted [] Rejected [] with standalone Accepted [] Rejected [] with HPA2 Interface Accepted [] Rejected [] with power test
Comments (if any)	
Attachments (if any)	LCU: Annex-1 (see in next page)
Filled by Bidder's Representative	Filled by ITER-India's/IO's Representative
Name:	Name:
Date:	Date:
Signature	Signature:


	Tender documents [PART-A(ii)]: Scope of Supply, work and Technical Specifications for Phase 2-Driver and Final stage amplifiers for 2 sets of ITER ICRF Sources.- GLOBAL TENDER NOTICE NO: I-I/ET-TPT/25001/25-26	INDUS Ref.
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LCU: Annex-1

Interlock	Interlock Simulation	Desired Actions	Results	Remarks
Water Cooling	By creating a fault in HPA2 Water Cooling System			
Air Cooling	By creating a fault in HPA2 Air Cooling System			
Temp & Pressure Security	By creating a fault in HPA2 Temp & Press Security System			
Dummy Load Fault	By creating a fault in Dummy Load System			
Tuning System	By changing Frequency of the system at all Power supply on state			
Filament Trip	By creating Filament Over Voltage condition			
CG Trip	By creating CG Over Voltage condition			
HVPS Trip	By creating HVPS Over Voltage condition			
SG Trip	By creating SG Over Voltage condition			
CG Reverse Current	By creating CG Reverse current condition			
CG Over Current	By creating CG Over current condition			
SG Over Current	By creating SG Over current condition			
APD max	By changing APD Max limit			
Over Reflection	By changing Max over reflection limit			
Emergency OFF	By pushing Emm OFF button			

Note:

Monitoring & Interlocks will be tested as per Logic required by Bidder's representative for safe operation.

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16.21 *Validation of Indian made HPA2*


The validation process mentioned below is prepared as per established FAT/SAT procedures of HPA2, however, bidder shall suggest additional validation/qualification tests if any for Indian make HPA2 during their offer.

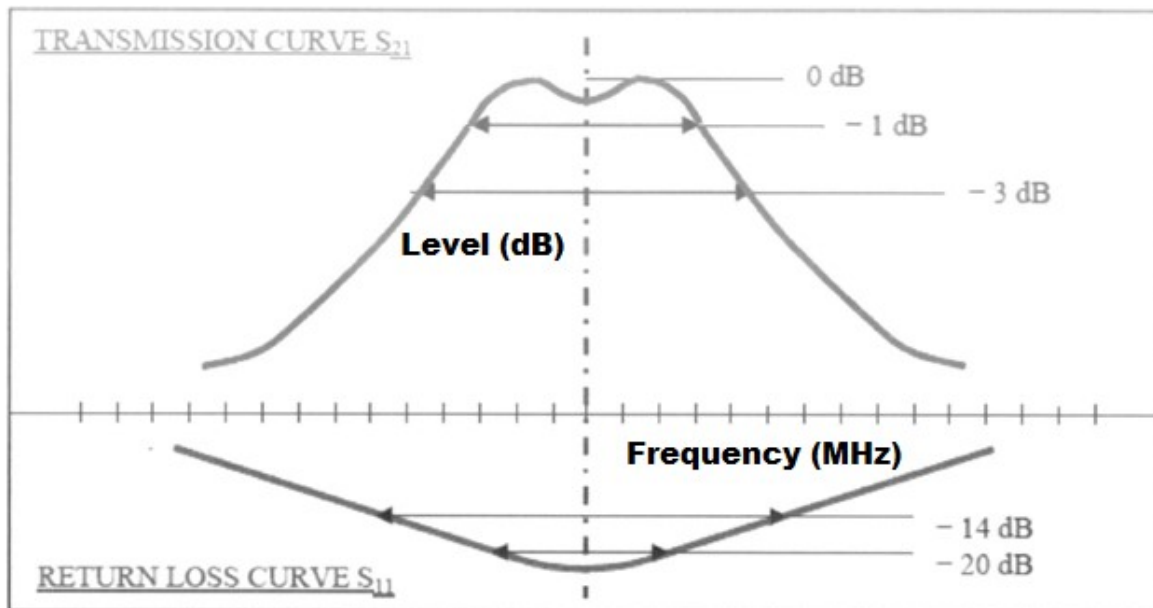
Grid tube protection (test report will be provided):

1. Calibrated copper wire burn test of HVPS for Anode (As per data sheet of TH781): Yes/No
2. Fast fuse test (1.0A) of Screen grid power supply for tube TH781: Yes/No
3. Fast fuse test (0.5A) of Control grid power supply for tube TH781: Yes/No
4. Over voltage & over current protection of HVPS for Anode as per defined threshold: Yes/No
5. Over voltage & over current protection of SGPS for screen grid as per defined threshold: Yes/No
6. Over voltage & over current protection of CGPS for control grid as per defined threshold: Yes/No
7. Cooling System:
 - a) Air flow for input circuit: Yes/No
 - b) Air flow for primary output circuit: Yes/No
 - c) Air flow for secondary output circuit: Yes/No
 - d) Air flow protection: Yes/No
 - e) Water flow rate and pressure for Anode: Yes/No
 - f) Water pressure for Anode inlet: Yes/No
 - g) Water pressure for Anode outlet: Yes/No
 - h) Water flow rate for Screen grid: Yes/No
 - i) Interlock with water outlet temperature threshold: Yes/No
8. Protections/interlocks through LCU:
 - a) Checking for all interlocks/protections as per requirement: Yes/No
 - b) Checking of filament ramp up and ramp down time: Yes/No
 - c) Arc detection-fast protection: Healthiness of two arc detectors (lamp test) and related interlocks: Yes/No


Cavity Test:

- Frequency: to be swept at specified range [35 MHz-65 MHz] within 180/360 s from lower to higher frequency or vice versa.
- Tuning configuration: for 36, 40, 42, 53, 55 & 60 MHz.
- All the low power tests (VNA test) along with parasitic test will be performed and compared with the FAT of HAP2 manufactured by bidder during Phase 2.

	Tender documents [PART-A(ii)]: Scope of Supply, work and Technical Specifications for Phase 2-Driver and Final stage amplifiers for 2 sets of ITER ICRF Sources.- GLOBAL TENDER NOTICE NO: I-I/ET-TPT/25001/25-26	INDUS Ref.
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Frequency (MHz): 36 MHz							
Tuning Positions:							
M1	M2	M3	M4	M5	M6	M7	M8
S Parameters measured on VNA:							
Vf (V)	If (A)	Va (kV)	Ia (A)	Vg2 (V)	Ig2 (mA)	Vg1 (V)	Ig1 (mA)
9.5	315	13.0	3	1250			
S11 at CF (dB)	S11, -20dB ΔF (MHz)	S11, -14dB ΔF (MHz)	S21, RF gain (dB) at CF	S21, -1dB ΔF (MHz)	S21, -3dB ΔF (MHz)	Output DC Coupling (dB)	Tuning time
Parasitic Test: HOMs observed on VNA				Result:			
Vf (V)	If (A)	Va (kV)	Ia (A)	Vg2 (V)	Ig2 (mA)	Vg1 (V)	Ig1 (mA)
9.5	315	13.0	0 to 8	1250			

	Tender documents [PART-A(ii)]: Scope of Supply, work and Technical Specifications for Phase 2-Driver and Final stage amplifiers for 2 sets of ITER ICRF Sources.- GLOBAL TENDER NOTICE NO: I-I/ET-TPT/25001/25-26	INDUS Ref.
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Frequency (MHz): 40 MHz							
Tuning Positions:							
M1	M2	M3	M4	M5	M6	M7	M8
S Parameters measured on VNA:							
Vf (V)	If (A)	Va (kV)	Ia (A)	Vg2 (V)	Ig2 (mA)	Vg1 (V)	Ig1 (mA)
9.5	315	13.0	3	1250			
S11 at CF (dB)	S11, -20dB ΔF (MHz)	S11, -14dB ΔF (MHz)	S21, RF gain (dB) at CF	S21, -1dB ΔF (MHz)	S21, -3dB ΔF (MHz)	Output DC Coupling (dB)	Tuning time
Parasitic Test: HOMs observed on VNA Result:							
Vf (V)	If (A)	Va (kV)	Ia (A)	Vg2 (V)	Ig2 (mA)	Vg1 (V)	Ig1 (mA)
9.5	315	13.0	0 to 8	1250			


Frequency (MHz): 42 MHz							
Tuning Positions:							
M1	M2	M3	M4	M5	M6	M7	M8
S Parameters measured on VNA:							
Vf (V)	If (A)	Va (kV)	Ia (A)	Vg2 (V)	Ig2 (mA)	Vg1 (V)	Ig1 (mA)
9.5	315	13.0	3	1250			
S11 at CF (dB)	S11, -20dB ΔF (MHz)	S11, -14dB ΔF (MHz)	S21, RF gain (dB) at CF	S21, -1dB ΔF (MHz)	S21, -3dB ΔF (MHz)	Output DC Coupling (dB)	Tuning time

	Tender documents [PART-A(ii)]: Scope of Supply, work and Technical Specifications for Phase 2-Driver and Final stage amplifiers for 2 sets of ITER ICRF Sources.- GLOBAL TENDER NOTICE NO: I-I/ET-TPT/25001/25-26	INDUS Ref.
		II-FB7DPL6-v_2_1

Parasitic Test: HOMs observed on VNA					Result:		
Vf (V)	If (A)	Va (kV)	Ia (A)	Vg2 (V)	Ig2 (mA)	Vg1 (V)	Ig1 (mA)
9.5	315	13.0	0 to 8	1250			

Frequency (MHz): 53MHz							
Tuning Positions:							
M1	M2	M3	M4	M5	M6	M7	M8
S Parameters measured on VNA:							
Vf (V)	If (A)	Va (kV)	Ia (A)	Vg2 (V)	Ig2 (mA)	Vg1 (V)	Ig1 (mA)
9.5	315	13.0	3	1250			
S11 at CF (dB)	S11, -20dB ΔF (MHz)	S11, -14dB ΔF (MHz)	S21, RF gain (dB) at CF	S21, -1dB ΔF (MHz)	S21, -3dB ΔF (MHz)	Output DC Coupling (dB)	Tuning time
Parasitic Test: HOMs observed on VNA					Result:		
Vf (V)	If (A)	Va (kV)	Ia (A)	Vg2 (V)	Ig2 (mA)	Vg1 (V)	Ig1 (mA)
9.5	315	13.0	0 to 8	1250			

Frequency (MHz): 55 MHz							
Tuning Positions:							
M1	M2	M3	M4	M5	M6	M7	M8
S Parameters measured on VNA:							
Vf (V)	If (A)	Va (kV)	Ia (A)	Vg2 (V)	Ig2 (mA)	Vg1 (V)	Ig1 (mA)
9.5	315	13.0	3	1250			


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S11 at CF (dB)	S11, -20dB ΔF (MHz)	S11, -14dB ΔF (MHz)	S21, RF gain (dB) at CF	S21, -1dB ΔF (MHz)	S21, -3dB ΔF (MHz)	Output DC Coupling (dB)	Tuning time
Parasitic Test: HOMs observed on VNA				Result:			
Vf (V)	If (A)	Va (kV)	Ia (A)	Vg2 (V)	Ig2 (mA)	Vg1 (V)	Ig1 (mA)
9.5	315	13.0	0 to 8	1250			

Frequency (MHz): 60 MHz							
Tuning Positions:							
M1	M2	M3	M4	M5	M6	M7	M8
S Parameters measured on VNA:							
Vf (V)	If (A)	Va (kV)	Ia (A)	Vg2 (V)	Ig2 (mA)	Vg1 (V)	Ig1 (mA)
9.5	315	13.0	3	1250			
S11 at CF (dB)	S11, -20dB ΔF (MHz)	S11, -14dB ΔF (MHz)	S21, RF gain (dB) at CF	S21, -1dB ΔF (MHz)	S21, -3dB ΔF (MHz)	Output DC Coupling (dB)	Tuning time
Parasitic Test: HOMs observed on VNA				Result:			
Vf (V)	If (A)	Va (kV)	Ia (A)	Vg2 (V)	Ig2 (mA)	Vg1 (V)	Ig1 (mA)
9.5	315	13.0	0 to 8	1250			

M1: Second input tuning
M3: Input coupling
M5: Primary output tuning
M7: Secondary output tuning

M2: First input tuning
M4: Neutralization
M6: Primary to secondary output coupling
M8: Output coupling

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Standalone Power test on Matched load:

During run test for 120kW/2000s following parameters will be recorded-

Parameters	Freq. (MHz)	Vf (V)	If (A)	Vg1 (V)	Ig1 (A)	Vg2 (V)	Ig2 (A)	Va (kV)	Ia (A) (idle)	Ia (A)	Pf (kW)	Pr (W)
SSPA	36	-	-	-	-	-	-	-	-	-		
HPA-2	36											
Harmonics level: H0: dB, H1: dB, H2: dB, H3: dB, H4: dB Record of output power at centre frequency and at +/- 1MHz keeping input power constant: CF: MHz Pout: kW F1: MHz Pout: kW F2: MHz Pout: kW Pin: kW												

Parameters	Freq. (MHz)	Vf (V)	If (A)	Vg1 (V)	Ig1 (A)	Vg2 (V)	Ig2 (A)	Va (kV)	Ia (A) (idle)	Ia (A)	Pf (kW)	Pr (W)
SSPA	40	-	-	-	-	-	-	-	-	-		
HPA-2	40											
Harmonics level: H0: dB, H1: dB, H2: dB, H3: dB, H4: dB Record of output power at center frequency and at +/- 1MHz keeping input power constant: CF: MHz Pout: kW F1: MHz Pout: kW F2: MHz Pout: kW Pin: kW												



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Parameters	Freq. (MHz)	Vf (V)	If (A)	Vg1 (V)	Ig1 (A)	Vg2 (V)	Ig2 (A)	Va (kV)	Ia (A) (idle)	Ia (A)	Pf (kW)	Pr (W)
SSPA	42	-	-	-	-	-	-	-	-	-		
HPA-2	42											

Harmonics level: H0: dB, H1: dB, H2: dB, H3: dB, H4: dB

Record of output power at center frequency and at +/- 1MHz keeping input power constant:

CF: MHz Pout: kW

F1: MHz Pout: kW

F2: MHz Pout: kW

Pin: kW

Parameters	Freq. (MHz)	Vf (V)	If (A)	Vg1 (V)	Ig1 (A)	Vg2 (V)	Ig2 (A)	Va (kV)	Ia (A) (idle)	Ia (A)	Pf (kW)	Pr (W)
SSPA	53	-	-	-	-	-	-	-	-	-		
HPA-2	53											

Harmonics level: H0: dB, H1: dB, H2: dB, H3: dB, H4: dB

Record of output power at center frequency and at +/- 1MHz keeping input power constant:


CF: MHz Pout: kW

F1: MHz Pout: kW

F2: MHz Pout: kW

Pin: kW

Parameters	Freq. (MHz)	Vf (V)	If (A)	Vg1 (V)	Ig1 (A)	Vg2 (V)	Ig2 (A)	Va (kV)	Ia (A) (idle)	Ia (A)	Pf (kW)	Pr (W)
SSPA	55	-	-	-	-	-	-	-	-	-		
HPA-2	55											

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Harmonics level: H0: dB, H1: dB, H2: dB, H3: dB, H4: dB

Record of output power at center frequency and at +/- 1MHz keeping input power constant:

CF: MHz Pout: kW

F1: MHz Pout: kW

F2: MHz Pout: kW

Pin: kW

Parameters	Freq. (MHz)	Vf (V)	If (A)	Vg1 (V)	Ig1 (A)	Vg2 (V)	Ig2 (A)	Va (kV)	Ia (A) (idle)	Ia (A)	Pf (kW)	Pr (W)
SSPA	60	-	-	-	-	-	-	-	-	-		
HPA-2	60											

Harmonics level: H0: dB, H1: dB, H2: dB, H3: dB, H4:

Record of output power at centre frequency and at +/- 1MHz keeping input power constant:


CF: MHz Pout: kW

F1: MHz Pout: kW

F2: MHz Pout: kW

Pin: kW

Performance evaluation criteria	
Visual evaluation	Accepted [] Rejected []
	Accepted [] Rejected []
	Accepted [] Rejected []
	Accepted [] Rejected []
Comments (if any)	
Attachments (if any)	
Filled by Bidder's Representative	Filled by ITER-India's/IO's Representative
Name:	Name:
Date:	Date:
Signature:	Signature:

	Tender documents [PART-A(ii)]: Scope of Supply, work and Technical Specifications for Phase 2-Driver and Final stage amplifiers for 2 sets of ITER ICRF Sources.- GLOBAL TENDER NOTICE NO: I-I/ET-TPT/25001/25-26	INDUS Ref.
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17 Annexure-H: Description of items to be provided by ITER-India

ITER-India is responsible for the following systems/subsystems/components to perform SAT activities as per conditions given in the contract for Phase-2 at ITER-India lab. Subsequently these items will be part of RF power source.

Bidder are suggested to go through the document thoroughly and discuss with ITER-India for any query/justification during pre-bid meeting, to finalize the choice of the components.

Bidder will define as well what could be the parameters/specifications dimensioning their own design as the RF source final design including the components and processes described in this chapter has to be accepted by IO through formal process.


17.1 Low Power Components

17.1.1 Specifications for RF Synthesizer

An RF synthesizer is utilized to generate a low power signals as per operating frequency and to fulfil other modulation requirements.

Table H1: Specifications for RF Synthesizer

Parameter		Specifications
Frequency	Frequency range	9kHz to 1GHz
	Frequency resolution	0.001Hz
	Frequency switching speed	≤ 5 ms
	Reference input/output	10 MHz
	Sweep modes	Step sweep, List sweep
	Sweep range	Within instrument frequency range
Amplitude	Output power	≥ +18 dBm
	Settable range	+18 to -144 dBm
	Resolution	0.01 dB
	Amplitude switching speed	≤ 5 ms
Spectral Purity	Harmonics	< -35 dBc
	Non-harmonics	≤ -65 dBc nominal
Analog Modulation	Modulation types	AM, FM, PM and Pulse modulation
Frequency Modulation	Max. deviation	10 MHz
	FM resolution	0.025% of deviation or 1 Hz
Phase Modulation	Max. deviation	5 Radians
	PM resolution	0.1% of deviation
Amplitude Modulation	Maximum depth	100%
	AM depth resolution	0.1% of depth
	Standard internal analog modulation source waveform	Sine, square, triangle, positive ramp, negative ramp
Proposed Model		N5171B (Maker: Keysight)

	Tender documents [PART-A(ii)]: Scope of Supply, work and Technical Specifications for Phase 2-Driver and Final stage amplifiers for 2 sets of ITER ICRF Sources.- GLOBAL TENDER NOTICE NO: I-I/ET-TPT/25001/25-26	INDUS Ref.
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17.1.2 RF switch & Splitter

An RF switch at the output of the synthesizer is used to turn RF power ON/OFF. The output of the RF switch is fed to a low power 1x5 splitter to drive four RFPS and a source connected to the test facility. Each output of 1x5 splitter is connected to a 1x2 power splitter to drive two identical cascaded chains consisting of SSPA, HPA-2 & HPA-3. The 1x2 splitter provides the drive signal for both chains of amplifiers at the desired frequency, which is generated by a singular source signal, in order to avoid any deviation in frequency between the two chains. The RF switch is activated by LCU to switch the RF OFF in case of fault detection or during emergency. This is a fast RF ON/OFF switch with an attenuation better than 60dB when switched off. It is operated by LCU through a TTL signal within ~1μs to turn the RF signal OFF. The detail specifications are as following:

Table H2: Specifications for RF switch


Input/ output connectors	N (f), 50 Ω
Operating Frequency Range	36 to 60 MHz
Input power	-10 to +20 dBm
Switching time	Less than 1 μs
Attenuation inserted when off	Better than 60 dB
ON/OFF voltage levels	TTL compatible
Proposed Model (Custom Built)	Maker: ITER-India

Table H3: Specifications for 1x5 splitter

Input/output connectors	N (f), 50 Ω
Operating frequency	35-65 MHz
Input power	-15 to +23dBm
Input to output ratio	1:1
VSWR	Better than 1.2
Isolation between output ports	≥20 dB
Phase balance at output	+/- 0.5°
Amplitude balance at output	+/- 0.2 dB
Proposed Model (Custom built)	AUM-0005-PDK (Maker: AUM Sales)

Table H4: Specifications for 1x2 splitter

Input/output connectors	N (f), 50 Ω
Operating frequency	35-65 MHz
Maximum input power	30dBm
Input to output ratio	1/2
VSWR	Better than 1.15
Isolation between output ports	≥30 dB
Phase balance at output	+/- 0.2°
Amplitude balance at output	+/- 0.2 dB
Proposed Model	ZFSC-2-4-N+ (Maker: Mini-Circuits)

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17.1.3 *Voltage control phase shifter*

Two low power phase shifters are connected at each arm of the output of 1x2 splitter. They are controlling/setting the required phasing of the RFPS during operation, with respect to phase reference signal, and maintaining predefined phasing of the two inputs of the 3dB Hybrid combiner. The feedback control loop has a fine real time phase adjustment and is interfaced with the voltage-controlled phase shifter to fulfil the requirement. The specifications of the voltage-controlled phase shifter are as following:

Table H5: Specifications of voltage control phase shifter

Input/ output connectors	N (f), 50 Ω
Operating Frequency Range	35 to 65 MHz
Input power	-10 to +23 dBm
Phase variation	0° to 360° continuously
Phase accuracy	+/- 3°
Control input	0 to 10V, 30mA, DC to 10 kHz
Control input step size	10 mV with a response time of 10 μ s


17.1.4 *Voltage control linear attenuator*

As per requirement, the RFPS should have power modulation range starting from few kW to 2.5/3.0 MW at output of combiner. To have few kW RF power at the output of combiner, the input drive to SSPA is controlled by using voltage control attenuator according to desired power by LCU. A feedback control loop interfaced with attenuator has a fine online amplitude variation to ensure constant output power irrespective of load variation up to 2:1 VSWR.

An additional voltage-controlled attenuator is connected in series as per requirement. Its drive power variation starts from 0 dB up to ~50 dB with an input DC control voltage of 10 V to 0V. The detail specifications are given below.

Table H6: Specifications of voltage control linear attenuator

Input/output connectors	N (f), 50 Ω
Operating Frequency Range	35 to 65 MHz
Input power	-10 to +23 dBm
Insertion loss at control voltage of 10V	Maximum 0.5dB
Attenuation at control voltage of 0V	Minimum 50dB
Attenuation variation	5dB/volt, 0 to 50 dB continuously for control voltage 10 to 0V, with resolution of ± 1 dB
Control input	0-10 V, 30 mA, DC to 1 kHz. (BNC connector)
Control input step size	10 mV with a response time of ≤ 15 μ s

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17.2 Solid State Power Amplifier (SSPA)

The SSPA is a broadband power amplifier that covers the specified frequency range with gain flatness of better than 0.5dB within 4MHz bandwidth. The required maximum output power can be adjusted from 0 to 10kW within the operating frequency range to control the output power of HPA-3. The output of voltage control linear attenuator is connected to the input of SSPA to drive it. The SSPA is protected from overdrive, over-VSWR and thermal overload to avoid any damage. The main specifications of SSPA are as follows:


Table H7: Specifications of Solid-State Power Amplifier (SSPA)

Input connectors	N (f), 50 Ω
Output connectors	3 1/8 inch EIA flange, 50 Ω
Operating frequency range	35 to 65 MHz
Nominal output power level	0 W to 10kW
Nominal drive power	10 dBm
Nominal gain	60 dB
Duration of operation	3600s “ON” time with 25% duty cycle
Harmonic and spurious	Better than -20 dBc
Self-protection and indicator on front panel for output VSWR limit (3:1)	Over-current, Over-heating, Over-input drive, Internal fault, Power supply fault, Cooling fault
Fast ON/OFF with external trip signal: (BNC/SMA type connector)	RF OFF: < 5 μ s RF ON: < 1 μ s
RF samples (With external 3” Directional Coupler)	Forward power & reflected power (N Type female)
RF leakage	$\leq 1\text{mW/cm}^2$
Cooling water parameters type & quality of the water:	Inlet pressure: 5 bar max Water inlet temperature (Maximum): 35 $^{\circ}\text{C}$ Flow rate: Minimum of 28 LPM DMDI water
AC mains input	AC mains input: 400 V, $\pm 10\%$ (3 phases) , @ 50 Hz
No damage maximum input power	20 dBm
Approximate overall size of the unit	62cm(W) X 91cm(D) X 149cm(H)
Approximate weight	350 kg
Storage temperature	0-50 $^{\circ}\text{C}$
Operating temperature	10-40 $^{\circ}\text{C}$
Maximum room humidity	95%, non-condensing

17.3 Description of local control unit (LCU)

The local control unit is required to control the operation of its RF source remotely through GUI running on CODAC terminal and able to communicate with different control units of plant I&C as well as central control system, CODAC.

The local control unit for prototype is similar to the R&D LCU as per functional requirements. However, developmental platform will be CODAC core system instead of LabVIEW. All the information regarding the status of the RFPS are communicated to the Plant I&C by the LCU

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in real time. Similarly, any command/information from CODAC is transmitted to the LCU through plant I&C. LCU of RF power source communicates with the plant I&C system through Plant System Host (PSH). The Plant I&C system is connected with the LCUs of transmission line and antenna. These LCUs & plant I&C are connected through PON, TCN and local SDN network. The ICH main controller and RFPS LCU are connected through SDN for fast exchange/sharing of data/information. The RFPS LCU is directly connected with the HVPS LCU through hardwired optical signals for status update & control purposes, as it is considered an integral part of RFPS. A few interfacing signals with different LCUs may require hardwired interfacing for safe operation of integrated system. The following figure shows the network communication between different I&C components of IC H&CD plant and central control system (CODAC).

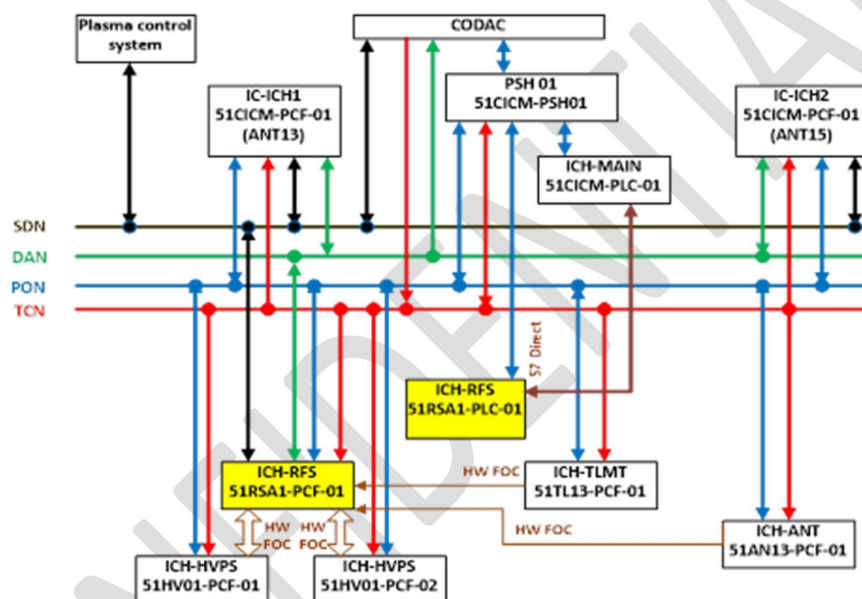



Fig. H-2: Network communication between different plant systems with LCU

The following modules will be developed for the data acquisition, control and protection requirements of the RF source:

1. Sequence control system;
2. Local fast protection and RF reapplication;
3. Amplitude & phase measurement;
4. Real time control loop which includes phase, frequency and power control loop along with anode voltage control loop;
5. Data acquisition, monitoring & event logging;
6. Tuning motor control;
7. Management of water & air cooling distribution system.

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17.3.1 *Sequence Control System*

Each subsystem in the chain of amplifiers is set to operation or shutdown under the supervision of a dedicated control loop which brings the system from “OFF” to “Ready for RF-ON” state by sequentially biasing different electrodes of high power tube. Once the system is in “RF ON” state, the local control loop becomes active to change the different RF parameters in real time as per ITER experimental requirement.

Each subsystem will be driven independently through the start up/down sequence and can remain for an indefinite time at each level, unless:

- An operator command requests a higher or lower level;
- An alarm incompatible with the actual level of readiness occurs.

Thus, it ensures a proper operational sequence between the different states of the amplifier as shown in figure below.

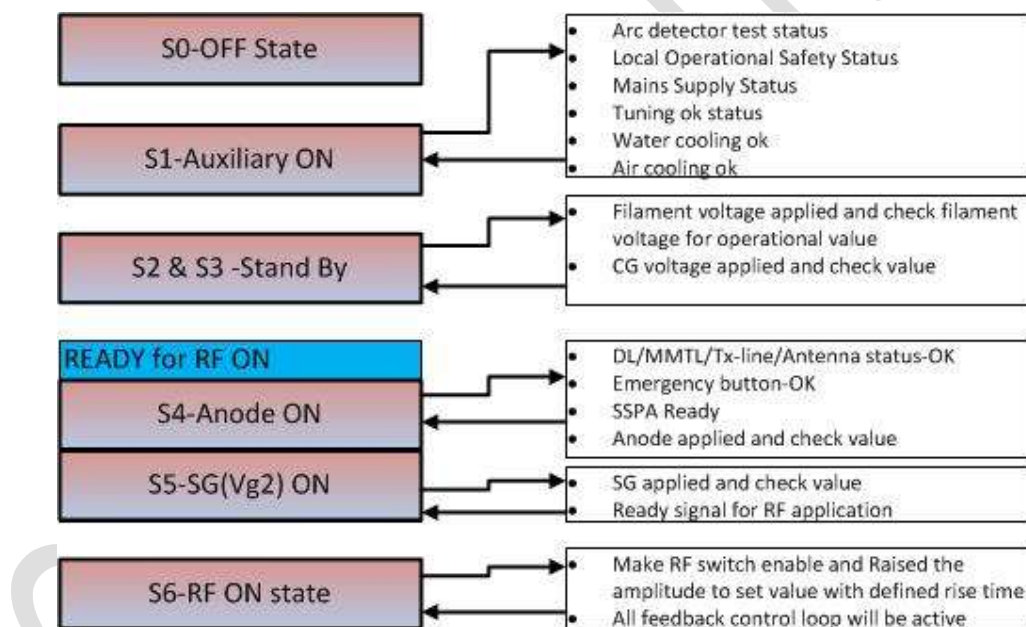



Fig. H-3:Operational sequence between the different states

The set-up time from standby to nominal power shall be 200 ms.

17.3.2 *Local Protection and RF re-application*

The local protection system will be developed using NI make FPGA module and will be able to generate an OFF signal within 10μs. If the operating parameter crosses the maximum threshold specified by system designer, RF drive and required power supply(s) will be

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withdrawn. In order to maintain smooth operation, all these signals will be connected to a fault handling system.

Fault signals are classified in two categories:

- (3) RF-related faults and
- (4) Power supply related faults.


RF-related fault like arcing fault, Over VSWR, amplitude control timeout, etc. will be considered for reapplication of RF. In this case, RF will be switched off within 10 μ s then, after a pre-defined recovery time, re-applied with a programmable ramp up time (the anode voltage will not be switched-off during this process). This process will repeat itself until the number of faults exceed the maximum predefined allowed number.

Different arc detectors are installed at different locations to detect the light of an arc in the system and generate the digital signal to take further action by local protection system. For cavity arc, RF as well as anode voltage, SG voltage & CG voltage will be removed by fast protection module. For external arc, RF will be switched off and reapplied using RF reapplication module without removing anode voltage.

If power supply related faults like SG over current, Anode over current, CG over current etc. are detected, RF will be switched off and corresponding power supply(s) will be switched off depending on the fault condition.

17.3.3 *Amplitude & Phase Measurement*

The amplitude and phase of the RF signals is measured using direct sampling method. The signal received from the directional coupler in the range of 35-60 MHz will be directly sampled, digitized and processed for amplitude & phase measurement. This measurement technique will be used at four locations in each source, i.e. DC1, DC4, DC7 & DC8, which are shown in the following figure. As this requires large FPGA resources, only those locations are considered for DDC measurements that are required for amplitude & phase control loop. At the other locations, RF detectors are used to convert RF samples into DC voltage and acquire for further processing.

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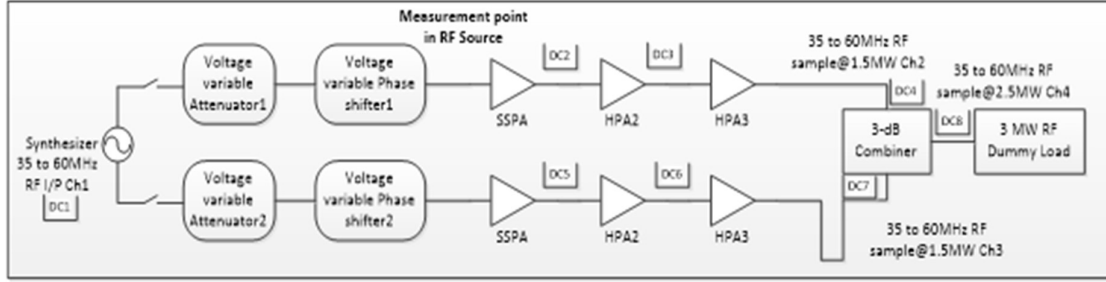


Fig. H-4:Measurement points for amplitude and phase for RF source

17.3.4 Real time control loop

The critical requirement for RF source is to control/maintain the amplitude, phase & frequency of the RF output. For measurement & control of amplitude and phase, a Digital I&Q-based technique is considered where Digital down conversion (DDC) and appropriate decimation process will be used to optimize the sample of I&Q for calculation of amplitude & phase. The following figure describes the basic architecture of amplitude & phase measurement & control loop for each source:

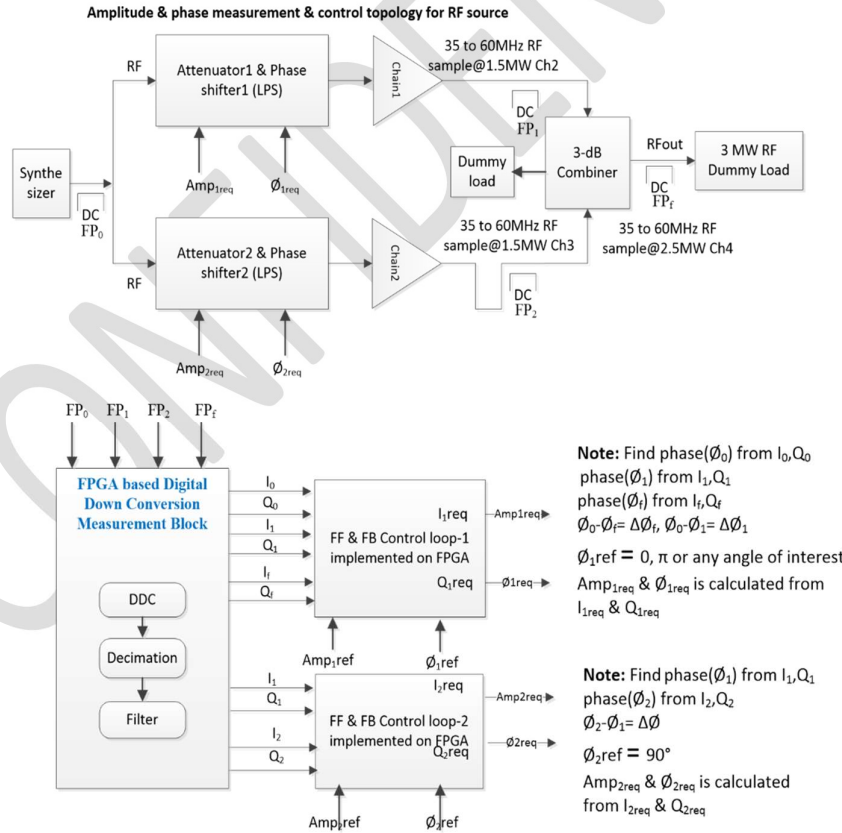



Fig. H-5:Amplitude & phase measurement and control topology

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17.3.4.1 Phase control loop

In each source, two phase control loops will be incorporated. One to maintain the phasing of the source output with respect to phase reference provided by plant I&C (main controller) and the other to maintain 90° phasing between the outputs of the two amplifiers chains, which are connected at the input of the 3dB Hybrid combiner.

17.3.4.1.1 Phase control loop for Individual Source

Phasing references for individual source are generated by the Plant I&C and communicated to the Local Control Unit (LCU). Corresponding to this, the LCU will generate a reference for controlling the phase output of the source.

The measurement block takes the RF samples as FP_0 , FP_1 , FP_2 & FP_f and digitizes through 4-channel digitizer for further processing to get I, Q corresponding to each RF signal. Control loop 1 is responsible for controlling the phase of the source output and hence it will calculate the relative phase between FP_0 & FP_1 ($\Delta\phi_1$) and FP_0 & FP_f ($\Delta\phi_f$) and then try to maintain $\Delta\phi_f$ as requested by plant I&C. To that end, control loop 1 generates the signal ϕ_{1req} , to control the phase shifter in chain-1.

17.3.4.1.2 Phase control loop for 3dB Hybrid combiner


To maintain a predefined phasing (90°) between the two inputs of the 3dB Hybrid combiner, control loop 2 is used. It will calculate the relative phase between FP_1 & FP_2 ($\Delta\phi$) and then generate reference for phase control at 90°. Corresponding to this phase reference, the signal ϕ_{2req} is generated to control the phase shifter connected in chain-2.

Each controller of Plant I&C (main controller) and RF synthesizer should be phase-locked to a single reference. The reference signal of fixed frequency (10MHz) is provided by plant control system otherwise synchronized through TCN.

17.3.4.2 Frequency control loop

The frequency control scheme will allow 1 kHz of accuracy and a response time of 1 ms. The RF Synthesizer interfaces with the RFS controller through PON N/w by mean of an Ethernet port.

Frequency changes within the amplifier bandwidth (2MHz) are obtained by frequency synthesizer itself. The frequency of operation can be changed up to hundreds of Hz by changing the control voltage of frequency modulating signal of synthesizer. LCU controller will generate the control voltage as modulating signal, based on the reference signal received from the plant I&C (main controller).

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17.3.4.3 Power Control Loop

The regulation system provides constant output power during load variation up to VSWR ~2:1 and at the same time protects the amplifying devices (Diacrode/tetrode) of RFPS by reducing the RF power instead of turning it off (Limiting Mode Operation).

To optimize the operation and safety of the tubes, mainly two parameters are regulated as following:

- The output power is regulated as per the requested power level by comparing the measured feedback signal with the reference level (derived from reference signal & provided by Plant Control System)
- Local amplitude control loop will be developed around each chain of amplifier where reference for each chain is derived locally based on the overall reference for individual source communicated by Plant I&C (main controller).
- Each local control loop will maintain the output by generating control signal of Amp_{1req} & Amp_{2req} for attenuator connected in each chain of amplifier.
- As 3dB Hybrid combiner is passive component, having fixed efficiency for any operating frequency and for 90-degree input phasing, it is expected that final output power will be sum of output power of each chain (with fixed efficiency).


17.3.4.4 HPA3 Anode voltage and RF power regulation loop

Anode Voltage is regulated (VA LOOP) to enhance the electrical efficiency by optimizing anode voltage, which is governed by screen grid current (I_{g2}) and correspondingly minimizing the dissipated power.

Normally I_{g2} varies due to change in load impedance. The regulation system keeps I_{g2} constant at its pre-defined value by adjusting the anode voltage. In this way the efficiency of the system is optimized.

Regulation loops (VSWR & VA loops) are integrated in one system as anode voltage influences both SG current (I_{g2}) and Anode Power Dissipation (APD) by optimizing both the parameters. Also fault handling system will be enabled so that if any regulation loop fails to keep the parameter below the safety limit, RF will be withdrawn to protect the tubes.

Note: It may be important to perform a global simulation of the whole system to validate LCU control. For this purpose, bidder is required to provide with a calculation model of the tubes to ITER-India.

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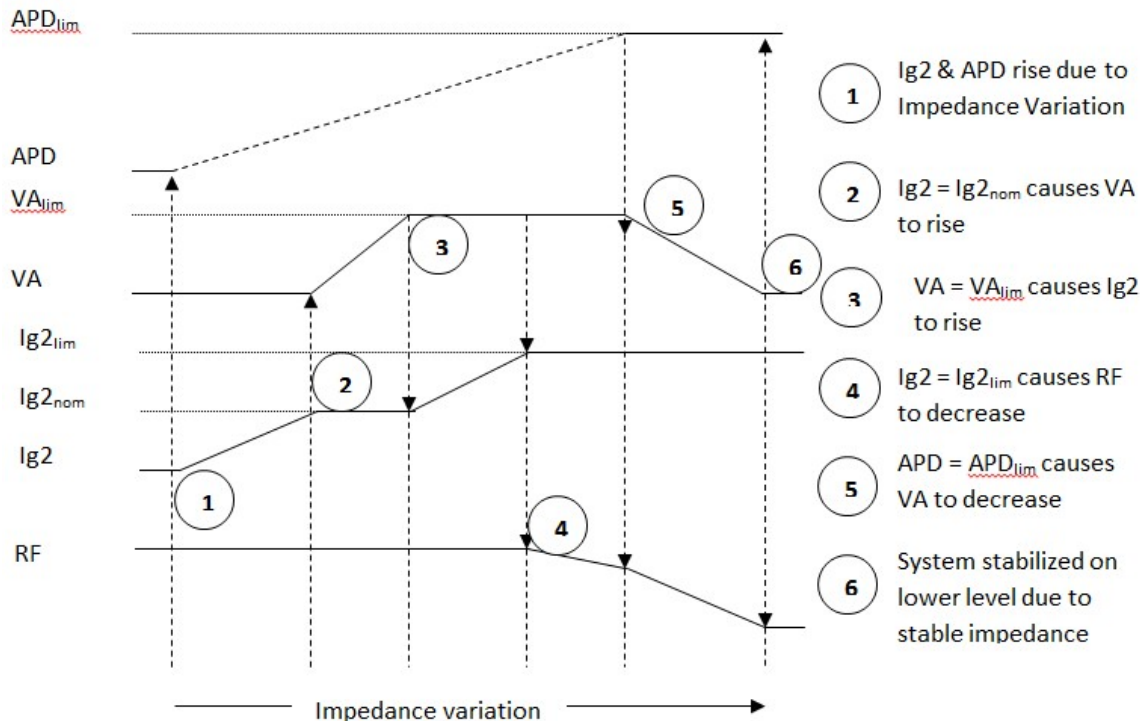



Fig. H-6: Anode voltage & RF power regulation

In case due to any reason Anode voltage cannot be increased and $Ig2$ reaches its second limit; reference to amplitude control loop is forced to decrease the RF drive power to keep $Ig2$ within the limiting value. The $Ig2$ regulation works as long as dissipated power APD remains under limit. As soon as it crosses the limiting value, anode voltage will be reduced further which leads the source in limiting mode.

Thus, output power is automatically limited by power regulation loop, if one or more system parameters are detected 'out of range'. In this case limiting value of different parameters are considered in the loop and input RF drive is decreased to get 'in range' condition. Plant I&C should be informed in real time about the output power delivered to the load so that it can take appropriate action to maintain the required output power. Different parameters like CG current, SG current, Plate current and VSWR (P_{fwd} and P_{refl}) at source end are monitored continuously throughout the RF pulse duration.

17.3.5 Data Acquisition, Monitoring & Event Logging

A continuous acquisition for all operational parameter i.e. voltage & current of each power supply, FP/RF at output of each stage, trip, OC & other status of different power supplies and subsystems are acquired continuously during RF shot at 1mS time scale and archived using DAN. Also, these data are acquired & archived at the rate of $1\mu s$ for time interval of 100mS pre & post data whenever any fault triggers the event of RF-off. During commission of the source, this feature will be very useful to analyse the real cause of fault.

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The acquired data is stored for off-line analysis purpose and user/operator may select channels of their interest for continuously monitoring in the form of online graph & digital indicators on HMI.

The event logging system logs different faults and commands with time stamping for future record.

17.3.6 *Motor Control System*

The Motor Control System controls the positioning of the tuning elements according to the operational frequency requested by Plant I&C. Predefined position of each tuning element corresponding to each operating frequency is saved as file. Based on the operating frequency, particular file is read by controller and position of each tuning motor is send to motor controller for moving the tuning element at required position.

17.3.7 *Management of water & air cooling distribution system*

Various parameter of water-cooling system like flow rate at individual branch, water pressure and temperature at inlet & outlet is continuously monitored and if any parameter is going out of defined range then source will be shut off and brought the system at S1-state by sequence control loop.


For proper air-cooling, many blowers are used, which will be sequentially switched on to reduce the transient loading of AC mains. At critical location, airflow is monitored using differential pressure switch and if the airflow is not sufficient then source will be shut off and brought the system at S1-state by sequence control loop.

17.3.8 *Summary of channel list used in LCU*

Preliminary channels for acquisition & controls areas listed below:

Table H8: channel list used in LCU

Type of signal	PS related signal	RF parameter related signal	Arc detector signal	Water & air cooling related signal
AI	32	20	0	100
AO	8	8	0	0
DI	75	12	38	34
DO	32	28	6	24
Total	141	48	44	158

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17.4 3dB hybrid Combiner

3dB hybrid combiner is an important component to combine the output power of two identical chains of RF amplifiers to get 2.5MW/2000s output power up-to load VSWR 2:1 in the specified frequency range of 36-60MHz.

Table H9: Technical Specification of 3dB hybrid Combiner


Operating frequency range	36MHz to 60MHz
Power rating	2.5MW/2000s with 25% duty cycle up-to VSWR 2:1
Design capability	3.0MW/3600s with 25% duty cycle up-to VSWR 1.5:1
No. of ports	4
Characteristic Impedance	50 $\Omega \pm 0.5 \Omega$
Input & output flanges	12 inch Swivel
Insertion loss (at 3dB point):	0.14dB (maximum) at VSWR < 1.1
Return Loss /Isolation	Better than -24dB when ports are terminated with 50 Ω
Phase imbalance between Input ports	2.4°
Amplitude Imbalance over the operating frequency range	3 dB ± 0.5 dB
Weight	~ 500 kg
Overall dimension (L X W X H)	~ 2400 mm X 950 mm X 600 mm
Thermal management	Forced air cooled

17.5 Coaxial Tx. line (3 1/8 inch) components:

17.5.1 Specifications of straight section, Tee and Elbows

Table H10: Specifications of 3 1/8 inch Tx. line

Specification	Details
Operating frequency range	35MHz to 65MHz
Power rating	10 kW/3600 s with 25% duty cycle
Characteristic Impedance	50 $\pm 0.5 \Omega$
Input & output flanges	3 1/8 inch (EIA)
Insertion loss	Better than 0.01dB
Return Loss	Better than -35dB
Inner Conductor joint	BeCu with silver plating
Inner Conductor support	Teflon disc

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17.5.2 Specifications of directional coupler

Table H11: Specifications of 3 1/8 inch directional coupler

Specification	Details
Operating frequency range	35MHz to 65MHz
Power rating	10 kW/3600 s with 25% duty cycle
Measurement ports	4
Characteristic Impedance	$50 \pm 0.5 \Omega$
Input & output flanges	3 1/8 inch (EIA)
Coupling port connection	Type N
Insertion loss	Better than 0.01dB
Return Loss	Better than -35dB
Directivity	Better than -30dB
Forward/ Reverse Coupling	-49 dB (at 50MHz) -52 dB to -47.5dB (from 35MHz to 65MHz)
Inner Conductor joint	BeCu with silver plating
Inner Conductor support	Teflon disc

17.6 Coaxial Tx. Line (6 1/8 inch) components

17.6.1 Specifications Straight section, Tee and Elbows


Table H12: Specifications of 6 1/8 inch Tx. line

Specification	Details
Operating frequency range	35MHz to 65MHz
Power rating	120 kW/3600s with 25% duty cycle
Characteristic Impedance	$50 \pm 0.5 \Omega$
Input & output flanges	6 1/8 inch (EIA)
Insertion loss	Better than 0.01dB
Return Loss	Better than -35dB
Inner Conductor joint	BeCu with silver plating
Inner Conductor support	Teflon disc

17.6.2 Specifications Directional Coupler

Table H13: Specifications of 6 1/8 inch directional coupler

Specification	Details
Operating frequency range	35MHz to 65MHz
Power rating	≥ 120 kW/3600 s with 25% duty cycle
Measurement ports	4
Characteristic Impedance	$50 \pm 0.5 \Omega$
Input & output flanges	6 1/8 inch (EIA)
Coupling port connection	Type N
Insertion loss	Better than 0.01dB

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Specification	Details
Return Loss	Better than -35dB
Directivity	Better than -30dB
Forward/ Reverse Coupling	- 60 dB (at 50MHz) -63 dB to -57 dB (from 35MHz to 65MHz)
Inner Conductor joint	BeCu with silver plating
Inner Conductor support	Teflon disc

17.7 Specifications of 12 inch Tx line components

17.7.1 Specifications of 12 inch Straight section, Tee and Elbows

The specifications of 12 inch Tx line components i.e. straight section, Tee and Elbows are as given in the table below:

Table H14: Specifications of 12 inch Tx. line


Technical Specification	
Operating frequency range	35MHz to 65MHz
Power rating	2.5MW/2000s with 25% duty cycle up-to VSWR 2:1
Design capability	3.0MW/3600s with 25% duty cycle up-to VSWR 1.5:1
Characteristic impedance	50 $\Omega \pm 0.5 \Omega$
Input & output flanges	12 inch Swivel
Insertion loss	Better than 0.01dB
Return Loss	Better than -35dB
Thermal management	Forced air cooled (annulus region) Outer conductor water cooled
Elbow type	90° Miter Bend
Inner Conductor joint	Bullet: Brass Finger contacts: BeCu Plating: Silver
Inner Conductor support	Teflon disc

17.7.2 Specifications of 12 inch directional coupler

Directional couplers are used in the output of HPA3 to monitor the forward and reflected RF power in the specified frequency range 35-65MHz.

Table H15: Specifications of 12 inch directional coupler

Technical Specification	
Operating frequency range	35MHz to 65MHz
Power rating	2.5MW/2000s with 25% duty cycle up-to VSWR 2:1

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Design capability	3.0MW/3600s with 25% duty cycle up-to VSWR 1.5:1
Measurement ports	4
Characteristic impedance	50 $\Omega \pm 0.5 \Omega$
Input & output flanges	12 inch Swivel
Coupling port connection	Type N
Insertion loss	Better than -0.02dB
Return Loss	Better than -40dB
Forward/ Reverse Coupling	-60 dB (at 50MHz) -62 dB to -57 dB (from 35MHz to 65MHz)
Directivity	Better than -29dB
Thermal management	Forced air cooled (annular space) Outer conductor water cooled
Directional coupler type	Loop coupled
Inner Conductor joint	Bullet: Brass Finger contacts: BeCu Plating: Silver
Inner Conductor support	Teflon disc

17.7.3 Specifications of 12 inch gas barrier

Gas barriers are used to isolate air cooling between cavities and transmission lines in the specified frequency range 35-65MHz.

Table H16: Specifications of 12 inch gas barrier

Technical Specification	
Operating frequency range	35MHz to 65MHz
Power rating	3.0 MW (maximum), 3600s, 25% duty cycle
No of ports	2
Characteristic Impedance	50 $\Omega \pm 0.5 \Omega$
Input & output flanges	12 inch Swivel
Insertion loss	Better than 0.01dB
Return Loss	Better than -35dB
Gas inlet/outlet connection	4 inch (ID 100mm)
Thermal management	Forced air cooled (annulus region) Outer conductor water cooled
Barrier	Teflon disc
Inner Conductor joint	Bullet: Brass Finger contacts: BeCu Plating: Silver
Inner Conductor support	Teflon disc

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17.8 Test Bed

Test bed comprises of 12” mismatch transmission line sections (Stub & Phase shifter) and a 3MW dummy load.

17.8.1 Mis-Match Transmission Line (MMTL)

MMTL will be used in between RF source output and dummy load to check the performance of the RF source under the specified VSWR conditions in the specified frequency range 35-60MHz. It consists motorized 12 inch phase shifter and stub to set the desired VSWR and phase of the reflection coefficient. As per PA obligation this system is deliverable to IO to conduct performance test of RFPS.

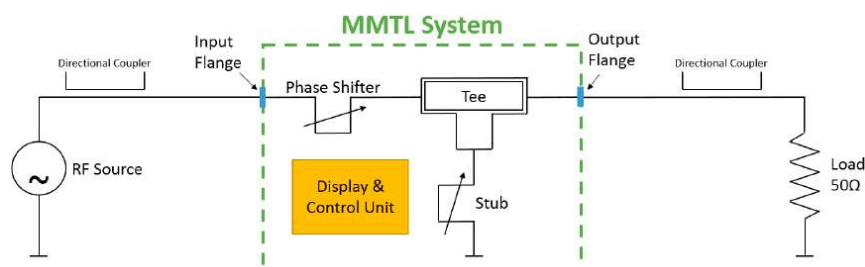


Fig. H-7:MMTL System

Table H17: Technical Specification of MMTL


Technical Specification	
Operating frequency range	35MHz to 65MHz
Power rating	3.0 MW (maximum), 3600s, 25% duty cycle
No of ports	2
Characteristic Impedance	50 $\Omega \pm 0.5 \Omega$
Input & output flanges	12 inch Swivel
VSWR range (Adjustable)	Up to 3:1
Reflection phase angle	From 0° to 180°
Thermal management	Forced air cooled (annulus region)
Inner Conductor joint	Bullet: Brass Finger contacts: BeCu Plating: Silver
Inner Conductor support	Teflon disc

17.8.2 3MW dummy Load

3MW dummy load having 12 inch flange as interface to connect the transmission line, which is used to test the RF source in the specified frequency range 35-60MHz.

Table H18: Technical Specification of 3MW dummy Load

Technical Specification	
Operating frequency range	35MHz to 65MHz

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Max. RF Power	3.5MW for 10s
Nominal RF Power	3.0MW/ 3600 s, 25% duty cycle
Characteristic Impedance	50 $\Omega \pm 0.5 \Omega$
Input flange	12 inch
VSWR	<ul style="list-style-type: none"> Frequency range (35-60MHz): ≤ 1.1 Frequency range (66 -100MHz): ≤ 1.3
Resistive material	Soda water (Na ₂ CO ₃)
Dimension	4500mm(L) X 2000mm(W) X 2400mm(H)
Inner Conductor joint	Silver plated with Teflon support
Cooling water	Deionized or tap water
Max. inlet Temp/pressure/flow	40°C/ 5 bar /103 m3/h

17.8.2.1 Frequency response

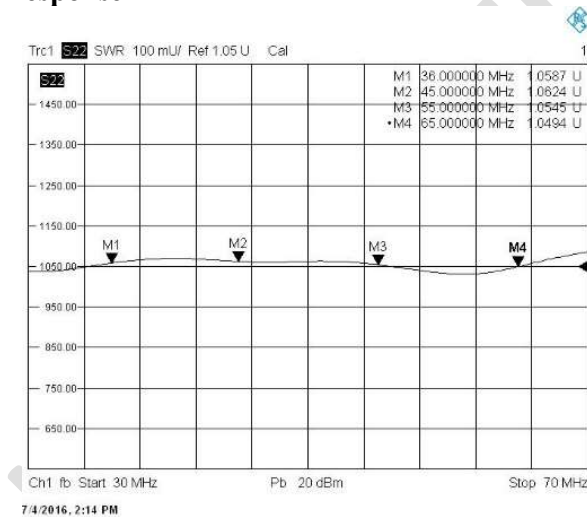


Fig. H-8:Frequency response of 3MW dummy Load


17.9 Power Supplies for Driver & final stage amplifiers (HPA2 & HPA3)

ITER-India is planning to use commercially available power supplies for HPA2 & HPA3 auxiliary power supplies, which are light weight and compact in nature. However, the HV power supply will remain the same as used during phase-1.

17.9.1 Auxiliary power supplies for HPA2 & HPA3

The required auxiliary power supplies and specifications for biasing HPA-2 & HPA3 are as follows:

1. Filament power supply
2. Control grid power supply
3. Screen grid power supply

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The control grid, screen grid and anode must be protected against over currents by means of fast-acting protective devices as per data sheet with a response time of < 20mS and the RF drive power in less than 100µs.

The major specifications for auxiliary power supplies are given in the following tables.


17.9.1.1 Specification for Filament Power Supply

17.9.1.1.1 HPA-2 Filament Power Supply

Preferred Model & General specification for HPA-2 Filament PS

Table 11 : Preferred Model & Specifications for HPA-2 Filament PS

Sr. No.	Descriptions	Details
1.	Make	Magna Power
2.	Model No	XR 10-375/380
3.	Optional components (additional with standard PS unit)	Isolated external voltage programming
4.	General Specifications	
4.1	Nominal AC Input	400 [VAC], 50 [Hz], 3ph+PE
4.2	AC Input isolation	≥ 1 [kV AC/DC] Input voltage terminal to ground
4.3	Output Voltage	0 -10 [VDC]
4.4	Output Current	375 [ADC]
4.5	Voltage ripple (RMS)	≤ 0.5 [%] of rated Value
4.6	Line Regulation	≤ ± 0.1 [%] maximum change in output voltage for ±10[%] change in line voltage
4.7	Load Regulation	≤ ± 0.1 [%] maximum change in output voltage for no-load to full-load change
4.8	DC Output isolation	≥ ±0.5 [kVDC], output voltage terminals to ground
4.9	Cooling	Forced air cooled
4.10	Remote mode control	By external voltages mode for Digital & analogue Input and Output signals
5.	Protection Specifications	
5.1	Fault protection (to turn off the power supply)	1. Overcurrent protection -Settable 2. Overvoltage protection - Settable 3. Short circuit protection 4. Over temperature protection
5.2	Ramp Up and Ramp down Requirement	Controlled by varying voltage setting reference voltage (Vref) through LCU by external voltage programming


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17.9.1.1.2 HPA-3 Filament Power Supply Unit

Preferred Model & General specifications for HPA-3 Filament PS

Table 12 : Preferred Model & Specifications for HPA-3 Filament PS

Sr. No.	Descriptions	Details
1.	Make	Magna Power
2.	Model No	TSD 20-1000/380
3.	Optional components (additional with standard PS unit)	Isolated external voltage programming
4.	General Specifications	
4.1	Nominal AC Input	400 [VAC], 50 [Hz], 3ph+PE
4.2	AC Input isolation	≥ 1 [kV AC/DC] Input voltage terminal to ground
4.3	Output Voltage	0 -20[VDC]
4.4	Output Current	1000 [ADC]
4.5	Voltage ripple (RMS)	≤ 0.5 [%] of rated Value
4.6	Line Regulation	$\leq \pm 0.1$ [%] maximum change in output voltage for ± 10 [%] change in line voltage
4.7	Load Regulation	$\leq \pm 0.1$ [%] maximum change in output voltage for no-load to full-load change
4.8	DC Output isolation	$\geq \pm 0.5$ [kVDC], output voltage terminals to ground
4.9	Cooling	Forced air cooled
4.10	Remote mode control	By external voltages mode for Digital & analogue Input and Output signals
5.	Protection Specifications	
5.1	Fault protection (to turn off the power supply)	1. Overcurrent protection -Settable 2. Overvoltage protection - Settable 3. Short circuit protection 4. Over temperature protection
5.2	Ramp Up and Ramp down Requirement	Controlled by varying voltage setting reference voltage (V_{ref}) through LCU by external voltage programming

	Tender documents [PART-A(ii)]: Scope of Supply, work and Technical Specifications for Phase 2-Driver and Final stage amplifiers for 2 sets of ITER ICRF Sources.- GLOBAL TENDER NOTICE NO: I-I/ET-TPT/25001/25-26	INDUS Ref.
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17.9.1.2 Control Grid Power Supplies

17.9.1.2.1 HPA-2 Control Grid Power Supply

Preferred Model & General specifications for HPA-2 Control Grid PS

Table 13 : Preferred Model & Specifications for HPA-2 Control Grid PS

Sr. No.	Descriptions	Details
1.	Make	Magna Power
2.	Model No	MAGNA SL500-3/UI +HS
3.	Optional components (additional with standard PS unit)	Isolated external voltage programming
4.	General Specifications	
4.1	Nominal AC Input	230 [VAC], 50 [Hz], 1ph+PE
4.2	AC Input isolation	≥ 1.5 [kV AC/DC] Input voltage terminal to ground
4.3	Output Voltage	0 -500 [VDC]
4.4	Output Current	3 [ADC]
4.5	Voltage ripple (RMS)	≤ 0.5 [%] of rated Value
4.6	Line Regulation	$\leq \pm 0.1$ [%] maximum change in output voltage for ± 10 [%] change in line voltage
4.7	Load Regulation	$\leq \pm 0.1$ [%] maximum change in output voltage for no-load to full-load change
4.8	DC Output isolation	$\geq \pm 1$ [kVDC], output voltage terminals to ground
4.9	Cooling	Forced air cooled
4.10	Remote mode control	By external voltages mode for Digital & analogue Input and Output signals
5.	Bleeder current (Bleeder resistor connected at output of the power supply unit)	2 [A] at 500 [V]; $R_{eq} = 250$ [ohm] with combination of panel mount thick film resistor mounted on water cooled heat sink
6.	Protection Specifications	
6.1	Fault protection (to turn off the power supply)	1. Overcurrent protection -Settable 2. Overvoltage protection - Settable 3. Short circuit protection 4. Over temperature protection
6.2	Negative current protection requirement	Diode resistor circuit with Negative current detection added separately with the PS Unit, The fault signals from Negative current circuits are interfaced with LCU for protection requirement

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Sr. No.	Descriptions	Details
		(For protection validation Fuse test will be conducted)
6.3	Output over voltage protection	With adjustable spark gap At setting of 2.0 [kV]


17.9.1.2.2 HPA-3 Control Grid Power Supply

Preferred Model & General Specifications for HPA-3 Control Grid PS

Table 14 : Preferred Model & specifications for HPA-3 Control Grid PS

Sr. No.	Descriptions	Details
1.	Make	Magna Power
2.	Model No	MAGNA SL500-12/380 +HS
3.	Optional components additional (additional with standard PS unit)	Isolated external voltage programming
4.	General Specifications	
4.1	Nominal AC Input	400 [VAC], 50 [Hz], 3ph+PE
4.2	AC Input isolation	≥ 1.5 [kV AC/DC] Input voltage terminal to ground
4.3	Output Voltage	0 -500 [VDC]
4.4	Output Current	12 [ADC]
4.5	Voltage ripple	≤ 0.5 [%] of rated Value
4.6	Line Regulation	$\leq \pm 0.1$ [%] maximum change in output voltage for ± 10 [%] change in line voltage
4.7	Load Regulation	$\leq \pm 0.1$ [%] maximum change in output voltage for no-load to full-load change
4.8	DC Output isolation	$\geq \pm 0.5$ [kVDC], output voltage terminals to ground
4.9	Cooling	Forced air cooled
4.10	Remote mode control	By external voltages mode for Digital & analogue Input and Output signals
5.	Bleeder Current (Bleeder resistor connected at output of the power supply unit)	10 [A] at 500 [V]; $R_{eq} = 50$ [ohm] with combination of panel mount thick film resistor mounted on water cooled heat sink
6.	Protection Specifications	
6.1	Fault protection (to turn off the power supply)	1. Overcurrent protection -Settable 2. Overvoltage protection - Settable 3. Short circuit protection 3. Over temperature protection

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Sr. No.	Descriptions	Details
6.2	Negative current protection requirement	Diode resistor circuit with Negative current detection added separately with the PS Unit, The fault signals from Negative current circuits are interfaced with LCU for protection requirement (For protection validation Fuse test will be conducted)
6.3	Output over voltage protection	With adjustable spark gap At setting of 2.0 [kV]


17.9.1.3 Screen Grid Power Supplies

17.9.1.3.1 HPA-2 Screen Grid Power Supply

Preferred Model & General Specifications for HPA-2 Screen Grid PS

Table 15 : Preferred Model & specifications for HPA-2 Screen Grid PS

Sr. No.	Descriptions	Details
1.	Make	Magna Power
2.	Model No	TSD1500-3.3/380+HS
3.	Optional components additional (additional with standard PS unit)	Isolated external voltage programming
4.	General Specifications	
4.1	Nominal AC Input	400 [VAC], 50 [Hz], 3ph+PE
4.2	AC Input isolation	≥ 2.5 [kV AC/DC] Input voltage terminal to ground
4.3	Output Voltage	0 -1500 [VDC]
4.4	Output Current	3.3 [ADC]
4.5	Voltage ripple	≤ 1 [%] of rated Value
4.6	Line Regulation	≤ ± 0.5 [%] maximum change in output voltage for ±10[%] change in line voltage
4.7	Load Regulation	≤ ± 0.5 [%] maximum change in output voltage for no-load to full-load change
4.8	DC Output isolation	≥ ±2 [kVDC], output voltage terminals to ground
4.9	Cooling	Forced air cooled
4.10	Remote mode control	By external voltages mode for Digital & analogue Input and Output signals
5.	Bleeder current	0.75 [A] at 1500 [V];

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Sr. No.	Descriptions	Details
	(Bleeder resistor connected at output of the Fast protection circuit (series switch) unit)	$R_{eq} = 2000$ [ohm] with combination of panel mount thick film resistor mounted on water cooled heat sink
6.	Protection Specifications	
6.1	Fault protection (to turn off the power supply)	1. Overcurrent protection -Settable 2. Overvoltage protection - Settable 3. Short circuit protection 4. Over temperature protection
6.2	Fast Protection against short circuit & HVPS Interlock	For the fast protection requirement additional unit; (IGBT based) series switch used to isolate the PS during SC, by detecting SC. The fault signals from series switch will be interface with LCU for protection requirement. The HVPS Interlock signal also used to switch unit for protection of screen in absence of Anode voltage. For the validation of fast protection fuse test will be passed.
6.3	Output over voltage protection	With adjustable spark gap At setting of 2.5 [kV]

17.9.1.3.2 HPA-3 Screen Grid Power Supply

Preferred Model & General Specifications for HPA-3 Screen Grid PS

Table 16 : Preferred Model & specifications for HPA-3 Screen Grid PS

Sr. No.	Descriptions	Details
1.	Make	Magna Power
2.	Model No	TSD2000-10/380+HS
3.	Optional components additional (additional with standard PS unit)	Isolated external voltage programming
4.	General Specifications	
4.1	Nominal AC Input	400 [VAC], 50 [Hz], 3ph+PE
4.2	AC Input isolation	≥ 2.5 [kV AC/DC] Input voltage terminal to ground
4.3	Output Voltage	0 -2000 [VDC]
4.4	Output Current	10 [ADC]
4.5	Voltage ripple	≤ 1 [%] of rated Value

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Sr. No.	Descriptions	Details
4.6	Line Regulation	$\leq \pm 0.1$ [%] maximum change in output voltage for ± 10 [%] change in line voltage
4.7	Load Regulation	$\leq \pm 0.1$ [%] maximum change in output voltage for no-load to full-load change
4.8	DC Output isolation	$\geq \pm 2.0$ [kVDC], output voltage terminals to ground
4.9	Cooling	Forced air cooled
4.10	Remote mode control	By external voltages mode for Digital & analogue Input and Output signals
5.	Bleeder current (Bleeder resistor connected at output of the Fast protection circuit (series switch) unit)	1.33 [A] at 2000 [V]; $R_{eq} = 1500$ [ohm] with combination of panel mount thick film resistor mounted on water cooled heat sink
6.	Protection Specifications	
6.1	Fault protection (to turn off the power supply)	1. Overcurrent protection -Settable 2. Overvoltage protection - Settable 3. Short circuit protection 4. Over temperature protection
6.2	Fast Protection against short circuit & HVPS Interlock	For the fast protection requirement additional unit; (IGBT based) series switch used to isolate the PS during SC, by detecting SC. The fault signals from series switch will be interface with LCU for protection requirement. The HVPS Interlock signal also used to switch unit for protection of screen in absence of Anode voltage. For the validation of fast protection fuse test will be passed.
6.3	Output over voltage protection	With adjustable spark gap At setting of 2.5[kV]

17.9.2 High voltage power supply (HVPS) for HPA-2 & HPA-3

A single chain of amplifiers utilizes dual output high voltage power supply (HVPS) based on synchronized Pulse Step Modulation (PSM) technique to bias driver and final stage amplifiers. It will fulfil the high voltage operational requirement for the single chain as per specification under various conditions like testing at different frequencies including bandwidth of ± 1 MHz at 1dB point and tests under VSWR scenarios.

Therefore, the available high voltage for driver and final stage amplifiers will be as following:

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- (1) The upper limit for driver stage amplifier will be of 14 kV. However, the driver anode voltage will be kept 13kV to provide less dissipation on driver's tube and a little margin for Final stage.
- (2) Ceiling of 27kV with 14 kV of ΔV i.e. voltage above driver stage.

17.9.2.1 Specifications

The table below shows the basic specifications for the dual output HVPS.

Table H19: Specifications for dual output HVPS

Sr. No.	Parameters	Value
1	Max Total continuous power required by one amplifier chain from single HVPS	3050 kW
2.	Overshoot	2kV
3.	Fast switch OFF time	<10 μ s
HVPS output for Final stage		
4	Voltage range above driver stage voltage	4-14 kV
5	Maximum absolute voltage	27 kV
6	Maximum current to one end stage tube	170 A
7	Maximum output continuous power to one end stage tube	2800 kW
HVPS output for Driver stage		
8	Voltage range	8 – 14 kV
9	Maximum current to one Driver stage tube	20 A
10	Maximum output continuous power to one Driver stage tube	250 kW
Note: Energy Delivered by HVPS must be below 10 Joule in case of fault in the tubes.		

17.9.2.2 Protections

Following tube protective devices must act on the anode power supply as per general safety instructions for high voltage operation.


- Low anode cooling water protective device,
- Devices in case of lack of heater voltage and/or control grid voltage,
- Anode, control grid and screen grid overcurrent devices,
- Devices in case of excessive VSWR,
- Other protective devices for the transmitter circuit and user safety.

A fast-acting anode protective device, such as a crowbar/switching for fast turn OFF, shall be provided, and checked by short-circuiting the anode rectifier closer to the tube.

The peak DC anode voltage should not exceed the maximum rating for the DC anode voltage i.e. 22kV for TH781 and 30kV for TH628.

Short circuit test shall be performed by 0.3mm diameter of copper wire on TH781 & TH628L using 260mm & 540 mm length of copper wire respectively as per data sheet. HVPS cut-off must be fast enough to avoid melting the copper wire.

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17.9.3 *LT Distribution: Technical specifications*

17.9.3.1 *RF Source Distribution Panel Specifications*


Single Panel, cubical type, indoor, floor mounted, Incomer - Cables (Top entry type), Outgoings – Cables (Top exit type), suitable for use on 400 V, 3 ph., 4 wire, 50Hz system. It shall also be complete with all internal wiring, labels etc.

Table H20: RF Source Distribution Panel specifications


Sr. No.	Description	Quantity
A.	INCOMING FEEDER	1 No.
A.1.	400 A, 4 poles, 36kA Fixed, MCCB with Thermal magnetic based Overload & Short-circuit Fault Protection.	1 No.
A.2.	144 x 144 mm Voltmeter scaled 0-500V AC with selector switch and control fuses (on suitable fuse holder/base).	1 No.
A.3.	144 x 144 mm Ammeter scaled 0-400A AC with selector switch and control fuses (on suitable fuse holder/base).	1 No.
A.4.	Set of indicating lamps for R, Y, B phase	1 No.
A.5.	Set of indicating lamps for breaker status indication ON (Red), OFF (Green), TRIP (Orange/Amber), (Indication lamps shall be connected with Thermal magnetic based relay with auxiliary contacts.	1 No.
A.6.	Over voltage (OV) and under voltage (UV) relay	1 No.
A.7.	3 Over current & 1 Earth Fault relay (with IDMT & Instantaneous in both)	1 No.
A.8.	CT, 400/5A, Class-1, 15VA, Metering grade	3 Nos.
A.9.	CT, 400/5A, Class-5P, 10VA Protection grade (Bidder should specify in case more CTs are required for making the system complete in terms of protection and operation)	4 Nos.
A.10.	Auxiliary contacts	4 Nos. of NO + 4 Nos. of NC
A.11.	Transformer for control supply (Secondary voltage 230V, of minimum 1kVA or the designed value whichever is higher)	1 No.
A.12.	Standard wiring and accessories (including neutral link, CT shorting terminals etc.)	As per design
A.13.	Suitable provision for receipt of 1runs of 1.1 kV grade, 3.5 core, 240 sq. mm, Aluminium conductor (of 400A rms capacity), XLPE insulated Cable (Bottom entry)	As per layout.
A.14.	Spare shunt trip coil suitable for above MCCB	2 Nos.

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Sr. No.	Description	Quantity
A.15.	Spare control fuses	4 Nos. of each type used in panel
B.	OUTGOING Load point (LP-1&2): SSPA	2 No.
	40A, 4 pole, 10 kA Fixed, MCB with Overload, Short-circuit and Ground Fault Protection	2 No.
	Suitable provision for receipt 1 runs of 1.1 kV grade, 3.5 core, 6 sq. mm, copper conductor , XLPE insulated Cable (Top exit)	2 No.
C.	OUTGOING Load point (LP-3&4): Low power RF	1 No.
	5A, 4 pole, 10 kA Fixed, MCB with Overload, Short-circuit and Ground Fault Protection	1 No.
	Suitable provision for receipt 1 runs of 1.1 kV grade, 3.5 core, 6 sq. mm, copper conductor , XLPE insulated Cable (Top exit)	1 No.
D.	OUTGOING Load point (LP-5&6): Aux PS Cabinet	2 No.
	80A, 4 pole, 36 kA Fixed, MCCB with Overload, Short-circuit and Ground Fault Protection.	2 No.
	Set of indicating lamps for breaker status indication ON (Red), OFF (Green), TRIP (Orange/Amber) Indication lamps shall be connected with auxiliary contacts.	2 No.
	Auxiliary contacts	4 NO + 4NC
	Standard wiring and accessories (including neutral link, CT shorting terminals, hardware etc.)	As per design
	Suitable provision for receipt 1 runs of 1.1 kV grade, 3.5 core, 25 sq. mm, Aluminium conductor , XLPE insulated Cable (Top exit)	2 no.
E.	OUTGOING Load point (LP-7): Blower Motor Controller Cubicle	1 No.
	40A, 4 pole, 10 kA Fixed, MCB with Overload, Short-circuit and Ground Fault Protection	1 No.
	Suitable provision for receipt of 1 run of 1.1kV grade, 3.5 core, 6 sq. mm, Copper conductor , XLPE insulated cable (Top exit)	1 No.
F.	OUTGOING Load point (LP-8&9) Motor Controller Cubicle	2 No.
	40A, 2 pole, 10 kA Fixed, MCB with Overload, Short-circuit and Ground Fault Protection	1 No.
	Suitable provision for receipt of 1 run of 1.1kV grade, 3 core, 10 sq. mm, Copper conductor , XLPE insulated cable (Top exit)	1 No.
G.	OUTGOING Load point (LP-10) Fast Controller Cubicle	1 No.

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Sr. No.	Description	Quantity
	8A, 2 pole, 10 kA Fixed, MCB with Overload, Short-circuit and Ground Fault Protection	1 No.
	Suitable provision for receipt of 1 run of 1.1kV grade, 3 core, 10 sq. mm, Copper conductor , XLPE insulated cable (Top exit)	1 No.
H.	OUTGOING Load point (LP-11) Source cRIO cubicle	1 No.
	6.3A, 3 pole, 10 kA Fixed, MCB with Overload, Short-circuit and Ground Fault Protection	1 No.
	Suitable provision for receipt of 1 run of 1.1kV grade, 4 core, 6 sq. mm, Copper conductor , XLPE insulated cable (Top exit)	1 No.
I.	OUTGOING Load point (LP-12) Source PLC cubicle	1 No.
	4A, 3 pole, 10 kA Fixed, MCB with Overload, Short-circuit and Ground Fault Protection	1 No.
	Suitable provision for receipt of 1 run of 1.1kV grade, 4 core, 6 sq. mm, Copper conductor , XLPE insulated cable (Top exit)	1 No.
J.	OUTGOING Load point (LP-13) Field PLC cubicle	1 No.
	4A, 3 pole, 36 kA Fixed, MCCB with Overload, Short-circuit and Ground Fault Protection	1 No.
	Suitable provision for receipt of 1 run of 1.1kV grade, 4 core, 25 sq. mm, Copper conductor , XLPE insulated cable (Top exit)	1 No.
K.	OUTGOING Load point (LP-14&15) Spare	2 No.
	16A, 3 pole, 10 kA Fixed, MCB with Overload, Short-circuit and Ground Fault Protection	1 No.
	Suitable provision for receipt of 1 run of 1.1kV grade, 3 core, 10 sq. mm, Copper conductor , XLPE insulated cable (Top exit)	1 No.
L.	OUTGOING Load point (LP-16) Spare	1 no.
	32A, 3 pole, 10 kA Fixed, MCCB with Overload, Short-circuit and Ground Fault Protection.	1 no.
	Set of indicating lamps for breaker status indication ON (Red), OFF (Green), TRIP (Orange/Amber) Indication lamps shall be connected with auxiliary contacts.	1 no.
	Auxiliary contacts	4 NO+ 4NC


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17.9.4 *Safety key management system*

For human safety from the high voltage hazards during operation and maintenance, a safety key management system will be implemented in line with the requirement from the ITER organisation (IO). Logic for safety key management system is developed during phase 1 and similar arrangement will be implemented during phase 2.

The Key Management System (KMS) is designed to ensure personnel & system safety during maintenance along with their related systems & sub-systems. AC & DC voltages will be present at RF source at different interface locations & can also be dangerous if not properly managed. Ensuring that only authorized employees have access to critical areas is vital to safety, as well as smooth operations. It becomes imperative to consider employee safety when the system will be taken to maintenance from operation & vice versa.

To make ICRH RFS areas safe during maintenance operations, hazardous energy must be isolated. 'KMS' refers to a process whereby people are denied access to an area until it is safe (no hazardous energy is on). KMS algorithm is designed for this specific purpose & it works on the principle that it only releases access keys once isolation has been achieved, and only releases isolation keys once access keys have been returned. This means that there is no room for human error, and people are only operating in environments that are safe. With KMS, you can sequentially follow the key movement & restrict key access. This gives you greater oversight & control over the personnel and system safety.

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Key Management Safety System (KMSS) algorithm

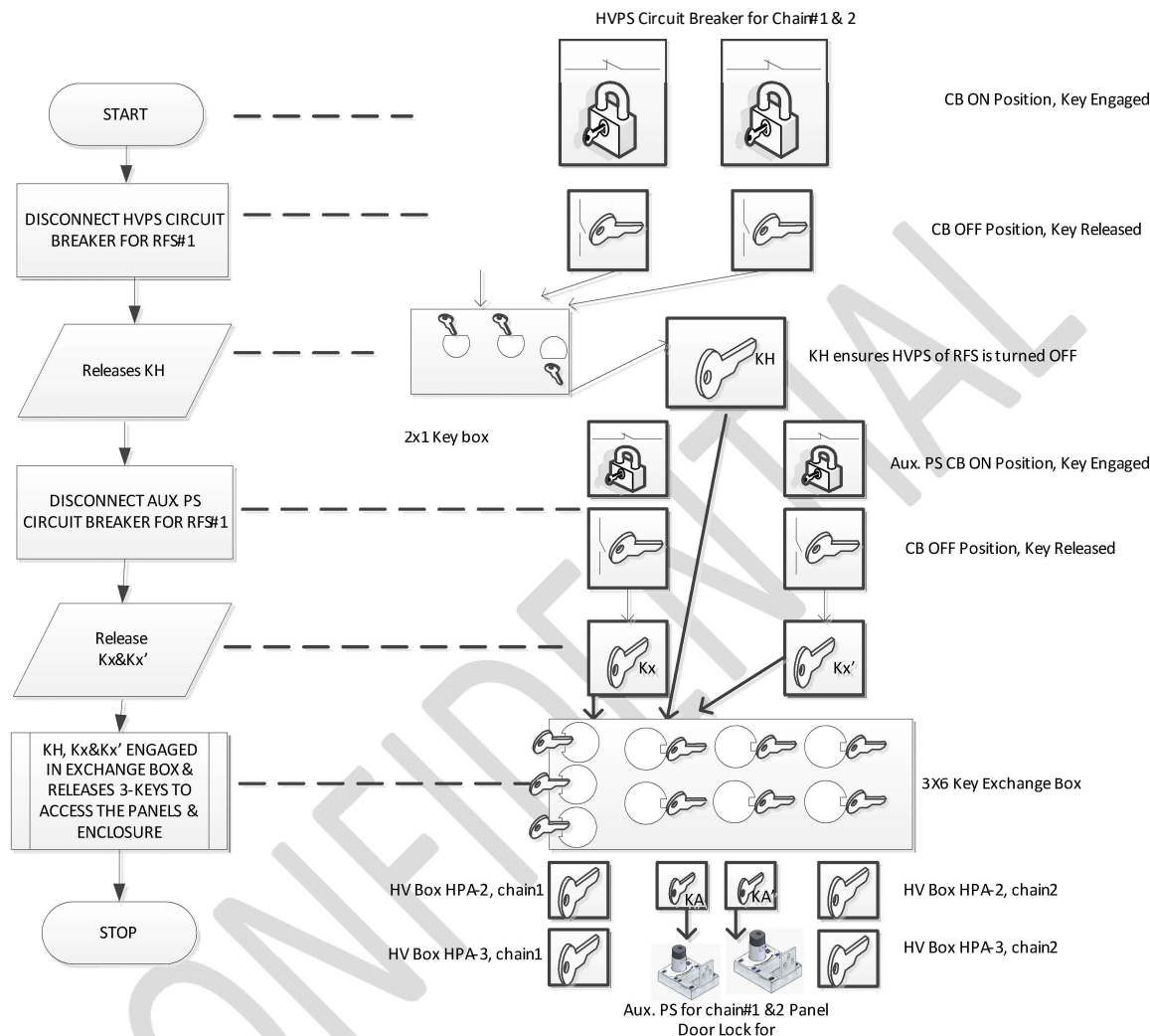



Fig. H-9: KMS Algorithm for Single RF source

Aim is to access the cavity/auxiliary power supplies cabinet so it must be ensured that fatal voltage must not be present inside the source during access.

Step#1: The first step is to ensure the circuit breaker of HVPS feeding both the chains of single RFS must be isolated. Once C.B turns off, key releases from respective chains, two keys can be combined to get single key, Kh using 2x1 key box.


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Step#2: At RFS side, auxiliary power supplies need to be cut off with the help of circuit breakers feeding the respective chain. Release of Ka & Ka' will ensure that input is disconnected for both the chains.

Step#3: Kh, Ka & Ka' will be trapped into the 3x6 key exchange box and 6 keys will be released to open the HV boxes and auxiliary power supplies cabinet.

Make of the Key-lock

During R&D testing, STI make was used but, as HVPS breaker is under the scope of ITER Organization, HVPS is under ITER-India & IO, hence, the lock & keys shall be compatible with overall system. The preferred make will be communicated to bidder in the later stage in order to make system uniform and optimized.

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18 Annexure-I: Proposed RF source Layout

In this annexure, a proposed RF source layout is described. This layout will be finalized mutually between ITER-India, IO and Bidder complying RF building interface requirements within two-month after placing of the contract. The interface with building major constraints for the RF source layout are the floor loading capability, the maximal pointed load values and the maximal volume occupancy.

Each RF source consists of two chains and a 3dB hybrid combiner; each chain comprising of a low power RF section, an SSPA, two high power tube-based amplifiers (HPA2 & HPA3), Inter-connecting Tx-lines, electrical power supplies, control & monitoring system (LCU) and the water & air cooling distribution system.

Different sub-systems/components of the RF source are mounted on a base frame, a support frame and a service platform. The HPA2, HPA3 and Trombone have their own independent support structures that will be connected to the base frame. This connection is not described/shown in this chapter as its definition will be one outcome of the RF source layout optimization and seismic analysis.

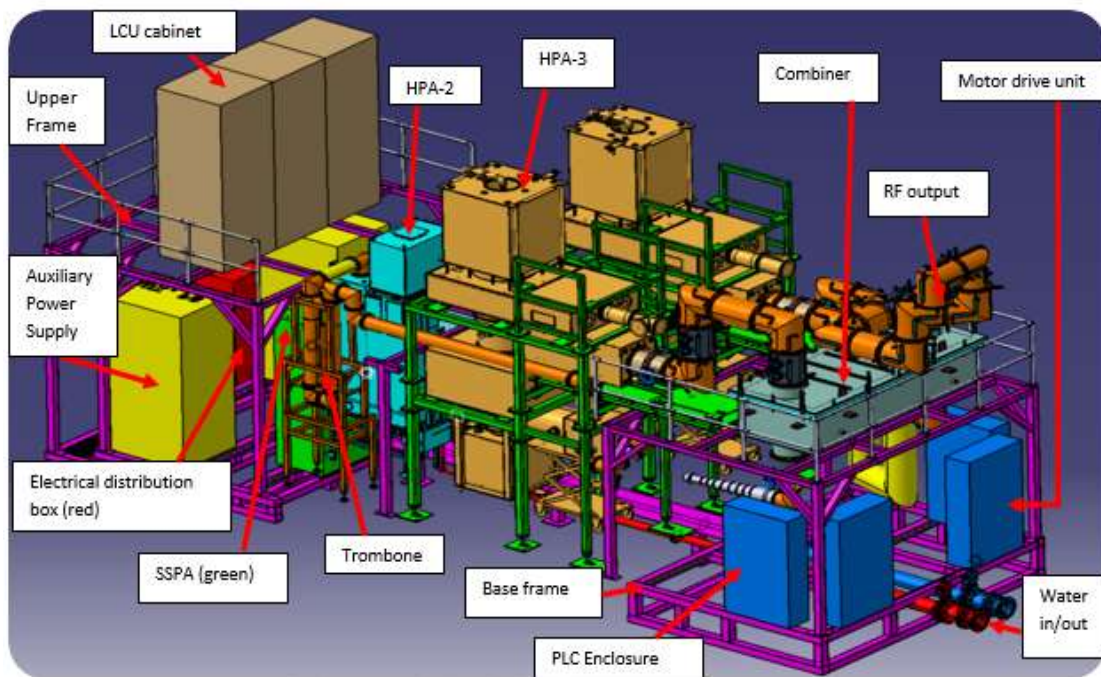



Fig. I-10: Layout of overall RF source

Considering the weight of HPA2 (0.85T), Trombone (0.48T) & HPA3 (2.5T), the load will be distributed on 4 columns for HPA2, 4 columns for Trombone & 6 columns for HPA3. However, during technical discussion with the bidder, it may be distributed and transfer through platform if needed.

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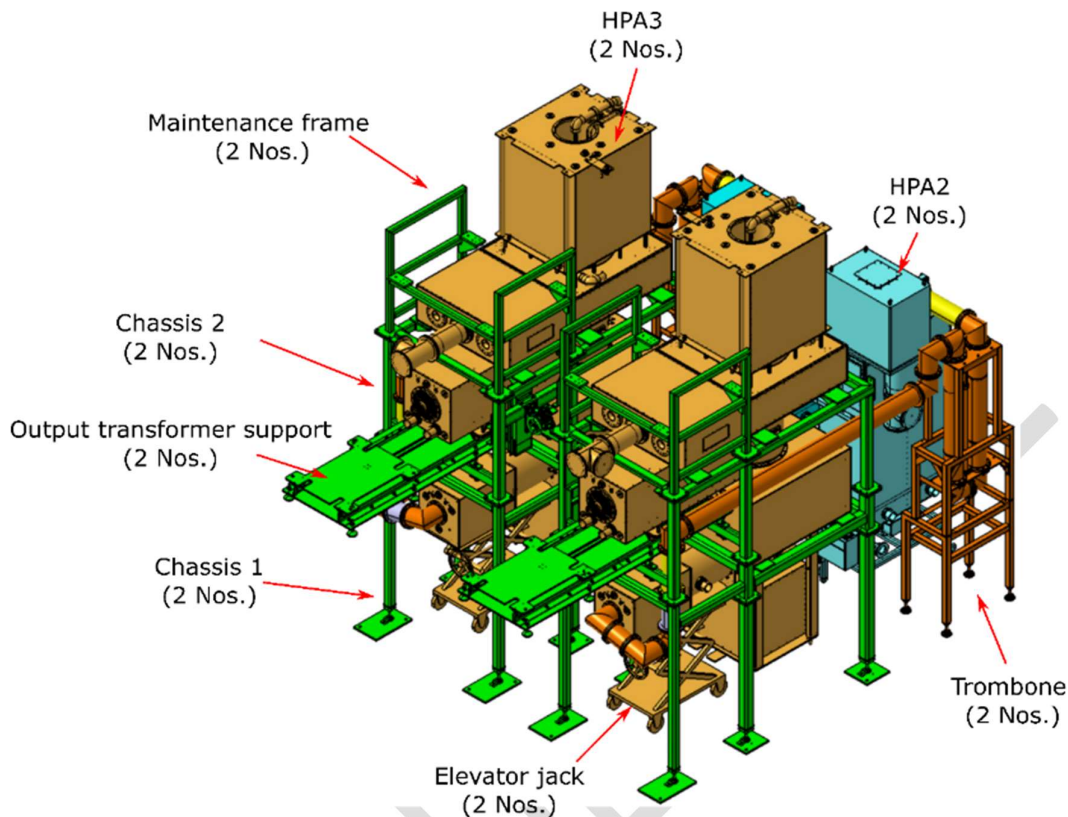



Fig. I-11: Layout of components supplied by Bidder

The total weight of components under bidder's scope shall not be more than **10.5 t** including air (blower) and water-cooling distribution. However, the weight of base frame, support frame and service platform are not included in the said weight of **10.5 t**.

The plan view of components supplied by Bidder is shown in **Fig. I-12**. The footprint for components supplied by Bidder needs to be kept within 3.4m (W) X 4.9 m (L) with a height of 5.0 m

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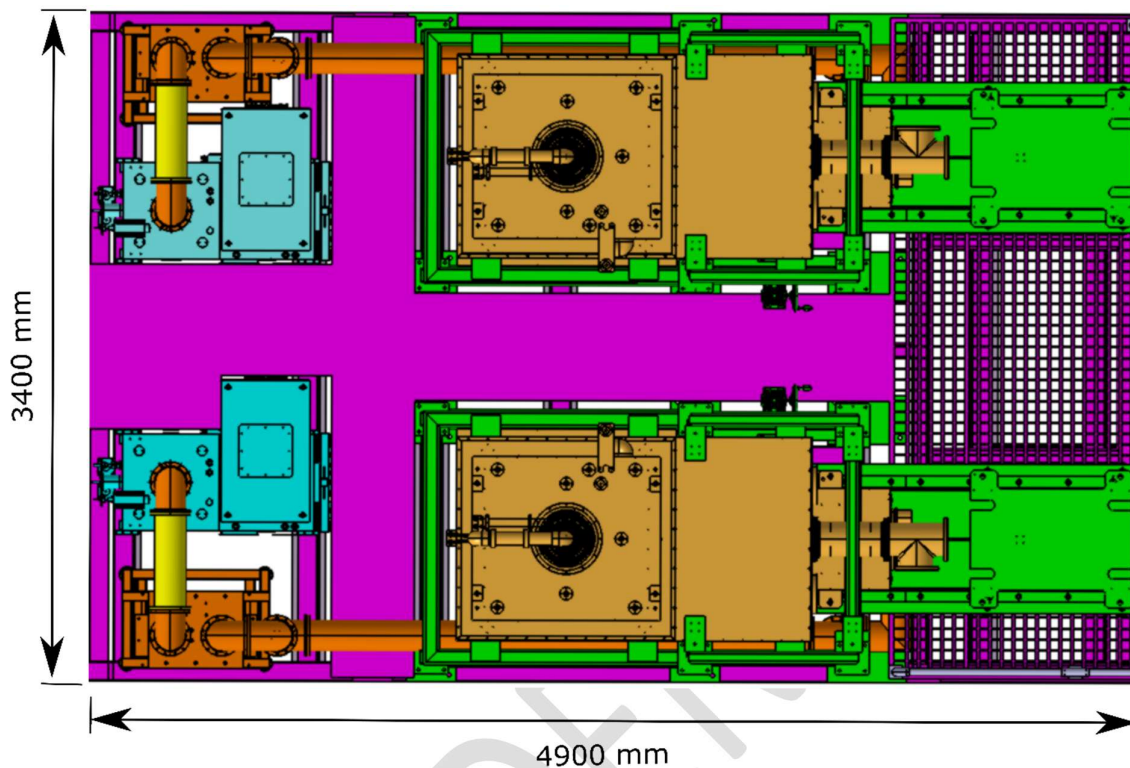


Fig. I-12: Plan View of components supplied by Bidder

Fig. I-13 shows the details of the base frame, the support frame, the service platform, the main water-cooling headers (inlet & outlet) and the interface flanges between water distribution and HPA2 & HPA3.

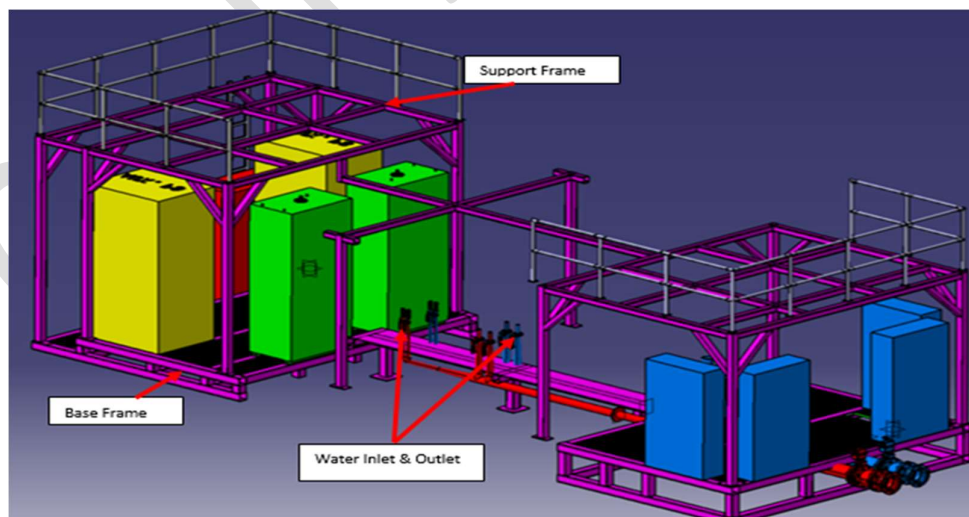



Fig. I-13: support & base frame, service platform and main water-cooling header

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The overall dimensions of base & support frame are shown in **Fig. I-14**. It is to be noted that the support frame, base frame and main water-cooling header up to the interface flanges of water distribution for HPA2 & HPA3 are under ITER India's scope. The base frame is considered to accommodate the main water-cooling lines up-to interface point, as well as electrical and control cables.

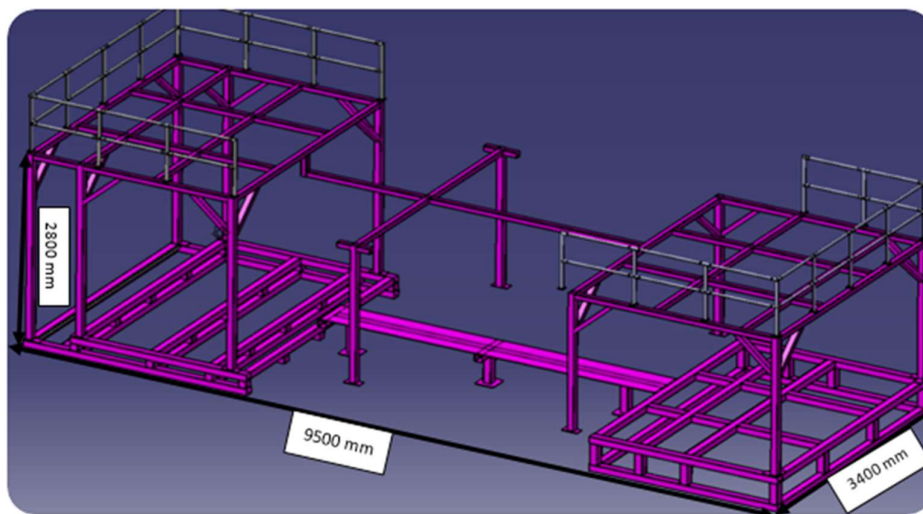


Fig. I-14: Overall dimensions of base & support frame

The details of inlet & outlet water cooling flanges for SSPA, HPA2, HPA3, dummy load and Tx-line is shown in **Fig. I-15**.

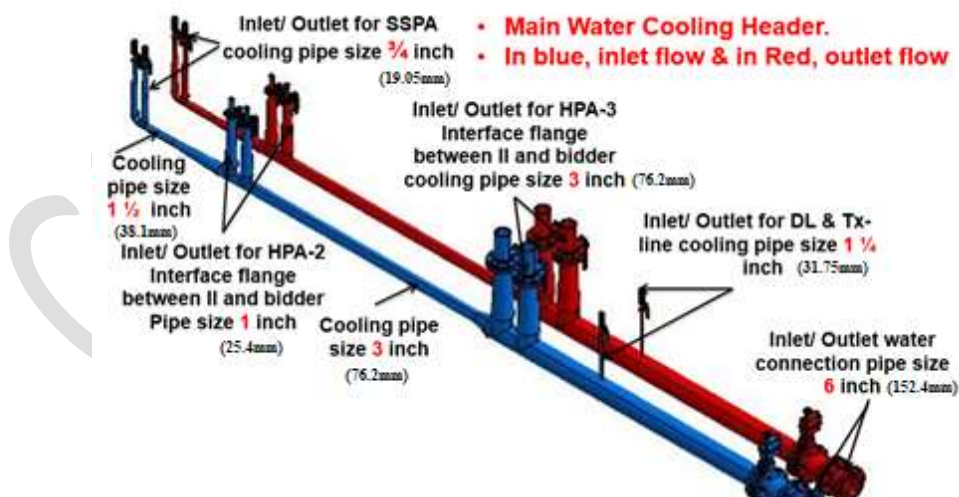



Fig. I-15: Layout of main water-cooling header

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The connection details for 3dB hybrid combiner are shown in **Fig. I-16**, which is under ITER-India's responsibility.

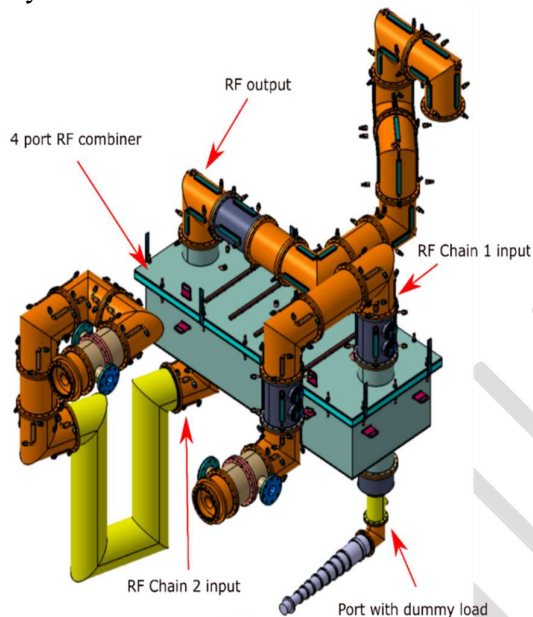



Fig. I-16:3dB hybrid combiner with Tx. Line components

Bidder needs to optimise the size and weight of the blowers for HPA2 & HPA3. Proposed locations for placing the blowers are shown in **Fig. I-17**.

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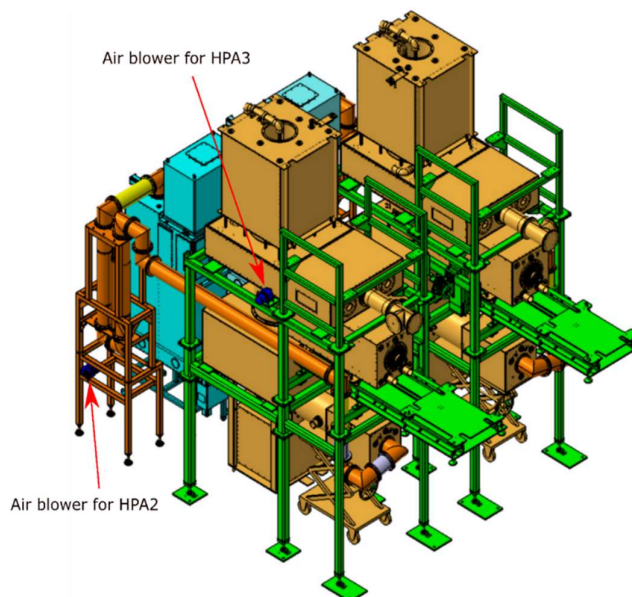


Fig. I-17: Proposed location of air blowers

The following table shows the approximate dimensions and quantities of sub-systems /components for one RF source.

Table II: Approximate dimensions and quantities

Sr. No.	Components	Dimensions (W x L) in mm per unit	Quantity
1	Aux. Power Supplies	1000x 800	2Nos.
2	HPA3	1460x3685	2Nos.
3	PLC enclosure	300x800	2Nos.
4	HPA2 + Trombone	1200x1300	2Nos.
5	SSPA	600x900	2Nos.
6	LCU	800x800	3 Nos.
7	Motor's driver enclosure	300x800	2 Nos.
8	Combiner + Tx. Line	2700x2140	1set
9	Electrical distribution box	1000x500	1Nos.



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Table J1: Flow Requirement for one RF Source

		Flow (LPM)	Flow (kg/s)
Single RF Chain requirement			
HPA-3	Anode (A)	775	13.175
	Top Screen grid (TSG)	4	0.068
	Bottom Screen grid (BSG)	4	0.068
	Cathode (CATH)	4	0.068
	Output Transformer (OPTS)	6	0.102
	Upper Anode decoupling capacitor (UADC)	6	0.102
	Lower Anode decoupling capacitor (LADC)	6	0.102
	Upper screen decoupling capacitor (USDC)	4	0.068
	Lower screen decoupling capacitor (LSDC)	4	0.068
HPA-2	Anode (A)	75	1.275
	Anode decoupling capacitor (ADC)	6	0.102
	Screen Grid (SG)	6	0.102
HPA-1	Solid state power amplifier (SSPA)	30	0.510
3 dB Combiner requirement			
	3dB hybrid combiner	25	0.425
	200kW Dummy Load	65	1.105
RF source (Single RF chain × 2 + Combiner) requirement		1950	33.15

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19.2 Proposed PFD diagram for Air cooling

Blowers are required to be placed just near to HPA2 and HPA3 amplifiers to optimise the space in the layout. The air flow diagram for two chains are shown below:

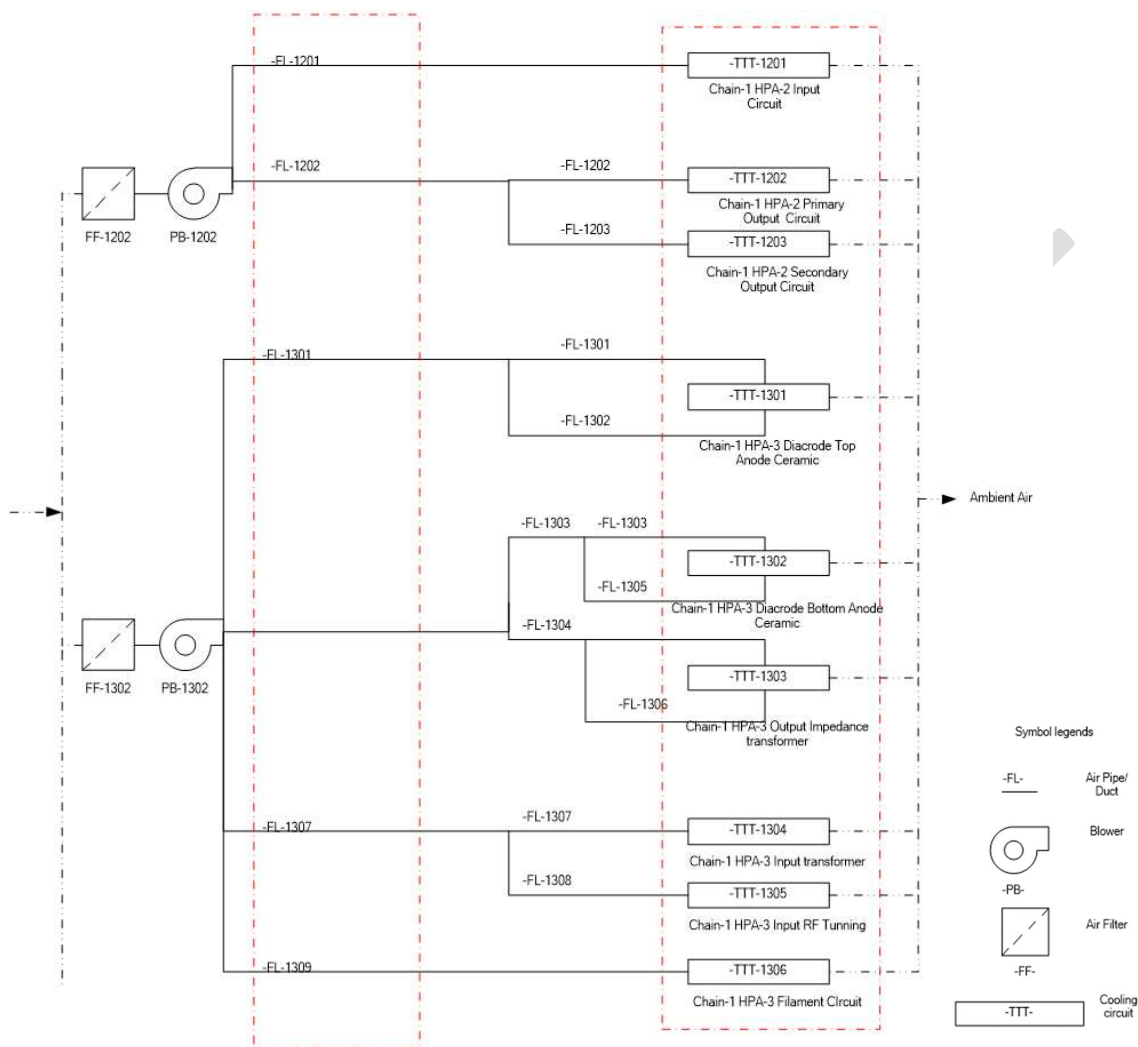



Fig. J-19:Air cooling PFD for Chain-1

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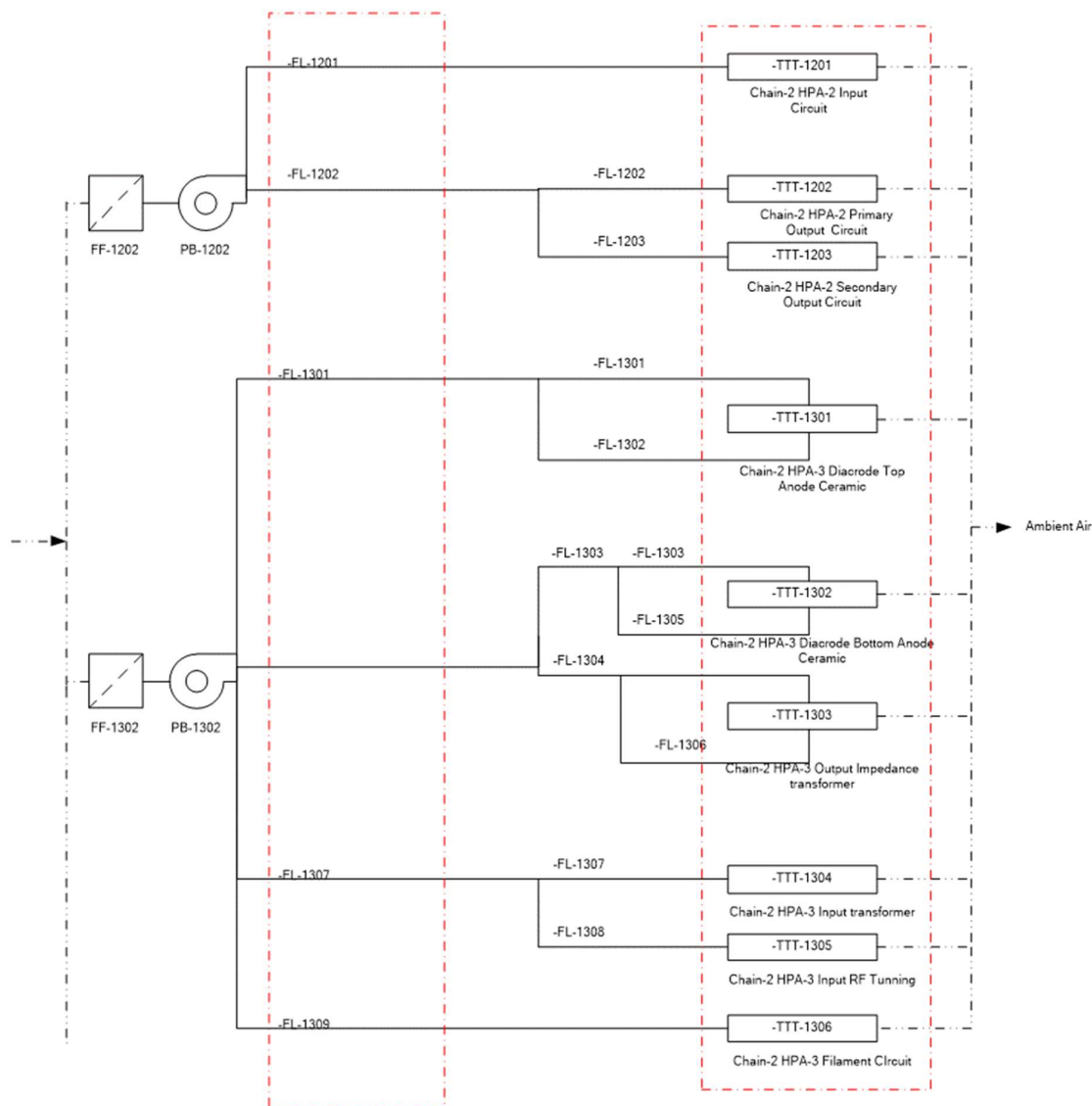



Fig. J-20:Air cooling PFD for Chain-2

Note: Differential pressure switch needs to be placed by Bidder at appropriate places

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20 Annexure-K: Acceptance of RF Sources

Acceptance test of each RF chains will be performed by Bidder with the support of ITER-India (as per the responsibility of the components) and approved by ITER-India/ITER Organization at ITER-India & IO sites.

Acceptance test of the full RF sources will be performed by ITER-India without participation of Bidder and approved by ITER Organization.

Table K1: Acceptance for RF sources during Phase 2

Sr. No.	RF Source	Final Acceptance will be given by ITER-India
01	RF chains of Prototype RF source at ITER-India site	Successful completion of Site Acceptance Test at ITER-India site as per section 8.1.2
02	Phase 2 Prototype RF chains at IO site	Successful completion of assembly, integration & Commissioning of components supplied by Bidder at IO site, France as per section 8.1.4
03	RF chains of Unit-1 RF source at ITER-India site	Successful completion of Site Acceptance Test at ITER-India site as per section 8.1.2
04	Phase-2 Unit 1 RF chains at IO site	Successful completion of assembly, integration & Commissioning of components supplied by Bidder at IO site, France as per section 8.1.4

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21 Annexure-L: Responsibility sharing matrix during SAT


21.1 Phase 2

Responsibility sharing in between respective parties (ITER-India and Bidder) is shown in L1.


Table L1 L1.

Table L1: Responsibility sharing matrix for Phase 2 (Prototype RF Source)


Item no.	Description of Component/subsystem/performance test	ITER-India Responsibility	Bidder Responsibility
At ITER-India site			
1	Synthesizer, power divider, RF Switch, attenuator, phase shifter, HPA1(~10 kW SSPA), Local Control Unit (LCU), cooling header, auxiliary power supplies, High voltage power supply, 3dB Hybrid combiner, transmission line components, directional couplers, RF source enclosure, support frame, base frame, service platform with ladder, Dummy Load & Mismatch Tx-line system	Assembly, Integration & test as standalone mode	Witness the test as standalone mode and generate the validation reports as defined in Annexure-G: Validation report formats for interfaces at ITER-India/IO
2	Modification and re-locating the existing HPA2, Trombone and HPA3 (supplied during Phase 1), with new cooling arrangements and tuning motors, on the service platform as per agreed layout which will be used in Unit 1 RF source	Carry out necessary modifications, assembly, integration and provide required test equipment, crane, trolley, skilled/technical man power etc.	Deliver the components for modifications, supervision in modification & involvement in assembly & integration
3	Assembly of HP components supplied for each chain of prototype and Unit 1 RF sources.	To provide required test equipment, crane, trolley, skilled/technical man power etc.	Assembly
4	Integration of HPA2 with required sub-systems	Refer section 21.2	Refer section 21.2
*5	RF power test of HPA2 on dummy load	Involvement in test campaign to manage the supplied systems/components	Demonstration of performance as per section 8.1.2

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Item no.	Description of Component/subsystem/performance test	ITER-India Responsibility	Bidder Responsibility
6	Integration of HPA3 with required sub-systems	Refer section 21.2	Refer section 21.2
*7	RF power test of RF chains on matched load	Involvement in test campaign to manage the supplied systems/components	Demonstration of performance as per section 8.1.2
*8	RF power test of RF chains on mis-matched load	Involvement in test campaign to manage the supplied systems/components	Demonstration of performance as per section 8.1.2
9	Assembly/integration of 3dB Hybrid combiner with required sub-systems	Assembly & Integration	No Participation
*10	RF power test of prototype RF source on matched & mis-matched loads RF power test of Unit 1 RF source on matched & mis-matched loads	Demonstration of performance as per section 8.1.2	No Participation
Note: ITER-India is responsible for dis-assembly, packing and delivery of Prototype & Unit-1 RF sources to IO site			
At IO site, France			
11	Synthesizer, power divider, RF Switch, attenuator, phase shifter, HPA1(~10 kW SSPA), Local Control Unit (LCU), cooling header, auxiliary power supplies, High voltage power supply, 3dB Hybrid combiner, transmission line components, directional couplers, RF source enclosure, service platform with ladder, Dummy Load & Mismatch Tx-line system	Assembly, Integration & test as standalone mode	Witness the test as standalone mode and generate the validation reports as defined in Annexure-G: Validation report formats for interfaces at ITER-India/IO
12	Assembly of sets of components supplied by Bidder	Coordination with IO for providing necessary infrastructure	Assembly
13	Integration of HPA2 with required sub-systems	Refer section 21.2	Refer section 21.2
*14	RF power test of HPA2 on dummy load	Participation that includes involvement in test campaign to	Demonstration of performance as per section 8.1.4

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Item no.	Description of Component/subsystem/performance test	ITER-India Responsibility	Bidder Responsibility
		manage the supplied systems/components	
15	Integration of HPA3 with required sub-systems	Refer section 21.2	Refer section 21.2
*16	RF power test of RF chains on matched load	Involvement in test campaign to manage the supplied systems/components	Demonstration of performance as per section 8.1.4
*17	RF power test of RF chains on mismatched load for Unit 1 only	Involvement in test campaign to manage the supplied systems/components	Demonstration of performance as per section 8.1.4
18	Assembly/integration of 3dB Hybrid combiner with required sub-systems	Assembly & Integration	No Participation
*19	RF power test of prototype RF source on matched only RF power test of Unit 1 RF source on matched & mis-matched loads	Demonstration of performance as per section 8.1.4	No Participation
Design Reviews			
20	To participate remotely/in-person as a team with ITER-India in Final Design Review (FDR) conducted with IO and resolve the queries, if any.	Presenting technical contents of overall RF source & components supplied by ITER-India	Involvement in presenting the technical contents of the components to be supplied by Bidder
21	To participate remotely/in-person as a team with ITER-India in Fabrication Readiness Review (FRR) conducted with IO and resolve the queries, if any.	Presenting technical contents of overall RF source & components supplied by ITER-India	Involvement in presenting the technical contents of the components supplied by Bidder
22	To participate remotely/in-person as a team with ITER-India in Manufacturing Readiness Review (MRR) conducted with IO and resolve the queries, if any.	Presenting technical contents of overall RF source & components	Involvement in presenting the technical contents of the components supplied by Bidder

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Item no.	Description of Component/subsystem/performance test	ITER-India Responsibility	Bidder Responsibility
		supplied by ITER-India	

* Financial implication for repair/replacement during tests in newly components supplied by Bidder shall be borne by Bidder and components supplied by ITER-India shall be borne by ITER-India.

21.2 *List of activities between Bidder and ITER-India/IO during SAT*

In this section, detailing of activities corresponding to responsibilities as given in L1.

Table L1, for ITER-India/IO and Bidder are described.

At ITER-India and IO site, Bidder will be responsible for unpackaging, reassembly and the connection of Bidder's delivery to the RF chain system (mechanical, water, LCU and power), with the support of ITER-India.

The commissioning and the performance of the components other than the HP components in the assembled RF chain is under the responsibility of ITER-India at ITER-India & IO site.

Bidder will be responsible for the installation & commissioning and for the SAT performance of the components delivered by bidder for the RF chain at ITER-India & IO site.

Bidder will check the performance of various components of ITER-India design by sampling, based on the measurements performed by ITER-India. The validation remains under the designer's responsibility.

21.2.1 *Activities under the responsibility of ITER-India/IO*

Following activities will be performed during assembly and integration of HPA2 & HPA3 at ITER-India & IO sites:

- ***Mechanical & Electrical:***


During Phase 2;

- Readiness of RF enclosure along with base frame, support frame and service platform with ladder.
- #Readiness of grounding connection points for all the sub-systems of RF source.
- #AC supply to feed equipment power.

- ***RF Systems/Sub-systems & Tx-line:***

During Phase 2;

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- Integration of low power RF components up to HPA1 (SSPA).
- Integration of Interconnecting Tx-line section between HPA1 & HPA2 and HPA2 & HPA3 along with Directional coupler.
- Integration of Tx-line section between the output flange of HPA2 & Dummy load along with Directional Coupler to test HPA2 as a stand-alone.
- Integration of Tx-line section between the output flange of HPA3 & Dummy load along with Directional Coupler and arc detectors to test HPA3 as a stand-alone.
- Integration of 3dB Hybrid combiner with output of both HPA3 along with directional coupler and arc detectors.
- #Integration of Test bed (Dummy load & Mis-match Tx line) with output of RF source.
- Modification and relocating of existing HPA2, Trombone & HPA3 (supplied during Phase1) on newly service platform at ITER-India site.

• **Power Supplies:**

During Phase 2;

- Readiness of Auxiliary Power Supplies for HPA2 & HPA3.
- Procurement of cables as well as laying of cables up to the terminals of HPA2 & HPA3.
- Readiness of HV power supplies for HPA2 & HPA3.
- Procurement of cables as well as laying of cables up to the terminals of HPA2 & HPA3.

• **Local Control Unit:**

During Phase 2;

- Interfacing of LCU with instruments related to water-air cooling system.
- Interfacing of LCU with blowers.
- Interfacing of LCU with motor controller/driver of moving mechanism.
- Interfacing of LCU with PS and low power RF section.
- Interfacing of LCU with arc detectors and test lamp.
- Interfacing of LCU with RF power measurement & control.
- Integrated testing of LCU and generation of report.

• **Cooling distribution:**


During Phase 2;

- Integration of cooling distribution for HPA1 along with required instrumentation.
- Integration of air & water-cooling distribution for test bed along with required instrumentation.
- Providing Air & water cooling to 12-inch Tx-line system, 3dB Hybrid combiner.
- Providing inlet and outlet headers (as per agreed P&ID).
- Piping for main supply and return line from cooling water plant to the lab, where testing will be done.
- Supplying cooling water.

• **Test bed for Phase 2:**

- Integration of components/sub-systems for test bed.

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#: ITER-India/IO will provide technical support & infrastructures at their respective sites.

21.2.2 *Activities under the responsibility of the Bidder:*

Following activities will be performed during assembly and integration of HPA2 & HPA3 at ITER-India & IO sites:

- ***Mechanical & Electrical:***
During Phase 2;
 - Make the ground connection with HPA2, Trombone & HPA3.
 - Connection of AC power to blowers, motor & its controller etc., for HPA2, Trombone & HPA3 components.
- ***RF Systems/Sub-systems & Tx-line:***
During Phase 2;
 - Assembly & integration of HPA2, Trombone & HPA3 amplifiers (cavity, tube, peripherals etc.) for each RF source with service platform as per agreed layout at ITER-India site.
 - Re-assembly of two sets of HPA2, Trombone & HPA3 for each RF source on service platform at IO site, France.
- ***Interface with LCU:***
During Phase 2;
 - Integration of hardware with cables and connectors of HPA2, Trombone & HPA3 to interface with LCU as per **Annexure-F: Hardware to be delivered by Bidder to interface with LCU.**
- ***Power Supplies:***
During Phase 2;
 - Connection of cables for Auxiliary & HVPS to pre-defined location/terminal of HPA2 & HPA3.
- ***Cooling distribution:***
During Phase 2;
 - Integration of internal cooling distribution (along with required instrumentation) of HPA2 & HPA3.
 - Connection with inlet & outlet flanges for HPA2 & HPA3.
 - Integration of blowers & required arrangement (along with required instrumentation) for component cooling of HPA2 & HPA3.

	Tender documents [PART-A(ii)]: Scope of Supply, work and Technical Specifications for Phase 2-Driver and Final stage amplifiers for 2 sets of ITER ICRF Sources.- GLOBAL TENDER NOTICE NO: I-I/ET-TPT/25001/25-26	INDUS Ref. II-FB7DPL6-v_2_1
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22 Annexure M: Reference for seismic analysis

The RF sources (including components supplied by the Bidder) are classified Non-seismic Components but have to be compliant with the following;

The seismic analyses process for ITER components and the corresponding spectrum to be used for the analysis are defined in the [22], [23] & [24].

The purpose of the analysis is to check the behaviour of the components under the loads corresponding to 3 types of earthquake: SL 1, SL 2 and EC8-ULS (defined in Eurocode 8)

Depending on the seismic classification, the Bidder has to demonstrate different or common conditions under the different earthquake events:

For SL 2:

- The RF sources shall not jeopardize the building stability.
 - In particular, the manufacturer shall provide the component response under SL-2.
 - It is part of ITER-India tasks to check for compliance as regard to building stability.
 - Bidder will perform a simulation of HPA2, Trombone and HPA3 behaviour under seismic loads (not connected to the other elements of the RF chain). Bidder will also provide ITER-India with a calculation model of the tubes.

For SL 1:

In compliance with the requirements for Investment Protection, the RF sources shall be designed to be reasonably expected to restart and operate in normal situation after an SL-1 event, without special maintenance or tests. Only analytical calculation for SL1 will be conducted without testing the system on the shake table.

For EC8-ULS

The RF source stability shall be maintained. This guaranties that occupational safety is ensured as per Eurocode 8 criteria. This applied to the area occupied by people.

Bidder will make their best effort to meet the targets in terms of layout, footprint and weight of their delivery, within the limits of the design evolutions requested in this Tender document. Bidder may include in their proposal with maximum numbers of runs for design activities to allow optimisation.