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43S7GL

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16 Jun 2021 / 2.2 / Approved

EXTERNAL REFERENCE / VERSION

MQP Level 3

Expected content of System Design deliverables

The purpose of this document is to provide the expected content for typical document deliverables of the System* Design Phases. It also provides detailed objectives and expected maturity at the end of each design phase until FDR. This document does not supersede any procurement arrangement or contract provision in terms of delivery scope / deliverable list.* - System in this document refers to the System of interest at any PBS level

Approval Process			
	Name	*Action*	*Affiliation*
Author	**Guigon A.**	**16 Jun 2021:signed**	**IO/DG/ENGN/CIO/CMD/DCC**
Co-Authors			
Reviewers	**Puppin S.** **Salamon B.**	**17 Jun 2021:recommended** **17 Jun 2021:recommended**	**F4E (EU)** **IO/DG/ENGN/CIO/CMD/DCC**
Approver	**Becoulet A.**	**17 Jun 2021:approved**	**IO/DG/ENGN**
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Change Log			
Expected content of System Design deliverables (43S7GL)			
Version	***Latest Status***	***Issue Date***	***Description of Change***
v0.0	In Work	14 Oct 2020	
v1.0	Revision Required	18 Dec 2020	Document created as per approved MQP doc request https://user.iter.org/?uid=3YX43J
v1.1	Signed	24 Feb 2021	Document title shortened to "Expected content of System Design deliverables" Previous version comments are implemented. Attached the track change version in the attachments. Please note that the answers to the comments made on previous version are attached as a table in previous version.
v1.2	Approved	01 Apr 2021	Incorporated all comments received from version 1.1
v2.0	Signed	03 Jun 2021	As per approved MQP doc request 593JVP the changes are: 01. The contents are largely duplicate to 4CK4MT 02. Scope of this document/Applicability by IO and DAs 03. Identification of documents to be generated by IO and by the DAs 04. Improve the mapping for application by IO and DA 05. Improve one-to-one correspondence in the mapping 06. Definition of Manufacturing Design and impact on the document 07. Definition of Final Design and Built To Print design and impact on this document 08. Definition of Acceptance and Approval and impact on this document 09. Some cards have lost quality compared to cards in SDP-WI (v1.0) 10. Clarification of some sentences
v2.1	Signed	04 Jun 2021	Corrected typos in Appendix. See also main changes on version 2.0
v2.2	Approved	16 Jun 2021	Under same approved MQP doc request https://user.iter.org/?uid=593JVP new minor version is initiated to resolve EUDA concerns which have been discussed between CIO/CMD and EUDA. By decision of IO management only two reviewers are left: S. Puppin and B. Salamon. The changes are: - Responded to F4E comments on version 2.1 - “Part Drawing” card has been moved from Manufacturing to Design Definition chapter - Corrected typos and updated UID for CMMs - Added few Acronyms

Table of Contents

1 Purpose

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* - System in this document refers to the System of interest at any PBS level

2 Scope

This MQP document is applicable to IO, any DA or IO-Contractor Design Developer at any PBS level of the ITER project.

This document gives additional details in terms of technical content of the documents of the list of deliverables built at the time of PA/Contract signature (usually using as a basis the list given in Appendix 1 of Design Review Procedure [1]).

3 Definitions and Acronyms

3.1 Definitions

Build to Print Design:

This wording is used in the context of a procurement arrangement or an IO contract.
A Build to Print (BtP) design defines a set of technical specification and drawings provided by the Customer which define exactly "what" and potential constraints on the "how" the Contractor has to manufacture the SSC. The Contractor only "procures and fabricates". It includes all details that might be verified by the customer at product acceptance.

The Built to Print design package is therefore a subset of the final design package for a SSC, after the exclusion of all the documentation not relevant for manufacturing.

3.2 Acronyms

See below. Refer also to ITER_D_2MU6W5 - ITER Abbreviations

Acronym	Meaning
BOM	Bill Of Materials
BtP	Build to Print
CAD	Computer Aided Design
C&ID	Control and Instrumentation Diagram
CD	Conceptual Design
CDR	Conceptual Design Review
CMM	Configuration Management Model
CODAC	Control, Data Access and Communication
COTS	Commercial Off-The-Shelf
DCM	Design Compliance Matrix
DD/DDD	Design Description Document (System Design Description)
DIR	Design Integration Review
DJP	Design Justification Plan
DM	Detailed Model
DPP	Document Production Plan
DR	Deviation Request
ECL	Equipment or Component List
EEC NRC	EEE = Electronic, Electrical and Electromechanical [items] NRC = Nuclear Radiation Compatibility
ESP/ESPN	FR: Equipement Sous Pression, Equipement Sous Pression Nucléaire (=PE/NPE)
FAR	Functional Analysis Report
FAT	Factory Acceptance Test

Acronym	Meaning
FD	Final Design
FDR	Final Design Review
FR	Functional Reference
GBS	Geographical Breakdown Structure
GDT	Generic Document Title
GD&T	Geometric Dimensioning and Tolerancing
I&C	Instrumentation and Control
ICD	Interface Control Document
ICM	Interface Compliance Matrix
ILS	System Integrated Logistics Support (Plan)
IS	Interface Sheet
LoD	List of Document deliverables
MPA	Multi Party Amendment
NCR	Non-Conformance Report
NSQ	FR: Note de Synthèse de Qualification (=QSR)
PBS	Product Breakdown Structure
PCR	Project Change Request
PD	Preliminary Design
PDR	Preliminary Design Phase
PE/NPE	Pressure Equipment, Nuclear Pressure Equipment
PFD	Process Flow Diagram
P&ID/PID	Piping and Instrumentation Diagram
PIA	Protection Important Activity
PIC	Protection Important Component
PNI	Part Number of ITER
PR	Project Requirements
QSR	Qualification Summary Report
R&D	Research and Development
ROX	Return Of Experience (also REX)
RPM	Requirement Propagation Matrix
RPrS	FR: Rapport Préliminaire de Sûreté
RQ	Requirement
SAT	Site Acceptance Tests
SDP	Systems Design Process
SDPD	System Detailed Performance Definition
SDR	System Design Review
SLD	Single Line Diagram
SLS	System Load Specification
SN	Serial Number
SRD	System Requirement Document
SSC	System, Structure and Component
TDF(C)	Technical Document Family (Card)
V&V	Verification and Validation

4 Reference Documents

[1] ITER_D_2832CF - Design Review Procedure
[2] ITER_D_25DSU2 - Procedure for the Preparation, Review and Approval of SRDs
[3] ITER_D_28VNJG - Design Interface Control Procedure
[4] ITER_D_V2ERKH - Management of Configuration Management Model (CMM)
[5] ITER_D_2M24AM - Procedure for the preparation, review and approval of the DDDs
[6] ITER_D_33TTPJ - Instructions for ITER System Load Specifications
[7] ITER_D_353AZY - Methodology for Plant System I&C specifications
[8] ITER_D_U344WG - Procedure for Identification and Controls of Items
[9] ITER_D_28QDBS - ITER Numbering System for Components and Parts
[10] ITER_D_22F4LE - Risk and Opportunity Management Procedure

[11] ITER_D_X3AUHZ - IO Template of Qualification Synthesis Report
[12] ITER_D_24VQES - Quality Classification Determination
[13] ITER_D_U5TYMP - Surveillance Plan for Construction
[14] ITER_D_2W4F7A - Procedure for the Preparation, Review, Approval, Award and Amendment of Procurement Arrangements
[15] ITER_D_28B3SF - Annex B Template Technical Functional Specification
[16] ITER_D_S7T73E - ITER Concept of Operations
[17] ITER_D_35CY6V - CAD Manual 14 - Diagram Guidelines

5 Basic Principle

This guideline document supports the Design Developer in understanding the expected content and maturity of typical design documents.

It is also relevant as a guidance to the type and maturity of documentation that is expected to be found in Annex-B of the three types of PAs (FS, DD, BtP).

6 Mapping with Design Review Procedure

The below table provides the mapping between the documents (first 2 columns) defined in Appendix 1 of Design Review procedure v4.1 (and kept unchanged till latest version) and the main documents (last 3 columns) description cards in chapter 7 of this document.

The cells (TDFCs) highlighted (blue colour) in the table below are applicable to IO only and they provide detailed information on the documents.

Note:

1. *Depending on the criticality of the System towards certain aspect (such as commissioning, maintenance, typical design with no innovation...) a simple presentation rather than a dedicated document at Design Review can be considered in particular for CDR and PDR.*

2. *When the LoD is established, the selected document titles can be different than the below proposed document titles depending on the IO/DA Supplier quality system. In this case, the only obligation by the IO PA TRO is to classify the documents with the right IO document type/subtype for their management in IO document management system.*

Groups	Document types as per Design Review procedure [1] Appendix 1	Chapter reference	Document Cards in Chapter 7	IO generated document	TDFCs applicable to IO only
Requirements	System Requirements Document (SRD)	7.1.1	System Requirements Document-SRD	X	WBYZ5V
	Interface Control Documents (ICD)	7.1.2	Interface Control Document-ICD	X	WBC5P7
	Interface Sheet (IS)	7.1.3	Interface Sheet-IS	X	
	Configuration Management Model Mock-Up (CMM)	7.1.4	Configuration Management Model-CMM	X	WA46NH
Description	System Design Description (DD)	7.1.5	System Design Description-DD	X (at System level)	WBYB3H
	System Functional Analysis	7.2.3	Functional Analysis Report-FAR		WBBZYV
	System Load Specifications (SLS)	7.1.6	System Load Specifications	X (at System level)	WBBFYH
	System Detailed Performance Definition	7.1.16	System Detailed Performance Definition-SDPD		WBYZ5V
	Process Flow Diagram (PFD)	7.1.9	Process Flow Diagram-PFD		WM7YBE

Groups	Document types as per Design Review procedure [1] Appendix 1	Chapter reference	Document Cards in Chapter 7	IO generated document	TDFCs applicable to IO only
	Detailed Diagrams (P&ID, SLD, routing/cabling)	7.1.10	Piping and Instrumentation Diagram-PID		
		7.1.11	Electrical Diagram		WNNCEM
		7.1.13	Equipment or Component List		WBXM7R
	Control and Instrumentation Documents (C&ID)	7.1.12	Instrumentation and Control Documents		WNB3M3
	Mechanical Engineering Model & Drawings	7.1.14	Detailed Model-DM		WAD2SF
		7.1.8	Part Drawing		WAD9FG
		7.1.7	Arrangement or Layout Drawing		WA9HY6
		7.4.1	Assembly or Component Definition Drawing		WA9VN6
		7.4.3	Isometric Drawing		
	Bill of Material (BOM) and Component Classification	7.1.15	Bill Of Material-BOM		W9ZCNP
	Component Technical Specifications	7.1.17	Component Technical Specification		WBYZ5V
		7.1.18	PA Annex B		WBYZ5V
Operation and Maintenance (including Shipping & Logistics)	System Integrated Logistics Support Plan (ILS)	7.3.2	Shipping or Logistics Plan		WC2HYW
	Operation Plan	7.5.1	Concept of Operations		WA44CK
	Periodic Test and Inspections Plans	7.5.2	Maintenance or Inspection Plan	X (at System level)	WBZZXJ
	Maintenance Plan				
Justification (Justification Folder-DJF)	Design Compliance Matrix (DCM)	7.2.2	Compliance Matrix - DCM or VCM		WCJSL7
	Design Reviews and Recommendations	7.7.3	Design Reviews and Recommendations		WCHEMH
	Report on action items and Chits from previous SDR				
	Report on Interfaces development from the review of Interfaces or DIR		Report on Interfaces development	X	
	Design Justification Plan	7.2.1	Design Justification Plan-DJP		WCJ4P2

Groups	Document types as per Design Review procedure [1] Appendix 1	Chapter reference	Document Cards in Chapter 7	IO generated document	TDFCs applicable to IO only
	Engineering Analysis Reports and Calculation Notes	7.2.4	Engineering Analysis and Calculation Report (including specific analyses in this card to be assessed such as RAMI, HIRA, Nuclear Safety)		27KDDA
	ROX and R&D	7.2.7	ROX and Research and Development Report		WCJ2U9
	Factory Qualification Test Plan	7.3.1	Factory Qualification Tests Plan		WCLRK9
	Qualification Summary Report for SIC Components	7.2.5	Qualification Summary Report for PIC Component		WCJSL7
DJF- Tests & Commissioning (including Construction)	On Site Assembly Plan	7.4.2	Assembly or Installation Plan		WBZX3G
	On Site Testing and Commissioning Plan	7.2.6	System Commissioning Plan	X (at System level)	WBYPHH
	Decommissioning Plan	7.6.1	Decommissioning Plan		WA8RU6
Design Management	Cost and Schedule – Risks Assessment	7.7.2	Issue or Risk or Opportunity Analysis Report		WAD6MT
	Work Plan	7.7.1	Design Plan	X (at System level)	WBZTQN
		7.7.4	Surveillance Plan – Annex 2	X	WBBQBC
	Report on PCR and Report on DR and NCR	7.7.5	Change Request or Record	X	WA2FUC

7 Main documents description cards

7.1 Design Definition

7.1.1 System Requirements Document (SRD)

System Design Document		System Requirements Document (SRD)
Objectives		The SRD gathers, in a unique document, all system level requirements the system shall fulfil. Every system requirement shall be clear, justified and achievable. The SRD is the basis against which the Design is assessed (see Design Compliance Matrix) and the basis for System Verification and Validation.
Maturity Level at the end of	Conceptual Design phase	The SRD shall be consolidated; meaning that all basic functions and requirements, including design, safety, quality and applicable codes, are clearly described (*). Requirements that may not be reachable shall be identified in order to propose modifications to the SRD. The requirements modifications proposed for some solution concepts should be properly justified in terms of technical impact on the overall project. The SRD shall refer clearly to the applicable codes and standards. During CD phase, the way to apply to the specific system, the Codes, Standards and Handbooks referred in PR shall be defined (codes shall be implemented according to the system or component classifications [12] ITER_D_24VQES - Quality Classification Determination). Additional standards or guidelines shall be clearly defined at system level. *Note (*): Requirements related to manufacturing, construction, assembly, installation, testing & inspection, operation, maintenance, and decommissioning should be consolidated as much as possible.*
	Preliminary Design phase	SRD shall be completed for all requirements not completely fixed previously (see note above). In particular, the applicable list of codes and standards shall be updated to take the codes applicable to the manufacturing phase into account if they have not been identified before.
	Final Design phase	No update, except major problem during the previous design phase
Comments		For additional information, see [2] ITER_D_25DSU2 - Procedure for the Preparation, Review and Approval of SRDs

7.1.2 Interface Control Document (ICD)

System Design Document		Interface Control Document (ICD)
Objectives		The ICD document identifies the interfaces between systems and the interfacing points, and links the PA to the IS. ROs of interfacing systems shall agree on a work plan to gradually refine the definition of the interface. *Note:* • *Interfaces are themselves defined in IS, CMM and/or additional databases for balances.*
Maturity Level at the end of	Conceptual Design phase	Interface Control Documents (ICD) shall be completed with all the interfacing systems. ICD shall list all expected Interfaces Sheets and their expected content. ICD shall list the progressive steps of refinement of the definition of interface with due dates. The planned steps must be consistent with the needs of design input data from any customer interfacing system and the capability to provide these data by any supplier interfacing systems.
	Preliminary Design phase	Updated consistently with design progress of interfacing systems.
	Final Design phase	Updated consistently with design progress of interfacing systems.
Comments		For additional information, see [3] ITER_D_28VNJG - Design Interface Control Procedure

7.1.3 Interface Sheet (IS)

System Design Document		Interface Sheet (IS)
Objectives		IS is the set of requirements coming from the two interfacing systems. Interface requirements should be consolidated, justified, clear, achievable and consistent with the system design definition and the upper level specifications (PR, RPRS, RQ database, etc.), including the description of the System Instrumentation, Controls and Interlocks (interface with CODAC definition). The IS can manage the technical definition itself or refer to drawings, CMMs, and/or databases (e.g. for balances).
Maturity Level at the end	Conceptual Design phase	Complete set of Interface Sheets is not required but identification of list of ISs is required. Nevertheless, allocation for main balances shall be defined with

of		services systems: • Overall needs from service systems: estimation/allocation of total electric power, heat removal, ventilation, gas and liquid services requested etc. • Main key-dimensions and space allocations, • Interfaces with more developed systems (having passed their CDR, PDR or FDR) shall be defined with a sufficient detail level to avoid delay to their design. Interface data identified in the associated Interface Sheets shall be available and approved, and therefore considered as input for the design. *Note: These allocations become Requirements for the PD phase and shall be considered as strong design commitment.*
	Preliminary Design phase	Complete set of Interface Sheets is required, and all IS shall be completed according to the current information. Balance allocations are confirmed Interface with I&C: All physical interfaces between Systems and I&C/CODAC are specified, and System operation updated.
	Final Design phase	Complete set of Interface Sheets is required, interfaces finalized for the most mature systems. Interface with I&C: System operation finalized. See comments for further information
Comments		At FDR, • Justification is made that interface definitions respect the interface specifications with the development of Interface Compliance Matrix (ICM). • Qualification tests of interface definition are defined in the Qualification and testing plans. For additional information, see [3] ITER_D_28VNJG - Design Interface Control Procedure

7.1.4 Configuration Management Model – CMM

System Design Document	Configuration Management Model - CMM
Objectives	The CMM is the reference for integration studies: interference checking, assembly and maintenance. The Configuration Management Models are simplified representations of the 3D models used to: • Control and define the interfaces with adjacent 3D models. • Control and define the space envelop of the adjacent models. A CMM represents the physical envelopes of the component/ system required including space required for maintenance/

		inspection. It also describes the trajectories to be considered for installation/ assembly of the plant systems and components or escape routes. The CMM represents space allocation for the system design, and is refined according to the level of integration constraints in the considered zone.
Maturity Level at the end of	Conceptual Design phase	All main physical interfaces shall be identified and related feasibility issues shall be addressed: • Main layout constraints (mainly constraints from Safety studies) shall be specified (associated layout studies will be performed later). • Initial checking for interferences and feasibility of maintenance and assembly operations shall be performed • Identification of main components shall be done, referring to PFDs
	Preliminary Design phase	Updated consistently with design maturity level.
	Final Design phase	Updated consistently with design maturity level.
Comments		For additional information, see [4] ITER_D_V2ERKH - Management of Configuration Management Model (CMM)

7.1.5 System Design Description (DD)

System Design Document		System Design Description (DD also called DDD)
Objectives		The System Design Description (also called SDD in some DAs and DDD historically) is the leading document of all System Design Description documents. It aims at summarizing the main results of the System Design: • To describe the design solution meeting the requirements stipulated in the related requirement documents such as SRD, Interface documents, CMM,.. • To point out possible remaining assumptions or issues. It refers to most important supporting documents and configuration data list relevant for the DD scope (schematics, drawings, analysis...) and does not copy the information given in these documents in order to ease maintaining consistency of the documentation. The DD, together with associated documents, is updated and refined all along the design process.
Maturity Level at the end	Conceptual Design phase	**General Purpose: <u>Feasibility assessment</u>** DD shall describe, at system level, at least one design solution which meets the requirements with an acceptable

of		level of risk. **Design Assumptions and Issues:** DD shall list and describe all assumptions made or issues raised during the CD phase. They could concern: • Input data, Requirements • Design itself: Design choice taken into account but which has to be confirmed by review, study to perform, etc. • Interface: Interface data not available when needed by design activity **Design Description** The System Design Description shall be sufficient to give confidence in the feasibility of the proposed solution (technical aspects but cost and schedule too). Alternate solutions can be defined. In such case, Pros & Cons shall be identified in order to prepare the selection to be finalized at the end of CD phase. This could include proposals for additional studies in order to allow relevant selection. For each solution proposed, the DD shall describe following with more details on finalized solution: • System Overall Architecture identifying the main components of the System and the main links between these components (with support of PFDs) • The functions allocated (with support of Functional Analysis) • The main technical characteristics required to justify the feasibility • In case of systems which behaviour highly depends on the state of the plant (e.g. Cooling Water System-CWS or Steady State Electrical Network-SSEN), the main performances in all operation states (with a preliminary version of the System Detailed Performances Definition).
	Preliminary Design phase	**General Purpose: <u>Selection and Description of the reference solution (system and main components)</u>** The goal of the PD phase is to detail the selected solution sufficient to enable the relevant authority to take the decision to go to the next phase of the Design where changes will increase the cost dramatically. At this stage, the general architecture is consolidated and the main (critical) components described adequately. The level of details varies for each system or component depending on the risk analysis: the design solution definition shall be developed until the related risk can be mastered (i.e. identified and quantified).

		Design Assumptions Updated consistently with design maturity level **Design Description** The selected solution is developed. The maturity of the definition of the system is sufficient to present the description of the design: • Physical architecture of the system • Integration of the design of the composing sub-systems • Allocations of specifications to the sub-system • Definition of the interfaces specifications between sub-systems • Identification of critical components based on a risk analysis.
	Final Design phase	**General Purpose: <u>Detailed and Finalized description of the selected solution.</u>** The goal of the FD phase is to have a final design solution definition ready to manufacture and acceptable by a supplier. **Design Assumptions** Updated consistently with design maturity level **Design Description** The selected solution is studied in detail. On the design solution accepted at PDR, this document also presents the description of the detailed design: • reminder of the system physical architecture • presentation of detailed design and associated performances of each sub-system down to component level (allowing future procurement).
Comments		For high level DDDs under IO responsibility, see [5] ITER_D_2M24AM - Procedure for the preparation, review and approval of the DDDs

7.1.6 System Load Specification (SLS)

System Design Document	System Load Specification
Objectives	The System Loads Specification (SLS) aims at defining the loads (functioning conditions, environmental conditions, other solicitations like interface loads and accidental loads) which have to be taken into account for the design of a System and associated components. *Note:* • *The requirement that the system operates safely under the loads specified in SLS is identified and adds requirements in the SRD and as such should be implemented in the design as any requirement of the SRD.*

		• *The SLS is a budgeting and design status document which evolves during design development* • *SLS first considers "external loads" propagated from ITER LS and interfaces. Then SLS considers "internal loads" derived from the design. It is therefore an input and an output of the design.*
Maturity Level at the end of	Conceptual Design phase	The Loads Specification shall describe: • All the external loads impacting the system to be identified (including incidental and accidental loads). • For each operating normal state, the main solicitations on the system (needed for concept studies, mainly design driving loads, loads with significant contribution to fatigue damage, etc.) • For main components already identified; preliminary assessment of the associated main loads (if any impact on the component feasibility assessment) in each operating state of the System Interface loads shall be identified if they have influence on the design concept.
	Preliminary Design phase	The Loads allocation shall be updated to take the current design of the System into account (at each operating state during normal operation and during incident/accident events). Loads that clearly do not cause any feasibility issue are not required at this stage of the design.
	Final Design phase	The Loads allocation shall be completed, taking the final design of the System into account. These loads shall be sufficient for the Components specification.
Comments		For information at System level under IO responsibility, see [6] ITER_D_33TTPJ - Instructions for ITER System Load Specifications

7.1.7 Arrangement or Layout Drawing

System Design Document		Arrangement or Layout Drawing
Objectives		Technical drawing showing the location of components, assemblies, systems, spaces, buildings, structures or sites.
Maturity Level at the end of	Conceptual Design phase	Not Applicable
	Preliminary Design phase	Geographical Breakdown Structure (GBS) based plan view of main equipment's, including at least main dimensions, FRs, positions against the building reference.
	Final Design phase	GBS based plan view of main equipment following ISO Standard (ISO-7519 & 10209) including FRs of all Components
Comments		

7.1.8 Part Drawing

System Design Document		Part Drawing
Objectives		Part drawing is a drawing depicting a single part which cannot be further disassembled and which includes all the necessary information required for the definition of the part [ISO 29845] Part drawings are detailed drawings use to support the design definition of mechanical items and/or components.
Maturity Level at the end of	Conceptual Design phase	Not applicable
	Preliminary Design phase	For critical parts: • Standard projected views of mechanical parts, components • Preliminary Geometry • Major Dimensions, • Preliminary definition of functional dimensions against datum system • Major Tolerances • Title block.
	Final Design phase	Standard projected views of mechanical parts, components Final Geometry All detailed Dimensions including GD&T Final definition of functional dimensions & tolerances Material, surface treatment... Title block. If the part is an IDI the title block shall identify PNI.
Comments		

7.1.9 Process Flow Diagram (PFD)

System Design Document		Process Flow Diagram (PFD)
Objectives		A Process Flow Diagram (PFD) gives an overview of the process flow and allows the quick identification of components and main functions of systems/sub-systems/ components. Associated to PBS node(s), a PFD should support unique identification of components and functional description of the system and sub-systems. It shall describe the plant processes and modes using graphical symbols and connecting lines representing flows of mass, energy flows or flows of physical items.
Maturity Level at the end of	Conceptual Design phase	PFD shall identify on main content sheet: • Main Components (all the necessary components to be able to clearly understand the process), • Main/key features of the components, • Exchanges between systems/sub-systems (input/outputs/flow direction), • Whenever possible room location (GBS) of components Comments: • "Main Components" are components needed to fulfil system's main functions or main requirements (space allocations, safety) or to be able to clearly understand the process • Components for constraint or secondary function are not identified at this stage
	Preliminary Design phase	Updated consistently with design maturity level. • Main components, pieces of equipment needed for the process shall be identified. • Tags shall be according to the ITER Numbering System for Components and Parts [9] • Connecting lines taking part in the process shall be depicted to represent flows. • Flow direction shall be indicated. • Room location (GBS) + Interface Points shall be shown. • Heat and mass balance for fluid/gas flows, for each operational scenario, are depicted. • Main characteristics operating conditions (pressure, temperature,) are shown. • Diamond with numbering on process lines shall be consistent with the heat and mass balance table. • Major bypass and recirculation lines shall be shown.
	Final Design phase	Updated consistently with design maturity level.
Comments		

7.1.10 Piping and Instrumentation Diagram (P&ID)

<table>
<tr><th colspan="2">System Design Document</th><th>Piping and Instrumentation Diagram (P&ID)</th></tr>
<tr><td colspan="2">Objectives</td><td>A Piping and Instrumentation Diagram (P&ID) represents the interconnection of process equipment and the instrumentation used to control the process by way of graphical symbols for equipment and piping as well as graphical symbols for process measurement and control functions.
Piping & Instrumentation Diagrams (P&ID):
• The goal of the P&ID is to explain how the system works in each operating state (normal and abnormal)
• P&IDs support identification of sensors, actuators and support system (CODAC interface definition)
• P&IDs refine the identification of components declared in the equipment list
• P&IDs are more detailed than PFDs including bleeds, vents, stoppers, etc.</td></tr>
<tr><td rowspan="3">Maturity Level at the end of</td><td>Conceptual Design phase</td><td>Not Applicable for P&ID</td></tr>
<tr><td>Preliminary Design phase</td><td rowspan="2">Attributes to be defined for Preliminary Design and Final Design:

<table>
<tr><th>Attributes</th><th>PDR</th><th>FDR</th></tr>
<tr><td>Process Components(Tagged)</td><td>Completed</td><td>Completed</td></tr>
<tr><td>Interface Point</td><td>Completed</td><td>Completed</td></tr>
<tr><td>Interfacing System</td><td>Completed</td><td>Completed</td></tr>
<tr><td>Location and Penetration</td><td>Completed</td><td>Completed</td></tr>
<tr><td>Secondary Lines (Vent/Drain/ Bypass/Sampling)</td><td></td><td>Completed</td></tr>
<tr><td>I&C Feature</td><td></td><td>Completed</td></tr>
<tr><td>Component Types (TTT codes)</td><td></td><td>Completed</td></tr>
<tr><td>Actuators</td><td></td><td>Completed</td></tr>
<tr><td>Normal & Fail Safe Position</td><td></td><td>Completed</td></tr>
<tr><td>Pipe Specification</td><td></td><td>Completed</td></tr>
<tr><td>Flange Connections</td><td></td><td>Completed</td></tr>
</table></td></tr>
<tr><td>Final Design phase</td></tr>
<tr><td colspan="2">Comments</td><td></td></tr>
</table>

7.1.11 Electrical Diagram

System Design Document	Electrical Diagram
Objectives	The Electrical diagrams are simplified conventional pictorial representations for an electrical circuit. They show the components of the circuit as simplified shapes and the power and signal connections between the devices. Depending on the current level of definition of the circuit, 3 types of electrical diagrams are considered on ITER: Single Line Diagram (SLD) represents thoroughly the power distribution path from the incoming power source to each downstream load. They allow the Load flow studies, electrical safety and maintenance studies, including redundancy and protective devices. - Only single logical links (rather than cables) shall be shown for logical power distribution. - Main transformers should show the power supply and voltage conversion. - A mechanism should exist to propagate voltage information between busbar and components below using top down direction. - Incoming line, protective devices (such as breakers, fuse, switches, etc.), Lock-out devices (such as disconnector, etc.) and command devices (such as switches, relays, etc.) should be shown on the diagram. - Labels should contain Capacity, ratings, power, voltage level, voltage conversion. - Protection Value, material designation and power cabling data should be indicated. The Cabling Diagrams represents the full cabling interconnection between the plant components and identify all cable interfacing components and their localization. Cabling diagrams have the role of defining cable components by giving them a name, a type and describing the origin and destination equipment with location information. - All cables shall be defined using the appropriate TTT Codes and shall be connected to components at both extremities. - Cable definition should include Cable name, Cable type ITER code, SIC level and train information, Quantity of signals and/or quantity of cables, Cable ownership, Segregation selected due to its cable type. - Identification of the PIC Components should be

		represented on the Diagrams. - All cable/component interconnections shall be represented. The Detailed Wiring Diagram represent the layout of cabinet electrical items and the associated detailed wiring connections. Note: I&C wiring diagram is part of Instrumentation and Control documents, see chapter 7.1.12 - All parts and wires shall be labelled according to the IEC Standards. - All terminal block connections shall be represented. - All physical implementation of the electrical parts shall be represented in the drawing. All the components shall be identified following the rules defined in the document ITER Numbering System for Components and Parts [9] and in CAD Manual [17]. All components symbols shall come from the software database (no manual symbol creation) or from an official list identified in the diagram.
Maturity Level at the end of	Conceptual Design phase	Detailed diagrams are not required A Preliminary version of SLDs can be useful to support the definition of electrical power balances.
	Preliminary Design phase	All Detailed Diagrams are initiated consistently with design maturity level. • Detailed SLDs are required • Preliminary version of Cabling Diagrams (consistently with design maturity level) – cubicles, penetration represented (at least all high and medium voltage cables) • Preliminary version of Routing Diagrams consistent with Preliminary Design studies (at least all high and medium voltage cables)
	Final Design phase	Updated consistently with design maturity level. • SLDs are updated according to the system developments during Final Design Phase, so the full content given in the chapter “Typical contents” is reviewed at FDR. • Cabling Diagrams are finalized, in parallel to the operation of cabling managements (Cables routing, segregation, etc.) to allow the complete definition of the cables before manufacturing. • Detailed Wiring diagrams are developed based on the inputs provided by SLDs and Cabling Diagrams

Comments	

7.1.12 Instrumentation and Control Documents (I&CD)

System Design Document		Instrumentation and Control Diagram
Objectives		This document type includes the I&C document deliverables expected at different control system development milestones. These deliverables are derived from the Plant Control Design Handbook (27LH2V) chapter 3.4. This list is not exhaustive and shall be updated as new documents are identified. Note: If PCDH is applicable for PA/Contract refer directly to PCDH for detailed information, otherwise basic requirements for I&C documents are provided in this card here.
Maturity Level at the end of	Conceptual Design phase	Not required
	Preliminary Design phase	The Control and Instrumentation diagrams shall be initiated. The list of I&C engineering data shall include: • Plant system I&C architecture • Plant system controller(s) performance and configuration requirements • List of inputs and outputs (I/O) of the I&C controllers • List of the Process Variables handled by the plant system I&C controllers • Configuration of I&C cubicles
	Final Design phase	Update of the former consistently with design maturity level. • Control Logic Diagrams • I&C cubicles with internal wiring and all internal I&C equipment (cubicle wiring diagram), • Cabling documents for cubicle connection with I/O cabinets, I&C Networks, earth and power supplies (cabling diagram), • Schematic diagrams of the full signal path (instrument loop diagram)
Comments		For information, see maturity level details in [7] ITER_D_353AZY - Methodology for Plant System I&C specifications

7.1.13 Equipment or Component List (ECL)

System Design Document	Equipment or Component List
Objectives	An Equipment / Component List (ECL) is a list describing System Components such as equipment, pipe lines and cables that are tagged with an unique identifier, i.e. Functional Reference (FR) number. Since FR numbers, which contain PBS-level-3 codes, represent

		the hierarchy structure within certain (sub-) system, ECL's are mostly flat lists. ECL attributes are as follows: 1) Importance classification, e.g. Quality Class (QC), Protection Important Component (PIC), 2) Physical layout, e.g. Geographical Breakdown Structure (GBS) and interfaces, 3) System functional properties, e.g. operation pressure, 4) Reference documents, etc. ECL's are an output of a system design; therefore they are associated with system-level drawings and diagrams, such as General Arrangement Drawings (For non-fluidic/electrical systems), Process Flow Diagrams (PFD's), Piping and Instrumentation Diagrams (P&ID's), Single Line Diagrams (SLD's), and Cabling Diagrams. Note: Mechanical systems are defined in drawings and associated BOM.
Maturity Level at the end of	Conceptual Design phase	Preliminary(*)
	Preliminary Design phase	Main Equipment list(*)
	Final Design phase	Equipment list / Fluid Equipment / Valves / Piping Lines /Instruments List(*) When a design solution element of System Component is identified, a Part Number of ITER (PNI) is added to the ECL, in addition to the FR.
Comments		(*) Equipment or Component list maturity required at each gate is defined by the associated document maturity.

7.1.14 Detailed Model-DM

System Design Document	Detailed Model-DM
Objectives	The Detailed Models are the 3D representations authored through CAD systems, contributing to the geometrical and functional representation of systems and components. They are used in the systems design justification, used as parent objects for the generation of CAD Drawings and Bill of Materials as required during manufacturing, construction and installation processes, as well as for the maintenance of Configuration Management Models (CMM) used in the design control and design integration processes. Detailed Model is meant to manage the detailed geometrical definition of a system or a component whereas CMM describes the bounding physical envelope and interfaces of a given System, sub-system or part of sub-system. Note: The DM shall fully respect the space allocation of the related CMM.

Maturity Level at the end of	Conceptual Design phase	, • Concept of the geometry to fulfil functional needs • Main interfaces are identified • Major Dimensions • Define the space occupied by the component/system Allow first calculations and simulations (e.g. Assembly, RH)
	Preliminary Design phase	• Conceptual design above plus: • Evolution of the design (preliminary implementation of transverse functions, more precise geometries, more details, main materials…) • All interfaces are defined; compliant with CMM In case of component, FR is defined
	Final Design phase	• Geometry fulfilling technical requirements; validated by analysis incl. simulations • All interfaces are respected • All dimensions are defined (tolerances & surface conditions/GD&T on drawings), except details for manufacturing needs • Free of clash against others design data • Gap analysis in 3D (functional tolerances on drawings) • Final material grades, treatments, welds, brazing… are defined • In case of IDI, PNI is defined • CAD structure takes into account delivery and assembly configuration • Final Design (3D) needs to include (based on discipline): Civil, steel (racks, platforms, stairwells, ladders, etc.), structural, piping (including tubing), equipment (mechanical and plant) layout, Raceway (cable tray), HVAC, Electrical, junction boxes, cabinets, cubicles, access, egress, maintenance, space reservation. HSE areas, showers etc., handling and lifting points (if fixed envelope of movement), tooling, storage areas, lighting, fire protection, all items tagged, HELB, shielding, provisions for assembling, temporary sealing, inspection, instrumentation…
Comments		

7.1.15 Bill of Material–BOM

System Design Document	Bill of Material - BOM
Objectives	A Bill of Material (BoM) is a list of materials typically associated to drawing material content and can be separated by item type. For additional information, see [8] ITER_D_U344WG - Procedure for Identification and Controls of Items

Maturity Level at the end of	Conceptual Design phase	N/A
	Preliminary Design phase	Main parts and part types are identified with estimated quantities.
	Final Design phase	All ITER Individually Distinguishable Item (not supply chain dependent) IDI's are designated with PNI's, and ITER Catalogue is completed.
Comments		IDI is an item or a group of items of interest to IO-CT's, which constitutes the ITER System as a part/component. More specifically: • Item of as-delivered situation to the site (or to another manufacturer's premises, as necessary); • Group of items to be site-assembled , e.g. kit of interface components; • Items to be dismantled and re-assembled on site; • Items subject to maintenance;

7.1.16 System Detailed Performance Definition (SDPD)

System Design Document		System Detailed Performance Definition
Objectives		This document aims at defining the performances for each Operating state of the System (during normal operation or incident/accident events)
Maturity Level at the end of	Conceptual Design phase	Not required during CD phase, except for systems which performances evolve in a large range according to the state of the plant (Cooling Water System-CWS or Steady State Electrical Network-SSEN, etc.)
	Preliminary Design phase	The feasibility of main performances specified for the System shall be justified: • The main expected performances (from SRD) of each operating state, during normal operation and incident/accident events, shall be analysed and detailed with relation to the architecture and options selected for the System (in particular all performances having any impact on the System overall architecture) • All expected performances shall be taken into account in the DD • A preliminary assessment of the solution shall be prepared, defining a preliminary allocation of performances to sub-systems/components <u>Comments</u> • At PD level, this assessment of main performances should be based on preliminary simulations, preliminary calculations, data from return of experience of similar

		systems • The associated requirement shall be clearly identified and updated in the SRD if necessary
	Final Design phase	All performances of the system, for each operating state during normal operation or during incident/accident events, shall be described. In particular, Components specifications shall be taken into account in performances calculations.
Comments		These simulations should not only use data from the system itself. Parameters from other Systems or from ITER Overall functioning studies could be needed. - Performances should not be assessed only in the worst (most penalizing) case (For ex: a system which is able to evacuate 1200MW is not necessarily able to evacuate 10MW). These simulations, or calculations, will be completed / detailed throughout the design

7.1.17 Component Technical Specification

System Design Document		Component Technical Specification
Objectives		To specify the component design solution which meets the component's requirements. This document focuses on the realization of the component. The same technical specification can also be used for family of components.
Maturity Level at the end of	Conceptual Design phase	Not required
	Preliminary Design phase	Main components are specified, consistently with design maturity level (Detailed Design). Specification of "Anticipated Components"; components with long Manufacturing lead time (additional studies, fabrication schedule, testing, commissioning, etc.), shall be completed (in order to launch anticipated Procurements).
	Final Design phase	All components are specified, consistently with design maturity level (Final or Build to Print Design) allowing future procurement. There could be two strategies for specifying component based on procurement scheme: 1) For procurement of Commercial Off the Shelf components (COTS), a Functional Technical Specification (called Build-to Specification) shall be written. This technical specification contains functional, performance, physical, interface, manufacturing and operation requirements. It contains as well the qualification and acceptance requirements.

		2) For procurement of a bespoke design, a Build to Print (BtP) technical specification shall contain reference to the drawings to be used as input for the manufacturing design and shall contain all manufacturing requirements.
Comments		A Component Technical Specification is an output of the system design.

7.1.18PA Annex B

System Design Document		PA Annex B
Objectives		Annex B Technical Specification is used for in-kind Procurement Arrangement (PA) to describe the **technical and technical management requirements of a supply** to be provided by the Domestic Agency. For the complete PA this document is associated with a specification of the General Conditions governing the IO procurements (called "Main") and a procurement management specification (called "Annex A"). Annex B can: • cover a system, sub-system or part of a sub-system scope. • be issued at the end of each design phase depending of the remaining design development to procure. • cover design, equipment supply, and on-site installation - Annex B contains data about the subject and context of the PA (IO organization, ITER and System projects), PA scope, the management of the Procurement (responsibilities, follow-up, control points, data management, reviews), technical interfaces, **technical requirements**, inspection and testing requirements, requirements for labelling, cleaning, packaging, handling, shipment and storage, commissioning, applicable and reference documents, list of appendices (List of documents and data to be provided by the DA, and PA supporting documents as drawings, diagrams and sketches, data sheets, tables, etc.).
Maturity Level at the end of	Conceptual Design phase	Called Functional Specification (FS)-PA Annex B: The applicable **technical requirements** are formed from the initial requirements (SRD/sSRD, ICD, IS, CMM, SLS) propagated to the PA scope and refined from the design documents developed during the Conceptual Design phase (also called Functional Baseline for the relevant PBS scope). • Consolidated SRD • Load Specifications • ICD and Interface Sheets for Overall needs • Design Description Documents • PFD, Block Diagram, CMM • DCM
	Preliminary	Called Detailed Design Specification (DD)-PA Annex B: The

	Design phase	applicable **technical requirements** are formed from the initial requirements (SRD/sSRD, ICD, IS, CMM, SLS) propagated to the PA scope and refined from the design documents developed during the Preliminary Design phase (also called Allocated Baseline for the relevant PBS scope). • Updated SRD **or** sub-SRDs if relevant • Revised Load Specification • Revised ICD and Interface Sheets • Design Description Documents update (Critical Component Specifications) • Revised PFD, P&ID, Single lines (Electrical), General Arrangement • Engineering Analyses Report (as detailed in Appendix) • DCM • Critical Component Manufacturing Plan/requirements
	Final Design phase	Called Build to Print(1) Specification (BtP)-PA Annex B: The applicable **technical requirements** are formed from the initial requirements (SRD/sSRD, ICD, IS, CMM, SLS) propagated to the PA scope and refined from the design documents developed during the Final Design phase (also called Product Baseline for the relevant PBS scope). • Final Component and Material Specifications • Final Drawing Package (part drawings, component / assembly definition drawings, interface drawings) • 3D detailed models if needed • Manufacturing specifications (Specs including the IO specific requirements in terms of material & forming spec., control spec., standards, welding & welder spec., control & qualification plan, procedures, Inspection/QA plan) • Factory Testing specific requirements
Comments		For more information, see [14] ITER_D_2W4F7A - Procedure for the Preparation, Review, Approval, Award and Amendment of Procurement Arrangements and for the template see [15] ITER_D_28B3SF - Annex B Template Technical Functional Specification (1) See Definitions

7.2 Definition Justification

7.2.1 Design Justification Plan

System Design Document		Design Justification Plan
Objectives		The Design Justification Plan (also called as Verification & Validation Plan) describes the strategy to provide evidence of the fulfilment of Design Input Requirements in the Design. The V&V Plan defines, for each system requirement (or class of requirement) defined the Design Input Requirements (i.e. PR, SRD, Sub-SRD etc…) , the way to conduct the justification, verification and validation of the design at any gates of the system development: • Test (on mock-up, prototype, at factory, etc.) • Alternate calculation • Simulation • Analysis of Design by Expert (based on ROX, R&D or similarity) • Inspection The V&V Plan defines the sharing of responsibilities (and means) between IO, DA and contractors, to demonstrate the performances in the Design and in the end products. During the MAIT (Manufacturing, Assembly, Installation, Testing) phases, the V&V Plan is then implemented through subsidiary verification plans on the H/W and S/W products like MIP (Manufacturing Inspection Plan), Acceptance Plans (FAT, SAT), Assembly and Installation Plans, Testing and Commissioning Plans.
Maturity Level at the end of	Conceptual Design phase	Required at that stage only for Functional Specification procured systems: the Plan shall define the Qualification, FAT/SAT (Factory Acceptance / On-Site Acceptance Strategy) and Commissioning strategy
	Preliminary Design phase	The V&V Plan shall describe, for each requirement, how its achievement is going to be demonstrated during the next phases of design and/or fabrication, qualification, assembly and installation and commissioning
	Final Design phase	Updated consistently with design maturity level, with identification of verification and validation activities needed to demonstrate lower level SSCs' functional and non-functional requirements achievement.
Comments		The Design Review Plan supports the V&V plan for the Design and Readiness Reviews aspects.

7.2.2 Design Compliance Matrix (DCM or VCM)

Verification Compliance Matrix (VCM) is not normally in the scope of this document but maybe used to check the implementation of requirements in the manufacturing, assembly, installation activities of prototypes during design.

Note: For some DAs the DCM and VCM may have a different name or even a slightly different format, nevertheless their content is equivalent (ex: DCM in EUDA = VCD QUAL (Verification Control Document – Qualification and VCM in EUDA = VCD ACC (Verification Control Document Acceptance).

<table>
<tr><th colspan="2">System Design Document</th><th>Design Compliance Matrix (DCM)</th></tr>
<tr><td colspan="2">Objectives</td><td>The DCM is used to support the evidence that all requirements are addressed by the available design solution. Interfaces Requirements compliance can be demonstrated in DCM too or in the Interface Status Report to be presented at the Interfaces Review before CDR, PDR.
At FDR, Full interface requirements compliance to be demonstrated through ICM.
The DCM shall list all requirements and shall allow traceability to their source. At least all requirements of the SRD shall be the “rows” of the DCM. As design progresses, additional applicable documents shall be added as a row in DCM. Note that the requirements from applicable document doesn’t need to be extracted, but might become the input to a separate Compliance Matrix.
Each row of DCM refers to justification prepared during all the design process.</td></tr>
<tr><td rowspan="3">Maturity Level at the end of</td><td>Conceptual Design phase</td><td>At CD stage, the DCM shall:
Roughly define why the requirements will be achieved by the solution(s) proposed. At this stage this justification can be engineer advice
Identify the requirements that may not be achievable (and therefore propose SRD update). In that case DCM shall refer to the analysis of impacts of the proposed modification</td></tr>
<tr><td>Preliminary Design phase</td><td rowspan="2">From PD to FD, the justifications given in front of each row of the DCM are gradually refined, referring to all documentation available in the justification folder.
At FDR, Full interface requirements compliance to be demonstrated through ICM.</td></tr>
<tr><td>Final Design phase</td></tr>
<tr><td colspan="2">Comments</td><td>Interfaces requirements compliance can be demonstrated in same DCM or processed as a separate DCM (called ICM at FDR) included in the Interface Status Report
Interface Compliance Matrix – a document used to monitor and assess the evolution of the Interface Requirement implementation into the system design and the justification of the achievement of the Interface Requirement objective</td></tr>
</table>

7.2.3 Functional Analysis Report – FAR

<table>
<tr><th colspan="2">System Design Document</th><th>Functional Analysis Report - FAR</th></tr>
<tr><td colspan="2">Objectives</td><td>The Functional Analysis of a system (or of any sub-system element acting as a system) is a top-down description of the system as a hierarchy of functions on multiple levels, from the main functions fulfilled by the system to the basic functions performed by the components.
Requirements and performances specified to the System are allocated to these functions. The objectives of functional analysis are to:
List all the system functions
Identify and check the exhaustiveness of system functional requirements
Ensure the functions are decomposed into a proper Function Breakdown Structure Allow the hierarchical traceability of the functions and their links to requirements
Identify logical links between functions.
Identify the enablers necessary to operate the function.
This allows a complex engineering system to be understood and realized. Enablers of the system function are identified for each Operating phase and State of the system in the context of the Global Operating States of the ITER Facility.</td></tr>
<tr><td rowspan="2">Maturity Level at the end of</td><td>Conceptual Design phase</td><td>All functions carried out by the System are identified:
Functional decomposition breaks the System down in a hierarchical decomposition
In every normal operating state of the plant/System:
Each function behaviour is exhaustively described
Expected objectives/performances defined in a clear, unambiguous way
Functional analysis, at each operating state during incident/accident events, should be performed later.</td></tr>
<tr><td>Preliminary Design phase</td><td>Updated consistently with design maturity level.
Each function’s behaviour is exhaustively described in all operating states of the plant/System (normal including maintenance, abnormal including incident/accident events).
The Functional Analysis shall take into account each Operating phase and state of the system in the context of the Global Operating States of the ITER Facility.
The logical links between the system functions are determined; the logical links between the system functions and project level functions / other systems functions are determined, in consistency with the system interfaces with the rest of the ITER Facility.</td></tr>
</table>

		Functional breakdown should be further detailed with associated enablers and performance requirements. Associated clients of this FA such as RAMI, IP analyses shall be updated accordingly.
	Final Design phase	Updated consistently with design maturity level.
Comments		

7.2.4 Engineering Analysis and Calculation Report

System Design Document		Engineering Analysis and Calculation Report
Objectives		Engineering Analysis Reports as well as Calculation Reports are support documents for System Design and its justification, including integrated verification and validation. Engineering analysis refers to the study and work performed for the qualitative or quantitative evaluation of engineering data or physical parameters that support the development and justification of SSC design. Analyses may be supported by calculations. Please note the return of experience report is referred in section 7.2.7 A list of the main Engineering Analyses is provided in the Appendix, and are produced as per needs identified in the procurement arrangement or contract
Maturity Level at the end of	Conceptual Design phase	At each design stage, Analyses and Calculations are carried out. It is worth highlighting that a plan for progressive refinement of studies (with clearly planned documentation) allows updating of reports and avoids overlaps between documentation. Analyses must be provided to justify the design concept. It is considered sufficient to comply with main driving requirements at the end of Conceptual, Preliminary design phase and to necessarily justify that the design complies with all design requirements at the end of FDR.
	Preliminary Design phase	
	Final Design phase	
Comments		Includes the important, specific analyses such as RAMI, HIRA, Nuclear Safety, Structural Analysis Report,..

7.2.5 Qualification Summary Report for PIC Components (QSR)

System Design Document	Qualification Summary Report for PIC Components
Objectives	For each Safety related equipment (system or components), an associated Qualification Summary Report summarizes all the justification elements established to demonstrate that the equipment satisfies its design and performance requirements. These notes are support documents for the RPrS and the RPS, and submitted to the French Safety Authority. These stand-alone synthesis notes cover the justification from the design phase until commissioning. *Note: Justification documentation related to ESP/ESPN is an important part of the NSQ.*

		[1] Qualification Summary Report for PIC Components also called as Qualification Synthesis Report for PIC Components. For more information ref [11] ITER_D_X3AUHZ - IO Template of Qualification Synthesis Report
Maturity Level at the end of	Conceptual Design phase	Not required
	Preliminary Design phase	Preliminary issue of QSR for PIC elements (system and components) consistent with design maturity level and Current RPrS. The PIC qualification may involve (one or more methods): • Test made under conditions as representatives as possible • Comparison with similar equipment already qualified • Calculations • Analysis based on ROX
	Final Design phase	To complete and update to be consistent with design maturity level and Current RPRS. For Off the Shelf components, for which qualification documents can be produced only after FDR it is required to at least provide the plan for qualification along with technical elements justifying its feasibility.
Comments		

7.2.6 System Commissioning Plan

System Design Document		System Commissioning Plan
Objectives		Commissioning Plan describes the overall commissioning strategy and all the commissioning tests which are necessary for providing validation of safety and functional requirements and the performance of the concerned system, the logical sequence of those tests, and identifies the commissioning phases during which those tests are to be performed. The main target of commissioning is ensuring that the system will correctly perform in all anticipated conditions.
Maturity Level at the end of	Conceptual Design phase	N/A
	Preliminary Design phase	A preliminary System Commissioning Plan shall be prepared that identifies the scope of commissioning, commissioning packages, interfaces and dependencies on interfaces and utilities. Depending on the criticality of the commissioning aspect, a simple presentation at Design Review can be considered.
	Final Design phase	A final System Commissioning Plan shall be prepared that includes all elements of the template, including the list of

		commissioning tests. The strategy for procurement of spares and consumables, and needs for temporary services during commissioning shall be defined. Marked-up PID and Single Line Diagram shall be included to show the scope of commissioning and turn-over packages.
Comments		For additional information, see ITER_D_X8KGJE - Working Instruction for Preparing Commissioning Plans and Test Procedures For template, see ITER_D_VVSZNU - Commissioning Plan Template

7.2.7 ROX and Research and Development Report

System Design Document		ROX and Research and Development Report
Objectives		Collect data from past experience on similar projects (REX/ROX, or ROE i.e. existing knowledge) or developments(R&D i.e. new knowledge) to support SSC design justification/V&V or design decisions on any aspect (establishment of the requirements, functional decomposition, selection of the architecture and design solution, qualification of the design, approach for verification or validation, etc.
Maturity Level at the end of	Conceptual Design phase	The designer identifies what previous experience can be useful for the design: • Reports from previous operational experience are collected and listed to support system design justification. • ROX data becomes input data for the design itself and supports choices for design and system design justification • R&D results, from completed studies, used to justify the design and the performances.
	Preliminary Design phase	Updated if necessary to account for lower PBS level elements which require ROX or R&D justification
	Final Design phase	Updated if necessary to account for lower PBS level elements which require ROX or R&D justification
Comments		Technology Readiness Assessment (TRA) can be considered as part of the ROX

7.3 Manufacturing aspects

7.3.1 Factory Qualification Tests Plan

System Design Document		Factory Qualification Tests Plan
Objectives		To describe the strategy for System Qualification Testing in case of prototypes developed before finalizing the design.
Maturity Level at the end of	Conceptual Design phase	Not required Specific plan needed if qualification test requirements (specifics means expected for qualification test activities) have an impact on the System architecture.
	Preliminary Design phase	Provided Qualification test plan shall include: • Main phases (description, schedule, etc.) • Specific means and Qualification tools
	Final Design phase	Updated to incorporate the prototype test results.
Comments		

7.3.2 Shipping or Logistics Plan

System Design Document		Shipping or Logistics Plan
Objectives		To plan and be prepared for Shipping, Logistics, Handling, and Transportation Activities, especially when it is related to PIC or Critical shipments. Transportation of PIC is a PIA, regulated by the French Authorities, and it must follow nuclear safety requirements. The key stakeholders are IO TRO, DA, Supplier, IO ILM (Integrated Logistics and Materials Management), LSP (Logistics Service Provider), and OLC (On-Site Logistics Contractor) For information on surveillance of relevant PIA, please see [13] ITER_D_U5TYMP - Surveillance Plan for Construction section A4.08
Maturity Level at the end of	Conceptual Design phase	Not Applicable
	Preliminary Design phase	Plan and requirements are to be established (preliminary).
	Final Design phase	Updated consistently with the design (complete).
Comments		

7.4 Assembly and Installation

7.4.1 Assembly or Component Definition Drawing

System Design Document		Assembly or Component Definition Drawing
Objectives		To describe the assembly/component in terms of dimensions and composing parts. To provide all physical requirements and constraints to be respected so that the components/assembly fits its purpose. The Assembly/Component drawing also contains the Bill of Material (BoM) displaying the main information of the composing parts and referring to the part drawing if any.
Maturity Level at the end of	Conceptual Design phase	Drawings are not required except outlines or sketches useful to support the description of the solution(s).
	Preliminary Design phase	Drawings are initiated consistently with the design maturity level.
	Final Design phase	Fully defined Geometry, Fully defined overall Dimensions ,Fully defined Tolerances of the Assembly (Tolerance study) respecting ISO 1101; Material, Surface quality, Welds definition through standard symbols & identification, Weight and Centre of gravity Special conditions (Protection, Gas sealing) to be defined. Must contain an Item list (drawing BoM, mapped with balloons) including part identifiers (Functional Reference (FR) & PNI when relevant), part designation, part material, quantity, weight (only if above 25kg), drawing number if relevant. Consistent with design maturity level.
Comments		

7.4.2 Assembly or Installation Plan

System Design Document		Assembly or Installation Plan
Objectives		The objective of this document is to describe the overall strategy and assembly operations to be done on-site. This document does not address the technical issues already defined in SRD and/or DD. This document addresses the industrial strategy aimed at taking the overall on-site assembly logic into account.
Maturity Level at the end of	Conceptual Design phase	A preliminary version of the On-site Assembly Plan shall be established to identify: • Main Assembly requirements sufficiently detailed to assess the major impacts on the design

		○ This includes factors such as accessibility, integration enabling systems and required interfacing/interconnections for intermediate assembly configurations • Identify the constraints on the design arising from the Integration strategy
	Preliminary Design phase	The On-site Assembly Plan shall be completed in order to propagate the associated detailed requirements to the design. Major requirements of this plan shall be included in the SRD update prepared during this phase.
	Final Design phase	Updated consistently with design maturity level.
Comments		

7.4.3 Isometric Drawing

System Design Document		Isometric Drawing
Objectives		To represent (2D) the pipe routing for structural analysis calculations and define the associated Bill of Material.
Maturity Level at the end of	Conceptual Design phase	Critical and very large process lines and components.
	Preliminary Design phase	Basic routing without detailed support information. Location of main supports. Identification of basic valves.
	Final Design phase	Detailed isometric, including all supports modelled, all welds tagged, all valves, inline instruments. BoM to include Functional Reference (FR) or/and PNI codes. Descriptions to be from IO Materials management system. Isometrics implementing 95% of the requirements. All process data including design, operating & testing requirements defined and associated structural analysis report approved.
Comments		

7.5 Operation and Maintenance (O&M)

7.5.1 Concept of Operations

System Design Document		Concept of Operations
Objectives		The Concept of Operations describes the overall approach and strategy to operating ITER and individual systems.
Maturity Level at the end of	Conceptual Design phase	Outline concept that covers the basis lifecycle of this system.
	Preliminary Design phase	Elaborated operations strategy and principles. Identification of Operating Modes and Transitions and their relationship to global plant operating states
	Final Design phase	Final operations strategy and principles. Definition of detailed plant Operating Modes and Transitions and their relationship to global plant operating states in different operating modes.
Comments		For additional information see [16] ITER_D_S7T73E - ITER Concept of Operations

7.5.2 Maintenance or Inspection Plan

System Design Document	Maintenance or Inspection Plan

Objectives		The Maintenance & Inspections (M&I) Plan defines the schedule of preventative and corrective M&I activities to be performed on the SSC over its in-service life. This includes Protection Important Activities (PIA) and mandatory M&I activities applicable to PIC components, but also all other M&I activities required to ensure that the SSC performs reliably whilst in-service, and is maintained efficiently in order to achieve operational objectives. The M&I Plan should provide reference to supporting RAMI Analysis and Maintainability design related studies (e.g. RH compatibility assessment, ORE assessments, HoF assessments, etc.) in order to demonstrate that the M&I plan is practically and technically feasible, is compatible with ITER operations, and that implications for workers have been assessed and adhere to all applicable guidelines and constraints. The M&I Plan shall also clearly identify the Integrated Logistics Support (ILS) requirements to enable efficient implementation of the M&I activities, including identification of temporary services, tools & equipment, utilisation of supporting services, monitoring, waste handling, human resource, materials & spares and any other logistics aspects that are necessary to support the SSC M&I activities. The M&I Plan shall include statutory and regulatory requirements. Detailed guidance and expectations for the M&I plans are detailed in the 'SSC M&I Plan Template' [YH2XTM], and the 'Reviewer's SSC M&I Plan Checklist' [in Production].
Maturity Level at the end of	Conceptual Design	An M&I Plan is not a requirement at CDR stage. However, initial consideration of the following aspects such as Identification of M&I requirements, Initial RAMI analysis, Initial development of the concept of maintenance for the SSC, Identification of constraints on performing M&I tasks on the SSC (e.g. access requirements, parallel activities in the plant, hazards to workers, etc.) to be part of design documentation
	Preliminary Design	An initial PDR version of the M&I Plan shall be produced with available information. The M&I Plan should serve to provide an initial summary of the envisaged tasks to be performed, which shall inform ongoing design maintainability and maintenance assessment studies, and highlight any issues or risks related to M&I. It should also enable initial assessment of compatibility with the plant operation & maintenance concept to be performed. Major ILS aspects such as preliminary identification of tools & equipment, spares, use of supporting facilities & temporary services, temporary staging areas, waste management etc. should be included.

	Final Design	The FDR version of the M&I Plan shall be updated of the PDR version, in-line with the level of design maturity, and design substantiation required for FDR. All applicable sections of the M&I Plan Template should be complete, with any assumptions or details to be refined clearly highlighted. The M&I Plan should be substantiated with supporting Design Maintainability Assessments and RAMI analysis, and the M&I tasks should be assessed for compliance with ITER guidelines and administrative constraints. The level definition in the schedule of M&I tasks should allow the M&I Plan to be integrated into the overall maintenance and operations plan for the facility. Following approval of the plan, detailed maintenance procedures and maintenance task analysis studies will subsequently be completed in the next phase. ILS aspects should also be elaborated to the extent that all logistics requirements can be integrated, and validated in the context of the plant.
Comments		**Specific Guidance:** Expectations at design gates is available in: YH3TFW

7.6 Decommissioning

7.6.1 Decommissioning Plan

System Design Document		Decommissioning Plan
Objectives		The objective of this document is to either: • Describe the overall strategy and decommissioning operations if the system specificities require additional information besides the ITER overall decommissioning strategy OR • Justify that the system does not require any specific decommissioning requirements
Maturity Level at the end of	Conceptual Design phase	Not required
	Preliminary Design phase	The decommissioning plan shall be complete in order to propagate the associated detailed requirements to the design. The major requirements of this plan shall be included in the SRD update prepared during this phase.
	Final Design phase	Updated consistently with design maturity level.
Comments		

7.7 Product Lifecycle Records

7.7.1 Design Plan

<table>
<tr><th colspan="2">System Design Document</th><th>Design Plan</th></tr>
<tr><td colspan="2">Objectives</td><td>Design Plan describes all critical elements within the design phase, e.g. scope, work to be done, stakeholders, documentation, gates, interface, project management, issues and risks. Design Plan consists of two parts, i.e. Design Management Plan (DMP) and Design Document Production Plan (Design-DPP). With Design-DPP, all the relevant design and design management documents, and planned document deliverables are identified and controlled. Design Plan is to be maintained throughout the project lifecycle, so as to be able to provide links to relevantly official data sources related to the scope.</td></tr>
<tr><td rowspan="3">Maturity Level at the end of</td><td>Conceptual Design phase</td><td rowspan="3">Based on the documents/activities identified in this document and the mitigation actions identified in the System Risk Analysis, each System RO has to identify the activities to be performed for the System Design and the associated deliverables. The deliveries shall be scheduled in accordance with the project milestones from IPS and the Design Review Schedule.
This Design Plan shall be issued at the end of each Design Phase to plan the activities of the next phase. The activities of the phase after are roughly identified (rolling wave approach).
This Design Plan shall be updated as needed during the Design Phase.</td></tr>
<tr><td>Preliminary Design phase</td></tr>
<tr><td>Final Design phase</td></tr>
<tr><td colspan="2">Comments</td><td></td></tr>
</table>

7.7.2 Issue or Risk or Opportunity Analysis Report

System Design Document	Issue or Risk or Opportunity Analysis Report
Objectives	From a technical point of view, risk analysis shall address at least the following topics: • Technical innovation (technical solution already done or for the first time, need of improvement, prototyping, testing, etc.) • Exhaustiveness of the technical compliance (design solution against requirements, action plan for requirements not fulfilled, etc.)

		• Focus on Safety (compliance with the requirements, interaction with the French safety body, additional demonstration or studies to be planned, etc.) • Manufacturing long lead time (additional studies, fabrication schedule, testing, commissioning, etc.) • Interface definition • Cost containment constraints up to the handover to the operator
Maturity Level at the end of	Conceptual Design phase	From a technical point of view, risk analysis shall address at least the following topics: • Technical innovation (technical solution already done or for the first time, need of improvement, prototyping, testing, etc..) • Exhaustiveness of the technical compliance (design solution against requirements, action plan for requirements not fulfilled, etc.) • Focus on Safety (compliance with the requirements, interaction with the French safety body, additional demonstration or studies to be planned, etc.) • Manufacturing long lead time (additional studies, fabrication schedule, testing, commissioning, etc.) • Interface definition • Cost containment constraints up to the handover to the operator For more information on Risk Management, refer to [10] ITER_D_22F4LE - Risk and Opportunity Management Procedure
	Preliminary Design phase	
	Final Design phase	
Comments		

7.7.3 Review or Decision or Recommendations Report (RRR)

System Design Document	Review or Decision or Recommendations Report
Objectives	Many technical reviews (Design Reviews, Readiness Reviews, etc…) are organized during the life cycle at different PBS levels to support technical decisions or Authorization To Proceed at various gates. The Review or decision or Recommendations Report (RRR) document type is used to cover all the documentation generated for the identification, preparation, execution of the review and resolution of issues up to the close-out report.

		The RRR documents all the activities and decisions taken during the review period and demonstrates that the input package has been reviewed and recommendations from the panel have been properly taken into account.
Maturity Level at the end of	Conceptual Design phase	Necessary and complete for all DRs, including those managed at component level.
	Preliminary Design phase	
	Final Design phase	
Comments		including Design Review management documents: Notification, Agenda, Input Data Package, Panel Report, Close-out Report, Report on interfaces

7.7.4 Surveillance Plan - Annex 2

System Design Document		Surveillance Plan – Annex 2
Objectives		The Annex 2 of the Surveillance plans contains the list of PIA, the related defined requirements, the external actors in charge of it and the actor of the surveillance. *Surveillance plans describe the system of surveillance put in place by the ITER Organization, as the Nuclear Operator, to survey all the Protection Important Activities (PIA) carried out by external interveners for the design, manufacturing, tests, reception, on-site assembly, operation, final shutdown, dismantling, maintenance and surveillance of ITER Plant and PBSs, as required by the article 2.2.2 of the INB Order.*
Maturity Level at the end of	Conceptual Design phase	For PIC and PIA, an approved Surveillance Plan should cover each lifecycle phase. The list of PIA, the related defined requirements and the external actors in charge of it shall always be kept up to date, regardless of the gates.
	Preliminary Design phase	
	Final Design phase	
Comments		

7.7.5 Change Request or Record

<table>
<tr><th colspan="2">System Design Document</th><th>Change Request or Record</th></tr>
<tr><td colspan="2">Objectives</td><td>Documents of this group allow the record of actions done to process any technical (product) “change”. A “change” is any prospective modification to a document part of the ITER baseline (input requirements). Documents of this group permit traceability and evidence (records) of actions done or decision taken.
Different types of change requests belonging to this group are:
• Change Notice-CN
• Deviation Request-DR
• Non-Conformance Report-NCR
• Project Change Request-PCR</td></tr>
<tr><td rowspan="3">Maturity Level at the end of</td><td>Conceptual Design phase</td><td rowspan="3">Documents belonging to this group can be issued at any time during the project lifecycle. However at each gate reviews the list and status of these documents for the considered scope should be presented so that the reviewers make their assessment on the basis of these documents and the remaining risks.</td></tr>
<tr><td>Preliminary Design phase</td></tr>
<tr><td>Final Design phase</td></tr>
<tr><td colspan="2">Comments</td><td></td></tr>
</table>

Appendix

Different Engineering analysis and calculation reports types and their definitions

Analysis/Calculation type	Definition
Functional Analysis	Covered in document card 7.2.3
Nuclear Safety Analysis	Nuclear Safety analysis is performed to demonstrate safety requirements for the System are achieved in all normal, incidental and accidental conditions considering all technical risks and issues including human and organisational factors.
Reliability, Availability, Maintainability and Inspectability (RAMI) Analysis	RAMI analysis is performed as a technical risk control approach during the System lifetime. It is based on a functional analysis of the System for identifying and classifying the possible failure modes (FMEA/FMECA) and then reducing their effects thanks to corrective or preventive actions which translate into requirements for the SSC design and development.
Integrated Logistics Support (ILS) Analysis	The Integrated Logistics Support (ILS) Analysis is the integrated planning and action of a number of disciplines in concert with one another to assure system availability. The impact of ILS is often measured in terms of metrics such as reliability, maintainability, availability, and inspectability (RAMI), and sometimes system safety.
Failure Modes and Effects Analysis / Failure Modes Effects and Criticality Analysis (FMEA/FMECA)	The Failure Modes, Effects and Criticality Analysis (FMECA) is a method using both the Functional breakdown of the System and the Reliability Block Diagrams RBDs as input. Its four main phases are: • Identification of all the Failure Modes (FM) for the basic functions, • Qualitative assessment of causes and effects on the main functions of the system, the overall system itself and the operation of the whole ITER machine, • Quantitative assessment of the Occurrence of the causes and Severity of the effects, • Prioritization in Minor, Medium and Major Risks as a function of the Initial Criticality, of all failure modes in a Criticality Matrix (Chart). It is an input for the RAMI analysis
Hazard Identification and Risk Assessment (HIRA) Analysis	The HIRA analysis if performed to identify all the possible hazards to the occupational health and safety and assess the identified hazards to understand how likely they are to occur and how great their potential impact will be on the System. Process outputs are notably: - Hazards linked with the system; - Mitigation measures legally required; - Mitigation measures required in order to obtain a tolerable level of risk All the mitigation measures translate in requirements for the SSC development. HIRA analysis is an input for the RAMI analysis
Fire Protection Analysis	Fire Protection analysis is performed on the environment of the System to collect the input data regarding fire loads and define the load specification under fire situations and verify their implementation in the System design.

Analysis/Calculation type	Definition
Human factor Analysis	The Human Factors principles are applied on the System in order to assess the potential risks of interaction between them and the optimized way to reduce the human error and ensuring the safety of humans with the psychological aspects. Human factor Analysis is used to define HF requirements and verify their implementation in the System design..
Overall structural loading and behavior/Structural Analysis	The computation of deformations, internal forces, and stresses under consideration of physical laws and through the application of mathematical equations. It incorporates the fields of mechanics and dynamics as well as the failure theories of materials. This analysis is used to verify the integrity of the System design in all conditions. The structural integrity of an SSC is justified in a Structural Integrity Report, which will be supported by one or more Structural Analysis Reports.
EM compatibility, magnetic perturbation analysis	The computation of electromagnetic (EM) and electric potentials to determine magnetic fluxes and induced currents distributions in space under consideration of physical laws and through the application of mathematical equations. This analysis is used to verify the integrity of the System design in all conditions.
Radiation hardness Analysis	Radiation Hardness Analysis is performed to define the radiation condition, evaluate shielding effectiveness and assess improvement and verify the achievement of the requirements in the design, including equipment qualification to radiation conditions.
Nuclear analyses, shielding/activation, contamination Analysis	The computation or simulation of nuclear radiation transport, neutron activation, computation of nuclear responses (flux, heating, dose, damage, gas production, source estimates, etc.), and the production of radiation maps. This analysis is used to define shielding or contamination protections requirements and verify their implementation into the System design and its operation.
Simulation Analyses (behavioral analyses, assembly and tolerances, maintenance, …)	Simulation analyses are performed to have adequate understanding of the behavior of the System in the normal, Incidental and accidental conditions. It is done by developing static and dynamic models and simulating them over time. This analysis is used to define or detail requirements and verify their implementation into the System design.
Remote Handling Analysis	Remote handling analysis is the analysis performed to assess the need of Remote handling during its lifecycle and ensure the feasibility for operators to safely, reliability and repeatedly perform manipulation of items remotely without the need to be in personal contact. This analysis is used to define the Remote Handling system requirements (on itself and on interfacing systems), and verify their implementation into the design solutions.
0D or 1D Thermohydraulic Analysis	0D or 1D thermal-hydraulic analyses are performed with codes based upon the solution balance equations for liquid and gas that are supplemented by a suitable set of constitutive equations, organized in a number of lumped volumes connected with junctions. Thermal-hydraulic components such as valves, pumps, separators, etc. can be defined in order to represent the overall system configuration, in order to simulate

Analysis/Calculation type	Definition
	behaviour of the complete system. Computer codes of that type can model the integral behaviour of the system and feedbacks between physical processes during normal, off-normal and accident conditions.
ALARA Analysis	ALARA analysis is performed implementing the radiation safety principle which is based on the minimization of radiation doses and limiting the release of radioactive materials into the environment by employing all “reasonable methods.
Computational Fluid Dynamics-CFD Analysis	Computational Fluid Dynamics (CFD) is the analysis of fluid flows using numerical solution methods. Using CFD complex problems can be analysed with 2D or 3D explicit description of area of interest. Computers are used to perform the calculations required to simulate the flow of the fluids, and the interaction with surfaces defined by boundary conditions, and provide very detailed flow field solutions, accounting for local phenomena (velocity profiles, turbulence effects, etc.) explicitly modelled.
Constructability Analysis	Constructability analysis is performed to study the required construction processes before to be built with the available construction knowledge and experience and preventing the errors, delays.
Contamination Analysis	The simulation of contamination transport and computation of responses (residual contaminant estimates, airborne activity, DAC, surface contamination etc.,) and production of contamination maps.
EEE NRC Analysis	EEE NRC analysis is performed to ensure the compatibility of electronic functions, electrical functions and electromechanical functions with the nuclear radiation condition of their installed location.
Logistics Analysis	Analysis of the various ways of handling, packaging and transportation of the System with associated advantages, constraints and risks. Used to select the logistic system and define requirements on it and interfaces (means, preservation, acceleration, protection, handling tools center of gravity, etc..); and to verify their implementation into the logistics system and into System design.
Maintainability Analysis	Maintainability assessment is performed with the help of RAMI analysis which aims to ensure, before the production starts, that the design does not contain any issues which could cause unreliable operation of the SSC
Manufacturability Analysis	Analysis of the various ways of manufacturing/producing the System with associated advantages, constraints and risks. Used to define requirements on the manufacturing system and to verify their implementation into the manufacturing system and into the System design.
Seismic Analysis	The computation of the responses due to earthquake for the seismic qualification of the SSC (structure, system and component), including deformations (strain, displacement, velocity and acceleration) and forces (stress, force, moment, etc.).

Analysis/Calculation type	Definition
Task Analysis	Task analysis is performed to describe the tasks undertaken with System used as a basis for the human reliability assessment, development of procedures and interface designs. Task analysis is required for any human activity that interacts with Protection / Safety Important Functions or Components; the interaction might be deliberate, or accidental.
Investment Protection Analysis	The definition of the ITER Investment Protection Functions will follow a systematic approach, with an exhaustive analysis of the failure scenarios in the different systems and their effect on the integrity and operation of the machine. The mandate is to protect the investment while minimizing the impact to the operation of ITER.