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Sub-System Requirements Document-sSRD

s-SRD-16-TW (Temporary First Wall Panels)

This sub-SRD contains all of the functional, design, safety, operational and quality requirements for the Temporary First Wall Panels.

Approval Process			
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Previous Versions Reviews	**Hunt R.** **Martin A.** **Lee J. *** **Wu Y.**	**05 Nov 2025:recommended v2.0** **12 Nov 2025:recommended v2.0** **06 Nov 2025:recommended v2.0** **05 Nov 2025:recommended v2.0**	**IO/DG/CP/TKP/BKT** **IO/DG/ESD/DOME/SMS** **IO/DG/SQD/SES** **IO/DG/ESD/NSE**
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Change Log			
s-SRD-16-TW (Temporary First Wall Panels) (C59SXF)			
Version	***Latest Status***	***Issue Date***	***Description of Change***
v0.0	In Work	03 Sep 2024	
v1.0	Revision Required	04 Sep 2024	Add document
v1.1	Approved	11 Oct 2024	Change according to comments from IDM reviewers and blanket team colleagues
v2.0	Revision Required	04 Nov 2025	Completion of the implementation of the PCR-1600 (Baseline 2024) and its daughter PCRs, especially the PCR-1630 (In-Vessel changes, including the replacement of Beryllium by Tungsten as Blanket First Wall material, the replacement of First Plasma Protection Components by Temporary First Walls, the change of poloidal profile of the FW and TFW and the radial customization of three poloidal rows of FW for alignment with the magnetic field) Propagation of the updated and new requirements from the PR v7.1
v2.1	Approved	19 Nov 2025	Short cycle revision to implement reviewer's comments on v2.0

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PURPOSE

[16TWs1-I] The objective of this sub-System Requirements Document (sSRD) is to identify all sub-system-level functional, design, safety, operational, and quality requirements for the Temporary First Wall (PBS 16.TW).

[16TWs187-R] There are some outstanding topics in this sSRD version, which are under investigation as detailed in the dedicated Reconciliation Report (RR, [ADc18]). The implementation of this sSRD into the system's design shall include the agreed resolutions of these issues, as traced in this RR.

Table 0.1: Record of changes induced on this document by PCRs

SRD version	Section / Paragraph identifier	PCR reference
v1.0	Initial issue	001630 Baseline 2024 - Scenario B - In-vessel changes (daughter of PCR-001600)
v1.1	Reflect reviewers' comments	
v2.0	Completion of the implementation of the PCR-1600 (Baseline 2024) and its daughter PCRs, especially the PCR-1630 (In-Vessel changes, including the replacement of Beryllium by Tungsten as Blanket First Wall material, the replacement of First Plasma Protection Components by Temporary First Walls, the change of poloidal profile of the FW and TFW and the radial customization of three poloidal rows of FW for alignment with the magnetic field) Propagation of the updated and new requirements from the PR v7.1	PCR-1600; PCR-1630
V2.1	Implementation of reviewer's comments on v2.0	

SCOPE

[16TWs2-I] This sSRD lists the functional, design, safety, operational, and quality requirements on the Temporary First Wall (PBS 16.TW).

[16TWs3-I] The requirements specified in this s-SRD provide the detailed allocation of the requirements given in the SRD-16 [ADi201].

[16TWs5-I] Sections 1 to 6 of the sSRD describe the system in its final configuration and the associated requirements that this system must satisfy to undertake the Deuterium-Deuterium (DD) operation campaigns. Section 7 presents specific requirements (if any) that the system must satisfy during each of the 3 operational phases: Start of Research Operation (SRO), first D-T phase (DT-1), and second D-T phase (DT-2). In the case of this sub-system, only SRO is relevant, so requirements are not listed for the other two phases.

DEFINITIONS

[16TWs6-I] CMM Configuration Management Model

TFW Temporary First Wall

OI Operational Instrumentations

SB Shield block

SRO Start of Research Operation

[16TWs7-I] For a complete list of ITER abbreviations see ITER Abbreviations [R302].

REFERENCES

[16TWs9-I] This s-SRD makes reference to the documents in this section and to the Interface Control Documents (ICDs) that are listed in Section 1.5.

[16TWs10-I] All complementary applicable documents are tagged with a [ADc]-series number; all input applicable documents are tagged with a [ADi]-series number; all reference documents are tagged with a [R]-series number.

[16TWs11-R] The system shall be compliant with the applicable versions for each Complementary and Input Applicable Document that are given in the Applicable Document References Matrix for SSRD - Temporary First Wall Panels (REFS-16.TW) (ITER_D_B7DTCC).

Complementary applicable documents

[16TWs12-I] The following documents, which contain mandatory technical requirements to be satisfied by the system, are complementary to this s-SRD. Interface Control Documents (ICDs) are not explicitly listed (listed instead in section 1.5) and are also ADc. Propagation and compliance of the system with the requirements recorded in these documents must be demonstrated in the same manner than this SRD.

[16TWs188-ADc] [ADc1] TFW Load Specification (ITER_D_92NARK)

[16TWs189-ADc] [ADc3] Plasma Heat Load Specification for the ITER Tungsten First Wall (ITER_D_9PSPKZ)

[16TWs190-ADc] [ADc4] ITER Vacuum Handbook (ITER_D_2EZ9UM)

[16TWs191-ADc] [ADc5] ITER Materials Properties Handbook, Introduction, baseline 2009 (ITER_D_2NRCSB)

[16TWs192-ADc] [ADc6] ITER Site Signage & Graphics Standards (ITER_D_4ALJEU)

[16TWs193-ADc] [ADc7] ITER Operational States (ITER_D_54L85L)

[16TWs194-ADc] [ADc8] In-vessel Components, SDC-IC (ITER_D_222RHC)

[16TWs195-ADc] [ADc9] Quality Classification Determination (ITER_D_24VQES)

[16TWs196-ADc] [ADc10] ITER Seismic Nuclear Safety Approach (ITER_D_2DRVPE)

[16TWs197-ADc] [ADc11] Safety Important Functions and Components Classification Criteria and Methodology (ITER_D_347SF3)

[16TWs198-ADc] [ADc13] Blanket Module Alignment, Gap, and Step Requirements (ITER_D_87V3SE)

[16TWs199-ADc] [ADc14] Chemical composition and impurity requirements for materials (ITER_D_REYV5V)

[16TWs200-ADc] [ADc15] Load Specification for the ITER Vacuum Vessel (ITER_D_2F52JY)

[16TWs201-ADc] [ADc18] Reconciliation report for SRD-16-TW (temporary first wall) [C59SXF] with ITER Technical Baseline (ITER_D_ETP2F6)

[16TWs202-ADc] [ADc19] ITER Investment Protection Handbook (ITER_D_3VUMVW)

[16TWs204-ADc] [ADc20] PBS 16 - System Human & Organizational Factors Requirements (ITER_D_E34FCA)

Input applicable documents

[16TWs30-I] The following documents have been used as input to produce this SRD. This means that all the technical requirements they contain that are applicable to the system have been fully propagated to this system and that the resulting system requirements have been recorded in this s-SRD and/or one of its complementary applicable documents. Compliance with an Input Applicable Document (ADi) to this SRD will be demonstrated via the achieved compliance of this SRD and its ADc. An ADi only partially propagated to the system is identified as ADc until its propagation is complete.

[16TWs31-ADi] [ADi201] SRD-16 (Blanket System) from DOORS (ITER_D_28B2Q4)

[16TWs32-ADi] [ADi202] RPM from SRD-16 to s-SRD 16.TW (ITER_D_APRVLH)

Reference documents

[16TWs33-I] A reference document is a document only "For information". It provides background information to improve the understanding of the project, the system, and its requirements. There is no need for the supplier to demonstrate compliance to these documents.

[16TWs34-I] [R301] SRD-17.OI (ITER_D_TK5LMV)

[16TWs35-I] [R302] ITER Abbreviations (ITER_D_2MU6W5)

[16TWs36-I] [R303] Configuration Management Model (CMM) process(ITER_D_V2ERKH)

[16TWs37-I] [R304] ITER Tritium Handbook (ITER_D_2LAJTW)

[16TWs39-I] [R306] RH Compatibility Procedure (ITER_D_2NRTWR)

[16TWs40-I] [R307] ITER Quality Assurance Program (QAP) (ITER_D_22K4QX)

[16TWs41-I] [R308] Design Verification and Validation Procedure (ITER_D_R3KD8C)

[16TWs42-I] [R309] Final Report of Negotiations on the Joint Implementation of the ITER Project: Attachment II: Record of Negotiators' Common Understandings (ITER_D_2W47FG)

[16TWs43-I] [R310] 16.TW Risk Analysis Report (ITER_D_C59UUJ)

[16TWs20-I] [R311] ITER Remote Handling Code of Practice (ITER_D_2E7BC5)

[16TWs203-I] [R312] EDH Guide A: Electrical Installations for SSEN Client Systems (ITER_D_2EB9VT)

[16TWs205-I] [R315] ITER Configuration Management Implementation Plan (CMIP) (ITER_D_27LHHE)

[16TWs206-I] [R316] Staged Approach Configuration – PBS Level 3 (ITER_D_SNE6G8)

[16TWs207-I] [R317] ITER Research Plan (IRP) – Level 2 – First Integrated Commissioning (IC-I) (ITER_D_EEFPLC)

[16TWs208-I] [R318] ITER Research Plan (IRP) – Level 2 – Start of Research Operation (ITER_D_EEFS7U)

1 FUNCTIONS, BASIC CONFIGURATION, CLASSIFICATION AND SYSTEM BOUNDARIES

1.1 System Functions

[16TWs44-I] SRO will be a learning environment for operators for the benefit of DT-1. With this context, the design of The TFW should mimic to the best extent possible the full Tungsten First Wall used in later operation.

[16TWs46-R] The TFW shall define the plasma boundary during limiter operation.

[16TWs47-R] The TFW shall contribute to absorbing radiation and particle heat fluxes from the plasma as defined in the [ADc1] TFW Load Specification.

[16TWs48-R] The TFW shall protect the shield block, Vacuum Vessel, and other in-vessel components against transient thermal responses that are higher than acceptable to those components.

[16TWs49-R] The TFW shall provide passage for the in-vessel viewing systems, microwave antennas or launchers, the gas and pellet fuelling systems, and other ancillaries.

[16TWs50-R] The TFW shall provide mechanical mounting support for relevant plasma diagnostics.

1.2 System Basic Configuration

[16TWs52-R] Each TFW shall attach to the shield blocks (SB) through a mechanical attachment system of a central bolt and a system of Key Pads which mimics the configuration of the final First Wall.

1.3 Classification of Systems, Structures and Components (SSCs)

[16TWs53-R] Quality classification: The TFW shall be designed as Quality Class 2 items, according to the [ADc9] Quality Classification Determination.

[16TWs54-R;Defined Requirement] Safety Importance Classification: The TFW shall be considered as non-Protection Important Components (non-PIC, original terminology “non-Safety Importance Class, non-SIC components), with no associated safety credit function, in accordance with the [ADc11] Safety Important Functions and Components Classification Criteria and Methodology.

[16TWs55-R;Defined Requirement] Seismic classification: The TFW shall be designed as a Seismic Class 2 (SC2) component, according to the [ADc10] ITER Seismic Nuclear Safety Approach.

[16TWs56-R] Vacuum classification: The TFW does not form part of the primary vacuum boundary, but are inside the primary vacuum; they therefore shall be designed as Vacuum Class VQC 1B components.

[16TWs57-I] Remote handling classification: The TFW is not Remote Handling (RH) Classified [R306].

[16TWs58-I] Tritium classification: The TFW has no tritium classification, in accordance with the classifications defined in the ITER Tritium Handbook [R304].

[16TWs59-I] Electrical power classification: The TFW has no Electrical Power availability classification [R312].

[16TWs209-R;Defined Requirement] When workers must enter into a zone with radiological an/or non-radiological hazards to perform tasks for the foreseen installation/upgrades and maintenance of the Blanket Temporary First Walls panels, these tasks shall be allocated one of the following Operation Task Classes (OTC):

- In a zone with radiological risks (exposure to ionizing radiations and/or radioactive contamination)
  - OTC1-1: for any task which represents 1% or more of the ITER annual collective radiation dose exposure limit,
  - OTC1-2: for any task which is in the range from 0.1% to 1% of the ITER annual collective radiation dose exposure limit,

- OTC1-3: for any task which represents less than 0.1% of the ITER annual collective radiation dose exposure limit.

- In an environment of toxic and/or other hazardous but without risk of radiation exposure or radioactive contamination
  - OTC2-1: for any task which is not classified as OTC1 and deals with Beryllium and require Beryllium waste management (associated with TBM components and related activities),
  - OTC2-2: for any other OTC2 operation tasks that are not classified as OTC2-1.
- Operation Task Class 3 (OTC3) includes any operation task that is not classified as OTC1 or OTC2..

[16TWs210-R] The risks to the ITER investment and operational time due to a fault or failure of a Blanket System component (including risks from their foreseen installation, operation and maintenance) shall be assessed and allocated an IP category, in accordance with the Investment Protection Handbook [ADc19].

1.4 Design Basis Conditions and Events

[16TWs211-I] The TFW is the primary system to interact with novel disruption loads during early operation of the ITER tokamak. Given the experimental nature of ITER, the load magnitudes (especially those deriving from plasma disruption) bear large uncertainty. Furthermore, the large energy of the ITER plasma has the potential to transfer unmanageable loads onto the TFW which cannot be managed with an affordable design. In this context, this specification first defines requirements to accommodate all normal operational loads (like stationary plasma and heating system loads). Transient loads are also accommodated to a limited degree, but all foreseen experimental scenarios cannot fully be accommodated. Instead, these transient loads are to be investigated experimentally during the SRO campaign, with this specification providing requirements to ensure that the structural integrity of the TFW is maintained as best possible through the campaign.

[16TWs63-R] The TFW shall be designed in accordance with plasma scenarios that are specified in the [ADc3] Plasma Heat Load Specification for the ITER Tungsten First Wall.

[16TWs64-R] The TFW shall be designed in accordance with the design basis, loads, and load combinations that are specified in [ADc1] TFW Load Specification.

1.5 System Boundaries and Interfaces

[16TWs184-R] PBS 15-VV (Vacuum Vessel):

- Physical interface
- ICD-15.VV-16 Interface Control Document for Vacuum Vessel (PBS 15.VV) and Blanket System (PBS 16) (ITER_D_2NR7LR)

[16TWs65-R] PBS 16 (Blanket System):

- Physical interface
- ICD-16-16 Interface Control Document for interface within Blanket System (PBS 16)(ITER_D_AGBMZL)

[16TWs66-R] PBS 17 (Divertor):

- Physical and functional interface
- ICD-16-17 Interface Control Document for Blanket System (PBS 16)and Divertor System (PBS 17) (ITER_D_2KTFAD)

[16TWs67-R] PBS 18 (Fuelling and Wall Conditioning System):

- Physical interface
- ICD-16-18 Interface Control Document for Blanket System (PBS 16) and Fuelling & Wall Conditioning System (PBS 18) (ITER_D_2MGX75)

[16TWs68-R] PBS 22 (Machine Assembly and Tooling):

- Physical interface
- ICD-16-22 Interface Control Document for Blanket System (PBS 16) and Machine Assembly Tooling (PBS 22) (ITER_D_2FNR6R)

[16TWs212-R] PBS 23 (Remote Handling System):

- Physical interface
- ICD-16-23 Interface Control Document for Blanket System (PBS 16) and Remote Handling System (PBS 23) (ITER_D_2WSDXY)

[16TWs70-R] PBS 31 (Vacuum System):

- Functional interface
- ICD-16-31 Interface Control Document for Blanket System (PBS 16) and Vacuum System (PBS 31) (ITER_D_495KFU)

[16TWs71-R] PBS 47 (Plasma Control System):

- Functional interface
- ICD-16-47 Interface Control Document for Blanket System (PBS 16) and Plasma Control System (PBS 47) (ITER_D_6N5BTR)

[16TWs72-R] PBS 51 (Ion Cyclotron Heating and CD System):

- Physical and functional interface
- ICD-16-51 Interface Control Document for Blanket System (PBS 16) and ICH&CD System (PBS 51) (ITER_D_2LAEWB)

[16TWs73-R] PBS 52 (Electron Cyclotron Heating and CD System):

- Physical and functional interface
- ICD-16-52 Interface Control Document for Blanket System (PBS 16) and ECH&CD System (PBS 52) (ITER_D_33ZNNM)

[16TWs74-R] PBS 55 (Diagnostics):

- Physical and functional interface
- ICD-16-55 Interface Control Document for Blanket System (PBS 16) and Diagnostics System (PBS 55) (ITER_D_33MYP2)

[16TWs75-R] PBS 57 (In-Vessel Viewing System):

- Physical interface
- ICD-16-57 Interface Control Document for Blanket System (PBS 16) and In Vessel Viewing Systems (PBS 57) (ITER_D_NC8CVR)

[16TWs76-R] PBS 66 (Radwaste Treatment and Storage Systems):

- Physical interface
- ICD-16-66 Interface Control Document for Blanket System (PBs 16) and Rad-Waste Treatment & Storage System (PBS 66) (ITER_D_49CLTF)

2 DESIGN REQUIREMENTS

2.1 General requirements

[16TWs77-R] The TFW panels shall comply with the power handling requirements as defined in the [ADc1] TFW Load Specification without active water cooling.

[16TWs78-R] Debris from the TFW shall not compromise the structural integrity of other SSC.

[16TWs79-R] The TFW shall comply with the space reservation constraints and interface characteristics specified in the Configuration Management Model (CMM) [R303].

[16TWs81-R] The TFW shall take into account a reversible toroidal field and plasma current, assuming that the field line maintains the same pitch angle orientation.

[16TWs213-R] The TFW shall accommodate a boronized environment.

[16TWs214-R] The TFW shall comply with its System Human Factor Requirements (SHFR) document [ADc20].

[16TWs215-R] In order to remove or mitigate risks to ITER investment (in terms of components and operational time), the design and operation of the TFW shall implement adequate measures as identified by the IP risk assessment and defined by the Investment Protection Handbook [ADc19].

[16TWs216-R] The TFW design shall be standardized as much as possible for its main components to optimize their interchangeability.

2.2 System specific requirements

[16TWs80-R] The TFW panels shall be armoured by tungsten as the plasma facing material.

[16TWs217-R] Exposure to the plasma of other materials such as copper and steel shall be limited as per agreement with operations, in consideration of the combined exposure of all in-vessel components.

[16TWs45-R] The TFW shall be a conformal first wall with similar surface coverage as that of the First Wall, to within an acceptable variation.

[16TWs82-R] The plasma poloidal and toroidal contours of each TFW panel shall be similar to that of the final FW panel counterpart but could deviate for purposes of design simplification.

2.3 Structural requirements

[16TWs84-R] The TFW shall be designed for its full lifecycle, as defined in [ADc1] TFW Load Specification from construction, operation, to decommissioning, including testing, inspection, maintenance, and waste production [R317] [R318].

[16TWs85-R] The TFW shall comply with the [ADc8] In-vessel Components, SDC-IC for all individual and combined load cases defined in the [ADc1] TFW Load Specification.

2.4 Mechanical requirements (including load conditions)

[16TWs88-R] Operation of the TFW shall be able to be restored after events in categories I and II without maintenance intervention, and after one category III event with a maintenance intervention.

[16TWs89-R;Defined Requirement] After any event up to category IV, the overall deformation of the TFW shall be limited to an amount that does not compromise any Protection-Important Components.

2.5 Seismic requirements

[16TWs90-R] The TFW shall be capable to withstand an SL-1 event without requiring special inspection or test.

[16TWs91-R;Defined Requirement] During and after an SL-2 event, the TFW shall not jeopardize the confinement function of the VV and its extensions.

2.6 Fire protection requirements

[16TWs92-I] The TFW being metallic components (with no EEE items) have no specific fire protection requirements.

2.7 Electrical requirements

[16TWs93-I] There are no electrical requirements for the TFW.

2.8 Grounding and insulation requirements

[16TWs94-R] The TFW shall make an electrical earth connection to the SB without incurring joule heating damage at the connection(s).

[16TWs95-R] All TFW interfaces to the SB other than the planned electrical routing shall be insulated or provided with gaps to avoid electrical arcing.

2.9 Instrumentation and control requirements

[16TWs96-R] The TFW shall be equipped with operational instrumentation to collect data during operation.

[16TWs97-I] Instrumentation on TFW is covered by SRD-17.OI [R301]. Further detailed requirements as necessary are provided via interface sheet with PBS 17.OI.

2.10 Computer hardware and software requirements

[16TWs98-I] There are no hardware and software requirements for the TFW.

2.11 HVAC requirements

[16TWs102-I] There are no HVAC requirements for the TFW.

2.12 Vacuum requirements and vacuum classifications

[16TWs99-I] The TFW will be exposed to primary vacuum under normal and off-normal conditions.

[16TWs100-R] The design, assembly, construction, and operation of the TFW shall comply with the [ADc4] ITER Vacuum Handbook.

2.13 Thermal management requirements

[16TWs103-R] The TFW shall accommodate the loads resulting from baking the VV and other in-vessel components up to 240°C to remove the impurities that could affect the quality of the vacuum.

[16TWs105-R] The TFW shall satisfy [ADc8] In-vessel Components, SDC-IC for the relevant heat fluxes that are defined as design basis in the [ADc1] TFW Load Specification.

[16TWs106-R] The TFW shall account for the accumulated total energy loads from the three phases of the plasma discharge, as described in [ADc3] Plasma Heat Load Specification for the ITER Tungsten First Wall and propagated to the [ADc1] TFW Load Specification.

[16TWs218-R] The TFW shall satisfy [ADc8] In-vessel Components, SDC-IC under both diverted-like and limiter contact (depending on their poloidal location) during normal operations, as defined in the [ADc3] Plasma Heat Load Specification for the ITER Tungsten First Wall.

[16TWs107-R] The TFW shall satisfy [ADc8] In-vessel Components, SDC-IC under all load cases defined as design basis in the [ADc1] TFW Load Specification. All load cases defined as 'for performance analysis ' are considered out of design basis, but are to be investigated to assess the operational limits of the system. In either case, melting of the TFW plasma-facing surfaces is acceptable for transient events (especially REs and disruptions) where it does not impact the structural integrity.

[16TWs183-R] For normal plasma operation, the TFW shall be designed to avoid melting beyond shallow surface melting (millimetre scale) of the armour.

[16TWs108-I] The toroidal profile of TFW panels is intended to protect edges from direct incidence of high parallel heat fluxes (avoiding all edge loading is infeasible) whilst ensuring an efficient spreading of heat loads on the plasma-facing surface to mitigate local peak loading.

[16TWs109-R] The armour material thickness at the apex region in critical rows (specifically 6-11 and 18) shall be at least as thick as the DT First Wall in that location to tolerate Runaway Electrons.

2.14 Electromagnetic requirements

[16TWs110-R] The TFW shall satisfy [ADc8] In-vessel Components, SDC-IC under all calculated electromagnetic loads and load combinations as defined in [ADc1] TFW Load Specification.

[16TWs111-R;Defined Requirement] The TFW design shall be such that the electromagnetic loads that are transferred to the Vacuum Vessel will not exceed the values that are specified in the [ADc15] Load Specification for the ITER Vacuum Vessel.

[16TWs112-R] The TFW structural materials shall be non-magnetic. The ferrite content present in all welds shall not exceed 12%.

[16TWs219-R] The perturbation of magnetic field produced by TFW armour material W alloy shall be assessed and remain below the perturbation produced by existing systems (such as TBM, VV insert, etc.) in the ITER tokamak.

2.15 Nuclear shielding requirements

[16TWs113-I] There are no nuclear shielding requirements for the TFW, since the shield block will be capable of shielding all the nuclear loads to the Vacuum Vessel and ex-vessel components.

[16TWs220-R] During SRO, the TFW shall be designed to remain operable, without any planned maintenance, assuming a target maximum neutron production at the end of SRO of 1.5E+20 neutrons (with plasma generating neutron fluxes of 1E+15 - 1E+17 n/s with low neutron energy (~2.5 MeV, dominant)).

2.16 Chemical requirements

[16TWs114-I] There are no chemical requirements for the TFW.

2.17 Material requirements

[16TWs115-R] The TFW materials shall be selected in accordance with the properties specified in the [ADc5] ITER Materials Properties Handbook, Introduction, baseline 2009.

[16TWs116-R] Any TFW materials not listed in the [ADc5] ITER Materials Properties Handbook, Introduction, baseline 2009 shall be qualified in accordance with it and documented in the Materials Assessment Report.

[16TWs118-R;Defined Requirement] Materials composition shall provide as low as reasonably achievable requirements on radioactivity protection for the minimisation of radioactive waste and contact dose as per [ADc14] Chemical composition and impurity requirements for materials.

2.18 Manufacturing requirements

[16TWs120-R] The TFW shall be manufactured in compliance with EN Standards 13445, any appropriate ITER technical specifications, and the [ADc4] ITER Vacuum Handbook.

[16TWs121-R] All fluids and tools that are for use in the manufacture of the TFW shall comply with the [ADc4] ITER Vacuum Handbook.

2.19 Construction requirements

[16TWs122-R] The TFW shall implement unique identification of individual items and batches for monitoring during the life of the ITER project, in compliance with the [ADc6] ITER Site Signage & Graphics Standards.

[16TWs123-R;Defined Requirement] All solid, liquid and gaseous toxic, non-radioactive products needed for the construction and maintenance of the TFW shall be identified and their volumes and level of toxicity estimated to identify their appropriate management routes.

[16TWs221-R] TFW components that will require on-site storage following their delivery by suppliers, until their installation within ITER Facility (including all components to be installed during assembly phases and any spare components) shall be identified.

[16TWs222-R] The “fresh” TFW components shall be conditioned for transport to and storage on ITER Site as specified in applicable legislation and ITER specifications.

2.20 Assembly requirements

[16TWs124-R] The assembly of the TFW shall be performed consistent with maintaining its dimensional and geometrical tolerance requirements.

[16TWs125-R] The position and alignment of the TFW shall permit its assembly and operation and that of neighbouring systems.

[16TWs126-R] The position and alignment of the TFW shall ensure compatibility with power handling requirements as defined in [ADc13] Blanket Module Alignment, Gap, and Step Requirements.

[16TWs127-R] The position and alignment of the TFW shall be verified during assembly.

[16TWs128-R] The TFW shall include fiducial features to enable positional measurements.

2.21 Installation requirements

[16TWs129-R] The TFW shall be designed to permit their installation and removal, during pre-SRO assembly, SRO and post-SRO assembly phases within a mixed assembly systems / hands-on operating regime (interfaces with PBS 22 and PBS 23).

[16TWs130-R] All TFW interfaces with the Shield Blocks shall replicate as much as reasonably achievable those of the final First Wall.

[16TWs131-R] The TFW shall minimize any mandatory hands-on intervention for installation and removal of the TFW.

[16TWs132-R] The TFW, including handling fixtures, shall fit through the equatorial ports.

[16TWs133-R] The TFW shall include handling features that are compatible with hands-on assisted installation and removal.

[16TWs134-R] The weight of the TFW shall be compatible with the capacity of the In Vessel Tower Crane and Blanket Assembly Transporter, as specified in the concerned interface document.

[16TWs223-R] The fully-installed TFW shall include provisions for scaffolding to provide personnel access to the interior of the vacuum vessel for hands-on maintenance.

2.22 Testing and inspection requirements

[16TWs135-R] The TFW shall be subject to ITER Site Acceptance Testing, in accordance with the [ADc4] ITER Vacuum Handbook.

[16TWs224-I] At the end of the pre-SRO assembly period, an integrated commissioning should be performed as specified in the IRP [R317] [R318], to ensure correct functioning, and to assure readiness for plasma operations.

2.23 Decommissioning requirements

[16TWs136-R;Defined Requirement] The TFW shall be designed, constructed, operated and maintained in order to permit its safe and efficient decommissioning, in particular the removal of any hazardous substances onto its components (including tritium and activated/radioactively dust), and of its activated/radioactively contaminated components.

2.24 Other services

[16TWs225-R] Any TFW on-site deliveries or on-site logistics shall be within the limitations in size and weight of the components being transported to/within ITER Site (including packages and frames) shall be as follows:

- Maximum length: 19 m with an exception for crane beams: 47 m on a single line,
- Maximum width: 9 m,
- Maximum height: 9.1 m,
- Maximum weight: 600 t.

3 SAFETY DESIGN REQUIREMENTS

3.1 Safety design criteria

[16TWs138-I] No safety function is credited to the TFW, as it is a non-Protection Important Component.

[16TWs226-I] As a general principle, ITER is designed and operated so that it can be brought and maintained in a safe state in case of any incidents/accidents (including postulated combination of situations). The TFW being fully passive does not contribute directly to this state transition. However, its functional interfaces with its operation instrumentation (17.OI) may contribute indirectly in plasma, safety and interlocks controls (including the definition of associated operational limits).

[16TWs139-R;Defined Requirement] The TFW shall be designed such that assembly, maintenance, operation, failure or damage shall not prevent Protection-Important Components (PIC) from performing their safety functions when required.

[16TWs140-R;Defined Requirement] When operation associated with the TFW requires human interventions in a nuclear environment (including TFW panels replacement, if any authorized repair and waste management), its design shall ensure that the resulting doses to workers are ALARA and in any cases, their contributions* to:

- individual workers (full body/localized, maximum/averaged over a year) remains within the authorized dose limits,
- ITER collective annual worker dose (averaged over the operational lifetime of ITER) is below a fraction* of ITER annual target of 0.5 person.Sv.

* These contributions are to be agreed with IO Safety, before finalizing design and operation activities.

[16TWs227-R;Defined Requirement] The handling of activated and/or radioactively contaminated components of the TFW shall prevent or limit the spread of contamination across ITER facilities and areas.

3.2 Safety limits

3.2.1 Safety design base conditions

[16TWs228-I] No specific requirement.

3.2.2 Safety performance parameters

[16TWs144-R;Defined Requirement] The TFW shall contribute to the limitation of 4 kg total hydrogen generation in VV.

3.3 Monitoring requirements

[16TWs145-I] There are no safety-specific monitoring requirements for the TFW, as it consists of non-Protection-Important Components.

3.4 Safety-specific instrumentation

[16TWs146-I] There is no safety-specific instrumentation for the TFW, as it consists of non-Protection-Important Components.

[16TWs147-R] The TFW shall permit installation of material samples on the TFW panels, which permit to assess TFW net erosion and deposition. The installation, removal, and analysis of such samples is the responsibility of PBS 55.GD.

3.5 Safety related testing and inspection

[16TWs148-I] There are no safety-specific testing and inspection requirements for the TFW, as it consists of non-Protection-Important components.

3.6 Qualification requirements

[16TWs149-I] There are no safety requirements for qualification, as the TFW consists of non-Protection-Important Components.

3.7 Safety related operations and procedures

[16TWs150-R;Defined Requirement] TFW operations that potentially impact public or worker exposure to radiological or other hazards shall be controlled by appropriate approved procedures.

3.8 Occupational safety

[16TWs229-R;Defined Requirement] The activation of TFW shall remain low enough at the end of SRO phase to permit hands-on post-SRO assembly activities inside the Vacuum Vessel.

[16TWs152-R] Preventive measures shall be implemented in the design and operation of the TFW, as necessary, to reduce the frequency and/or the probability of an event to occur that could lead to workers injury. Rules shall be implemented for the construction, installation and utilization of equipment to protect people from OHS risks (cryogenic, anoxia, magnetic…).

[16TWs230-R] Staff shall be suitably trained and wear appropriate individual protection equipment before accessing an area where there may be non-nuclear safety risks to workers.

3.9 Environmental impact requirements

[16TWs153-R;Defined Requirement] Solid waste (radioactive and other hazardous substances) that will be generated during construction, normal operation (including its maintenance) and decommissioning shall be identified. Quantities and characteristics of these wastes shall be estimated. Their level of toxicity shall be kept ALARA.

3.10 Reliability requirements

[16TWs154-I] There are no safety related reliability requirements, as the TFW consists of non-Protection-Important Components.

3.11 Other requirements

[16TWs231-I] No specific requirement.

4 OPERATION AND MAINTENANCE

4.1 Operation

4.1.1 System operation states

[16TWs158-R] The TFW shall function during the combinations of system states and ITER Global Operation States, as defined in [ADc7] ITER Operational States.

4.1.2 Operational conditions

[16TWs159-I] The TFW is designed according to the operational conditions that are specified in the [ADc1] TFW Load Specification.

[16TWs232-I] During SRO phase, the Tokamak will operate continuously for a single experimental campaign of 27 months without any planned TKM Long-Term Maintenance (LTM).

4.1.3 Main control room

[16TWs160-I] There are no Main Control Room requirements for the TFW. The operational instrumentation for the Blanket System is covered by SRD-17.OI [R301].

4.2 Maintenance

4.2.1 Maintenance plan

[16TWs233-R] The maintenance requirements of the TFW shall conform to the maintenance periods that are defined for ITER. No scheduled maintenance shall be required outside the defined periods.

[16TWs234-R] No nuclear maintenance shall be planned during SRO on the TFW.

[16TWs235-R] In case of failure or damage of components of the TFW preventing the continuation of the safe and efficient operation of the Tokamak Machine during SRO, corrective maintenance shall be considered “in-situ” or using pre-SRO tools and non-nuclear facilities if the activation level is low enough, meaning happening before DD shots.

[16TWs236-R] If required, Post-SRO disassembly of TFW shall only start after a decay period permitting hands-on intervention using the Pre-SRO Assembly tools and existing non-nuclear facilities.

[16TWs161-R] The tiles of the TFW shall be replaceable in-vessel to permit unplanned repair and maintenance during the SRO phase.

[16TWs162-R] The TFW shall provide spare tiles for risk reduction during installation and customization.

[16TWs163-R] The short term maintenance of the TFW shall be limited to viewing the TFW surface using the In-Vessel Viewing System.

[16TWs165-R] All specific tools and test equipment needed for packaging, handling, storage, transportation, testing and maintenance of the systems equipment on site must be provided to IO. Assembly specific tools shall be designed in such a way as to be modified later to be used for maintenance during the operation phase of ITER, and shall thus be resilient and multi-purpose.

[16TWs167-R] From their manufacturing until entering in operation, all components of the TFW shall be preserved for Investment Protection. This shall ensure that components retain their required characteristics and performance, including prevention of deterioration over time and protection from external damage, during their shipping, storage, installation, testing, commissioning and maintenance prior to operation.

4.2.2 Remote handling

[16TWs168-I] The RH compatibility procedure may be used as a guideline for the design of handling features to enable the rapid assembly, maintenance and disassembly with a hands-on assisted program using the Blanket Assembly Transporter [R306][R311].

4.2.3 Hot cell

[16TWs172-R;Defined Requirement] The discarded and activated TFW materials shall be processed (including appropriate treatment/characterization, pre-packaging, packaging, and temporary storage) in the ITER Nuclear Maintenance and Radwaste management Facilities (NMRF), depending on their radioactive waste classification.

4.3 RAMI

4.3.1 Reliability. Availability. Maintainability. Inspectability requirements

[16TWs173-R] The TFW shall be designed, manufactured and operated to contribute achieving a target 91.8% availability during SRO.

[16TWs237-R] All components of the TFW shall be qualified to demonstrate they can perform their allocated functions with the required level of quality and performances. The extent and type of qualification (studies, calculations, testing, R&D, etc) shall be compliant with the applicable specifications, codes and standards, and commensurate with the level of risks associated with the components role, technological novelty and complexity, etc...

4.3.2 Risk reducing

[16TWs174-I] Risk management is performed through the ITER Risk Management system [R310].

5 QUALITY REQUIREMENTS

[16TWs175-R] The TFW shall be designed, manufactured, tested, commissioned, operated, and decommissioned in compliance with the ITER Quality Assurance Program [R307] and ITER Configuration Management Plan [R315], and supported by a complete documentation.

6 APPLICABLE CODES AND STANDARDS

[16TWs177-R] The EN 13445 code shall be applied as the main manufacturing code applicable to the TFW.

[16TWs178-R] The ITER In-vessel Components, [ADc8] In-vessel Components, SDC-IC shall be applied as the main structural criteria applicable to the TFW design.

7 ADDITIONAL REQUIREMENTS FOR THE STAGED APPROACH PHASES

[16TWs238-R] The TFW shall be installed and operated following the Staged Approach [R316].

7.1 Start of Research Operations (SRO)

[16TWs179-R] During Start of Research Operation (SRO) phase, the TFW System shall protect the vacuum vessel and other in-vessel systems from the plasma and ECRH beams within the design scenarios described in [ADc3] Plasma Heat Load Specification for the ITER Tungsten First Wall including the two objectives:

- 15 MA plasma current L mode operation at full-strength magnetic field (5.3 T at 6.2 m)
- 7.5 MA plasma current H mode operation at half-strength magnetic field (2.65 T at 6.2 m)

[16TWs180-R] The TFW shall be in service in their final configuration during the SRO phase.

7.2 Deuterium-Tritium Phase 1 (DT-1)

[16TWs181-R] Before starting DT-1, the TFW shall be removed.

7.3 Deuterium-Tritium Phase 2 (DT-2)

[16TWs182-I] The TFW have no requirements for DT-2.

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