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| IDM UID <u>E2ZJZF</u> |
| VERSION CREATED ON / VERSION / STATUS 01 Jul 2025 / 1.0 / Approved |
| EXTERNAL REFERENCE / VERSION |

Interface Sheet-IS

IS-43-41-502 Interface between Class II-IP Power Supply of SSEN (PBS 43.BR) and In-vessel coil power supply IS-43-41-502

| Approval Process | | | |
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| <i>Read Access</i> | LG: DA RO to sign off ICDs, GG: AIF- CEA SSA Liaison Committee Members &experts, LG: F4E-Architect/Engineering company, GG: MAC Members and Experts, GG: STAC Members & Experts, GG: CEA Decommissioning Experts, LG: CEA view, GG: DA Heads, Co-ordinators and Management, AD: ITER, AD: External Collabor... | | |

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| <i>Change Log</i> | | | |
|---|----------------------|-------------------|---|
| IS-43-41-502 Interface between Class II-IP Power Supply of SSEN (PBS 43.BR) and In-vessel coil power supply (E2ZJZF) | | | |
| <i>Version</i> | <i>Latest Status</i> | <i>Issue Date</i> | <i>Description of Change</i> |
| v0.0 | In Work | 22 May 2025 | |
| v1.0 | Approved | 01 Jul 2025 | <p>First release IS created to implement PCR-001640 (1ST STEP UPDATE)</p> <p>Explanation of the 2 steps update strategy:</p> <ul style="list-style-type: none"> - 1ST STEP UPDATE: first IS update to modify the PBS client power request and to close PBS client PCR(s) as soon as possible - 2ND STEP UPDATE: if needed, second IS update to modify PBS 43 data (consecutively to PBS client updated power request), supported by a global PBS 43 PCR raised for reconciliation with all 1st step updates |

Table of Contents

| | | |
|----------|--|----------|
| 1 | PURPOSE | 2 |
| 2 | ACRONYMS AND DEFINITIONS | 2 |
| 2.1 | ACRONYMS | 2 |
| 2.2 | DEFINITIONS | 2 |
| 3 | APPLICABLE DOCUMENTS | 3 |
| 4 | REFERENCE DOCUMENTS | 3 |
| 5 | INTERFACE DESCRIPTION | 3 |
| 5.1 | PBS 43 (STEADY-STATE ELECTRIC NETWORK) | 3 |
| 5.2 | PBS 41 (COIL POWER SUPPLY & DISTRIBUTION SYSTEM) | 4 |
| 5.3 | INTERFACE BETWEEN PBS 43 AND PBS 41 | 4 |
| 5.3.1 | <i>Physical interface</i> | 4 |
| 5.3.2 | <i>Functional interface</i> | 4 |
| 6 | INTERFACE REQUIREMENTS (IR) | 4 |
| 7 | DIVISION OF RESPONSIBILITIES | 5 |
| 7.1 | PBS 41 RESPONSIBILITIES | 5 |
| 7.2 | PBS 43 RESPONSIBILITIES | 5 |
| 7.3 | SHARED RESPONSIBILITIES AND UNDERSTANDING | 5 |
| 7.3.1 | <i>Interface sheet steps</i> | 5 |
| 7.3.2 | <i>PBS 43 and PBS 41 voltage drops</i> | 5 |
| 7.3.3 | <i>PBS 43 and PBS 41 circuit breakers</i> | 6 |
| 7.3.4 | <i>Interface sheet update process</i> | 6 |
| 8 | STAGED APPROACH | 6 |

1 Purpose

The purpose of the present IS is to define the interface requirements between PBS 43 and PBS 41 for the LV Class II IP power supply of the In-vessel coil power supply, part of the Coil Power Supply & Distribution System in agreement with ICD-41-43 [AD1].

2 Acronyms and definitions

2.1 Acronyms

| | |
|-------|--|
| AC/DC | Alternating Current/Direct Current |
| BD | Board, Distribution |
| CPSD | Coil Power Supply & Distribution |
| DT-1 | Deuterium Tritium phase 1 |
| DT-2 | Deuterium Tritium phase 2 |
| EDH | Electrical Design Handbook |
| EE | Electrical Enclosure (TTT code = BD, BP, BJ, CMC, CNP, CR, CU, PSU, VFD) |
| ICD | Interface Control Document |
| IP | Investment Protection |
| IR | Interface Requirement |
| IS | Interface Sheet |
| LV | Low Voltage |
| NA | Not Applicable |
| PA | Procurement Arrangement |
| PBS | Plant Breakdown Structure |
| PCR | Project Change Request |
| SRD | System Requirements Document |
| SRO | Start of Research Operation |
| TBD | To Be Defined |
| TKC | ToKamak Complex |

2.2 Definitions

All terminologies and acronyms related to the present IS are defined in [AD4] (EDH part2)

3 Applicable Documents

| Reference | Title | UID | Version |
|-----------|---|------------------------|---------|
| [AD1] | ICD-41-43 Interface Control Document for Steady State Electrical Network (PBS 43) and Coil Power Supply and PPEN (PBS 41) | 35BQZA | 1.4 |
| [AD2] | SRD-43 (Steady State Electric Power Supply Networks) from DOORS | 28B6Y9 | 3.6 |
| [AD3] | SRD-41 (Coil Power Supply and Distribution) from DOORS | 28B6XQ | 5.0 |
| [AD4] | Electrical Design Handbook (EDH) | 2DSPT6 | Folder |
| [AD5] | Staged Approach Configuration - PBS Level 3 | SNE6G8 | 4.0 |

4 Reference Documents

| Reference | Title | UID | Version |
|-----------|--|------------------------|---------|
| [RD1] | TEMPLATE of PBS 43 Electrical Interface Sheet for LV | 35WP5A | 4.4 |
| [RD2] | Definition of Important Electrical Terms in the PBS43 Interface Sheet Annexure | 5CZWB2 | 1.0 |
| [RD3] | EDH Standardisation Guides | 2N45UN | Folder |
| [RD4] | LV electrical calculation methodology. Standard cable sizing and short-circuit breaker | 5KQGZV | 5.4 |
| [RD5] | 3D Extract of Electrical Enclosures in Tokamak Complex | 2U6RJP | 2.14 |
| [RD6] | PBS 41 (Except PP) - Coordinates of equipment (except EE in the TKC) | CRM2SE | 1.6 |

5 Interface Description

5.1 PBS 43 (Steady-State Electric Network)

The main function of the Steady-State Electric Network (SSEN) is to transform AC power received from the French 400 kV transmission grid and distribute it to the ITER plant components (SSEN clients) that require steady state electric power.

The SSEN provides electrical power to PBS clients according to the following classification:

- Class I-Safety: Uninterruptible DC for components classified as PIC
- Class II-Safety: Uninterruptible AC for components classified as PIC
- Class II-IP: Uninterruptible AC for components classified as “Investment Protection”
- Class III-Safety: Emergency AC power (temporarily interruptible) for components classified as “Safety Important Class” PIC
- Class III-IP: Emergency AC power (temporarily interruptible) for components classified as “Investment Protection”
- Class IV: AC grid power (indefinitely interruptible).

5.2 PBS 41 (Coil Power Supply & Distribution System)

The CPSD consists of the following subsystems:

- Pulsed Power Electric Network (PPEN) which receives AC power from the HV grid and distributes it at intermediate voltage (IV) and medium voltage (MV) to the pulsed loads of ITER, comprising of the CPSS and H&CD PS.
- Reactive Power Compensation and Harmonic Filtering (RPC&HF) System connected at intermediate voltage (IV) compensates the reactive power and reduces harmonic distortion caused by AC/DC Converters and Heating power supply to level acceptable system operational requirements.
- Coil Power Supply System (CPSS) which receives AC power from the PPEN and supplies controlled DC power to the TF, PF, CS, CC, ELMs, and VS3 coils and stabilizing feedback loops VS1 and VS2 (the decision can be taken at a later stage).

The present IS applies for the LV Class II IP power supply for the In-vessel coil power supply, which is part of the CPSS

The In-vessel coil power supply provides controlled voltage/current for stabilization of plasma vertical displacements, varying current in the VS in-vessel coils (stabilizing feedback loop VS3).

5.3 Interface between PBS 43 and PBS 41

The present IS defines the interface requirements associated to the PBS 41 LV Class II IP power demand of the In-vessel coil power supply to PBS 43.

5.3.1 Physical interface

The physical interfaces between the Steady State Electrical Network (PBS 43) and the Coil Power Supply & Distribution System (PBS 41) take place at the connection between PBS 43 cables coming from the LV Class II IP (main and sub) distribution boards and the PBS 41 components terminal block.

Notes: PBS 43 cable routing is performed through IS-43-44 where PBS 43 specifies the components' FROM / TO coordinates (x, y, z). When the "TO" component belongs to PBS 41, coordinates are taken:

- From [RD5] for Electrical Enclosures (EE) in the TKC
- From [RD6] for all other components (i.e. EE out of the TKC and non EE)

5.3.2 Functional interface

The Steady State Electrical Network (PBS 43) provides the requested LV Class II IP power to PBS 41.

6 Interface Requirements (IR)

[4341-502i1-R] PBS 43 shall provide PBS 41 electrical components with the power requested in the ANNEX of the present IS.

[4341-502i2-R] PBS 41 shall design its components terminal block in consistency with the number and maximum cross sections of PBS 43 cables specified in the dedicated columns of the ANNEX of the present IS.

7 Division of Responsibilities

7.1 PBS 41 responsibilities

PBS 41 must demand low voltage electrical power to PBS 43 using the Excel file template in attachment of [RD1].

PBS 41 must refer to [RD2] to properly fill the Excel file template.

PBS 41 must ensure that the coordinates (x,y,z) of its electrical enclosures (EE) located in the TKC specified in [RD5] are correct.

PBS 41 must ensure that the coordinates (x,y,z) of its EE out of the TKC and non-EE specified in [RD6] are correct.

PBS 41 can use relevant guideline in [RD3] to develop its electrical design.

PBS 41 is responsible to ensure that information filled in its allocated cells are correct and up to date.

7.2 PBS 43 responsibilities

PBS 43 must complete the PBS 41 power request Excel file, in particular the information necessary for PBS 41 design, among others:

- The PBS 43 distribution board allocated to each PBS 41 load
- The number and maximum cross sections of PBS 43 cables connected to each PBS 41 component terminal block
- The protection devices characteristics

PBS 43 is responsible to ensure that information filled in its allocated cells are correct and up to date.

7.3 Shared responsibilities and understanding

7.3.1 Interface sheet steps

The allocation of PBS 43 distribution boards as well as the number and cross sections of PBS 43 cables depend on the PBS client load class, power and location. It is therefore understood that the completion of the present IS is the result of an iterative process:

1. PBS 41 requires power to PBS 43 using the Excel file template [RD1] and provides the coordinates (x,y,z) of its electrical loads to PBS 43
2. PBS 43 performs its electrical distribution design to meet PBS 41 power request and completes the Excel file accordingly
3. PBS 43 and PBS 41 approve the IS

Both PBS 43 and PBS 41 perform their design in consistency with specifications agreed in the completed Excel file of the approved IS.

7.3.2 PBS 43 and PBS 41 voltage drops

This section is applicable only if PBS 41, from its components interfacing with PBS 43 cables, further distributes power to downstream component(s) with the same voltage (400V or 230V)

The voltage drop requirements apply to the cable “chain” from the power source up to the final consumer. Therefore, it is shared between PBS 43 and PBS 41 cables. It is agreed that:

- Both PBS 43 and PBS 41 perform their design with the objective to respect the voltage drop sharing described in [RD04].

- PBS 41 must calculate the voltage drop for each of the cables of its scope and provide the values to PBS 43.
- PBS 43 will use voltage drop values provided by PBS 41 to verify that the overall voltage drop in the cables (from the source up to the final consumer) complies with the requirements: [43s718-R] and [43s370-R] of [AD2].
- Should the voltage drop requirements not be met, both PBS must discuss to find the best solution.

7.3.3 PBS 43 and PBS 41 circuit breakers

The selectivity is the coordination of overcurrent protection devices so that a fault in the installation is cleared by the protection device located immediately upstream of the fault. Therefore, the compliance with selectivity requirements relies on the “coordination” of PBS 43 and PBS 41 protection devices, if any.

The relevant characteristics of PBS 43 protection devices are specified in dedicated columns (P to X) of the Excel file template [RD1].

PBS 41 must take into account PBS 43 protection devices characteristics specified in the ANNEX of the present IS to design its own protection devices so as to comply with selectivity requirements.

Should the design of PBS 41 protection devices not be compatible with the selectivity requirements, both PBS must discuss to find the best solution.

7.3.4 Interface sheet update process

PBS 41 electrical power demand can evolve as its design matures. However, as PBS 43 electrical distribution already passed its FDR, any change in the PBS client power demand must be supported by a PCR.

Should PBS 43 not be able to meet the “new” PBS 41 power demand within its current design, both PBS must discuss to find the best solution.

Note: PBS 43 configuration will be updated on a regular basis embarking relevant PCR raised since the previous baselined configuration.

8 Staged Approach

This section aims at defining at which phase of the Staged Approach the physical and functional interfaces identified in this IS are required.

PBS 41 specifies the phase from which the power is needed in the column “When is the power needed?” of the Excel file attached to this IS

PBS 43 identifies the (main and sub) distribution boards distributing the power to PBS client components in the column “From Equipment' Functional Reference” of the Excel file attached to this IS. The related phasing of these boards – of their PBS level 3 node - is specified in [AD5].

| | |
|-------------------|--|
| Control cells | To be provided by P60-VV (P60-clonal) |
| | To be provided by P60-E3 (JES26) |
| Calculated fields | |
| | To be Modified/added P60, if needed |
| | Cells modified or added as compared to previous version (deletion does not appear) |