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MQP Level 3

ITER System Design Process (SDP) Working Instruction

The System Design Process-Working Instruction (SDP-WI) provides guidelines to the System -ROs for the planning of their documents during the design development phases and up to Manufacturing Readiness Review (MRR).

Approval Process			
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Change Log			
ITER System Design Process (SDP) Working Instruction (4CK4MT)			
Version	***Latest Status***	***Issue Date***	***Description of Change***
v0.0	In Work	21 Apr 2011	
v1.0	Approved	05 Jul 2011	First version
v2.0	In Work	02 Oct 2019	As per approved MQP doc request https://user.iter.org/default.aspx?uid=X45X3C the changes are: - Aligned with Technical Document Families and covered documents (TDFC). - Better integrated within the Design Control document structure. - Added Manufacturing Design and Preparation phase documents.
v2.1	Approved	04 Oct 2019	Technical change: update of the document numbers in the tables 1 and 2
v3.0	In Work	11 Sep 2020	As per approved MQP doc request https://user.iter.org/?uid=3JH453 there are no changes to the document but this review is to have DAs in the loop for impact assessment and make the documents Annex A PA AD through the MPA.
v3.1	In Work	01 Dec 2020	As per approved MQP doc request https://user.iter.org/?uid=3YWWSB the changes are: - Table 9: 2 documents merged (Engineering Analysis and Calculation Report), some clarification - Appendix 3: link to the new document containing the former Appendix 3.
v3.2	Revision Required	03 Dec 2020	Corrected bad pdf formatting in Appendix 2
v3.3	Approved	08 Mar 2021	Main changes made to address previous version comments: - Completed and improved few definitions (architecture, part definitions) - Added references to BOM and Identification of items procedures - Aligned with the new SIRO's role Please refer the attached track change version for changes made.
v4.0	Revision Required	20 Dec 2024	As per CWH2TR and further communication the changes are: -update as per IO Re-org -update due to changes of ICP document types in 2023 (TDF -> TDT) -update to align with other MQP Procedures (Design Review Procedure, L2 Design Control Procedures, SEMP..)
v4.1	Approved	07 Jan 2025	- Chapter 7.1: correction of RACI information for Design Integration Reviews - Appendix 1: clarification of requirements regarding CMM during Final Design

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1 Purpose

The **System Design Process**-Working Instruction (SDP-WI) provides guidelines to the System[1]-ROs for the planning of their documents during the design development phases and up to Manufacturing Readiness Review (MRR).
During these phase activities, the Design Development process covers the production of engineering deliverables describing and demonstrating the functionality and performance of the system model. It covers also the plans, instructions and procedures controlling the –abilities (manufacturability, assembly and installation-ability, testing and commissioning-ability, operability, maintainability, disposability of the system…) after the MRR until the end of the system product lifecycle.

The detailed description and maturity content of all engineering deliverables [Generic Document Titles -GDTs] and their procedures can be found in the Technical Document Types Cards (TDTC) [R7].
Note that in case of conflict the SDP-WI content has precedence over the TDTCs content.

The selection of each technical document shall be tailored to the complexity of the system, its criticality (e.g. according to their quality class [R9] or safety classes [R10] or to the maturity of involved technology), and the already achieved design development stage.

2 Scope

The SDP-WI shall be applied by any System-RO for preparation of the Conceptual Design, Preliminary Design, Final Design and Manufacturing Design phases.
This set of documents is defined at System level but as recommended by the Systems Engineering approach, each lower PBS node should also be defined by same document-types (i.e. sub-SRD, sub-Design Description (DDD), sub-Justification documents should be created at sub-system level, and so on…), down to the lowest Configuration Item [R2].

Note 1: The process is generic enough to be understood and tailored for any discipline (mechanical, electrical, I&C, etc...). Depending on the discipline deliverables may be called using a different terminology but should always correspond to a certain TDT/GDTs.

[1] See Definitions

3 Definitions and acronyms

3.1 Definitions

Term and definition
Configuration Management (CM) Relevance A document is CM relevant at a given gate when it is a reference against which the product(s) of any following phase is/are verified. The document is placed under Configuration Control (i.e. part of the Technical Baseline) after the gate closure. An update of such document will require a PCR.
Configuration Item (CI) A basic unit of Configuration Management (CM) for which a relevant authority exists and decides to control its definition as well as to closely monitor its changes. CIs may vary widely in complexity, size and type and may represent an entire system, a subset of it, or a component.
Component An ITER Component is a major piece of equipment uniquely located within an ITER System, such as a pump or a tank, which is tagged with a Functional Reference (FR).
Design Justification Document: Document that supports the justification of a design solution, i.e. documents providing evidence that the requirements in the technical requirement specification are satisfied.
Design Solution: Set of documents which describes the Functional and Physical Architecture of the considered SSC and which drives the realization, operation and maintenance, disposal of equipment satisfying the requirements as indicated in the technical requirement specification.
Function: A task to be performed by the system to achieve a required outcome or satisfy an operational need. Functions are captured in the context of performance requirements. (NB: not to be mixed with performance baseline)
Generic Doc Title (GDT): Name of each type of technical document, defined as outputs of MQP procedures and organised in Technical Document Types (TDT).
Manufacturing Design (MD): Set of Detailed Design documents produced by the Manufacturer which provides confidence in the Manufacturer's capability to satisfy Client's Procurement Specification. MD content is detailed in Appendix 1 of Working Instruction for Manufacturing Readiness Review (44SZYP). MD is an input to the shop floor and/or procurement work and does not therefore necessarily include detailed fabrication methods (*fabrication sequences, task lists and shop floor travellers)* used by the machine operators to implement MD's fabrication requirements.

Margin / Contingency

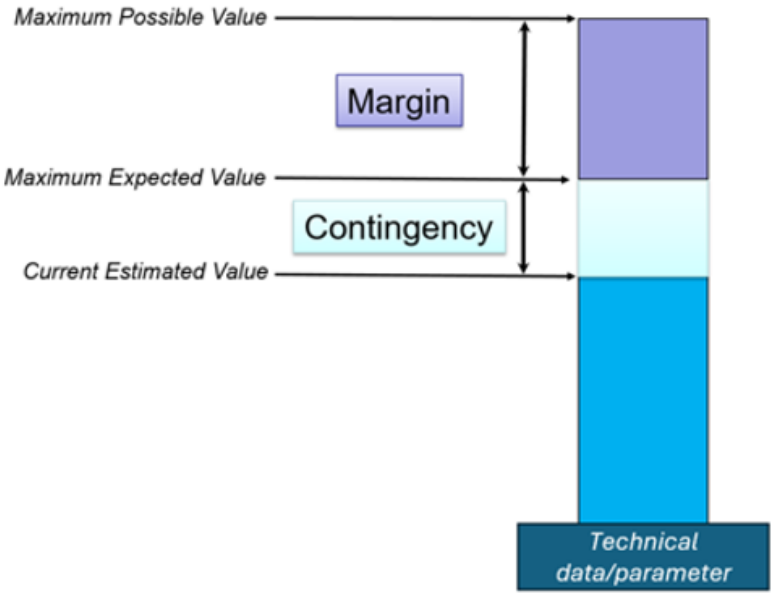
Margin is the difference between the maximum possible value and the maximum expected value.

Contingency is the difference between the current estimated value and the maximum expected value.

Current estimated value: it is the value of the technical data/parameter known at date

Maximum expected value: it is the most extreme value of the technical data/parameter that the design team expects will be observed as the design is refined and become more mature. It is based on the return of experience of the design teams.

Maximum possible value: it is the maximum expected value increased by the margin. It acts as a buffer to provide "design place" for a less mature design and to account for uncertainties.



Part: a single item which generally cannot be further disassembled.

System: A set of components which interact according to a design so as to perform a specific (active) function, in which an element of the system can be another system, called a subsystem.

NOTE: At ITER, "system" sometimes designates the top-level ITER systems, corresponding to PBS Level 1 or sometimes level 2 and which have a toplevel SRD (System Requirement Documents), also called Configuration Items Level 1. Currently around 90 "systems" are defined to cover the ITER Facility

The lower-level systems are called sub-systems and have dedicated sub-SRD (sub-System Requirement Document), also called Configuration Items Level 2.

System-RO: The System Responsible Officer (SysRO) is in charge of the full life cycle of the system. It is by default the Project Leader of the delivered system. Project Leader (SysRO) may nominate staff(s) for SysRO duties with associated responsibilities and authorities to one or more employees of the ITER Organization who have the competence necessary to accomplish the tasks under her/his OBS. Outside Project Leader OBS, CPL can nominate staff for those roles in collaboration with the Project Leader (SysRO).

Technical Document: Any container of (technical) information which:

- gives information about the technical aspects and technical management of system and enabling systems for each lifecycle phase,
- is subject to versioning and applicability, as well as to a given workflow towards approval (this is also valid for drawings, schematics and 3D data),
- and can be easily allocated to one of the Technical Document Type (TDT) & to one GDT.

3.2 Acronyms

See also ITER Abbreviations 2MU6W5

ATP	Authorisation-to-Proceed
CI	Configuration Item
CIC	Controls & Integrated Commissioning Program
CIDH	Central Integration Division Head
CM	Configuration Management
CMM	Configuration Management Model
COTS	Commercial Off-The-Shelf
CWP	Construction Work Package
DA	Domestic Agency
DCM	Design Compliance Matrix
DDD	System Design Description Document
DECO	Design Coordinator (from Design Office)
DIR	Design Integration Review
DIRO	Design Integration RO
DP	Design Plan
DPP	Document Production Plan
FAR	Functional Analysis Report
FBS	Functional Breakdown Structure
FS	Functional Specification
GDT	Generic Document Title
HAZOP	Hazard and Operability Study
HIRA	Hazard Identification and Risk Assessment
ICD	Interface Control Document
IS	Interface Sheet
PA	Procurement Arrangement
PBS	Product Breakdown Structure
PCR	Project Change Request
PE/NPE	Pressurized Equipment/Nuclear Pressurized Equipment
PIC	Protection Importance Component
PM	Program Manager
PR	Project Requirements
QARO	Quality Assurance Responsible Officer
RO	Responsible Officer
ROX	Return Of Experience (also REX)
RPM	Requirement Propagation Matrix
RQ	Requirement
RQM-RO	Requirement Responsible Officer
SIRO	System Integration RO
SOA	Sign-Off Authority
SDP	Systems Design Process
SDR	System Design Review

SEMP	Systems Engineering Management Plan
SIS SL	System Integration Section Leader
SLS	System Load Specification
SRD	System Requirement Document
SRO	Safety Responsible Officer
SSC	System Structure and Component
s-SRD	Sub- System Requirement Document (Children of an SRD)
TDT(C)	Technical Document Type (Card)
VCM	Verification Compliance Matrix

4 Reference Documents

[R1] ITER Systems Engineering Management Plan - ITER-SEMP (2F68EX)
[R2] ITER Configuration Management Implementation Plan (CMIP) (27LHHE)
[R3] Sign-Off Authority for Project Documents (2EXFXU)
[R4] Design Planning Procedure (U34ACR)
[R5] Design Input Control Procedure (U34CSG)
[R6] Design Development Procedure (U34DDZ)
[R7] Technical Document Types (TDT) Cards (BFF8H7) (folder)
[R8] Design Interface Control Procedure (28VNJG)
[R9] Quality Classification Determination (24VQES)
[R10] Safety Important Functions and Components Classification Criteria and Methodology (347SF3)
[R11] Data supplied by the IO operator to NPE manufacturer (VHBYMG)
[R12] Design Review Procedure (2832CF)
[R13] Implementation plan for design & manufacture of PE/NPE (VE2DSP)
[R14] PE/NPE - Manufacturing Design Controls for PE/NPE (WSJ6VM)
[R15] Procedure for Identification and Controls of Items (U344WG)
[R16] Work Instruction for Creation of Part Number of ITER, PNI and Cataloguing (UYGU3S)
[R17] Work Instruction for Generation of ITER Bill of Materials (BOM) (VXMR6K)
[R18] Yearly Design Review Plans (UZ9ZJG)
[R19] ITER Procedure for Performing Hazard and Operability (2F5L5M)
[R20] Identification of Occupational Health & Safety Requirements related to Design (TME48W)
[R21] Project Requirements (PR) (27ZRW8)
[R22] Project Change Procedure (22F4E5)
[R23] Design Integration Review Procedure (3CNWMT)

5 Basic principles

5.1 Roles for System Design Development

Generic roles established in Design Input Control Procedure [R5] and Design Development Procedure [R6] are transposed at System level the following way:

1. **Design Coordinator**:

The Design Coordinator is the person responsible for the execution of the System design and the execution of the SDRs

2. **Design Developer:**

The **Developer** of the **System Design** is the technical person who supports the Design Coordinator to produce the System Design Documentation.

3. **Design Approver:**

The Design Approver is the duly authorized person to approve the system design on behalf of his/her organization. Within the IO, the System Design Approver is the Program Manager of the related system.

5.2 Context

The ITER Systems Engineering Management Plan - ITER-SEMP [R1] define the systems engineering technical phases (Conceptual Design, Preliminary Design…), and the main objectives of each technical phases. During each technical phase, a set of technical documents (system requirements, design description, justification….) shall be developed to help maturing the design.

The **main objectives, inputs and outputs** of the design phases (Conceptual Design, Preliminary Design, Final Design and Manufacturing Design) are detailed in **Appendix 1.**

5.3 Preparation for System Design Development

The Design Development process is applied during each design phase, and the output controlled through 'phase reviews gates" [R1].

In each design phase, the Design Development process is applied recursively (progressively down the PBS levels) and till the required document maturity as detailed in this document is achieved.

5.3.1 Design planning

Each design phase starts with the definition/update of the Design Plan (DP) for the management of the phase and the identification of the documents (DPP) to be produced or refined during the phase.

Below is reminded the set of input for the System Design Development (*output of the System Design Plan [R4]):*

Description	Main Documents	Complementary documents (*)	Doc.# (Table 9)
Plan Activity	**System Design Plan (DP)**		7.1
Plan Deliverables		**System Document Production Plan (DPP)**	N.A.

(*) documents included in or separate from main document but referenced in it

Table 1 – Inputs from Design planning

5.3.2 Design Development Input Requirements

Below is reminded the set of design input requirements (*outputs of the System Design Input Control process [R5])*:

Description	Main Documents	Complementary documents	Doc.# (Table 9)
Specify System Requirements	**System Requirement Document**		1.1
		ICD/IS	1.2/1.3
		CMM	1.4
		ITER Load Specification	1.5
		ITER Concept of Operations	5.1

Table 2 – Inputs for Design Development

Note: Design input requirements for the other design phases include the baseline documents validated after the previous Design Reviews.

6 Process application during each design phase

The System Design Development process comprises 3 sub-activities [R6]:

1. Develop Architecture Definition (Physical & Functional)
2. Perform analyses and calculations (to support functional and physical decomposition, optimization of the architectures, trade-off analyses and to verify the preferred solution)
3. Specify the System Design Solution.

The System Design Development process is applied in each design phase as detailed **on Figure 1**.

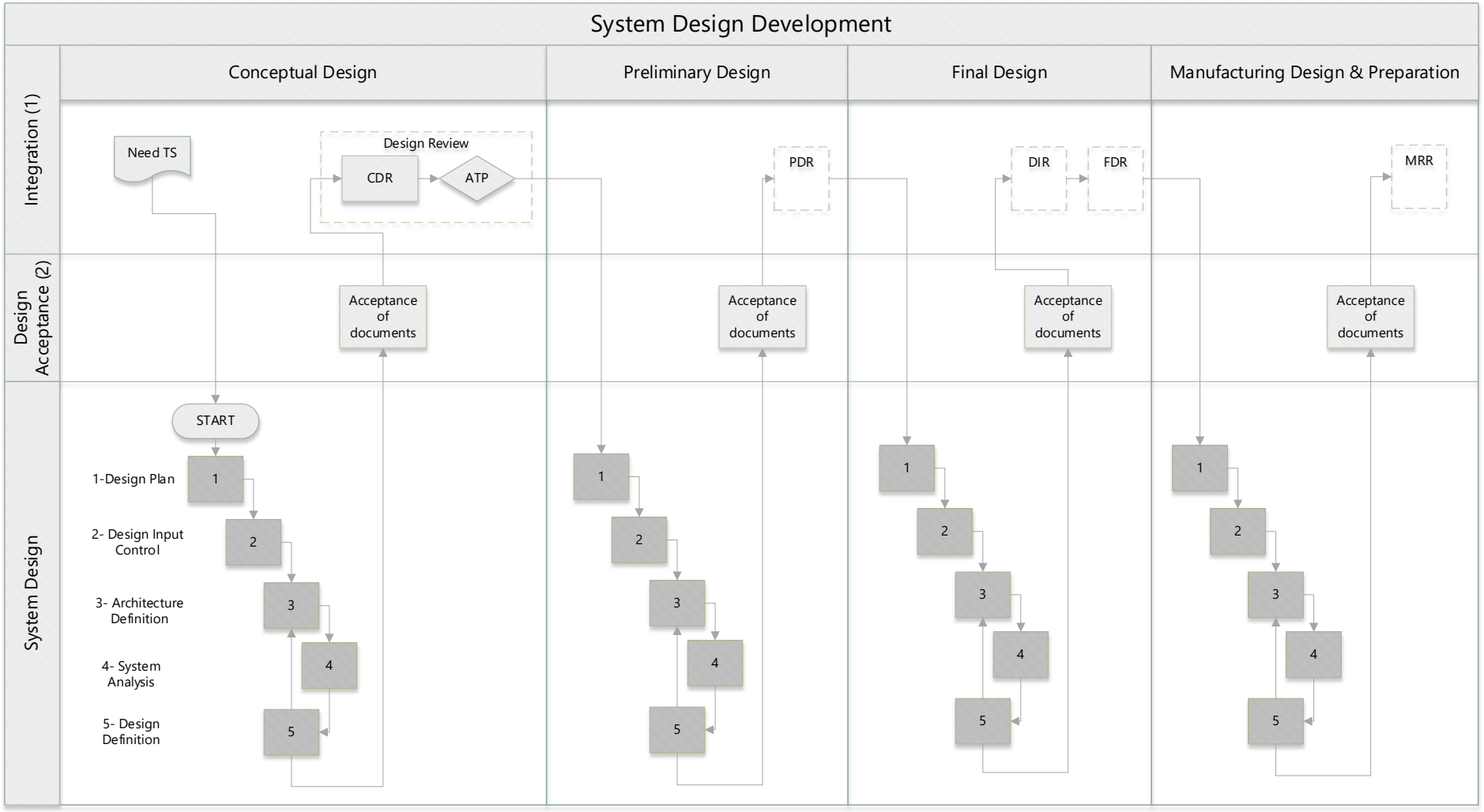


Figure 1: Process application during design activity phases

(1): Design Integration Review, Interface Review and System Design Review

(2): In case of Procurement

Note: The System Functional Solution Definition process [R6] is first applied in the Conceptual Design to decompose the System Functions down to the level necessary to identify a lower-level function which can be achieved by a feasible SSC. A feasible SSC is either an SSC existing on the market (Catalogues- Commercial Off-The-Shelf components - COTS) or an SSC which can be reasonably fabricated based on the Design Developer's experience (Return Of Experience - ROX).

In the Preliminary and Final Design, the System Functional Solution Definition process is applied at lower levels of the product to refine the sub-system and component design up to the component level (Detailed Design with Component Technical Specification).

For a system in development, most technical data/parameters carry both margin and contingency.

Generally speaking, the current maximal of a data/parameter change as the design of the system matures, and the margins and contingencies can be reduced as the design of the system reaches the Final Design Stage.

NB: Hidden margins shall be excluded to avoid stacking conservatisms that could lead to over costs and potential non feasibilities (exceeding the technical or regulatory constraints).

Once documents and documents maturity (also called "passing gate" criteria) are achieved for a given gate review, the System-RO shall organize (or make it organized) a System Design Review [R12] or an MRR for validation and authorization for use of the design package, according to the ITER Design Review Plan [R18] and Configuration Management Implementation Plan-CMIP [R2].

Note: A Review of Interfaces and/or a Design Integration Review (DIR) is/are organized before the FDR to check the correct development of Interfaces and/or the Integration of the Design in its environment.

6.1 Conceptual Design

The System-RO shall apply the Design Development process (Figure 1) for the objectives defined on **Table 5** in Appendix 2 and produce design documents for "Conceptual Design" maturity as detailed in the summary **Table 9** in Appendix 2**.**

During Conceptual Design, focus is finalisation of requirements, Functional analysis and search for solutions for the higher levels of the PBS (system, sub-system, up to critical components) and demonstrate feasibility of the system.

6.2 Preliminary Design

The System-RO shall apply the Design Development process (Figure 1) for the objectives defined on **Table 6** in Appendix 2 and produce design documents for "Preliminary Design" maturity as detailed in the summary **Table 9** in Appendix 2.

6.3 Final Design

The System-RO shall apply the Design Development process (Figure 1) for the objectives defined on **Table 7** in Appendix 2 and produce documents for "Final Design" maturity as detailed in the summary **Table 9** in Appendix 2.

6.4 Manufacturing Design

The System-RO shall apply the Design Development process (Figure 1) for the objectives defined on **Table 8** in Appendix 2 and produce documents for "Manufacturing Design" maturity as detailed in the summary **Table 9** in Appendix 2.

Note: When IO is acting as manufacturer, the design of PE/NPE is developed during the manufacturing design phase. See [R13]and [R14].

7 Responsibilities

7.1 System Design developed internally

The SDP-WI is implemented using the RACI matrix below:

Description	RO (Doer /writer)	Accountable (Approver)	Consulted (Contributor/ Reviewer)	Informed (User)
Generate SRD	SIRO & System-RO	Design Approver	SRO, Design Coordinator, Transverse Functions RO	RQM-RO
Develop Interfaces documents	SIRO & System-RO	SIS SL	Interfacing Systems (1)	
Develop System Design documents incl. Verification	Design Developer	Design Approver or delegate	SIRO, DIRO, SRO, QARO, DECO, Discipline Expert	
Organize Design Integration Review	DIRO (or SIRO if solely functional)	DIS SL	Design Team and other IO Stakeholders (see [R23])	
Organize System Design Review	Design Developer	Design Coordinator	IO Stakeholders (see [R1])	Interfacing Systems
Authorization To Proceed after Design Review close-out.	Design Developer	CID Head	Design Approver, Design Coordinator, SIRO, CIC Program Manager	

(1) When the interfacing system is procured by a DA/Contractor, DA/Contractor TRO shall be reviewer [R8]

Table 3 -RACI matrix for internal design

For the full detail of Sign-off of each design output, please refer to Project SOA [R3].

7.2 System Design developed through Procurement

The design development work (specified in a procured work package) for a given activity phase may be executed by other design development teams in other Organizations (Domestic Agencies-DA or IO Contractors). In that case the work is formalized through a procurement scheme (IO-direct contract or a Procurement Arrangement) signed by both parties.

During the procurement activities, performed mainly at sub-system level or below, the monitoring of the procured work is delegated to an IO-PA-TRO or an IO-Contract-TRO (who may be also the IO-System RO).

When preparing the design procurement scheme the IO-PA-TRO/ IO-Contract-TRO should ensure that the planning of the work and list of deliverables is compliant with the IO's rules.

During execution of the procured design activities, the IO-PA-TRO implements a Surveillance Plan and produces documentation related to the monitoring of the activities, review and acceptance/approval of deliverables according to approved procedures. He/she shall ensure the consistency and propagation of the System RQs to all the lower-level specifications and the compliance of delivered design with the RQs identified in the Procurement Technical Specification.

Appendix 1: Design Activity Phases: inputs, outputs and objectives

A- Conceptual Design (CON)

Conceptual Design Activity Phase	

Phase Inputs	• Inputs from upper level:
	  o Technical rules to be followed (codes & standards, handbooks, etc.)
	  o Allocations of Requirements to the systems (via SRDs) with relevant physical envelopes/space reservations (CMMs) and interface design specifications (ICDs) and preliminary PBS tree
	• Workplan (Design Plan/DPP for the Conceptual Design Activity phase). The plan shall clearly define the scope (system i.e. Configuration Item Level 1 or Level 2) and the boundaries.

Main Objectives	• To produce the documents for the considered system (Configuration Item) and maturity relevant for the Conceptual Design Activity phase as indicated in the Design Plan.
	• To consolidate design inputs and interfaces:
	  o Finalisation of the systems requirements (SRDs), including reference to all complimentary applicable documents (handbooks…)
	  o Boundaries of the system have been established, interfaces are properly and exhaustively identified through Interface Control Documents (ICD); ICD shall contain the work plan to specify all interface requirements (in IS) at the different interface points. In addition, allocation for main balances shall be defined with services systems and interfaces with more developed systems shall be defined with a sufficient detail level to avoid delay of their design.
	  o Physical interfaces requirements: CMMs of systems [mainly for Building Integration]
	• To outline at least one feasible design solution:
	  o Description of the proposed concept solution and its functioning (functional diagrams)
	  o Identification and localisation of main components (system layout drawing / 3D models)
	• To identify via the Design Compliance Matrix (DCM) which:
	  o Requirements have already been considered in the Design (and those which were not for risk assessment)
	  o Design options are assessed in terms of risks and the selected design solutions/options are justified and supported by necessary analyses
	• To identify impact of non-achievable requirements (draft PCR), with:

	○ Identification of modifications needed to SRD ○ Identification & assessment of impacts on Overall project requirements (PR) [R21].
Phase Outputs (Maturity Level)	• As a result of the Conceptual Design Activity phase: The system requirements are complete and the system is deemed **feasible.** The System Design Definition shall meet the requirements and is achievable at an acceptable risk and cost. • SRD, Interfaces and CMM are developed, • Functional Specifications (for FS PAs) and outline drawings of sub-systems are available with their traceability matrices to SRD (RPM, DCM). • System Architecture and system decomposition is prepared. • This Phase is terminated with the approval of the Close-out Report of the Conceptual Design Review (CDR), giving the Authorisation-to-Proceed (ATP) to the next activity phase (Preliminary Design).
Notes	*Non-achievable requirements may be accepted provided that their impact has been assessed, the change to the SRD identified and the impacts of the system requirements on the overall project assessed, as per PCR procedure [R22].*

Table 5 – Conceptual Design Activity Phase: inputs, outputs and objectives

B- Preliminary Design (PRE)

Preliminary Design Activity Phase	
Phase Inputs	• Consolidated Technical/Engineering data (system + Plant levels) produced by all systems during the CON phase • Workplan (Design Plan and DPP for the Preliminary Design Activity phase). The plan shall clearly define the scope (system i.e. Configuration Item Level 1 or Level 2) and the boundaries, especially if the scope is smaller than previous phase (Conceptual design).
Main Objectives	• To produce the documents for the considered system (PBS node) scope and maturity relevant for the Preliminary Design Activity phase as indicated in the Design plan. • At the beginning of the Preliminary Design Activity phase, to select a design option if various solutions were defined during Conceptual Design • To refine the Conceptual Design to confirm the technical feasibility and the robustness of selected design solution, considering costs and schedule constraints. Evidence is given in: o An update of the Design Description (DDD), considering carefully margins and contingencies. o Functional Diagrams (P&ID, SLD, I&C architecture, etc) o An update of the physical representation of the system o An update of the System Load Specification, o An update of the definition justification documents, referring to a first consistent set of justification notes demonstrating that the technical objectives of the systems requirements will be met (analyses, return of experience, tests, simulations) and that manufacturability, on-site delivery (for High Exceptional Loads), assembly/installation and start-up and maintenance of the system have been addressed • To allocate system requirements to the subsystems (e.g. in s-SRD) to comply with the general architecture of the system. • To fully define Interface requirement specifications that are necessary to perform, or that have an impact, on the Final Design activities (exhaustive and with appropriate maturity). An Interface Requirement defines the functional and physical requirements and constraints that exist at a common boundary between two SSC. The Interface Requirements are recorded in Interface sheets. • To plan the future steps of justification in a consistent way (in particular all the tests on mock-ups/prototype for design qualification/verification should be planned in Verification/Qualification Plan) • To re-assess the technical risks of the selected solution and provide mitigation plan before going to the detailed design (Risk/Hazard Analysis Report) [R19] [R20]. • To check that the proposed design solution definition still meets the RQs (DCM for SRD/s-SRD)

Phase Outputs (Maturity Level)	System Design with the preliminary design maturity: • General architecture (Functional: FBS, Physical PBS-GBS) is consolidated and the main (or critical) components described adequately NB: Level of details in the Design of PBS elements varies with each system or component depending on the level of risk (mature/COTS or to-be-developed technology) • All the Interface Requirements shall be fully defined. • 3D model / System Layout Drawing • System Load Specification is consolidated • Justification documentation, including verification plan are prepared ➢ This Phase is closed with the approval of the Close-out Report of the Preliminary Design Review (PDR), giving the Authorisation-to-Proceed (ATP) to the next activity phase (Final Design).

Table 6 – Preliminary Design Activity Phase: inputs, outputs and objectives

C - Final Design (FIN)

Final Design Activity Phase	
Phase inputs	• Technical/Engineering data produced during the PRE phase • Workplan (Design Plan and DPP for the Final Design Activity phase). The plan shall clearly define the scope (system i.e. Configuration Item Level 1 or Level 2) and the boundaries, especially if the scope is smaller than previous phase (Preliminary design).
Main Objectives	• To produce the documents for the considered system (PBS node) scope and maturity relevant for the Final Design Activity phase as indicated in the Design Plan. • To refine the design to a level where the final definition of the product (PBS element) is sufficiently complete to allow starting the manufacturing design & preparation phase (subsystem/component specifications are detailed enough to be "understandable" by the manufacturer). • To update all ICD/IS according to refined design definition • To have a complete and approved CMM (under config branch) • To build a complete set of justifications demonstrating that: o Component specifications and design are justified (supporting analyses, return of experience, tests and explanations) o The specification of the qualification process is fixed (test objectives, logical sequencing, expected results, etc.) • To develop documentation covering the following aspects of the system: manufacturability, on-site delivery, assembly/installation, commissioning, operation and maintenance of the system
Phase Outputs (Maturity Level)	• Complete definition of the system (DDD, diagrams, 3D models (DM/CM), drawings, component lists, etc) • Detailed definition of the composing PBS elements (i.e. Functional References) ready for manufacturing/detailed design. • Full set of justification documents (including DCM, Structural Integrity Reports, etc) • Plans for next phases (manufacturing, installation, commissioning, operation and maintenance) ➢ This Phase is closed with the approval of the Close-out Report of the Final Design Review (FDR), giving the Authorisation-to-Proceed (ATP) to the next activity phase (Manufacturing Design and Preparation).
Note	*When IO is the manufacturer of the PE/NPE to be designed, as part of the Final Design process, IO acting as Operator shall establish PE/NPE specific documents [R11].*

Table 7 – Final Design Activity Phase: inputs, outputs and objectives

D - Manufacturing Design & Preparation

Manufacturing Design & Preparation Activity Phase	
Phase inputs	• Detailed definition of the composing PBS elements (Functional References) ready for manufacture studies, • Workplan (Design Plan and DPP for the Manufacturing Design and Preparation Activity phase). The plan shall clearly define the scope (system i.e. Configuration Item Level 1 or Level 2) and the boundaries, especially if the scope is smaller than previous phase (Final design).
Main Objectives	• To produce the documents for the considered scope and maturity relevant for the Manufacturing Design and Preparation Activity phase as indicated in the Design Plan. • To refine the design definition (Manufacturing Design) to a detailed level for the workshop execution (manufacturing drawings, fabrication, factory acceptance tests, data sheet for COTS, Manufacturing and Controls procedures, Weld Plan, tooling, trainings, materials certificates, tagging procedure) • To generate Manufacturing-Bill of Materials (M-BOM) [R17] and deliverable list. • To generate Manufacturing Implementation Plan (MIP). • To build a complete set of justifications demonstrating that: o Manufacturing design is compliant with the Manufacturing requirements (Compliance Matrices - VCM), o Manufacturing Design is justified (supporting analyses, return of experience, tests and explanations), o Component Qualification is finalised (in particular for PIC) o Manufacturing processes are qualified
Phase Outputs (Maturity Level)	Manufacturing design: • Manufacturing Inspection Plan • Detailed definition of the composing products/equipment's and their identification following [R15] [R16], ready for procurement (for COTS) or actual fabrication. • Detailed definition of the welded joints (welding maps…) • Material certificates • Manufacturing Procedures, NDT procedures, tagging procedures • Factory Acceptance Test Plan and procedures, • Qualified manufacturing, coating and assembly processes and tools • Qualification of operators Requirements for the preservation of the product and its qualification over the product lifecycle. ➢ This Phase is closed with the approval of the Close-out Report of the Manufacturing Readiness Review (MRR), giving the Authorisation-to-Proceed (ATP) to the next activity phase (Manufacturing).
Note	*According to Implementation Plan [R13] and procedure [R14], when IO acts as manufacturer of PE/NPE it performs* • *a PE/NPE Technical Review of the inputs supplied by IO operator prior to the manufacturing design* • *and a PE/NPE Technical Review of the outputs of the manufacturing design.*

Table 8 – Manufacturing Design & Preparation Activity Phase: inputs, outputs and objectives

Appendix 2: Summary of the System Design Documents and maturity at gates (Table 9)

Table 9 gives the design documents to be typically developed or updated during the system design development phase up to MRR.

The details of these documents are given in **Appendix 3** and can also be found in [R7].

This documentation covers all the design development (definition, justification) of the system itself but also:

- design management documents (which control the production of design development documents),
- documents defining the input requirements,
- documents (implementation plans and procedures) which control the implementation of the design solution during the future phases of production or utilization of the system products.
- documents linked to the procurement activity.

The list shows for each gate the maturity level (or passing gate criteria) of the documents:

☒ : Not Required
PL: PreLiminary
CS: ConSolidated
CP: ComPlete
UD: UpDate of CP if needed
IfU: If Useful
S: At any Stage

Note 1: This list gives the main documents to be developed. It is expected that in addition to the cited documents the System-RO opens the TDTC / related MQP procedures and assesses which GDT should be produced as output of his/her work.

Note 2: This list is applicable for all systems, whatever the engineering discipline (mechanical, electrical, building, process, I&C, etc.). Some documents are specific to discipline work, they are not all indicated here and should be prepared according to the discipline's templates (codes, handbooks, guidelines etc…) shown in the TDTCs.

Note 3: Depending on the complexity of the system and the criticality of the discipline to be treated, it may be agreed that certain documents with preliminary status are replaced by a Section in the DDD,

Note 4: The reference documents and their relevant sections should be used extensively in the text of technical documents to avoid duplication and maintenance of information.

Appendix 2: Summary of the System Design Documents and maturity at gate (Table 9)

Doc. #	[Design Aspect] and System Design Documents	Procedure /Guideline	CDR	PDR	FDR	MRR	ICP Doc Types	TDTC UID
1.	**Design Requirements**							
1.1	System Requirements Document (SRD or Sub SRD) (1)	25DSU2	CP	UD	UD		System Requirements Document-SRD Sub-System Requirements Document-sSRD	BXPZJS BXQ4VC
1.2	Interface Control Document (ICD)	28VNJG	CP	UD	UD		Interface Control Document-ICD	BZVDCD
1.3	Interface Sheet (IS)		PL	CS	CP		Interface Sheet-IS	BZKUP3
1.4	Configuration Management Model-CMM	V2ERKH	PL	CS	CP	If U	Not Applicable	WA46NH
1.5	System Load Specification	22MAL7	PL	CS	CP		Load Specification	WBBFYH
	Design Description							
1.6	System Design Description (DDD)	2M24AM	PL	CS	CP		System Design Description-DD	BXQ6H5
1.7	System Layout Drawing	See TDTC	PL	CS	CP		System Layout Drawing	WA9HY6
1.8	Building Drawing	See TDTC	PL	CS	CP	UD	Site & Building Drawing	W9ZKZY
1.9	Process Flow Diagram (PFD)	T7GQGS	CP	UD	UD		Process Flow Diagram-PFD	BK6T9E
1.10	Piping and Instrumentation Diagram (P&ID)			PL	CP		Piping and Instrumentation Diagram-PID	C7Z4TS
1.11	Single Line Diagram (SLD)		PL	CP	UD		Single Line Diagram	C7Z3TJ
1.12	Cabling Diagram-CBD			PL	CP	UD	Cabling Diagram-CBD	C7YW7M
1.13	Detailed Wiring Diagram-WD				PL	CP	Detailed Wiring Diagram-WD	BK6V8E
1.14	Instrumentation and Control Document (PCDH Deliverables) (2)	27LH2V		PL	CS	CP	Instrumentation and Control Document	C94MZN
1.15	Instrumentation and Control - Physical and Functional Architecture			PL	CP	CP	Instrumentation and Control - Physical and Functional Architecture	C8D6LA BXQF2A
1.16	Equipment or Component List	See TDTC	PL	CS	CP	UD	Component list	WBXM7R
1.17	Bill Of Material-BOM	See TDTC		PL	CS	CP	Bill of Material - BOM	W9ZCNP
1.18	System Detailed Performance Definition	See TDTC	If U	If U	If U		Technical Requirements Specification	WBYZ5V
1.19	Component Technical Specification			PL	CP	UD	Technical Requirements Specification	WBYZ5V
1.20	Assembly Drawing	See TDTC		PL	CP	UD	Assembly Drawing	CBU322

Appendix 2: Summary of the System Design Documents and maturity at gate (Table 9)

							Isometric Drawing	CBU3LR
							Support Drawing	CBU3KA
1.21	Cubicle Internal Definition	7KLR8R			CP	UP	Cubicle Internal Definition	BK6VFR
2.	**[Definition Justification]**							
2.1	Design Justification Plan	See TDTC	PL	CP	UD		Verification and Validation Plan	WCJ4P2
2.2	Design / Verification Compliance Matrix (DCM/VCM)	473LQM	PL	CS	CP	UD	Compliance Matrix - DCM or VCM or ICM	C7YUNE
2.3	Interface Compliance Matrix	3L775F			CP		Compliance Matrix - DCM or VCM or ICM	C7YUNE
2.4	Functional Analysis Report - FAR	See TDTC	PL	CP	UD		Functional Analysis	WBBZYV
2.5	Structural Integrity Report	35BVV3	PL	CS	CP		Structural Integrity Report	C7ZZBT
2.6	Calculation report (3)	See TDTC			CP	If U	Calculations	C826XY
2.7	Engineering Analysis (4)	See TDTC	PL	PL	CP	If U	Engineering Analysis	C824CS
2.8	Qualification Plan	XB5ABP		PL	PL	CP	Qualification Plan-QP	C94HZF
2.9	Qualification Summary Report for PIC Components	XB5ABP				CP	Qualification Synthesis Report for PIC Component	C94L6Z
2.10	Acceptance Plan (FAT, SAT)	See TDTC			PL	CP	FAT & SAT Plan and Procedure	CBUJD9
2.11	Factory Acceptance Test Procedure	See TDTC				CP	FAT & SAT Plan and Procedure	CBUJD9
2.12	System Commissioning Plan	VVSZNU		PL	CP		Commissioning Plan	WBYPHH
2.13	Commissioning Test Procedure	X8KGJE			PL		Commissioning Test Procedure	WBY7QR
2.14	Requirement Validation Matrix	7WT3PG		PL	CP		Compliance Matrix - DCM or VCM or ICM	C7YUNE
2.15	ROX and Research and Development Report	See TDTC	If U	If U	If U	If U	ROX and Research and Development Report	WCJ2U9
3.	**[Manufacturing]**							
3.1	Manufacturing execution document (manufacturing procedure, test procedure…) (5)	See TDTC				CP	Manufacturing execution document	CBQCMG
3.2	Part Drawing	See TDTC			PL[6]	CP	Part Drawing	WAD9FG
3.3	Manufacturing Process Qualification Records	See TDTC				CP	Manufacturing execution document	CBQCMG
4.	**[Assembly and Installation]**							
4.1	Installation Drawing	See TDTC			CP		Installation Drawing	CBU2MH

Appendix 2: Summary of the System Design Documents and maturity at gate (Table 9)

4.2	Assembly or Installation Plan (*part of Construction Work Package Description-CWP*)	See TDTC		PL	CP		Installation Execution Document	CBUK45
5.	**[Operation and Maintenance]**							
5.1	Concept of Operations	XA95GG		PL	CP		Concept of Operations	WA44CK
5.2	Operation and Maintenance Manual	See TDTC			If U	PL	Equipment Operation and maintenance Manual	WNMXF4
5.3	System Maintenance and In-Service Inspection Plan	See TDTC		PL	CP		System Maintenance and In-Service Inspection Plan	WBZZXJ
6.	**[Decommissioning]**							
6.1	Decommissioning Plan	TYHA8S		PL	CP		Decommissioning Document	WA8RU6
7.	**[Product Lifecycle Records]**							
7.1	Design Plan	U34ACR	S	If U	If U		Design Plan	WBZTQN
7.2	Issue or Risk or Opportunity Analysis Report	22F4LE	S	S	S	UD	Not Applicable	N.A.
7.6	Quality Plan	22MFMW	If U	If U	If U	If U	DA-Suppliers Quality Plan DA Quality Plan Contractors Quality Plan	N.A.

Table 9 – Summary of the System Design Documents and maturity at gates

(1) The maturity for Sub-System Requirements Document-sSRD is Consolidated at CDR and Complete at the PDR

(2) Includes:

- Specifications of I&C controller type (slow/fast), (conventional/interlock, Safety) and network interface configuration. [D5],
- List of signals connected to the plant system I&C including name, type, sampling rate, allocation to I&C cubicle [D6],
- List of the data at Central I&C interface [D7],
- Hardware configuration of I&C cubicles showing the cubicle interfaces with Central I&C infrastructure, buildings, power supply and HVAC. [D8],
- Description of plant system state machines (PSOS) with transitions and state variables. The deliverable includes the PSOS/COS mapping table. [D9]

(3) Document type for final version of Computational Fluid Dynamics-CFD Analysis Report, Contamination Analysis Report, Electromagnetic-EM Analysis Report, Nuclear Analysis Report, Seismic Analysis Report, Structural and Thermal Analysis Report, Functional Analysis Report-FAR.

(4) Document type for any Engineering Analysis such as 0D or 1D Thermohydraulic Analysis Report, ALARA Analysis Report, Analysis Model, Checklist for Analyses or Calculations, Constructability Analysis Report, EEE NRC Analysis Report, Fire Protection Analysis Report, Hazard Analysis Report (HIRA, HAZOP), Human Factors and Organizational Performance Report, Investment Protection Analysis Report, Logistics Analysis Report, Maintainability Analysis Report, Manufacturability Analysis Report, Nuclear Safety Analysis Report, Operation Analysis Report, RAMI Analysis Report - including FMEA or FMECA, Remote Handling Analysis Report, Scoping Calculation Report, Simulation Analysis Report, Task Analysis Report.

(5) Document type for manufacturing input documents such as Calibration Plan (Manufacture), Data Sheet, , List of Manufacturing Tools and Equipment, Manufacturing Flow or Assembly Sequence, Manufacturing Instruction or Procedure, Manufacturing Plan, Manufacturing Process Qualification Report, Non-destructive Examination Procedure, Test Procedure, Training

Appendix 2: Summary of the System Design Documents and maturity at gate (Table 9)

or Qualification Record, Welding Data Input Package (for Manufacture), Welding Map (for Manufacture), Welding Procedure Specification-WPS, Welding Procedure Qualification Record-WPQR (for Manufacture), Material Property Report, Brazing Procedure Qualification Record-BPQR, Brazing Procedure Specification-BPS.

Appendix 3: Documents detailed contents and maturity at gates

For detailed descriptions of the above defined System design documents in Appendix 2 please refer to UID ITER_D_43S7GL