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MQP Level 2

Procedure for Analyses and Calculations

This document identifies requirements and procedures to be respected by all the ITER Project participants for analyses and calculations to ensure an existing, modified, or proposed design of a structure, system, or component (SSC) will meet the ITER Technical Requirements (or a sub-set of them).

Approval Process			
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Read Access	**GG: MAC Members and Experts, AD: ITER, AD: External Collaborators, AD: External Management Advisory Board, AD: Nuclear Safety Inspectors, AD: OBS - Quality Management Division (QMD), AD: DA, AD: Auditors, AD: ITER Management Assessor, project administrator, RO, LG: 5th working group, AD: IO_Director...**		

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Change Log			
Procedure for Analyses and Calculations (22MAL7)			
Version	***Latest Status***	***Issue Date***	***Description of Change***
v1.0	In Work	05 Dec 2005	
v2.0	Signed	08 Dec 2005	
v3.0	Approved	26 May 2008	
v4.0	Approved	23 Jul 2010	The old version has been updated to: - reorganise the document - include more details - improve consistency with other ITER documents. In attached file all modifications implemented are recorded using the track changes tool
v5.0	Signed	27 Jun 2017	The major changes implemented to the last distributed version are: •General improvement of the text; •Change of format and reorganisation of chapters; •A distinction has been introduced between applicable documents and references in chapter 4; •Introduction of flowchart (chapter 6); •Introduction of Appendix 1 with requirements from ITER Order dated 7 February 2012 relating to the general technical regulations applicable to INB; •Introduction of Appendix 2 for the list of related Analysis MQP Level 3 Instructions •The old Appendix on Validation of software is removed as replaced by reference to Software Qualification Policy (KTU8HH) •The old Appendix 2 on Analysis Report (AR) Cover Sheet has been removed
v5.1	Approved	08 Sep 2017	Please find the list of changes that have been implemented with respect to version 5.0 to improve the text and include reviewers comments. Comments from JADA (Neyatani Yuzuru) • Section 5.1: QP for PA can be used as QP for analysis • Section 5.1: Software already available in IO is recommended • Appendix A2: clarified that certification of the performed review is a requirement and the checklists are recommended method to perform it Comments from EPNS (J Elbez) • Chapter 1: reference to doc PQT8AC (framework instruction for safety demonstration to art 3.8 of INB order) is included • Chapter 4: PQT8AC is inserted in ref A3. All reference numbers have been updated accordingly Comments from QA and consistency with new version of MQP template 438T76 • Chapter 4: list of applicable documents and references corrected following QA suggestions • Comments, corrections, and suggestions for QA reviewers to the word document version 5.0 in IDM has been implemented • Chapter 8 with links with other processes and procedure has been introduced • The properties of the recorded documents and IDM types have been defined in chapter 9 Comments from A Guigon: - Made explicit that the procedure applies to analyses performed at system and plant levels - Added references to procedures prepared under design control

			process.
v6.0	In Work	02 Apr 2020	As per approved MQP doc request https://user.iter.org/?uid=YQSUHK the changes are: Appendix 2 of «ITER_D_24VQES - Quality Classification Determination» prescribes, in the first row, «Design controls including design reviews and independent(2) verifications» for both Class 1 and 2 SSCs. ITER_D_R3KD8C, referenced in the same row, mentions 22MAL7 as well. §5: Applicability if Independent Peer Review has been extended to QC2, whereas before it covered only QC1 and PIAs. This solves an inconsistency with Quality Class Determination v3.0 introduced in Dec 2010. §5.3 and §5.4 modified to cover the case of documents reporting on more than one type of analysis. Editorial corrections: improved sentences, added hyperlink to the referenced documents and to the acronyms.
v6.1	In Work	02 Apr 2020	Technical issue, the list of changes of the v. 6.1 is valid
v6.2	Signed	09 Apr 2020	Some minor corrections/typos, the changes for v. 6.1 are valid
v6.3	In Work	12 Oct 2020	This version covers the comments made by the reviewers. The document also implements, under Scope, the sentence that excludes old PAs from the applicability of Independent Peer Review to QC2s.
v6.4	In Work	01 Dec 2020	Updated version under same MQP doc request.
v6.5	Signed	07 Dec 2020	Still under same MQP doc request, technical update of the document with identification of some new changes: - Chapter 2 Scope -- The process has been aligned to the current MQP program, changing from Software Control and Model Development to Digital Models for Analyses. -- Removed the sentence that the requirement for Independent Peer Review of QC2 scope is applicable only to “new” PAs. This is not a new requirement. It was missing in the previous versions of this procedure. - Section 3.1 Definitions: added definitions of Damage, Design and Functional Requirements. - Section 3.2 Abbreviations: added abbreviation for Structural Integrity Report – SIR. - Chapter 4 Applicable Documents and References: -- Replaced reference 22K4QX with 2NCR3F. -- Added reference to Document Management Procedure (22K5JQ). -- Added reference to IO Generic Template (34BAZX). - Section 5.1 Planning and Preparing: -- Changed the requirement to prepare an analysis plan. Now it is stated that the requirements are given in Design Planning Procedure (U34ACR). -- Added the requirement to document the structural strength demonstration in the SIR. - Section 5.2 Performing: Added the requirement of writing an SIR, and that it is prepared regardless the design review phase or quality class of the component. - Section 5.5 Signatures: Updated to match the MQP L3 Instructions and the SOA document. - Chapter 6 Workflow: Updated to introduce the SIR in the process. - Chapter 8 Links with Other Processes: The process has been updated from Software Control and Model Development to Digital Models for Analyses. - Added Appendix C to provide the requirements for SIR.
v6.6	Approved	08 Dec 2020	Technical issue, all changes are listed in the change log of the previous versions
v6.7	Signed	27 Nov 2024	As per communication CS9VQR and tracked changes version the changes are: Nuclear analyses removed out of scope (scope of nuclear safety process)

			Permission to do technical checks and review by the same person added Reorg change: Safety Responsible Officer replaced the role of EPNS representative Reorg change: The roles of SMDA and EVDA removed Reorg change: SCD replaced SCOD Reorg change: Domain or Division Head do not approve structural integrity report Design Coordinator replaced the roles of Design Plan RO, Design Developer, Design Manager and SSC RO Design Approver approves system load specification Chapter Records developed Alignment with MQP template 438T76 Some minor corrections
v6.8	Approved	02 Dec 2024	Technical issue, all changes are listed in the previous revision

Table of Contents

1 Purpose

This document identifies requirements and procedures to be respected by all the ITER Project participants for analyses (see def.) and calculations (see def.) to ensure an existing, modified, or proposed design of a structure, system, or component (SSC) will meet the ITER Technical Requirements (or a sub-set of them).

This document propagates to analysis and calculations, including those that are classified as Protection Important Activities, the safety requirements as defined in the INB Order dated 7 February 2012 [A3] following the framework instruction for safety demonstration to art 3.8 of INB order [A4] in addition to the project requirements for the project investment protection.

2 Scope

This document applies to the ITER Organization involved in the performance of analyses and calculations. It also applies to Domestic Agencies or external contractors who are asked to perform the analysis or calculation task for the ITER project.

This process covers the activities associated with planning, preparing, technical checking (see def.) and reviewing, issuing, and revising analyses and calculations.

This process applies to all types of analyses. Instructions for specific types of analyses (structural, electromagnetic, etc.) provide implementation procedures as well as additional requirements and guidelines or alternative procedures (see Appendix B).

The procedure applies to analyses performed at System and Plant levels.

This process applies ITER-wide to the development of analyses and calculations that are related to all ITER quality class [R1] SSC. Specific requirements for analyses and calculations that are classified as Protection Important Activities (PIA) [R2] are specified. Relaxations of requirements for analyses and calculations performed for quality class 2, 3, and 4 SSC are specified in this document. This procedure is mandatory when any of the following apply:

- They are required or planned to be retained as a design verification and validation.
- They are required to document that an existing, modified, or proposed SSC will meet design or operational requirements.
- They constitute alternative calculations (see def.) for completing design verification of a SSC.
- They are required by other ITER procedures.

This procedure does not apply to:

- Preliminary or scoping calculations that are to be superseded with later analyses.

For preliminary or scoping calculations, the QA requirements shall be defined on a case-by case by the Analysis Co-ordinator (see Section 5.1).

3 Definitions and acronyms

3.1 Definitions

Term	Definition
Alternative (Alternate) calculations	A method of design verification used to confirm correctness of original analyses or calculations. Alternative calculations can be performed using different model(s) or by using different methodologies. Alternative calculations can be performed by the performer of the original analysis or by independent reviewers. As a guideline, alternative calculations are recommended when the calculation models and methodologies are complicated and difficult to be verified. Alternative calculations should also be performed in case of a large relevance to the design justification. Please note that some standards or guidelines use the word alternate instead of alternative. For this reason, in the context of this document, the two words are considered having the same meaning.
Analyses	In the context of this document, the term 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.
Analysis Co-ordinator	An IO staff who represents the IO Responsible Officer in coordinating the analysis of the SSC. She/he ensures the appropriateness and adequacy of requested analyses or calculations, and its completion with respect to time and cost.
Calculations	Quantitative computations to determine the value of a quantity or a physical parameter, such as flow rate, temperature, stress, or neutron flux, performed and documented in forms such as hand calculations, spreadsheets, Math-Cad files, or finite element models and associated computer output.
Calculation software	The computer programs, procedures, rules, and associated documentation and data pertaining to performing calculations using a computer or programmable device. This software includes, but is not limited to, software used in programmable devices such as calculators, purchased (e.g., Math-Cad, Excel, etc.) or site developed software, software layers, macros, routines, operating parameters, or data tables. The data referred to in this definition do not include the input and output data for the subject calculation.
Damage	It means that a part has separated into two or more pieces; has become permanently distorted, thus ruining its geometry; has had its reliability downgraded; or has had its function compromised, whatever the reason. Examples of damages are excessive deformation, plastic instability, progressive deformation, cracking, fatigue, fast-fracture, etc. Please note that some standards use the expressions failure or failure mode instead of damage. In the context of this document, all of these terms are considered as having the same meaning.
Deliverables	All products specified in the technical specifications. They generally include analysis reports, analysis models and specific software for pre or post-processing data.
Design	Ensemble of properties that defines the SSC in terms of geometric features, assigned materials and all those characteristics that will have an impact on the analysis and the application of the relevant design criteria, e.g. weld joint types and examinations.
Functional requirements	The mechanical limits set to guarantee the proper functioning or avoid malfunction of the SSC. Examples: Minimum temperature to avoid the formation of ice, maximum displacement to avoid contact with surrounding structures, minimum resonance frequency of supports to not invalidate pipe response spectrum analysis, etc. Note that

Term	Definition
	sometimes the functional requirements are referred to as service limits or serviceability limits.
Independent calculations	Calculations used to confirm the correctness of the original analyses or calculations performed using a different calculation approach or software carried out by persons who did not participate directly in the performance of the study in question. Note that the same software used on the original calculations could be used for the independent calculations provided the same error (such as an incorrect equation) could not occur in both software uses.
Independent Peer Reviewer	A qualified individual (or team) who performs the Independent Peer Review required by the Analysis Co-ordinator or Requester to identify oversights, errors, conceptual deficiencies, and other potential problems.
Model	The conceptual, mathematical, and numerical representations of the physical phenomena needed to represent specific real world conditions, process, and SSC. A computational model is a numerical implementation of the mathematical model, usually in the form of numerical discretization, solution algorithm, and convergence criteria.
Performer	A suitably qualified and experienced individual (or team) who carries out the calculation task according to the technical specification, performs self-checks and produces the reporting documentation.
Reviewer	An individual or group of individuals selected to verify all or specific aspects of the analyses and calculations. Reviewers are required to be sufficiently qualified by education and/or experience on the specific aspect they have to verify.
Technical Checker	The reviewer performing the Technical Checking (see definition).
Technical checking	A critical review of the analysis or calculation by a qualified individual to verify that the analysis or calculation is performed correctly and that it satisfies the stated objectives. The technical checking includes, among other tasks, a verification that the calculation models are adequate for the purpose of the analysis and the data in the analysis models are correctly implemented.
Validation	In general, terms the validation is the process of confirmation, through the provision of objective evidence, that the requirements for a specific intended use or application have been fulfilled. In specific terms, the analysis model validation is the process of determining the degree to which a model is an accurate representation of the real world from the perspective of the intended uses of the model. This also includes experimental confirmation of some parts of the model or the entire model as required.
Verification	In general, terms the verification is the process of confirmation, through the provision of objective evidence, that specified requirements have been fulfilled. In specific terms, the analysis model verification is the process of determining that a computational model accurately represents the underlying mathematical model and its solution. Verification ensures the traceability of the assumptions and inputs to the model.

Table 1 - Definitions.

3.2 Abbreviations

For a complete list of ITER abbreviations see: ITER_D_2MU6W5 - ITER Abbreviations.
Other abbreviations used in the document are listed in the following table.

A&C	Analyses and Calculations
C-TRO	Contract Technical Responsible Office
DA	Domestic Agency
CAD	Computer Added Design
DET	Data Exchange Task
FE	Finite Element
IO	ITER Organization
PA	Procurement Arrangement
PBS	Plant Breakdown Structure
PIA	Protection Important Activities
PR	Project requirements
QA	Quality assurance
QAP	Quality assurance Program
RO	Responsible Officer (of the system)
SI	International System of Units
SIR	Structural Integrity Report
SRD	System Requirement Document
SSC	System, Structure, Component
TA	Task Agreement
TO	Technical Officer
TRO	Technical Responsible Officer
UID	Unique Identifier

Table 2 - Abbreviations.

4 References

[A1] ITER Project Management Plan (PMP) (2NCR3F)
[A2] ITER Quality Assurance Program (QAP) (22K4QX)
[A3] Order dated 7 February 2012 relating to the general technical regulations applicable to INB - EN (7M2YKF)
[A4] GUIDELINE- FRAMEWORK INSTRUCTION FOR SAFETY DEMONSTRATION ART 3.8 INB ORDER (PQT8AC)
[A5] Requirements for Producing a Quality Plan (22MFMW)
[A6] Overall Surveillance Plan of the Chain of External Actors for Protection Important Components, Structures and Systems and Protection Important Activities (4EUQFL)
[A7] Instructions for ITER System Load Specifications (33TTPJ)
[A8] Instructions for Structural Analyses (35BVV3)
[A9] Instructions for Seismic Analyses (VT29D6)
~~[A10] Instructions for Nuclear Analyses (R7XRXB)~~ [Reference no longer used]
[A11] Instructions for EM Analyses (TSZ9KQ)
[A12] Instructions for Computational Fluid Dynamics Analyses (VUEEDB)
[A13] Instructions for the Storage of Analysis Models (U34WF3)
~~[A14] Instructions for Contamination Analysis (XQVZKS)~~ [Reference no longer used]
[R1] Quality Classification Determination (24VQES)
[R2] Guideline for Identification of the Protection Important Activities (PIA) (SBYJXD)
[R3] Project Requirements (PR) (27ZRW8)
[R4] Design Review Procedure (2832CF)
[R5] Procedure for Verification and Publication of CAD Data (U348ND)
[R6] Load Specifications (LS) (222QGL)
[R7] Preliminary Safety Report (RPrS) (3ZR2NC)
[R8] Accident Analysis Report (AAR) Volume I - Event Identification and Selection (2DPVGT), Accident Analysis Report (AAR) Volume II - Reference Event Analysis (2DJFX3), Accident Analysis Report (AAR) Volume III - Hypothetical Event Analysis (2E2XAM).
[R9] Design Planning Procedure (U34ACR)
[R10] Guideline for Structural Integrity Report (35QTKD)
[R11] Software Qualification Policy (KTU8HH)
[R12] Provisions for Implementation of the Generic Safety Requirements by the External Actors/Interveners (SBSTBM)
[R13] Sign-Off Authority (SOA) for Project Documents (2EXFXU)
[R14] Design Verification and Validation Procedure (R3KD8C)
[R15] Design Development Procedure (U34DDZ)
[R16] Document Management Procedure (22K5JQ)
[R17] IO Generic Template (34BAZX)

5 General Principles

5.1 Planning and Preparing

The Analysis Co-ordinator plans (with support from others as needed) the analysis or calculation and prepares the technical specification that provides all the information required to perform the analysis (the technical specification is not mandatory if the analysis is performed internally to IO). The documentation has to:

- Define the subject of the analysis or calculation pertaining to the SSC.
- Define the SSC categorisations (safety, quality, seismic, vacuum, etc.) that are relevant for the analysis and calculations.
- Specify the objective of the analysis, if it is PIA, its work scope, requirements (including acceptance criteria and standards to be met), deliverables, assumptions, and, as applicable, other controlling documents associated with the analysis or calculation.
- Clearly define the state condition of the SSC, the event and associated load conditions and combinations.
- Specify the format of the reports and deliverables.
- Define the need of a peer review, independent and alternative calculations (see Section 5.4).

The reviewers of input data and deliverables shall be identified, the scope of their reviews shall be defined and the agreement to provide the reviews shall be obtained.

Input design data shall be traceable and retrievable. A way of ensuring proper traceability and link between the design and the analysis is to make use of the CAD Data Exchange Task (DET) process proposed in [R5]. The DET UID can be referenced in the analysis report and in the geometry section of the metadata of the model.

In defining the load specification and combination, the Analysis Co-ordinator shall verify that specifications are consistent with the SRD document and in accordance with [R3], [R6], and [A7]. In case of PIA analysis, all scenarios and conditions considered in the safety demonstration (e.g. RPrS [R7] and Accident Analysis Reports [R8]) that are relevant for the equipment under consideration shall be considered and properly combined with concomitant events.

The requirements for the design planning are given in [R9]. When planning analyses, it should be borne in mind that one of their major objectives is the insurance that an existing, modified, or proposed SSC will meet the functional requirements (see def.) and the required structural strength in respect to the possible structural damages (see def.). This demonstration shall be documented in a Structural Integrity Report.

In preparing the technical specifications, the Analysis Co-ordinator shall ask revision of the document by:

- A competent person from the ITER Safety Department (in case the analysis is classified as PIA).
- The persons responsible of the load specifications of the systems that are under the scope of the analysis.

In case of activities performed under an ITER Task Agreement, or part of a PA, or under direct ITER contract, the DA Task Officer or the Performer's Manager shall provide a quality plan for the analysis or calculation. This shall include the definition of the resources, the personnel

involved and the calculation software (including its validation for the purpose of the analysis) to perform the analyses. The personnel involved include the Performer(s) and the reviewer(s).

The Quality Plan shall be provided in accordance to [A5]. The Quality Plan for the PA may substitute the Quality Plan for the analysis and calculation by mutual agreement between IO-DA TROs.

The personnel performing analyses or calculations shall meet the qualification required for the task to be performed. There are specific requirements for Protection Important Activities that are defined in [A3] (See Appendix A for analysis requirements from INB Order [A3] for analyses). The Analysis Co-ordinator shall ensure that these requirements are met. The IO Analysis Co-ordinator shall inform all external interveners (DA Task Officers, Contractor Managers, etc.) of the provisions required for implementing the INB Order [A3], [A4]. A specific surveillance plan shall be written by the IO Responsible Officer (or the IO Analysis Co-ordinator) in agreement with [A6].

If calculation software (see def.) is used to perform the calculation, a software validation shall be provided to ensure that the software is performing properly for the physical problem associated with the particular application and within the defined limits for each parameter employed.

If an analysis is externalized, the use of software already available in the IO is recommended for cost-optimization (so that the analysis can be directly controlled by IO staff).

The procedure for the validation of the software is provided in [R11].

The Analysis Co-ordinator approves the quality plan.

The Analysis Co-ordinator decides if independent and alternative calculations or verification are needed. This decision is based on the criticality of results, design margin to acceptable or limit values, and difficulties of validation.

An alternative verification can be:

- An experimental test to validate the A&C.
- A calculation performed using an alternative simplified FE model that captures the most important feature of the SSC.
- A hand calculation.
- A comparison of results with previous calculations performed on a different model.

The nature and extent of this verification will depend on the safety-related importance of the study consideration. The verification will take place in the course of examinations carried out by persons who did not participate directly in the performance of the study in question.

The generic requirements for application of the INB Order [A3] to be included in the technical specifications are provided in [R12]. In particular, for Protection Important Activities the surveillance of the activities must be undertaken by the operator according to Article 2.2.2 and 2.2.3 of INB Order [A3].

5.2 Performing

The Performer shall use the appropriate reporting format for the analysis or calculation as defined by the Analysis Co-ordinator or in the technical specification.

The Performer shall use only applicable input data, derived from a valid, referenced source. In case of uncertainties in the input data (non-certified input data) or the methodology, the Performer shall report these uncertainties and the impact on the conclusions. This process may require a range of assumptions and sensitivity studies to evaluate the impact of the uncertainties on the conclusions and the implementation of uncertainty factors on the results. She/he selects and justifies the validity of the analysis method for the specific application.

She/he performs the analysis or calculation in accordance with the requirements contained in the technical specification. The results shall be presented to demonstrate that the acceptance criteria (by IO requirements or selected Standards) are met and safety limits are respected indicating the achieved margins.

The Performer carries out self-checks and sensitivity studies to address potential inconsistencies and errors, to address uncertainties and to check or to demonstrate the accuracy of the results.

If a suspected error is identified in the calculation software or programmable device, the Performer reports it using the internal ITER non-conformance system and as directed contacts the software developer and reports the error.

All analyses shall be performed using the International System (SI) base and derived units. The only exception to this rule is that degrees Celsius may be used instead of Kelvin.

The Performer shall document the analysis (see Chapter 9):

- Including sufficient detail so a person who is technically qualified in the subject can understand the work, review it, and check the adequacy of the results without recourse to the originator.
- Providing all material legibly and in a form suitable for reproduction, filing, and retrieval (electronic documents are preferred).

The analysis documentation shall include the following information, as a minimum, unless an alternative format is specified in the analysis plan and is approved by the Analysis Co-ordinator:

A) Analysis or calculation title
B) Document identifier (including revision number).
C) Performer's name and date of completion (if Performer is not an employee of the company, list the Performer's company name, address, and phone number).
D) Identification of the analysis or calculation subject matter.
E) Purpose of performing the analysis or calculation.
F) Scope and applicability of the analysis or calculation.
G) The safety, quality, seismic, vacuum and other classification as specified in the technical specifications of the SSC and the unique identification of the SSC being addressed.
H) Subject-specific data or other information applicable to the analysis or calculation (such as structural loads and materials).
I) Justification for applicability and adequacy of referenced data used in the analysis.
J) Analysis or calculation inputs and their sources, including the results of literature searches or other background material.

K) Assumptions (including the technical basis), justification for their applicability and use, and, as applicable, those assumptions that must be verified as the design proceeds and which the analysis or calculation supports.
L) Acceptance criteria and references to their applicability.
M) Analysis or calculation details.
N) Conclusions drawn from the analysis or calculation.
O) Recommendations, if any, resulting from the analysis or calculation.
P) References cited by the analysis or calculation.

A Structural Integrity Report shall be written, regardless of the design review phase or quality class, to justify that the SSC meets all the required structural design criteria.

The Structural Integrity Report shall be a different document from the analysis reports used to describe the analyses. It summarizes the assessments covered by one or more analysis reports.

Specific requirements and instructions for Structural Integrity Reports can be found in Appendix C.

If calculation software was used, the following information shall be included in the analysis documentation:

a) Program name and, if applicable, number.
b) Software version.
c) Software tracking number, or include the validation documents as an appendix or in the reference chapter. If validation was done as part of the calculation, include the test problem(s), software validation results, conclusions, and resolutions of deficiencies.
d) State how the server or computer and operating system meet the software's systems requirements.
e) The basis (or reference thereto) supporting the application of the computer program to the specific physical problem.

In case of analysis classified as PIA performed under PA, TA or external contract agreement, the Analysis Co-ordinator shall ensure that regular meetings are organised to monitor the progress and quality of the work performed by the external interveners. She/he shall perform and record surveillance following the specific surveillance plan (see 5.1).

5.3 Reviewing and Technical Checking

The level of rigor that is to be applied during the reviewing or technical checking process is based on the safety class, the safety relevance, and the quality class. More complex analyses or calculations should receive a detailed verification of the technical correctness.

The Contract or Performer's Manager assigns Technical Checker(s) and Reviewer(s) who have not developed the analysis or calculation, but who demonstrate technical expertise relevant to the analysis or calculation being reviewed or technical experience on similar work sufficient to assess the technical adequacy of the analysis or calculation and compliance with design inputs.

The Technical Checker or Reviewer checks the analysis or calculation package for technical adequacy and conformance with project requirements specified in the planning document. In most cases one Reviewer is appointed to verify the accuracy of the analysis procedure (model, assumptions, acceptance or design criteria, loads and boundary conditions, etc.) and a separate

Technical Checker is appointed to verify that the developed model reflects the effective design and that all input conditions are properly referenced and implemented. In general the following checks shall be performed:

- Check that the requirements defined in the specifications are met, including the scope and purpose as defined in the technical specification.
- Check that the calculation model data appropriately reflect the geometrical data and interfaces of the object under investigation.
- Check the basic approach, assumptions, subject-specific data (such as loads), and any equations or formulas applied are appropriate.
- Check that input data[1] are consistent with requirements or validated by referenced sources[2].
- Check the calculations are mathematically correct.
- Check the requirements and acceptance criteria are appropriate and used correctly.
- Check the conclusions reached are reasonable and consistent with the analysis or calculation approach, assumptions, input, and acceptance criteria.
- Check that the software is validated for the scope and purpose of the analysis.

The Technical Check and Review may be performed by the same person.

If alternative calculations are used as a checking method by the person performing the technical checking or reviewing, she/he shall properly document the performed A&C, the results comparison and shall archive the document and developed software and models.

The Technical Checkers or Reviewer shall provide comments resulting from review of the analysis or calculation to the Performer for resolution. Evidence (certificate) of the performed review shall be recorded. The type of checks to be performed depends on the analysis type and the analysis disciplines. Specific checklists are defined by specific instructions for analysis. These checklists provide guidance for an exhaustive and certified general review and technical check. Typically, one analysis or calculation document is expected to report about one or more analyses in one specific discipline (e.g. structural analysis or seismic analysis). When multiple disciplines are covered by the same document, all the applicable checklists for each of the relevant disciplines shall be completed during the review process.

The Performer shall modify the analysis or calculation and documentation as necessary to address review comments, and provide the modified analysis or calculation to the Technical Checker for concurrence.

The Technical Checkers or Reviewers check that the comments have been addressed in the modified analysis or calculation and in the documentations.

The Performer’s Manager or Supervisor approves the deliverables.

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[1] If a calculation has numerous input and output values, the Technical Checker or Reviewer can select a representative sample of the total input and output values for review as appropriate. In these cases, he shall justify the values selected in the review documentation.

[2] All references cited have to be retrievable and applied correctly (references such as e-mail messages and phone call records are attached to the analysis as appendices).

5.4 Independent Peer Review

The intent of the Independent Peer Review is to provide a high-level overview to help identify oversights, errors, conceptual deficiencies, and other potential problems. The Analysis Co-ordinator shall identify which A&C require an Independent Peer Review. When required, the Independent Peer Review shall be organized by the Analysis Co-ordinator.

Independent Peer Review of an A&C is mandatory when at least one of the following conditions is met:

- The A&C is used to justify the final design of a SSC classified as QC1 or QC2.
- The A&C is classified as PIA.

Examples:

- An A&C that is PIA will always need an Independent Peer Review, even if the SSC is at the conceptual or preliminary design stage (this may be the case if the A&C is used to justify safety assumptions).
- An A&C for a QC1 or QC2 SSC in the conceptual or preliminary design phase does not need an Independent Peer Review, unless the A&C is PIA. However, if that A&C is later used to justify the final design of the system, it will need an Independent Peer Review.
- An A&C for a QC3 or QC4 SSC never needs Independent Peer Review.

The Analysis Co-ordinator assigns one or more Independent Peer Reviewers knowledgeable about the subject matter under review.

The Independent Peer Reviewer shall not be involved in the original A&C, in any of its validation, or decision-making related to the original work, and is a distinctly different person than the Reviewer(s). To avoid being influenced by cost and schedule considerations, an Independent Peer Reviewer should not belong to the same company or organisation of the Performer. If the Independent Peer Reviewer is from the same company or organisation as the Performer, she/he shall not be involved in the performance or decision-making regarding the original work.

The Performer shall submit the analysis or calculation documentation and model (as required by the Independent Peer Reviewer) to the Independent Peer Reviewer for review.

The Independent Peer Reviewer shall provide a high-level review of the completed analysis or calculation that includes the following, as a minimum:

A. Design or analysis philosophy is sound.
B. Structural system, materials, acceptance criteria, and other pertinent factors are considered.
C. Analysis or calculation approach is reasonable and appropriate.
D. Inputs are reasonable and correct.
E. Assumptions are reasonably substantiated and justified.
F. Mathematical formulations and/or computer models (see def.) are appropriate and contain sufficient detail.
G. Outputs are reasonable for the given inputs and assumptions.
H. Acceptance criteria used are appropriate.

I. Conclusions are reasonable and representative of the outputs.

NOTE: ***The Independent Peer Reviewer does not perform a detailed check of the calculations because that would duplicate the technical reviewer's function.***

The Independent Peer Reviewer shall provide comments resulting from review of the analysis or calculation to the Performer for resolution. Evidence (certificate) of the performed Independent Peer Review shall be recorded. The type of checks to be performed depends on the analysis type and the analysis disciplines. Specific checklists are defined by specific instructions for analysis. These checklists provide guidance for an exhaustive and certified general review. Typically, one analysis or calculation document is expected to report about one or more analyses in one specific discipline (e.g. structural analysis or seismic analysis). When multiple disciplines are covered by the same document, all the applicable checklists for each of the relevant disciplines shall be completed during the review process.

The Performer shall modify the analysis or calculation as necessary to address all Independent Peer Review comments.

The Technical Checker(s) or Reviewer(s) shall confirm that the analysis or calculation modifications made in response to Independent Peer Review comments did not change the confirmation reached during the technical check.

The Independent Peer Reviewer shall confirm that comments have been resolved.

5.5 Signatures

The requirements for signatures are defined in the present present document, and it is reflected in the Sign-Off Authority for Project Documents [R13].

Performer, Reviewer(s), Independent Peer Reviewer(s) (if applicable), and Performer's Manager shall sign and date the analysis document. Analysis performed and reviewed inside IO shall be signed using IDM. DAs and subcontractors may sign the document using the appropriate spaces on their own analysis or calculation cover sheet.

In case of ITER TA and ITER contracts, signatures of DA TO or Contract managers or other involved personnel shall be required as specified in the contract or TA.

The reviewer's signature signifies:

- Items listed under Section 5.3 have been checked.
- Specific checks according to analysis type and discipline, defined in the appropriate instructions, have been performed.
- If Independent Peer Review was performed, modifications made in response to Independent Peer Review comments did not change the confirmation reached during the technical checking.
- Analysis or calculation complies with the requirements stated in the planning document.

The Independent Peer Reviewer's signature signifies:

- The analysis or calculation satisfies the review elements as specified in Section 5.4.

- Specific checks according to analysis type and discipline, defined in the appropriate instructions, have been performed.

If the Independent Peer Reviewer is a consultant or employee of an organization outside of ITER, a letter or report documenting the Independent Peer Reviewer's concurrence may be obtained in lieu of a signature on the approval sheet. This letter shall be uploaded to IDM in a manner that makes it impossible to modify it at a later stage in an untraceable manner. The way that IO IDM is currently implemented, that excludes uploading the letter as 'attachment' to the report. It is recommended to upload the letter as an attachment to 'comments'. If it is uploaded to IO IDM as stand-alone document, it shall be uploaded as document type "Checklist for Analyses/Calculations". Links shall be made from the analysis report to this letter, thereby making it possible to identify that the review has been performed.

The signature of the Performer's manager signifies:

- Approval of the document.
- Performer, Technical Checker, and Independent Peer Reviewer are qualified to perform their respective functions.
- Technical quality of the analysis or calculation product meets the requirements stated in the planning document.
- Concurrence that the conclusions reached by the analysis or calculation are valid.
- Approval to issue the analysis or calculation (unless the requester's acceptance is required).
- The document has dated signatures of the Performer, Technical Checker, and Independent Peer Reviewer, if applicable, and certification of the performed review (e.g. checklist, review report) is provided.

The ITER Responsible Officer (delegation can be given to the Analysis Co-ordinator) approves the calculation to document that the operational and facility-related assumptions are valid and the results are understood and accepted.

5.6 Revising

A revision to an existing analysis or calculation may be required when a change in one or more of the critical parameters (such as a change in acceptance criteria, operational parameters, or physical parameters) has occurred that potentially changes the results and conclusions reached in the original analysis or calculation.

The Performer:

- Generates a new document (if necessary through a new TA or contract).
- Includes a description of the changes or corrections with other pertinent information, such as a reason for the revision in the analysis or calculation summary.
- Clearly identifies all changes made in the new revision including the reason(s) for the revision.
- Reuses the existing document identifier, and indicate the revision number and, if used, effective date on the cover sheet, even if some pages are not being changed.
- Obtains approval for the revision from the same organization that approved the original analysis or calculation.

- Includes the effects of the revision on the overall previously approved analysis or calculation and on any design based on the analysis or calculation.

6 Workflow

6.1 Flow Chart

The process flow can be different if A&C are performed as part of an ITER PA or TA, or an ITER contract, or by IO member.

Unless superseded by other ITER procedures (TA procedure, QA plans, etc.) the process flow here described applies to all individuals defined in Chapter 7.

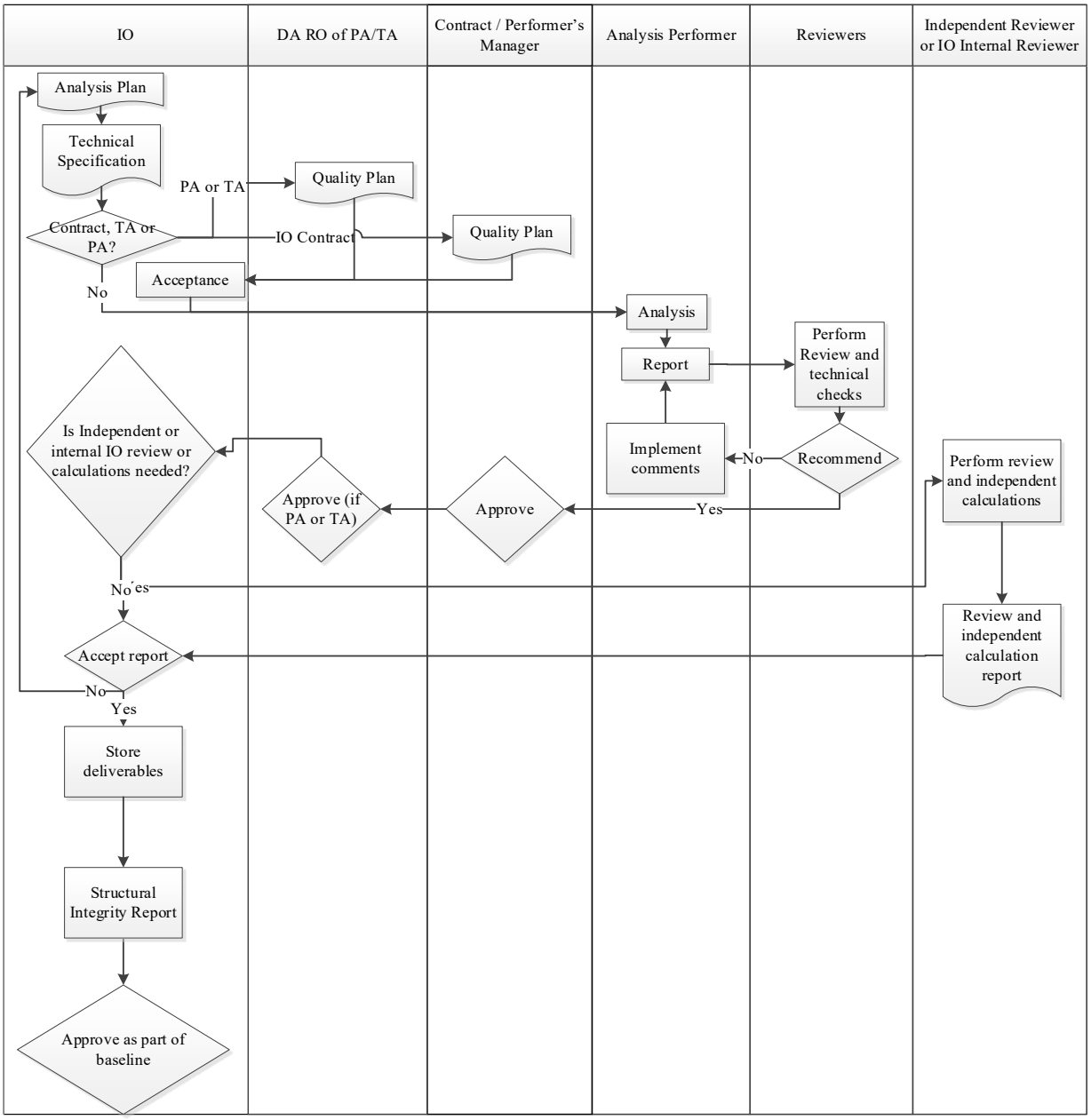

Figure 1 - Process flow chart.

6.2 Description of steps

6.2.1 A&C Performed Under an ITER TA or PA

Actor	Action
IO Analysis Co-ordinator	Define the analysis plan (schedule, cost, etc.). In collaboration with the ITER system RO, ensure that budget for analysis is available. Prepare the technical specification. If the analysis is classified as PIA, ensure that the surveillance plan is prepared and implemented. Provide the requirements for A&C. Provide all the background information required to perform the work. Define the need for an Independent Peer Review and Technical Checking, for independent or alternative calculations (see definitions).
IO TAor PA TRO	Ensure that the TA and PA are consistent with the analysis plan, budget, technical specification, and requirements.
DA TA or PA Responsible Officer	Provide human resources and Quality Plan. Certify that resources are qualified. Provide technical specification in compliance with IO specifications. Provide, in agreement with the Analysis Co-ordinator, the activity schedule.
IO TA or PA TRO	Accept the quality plan from DA TA or PA RO.
Contract Manager	Ensure that resources are qualified. Define Performer(s) and reviewer(s).
Performer	Perform Analyses or Calculations and provide deliverables as specified in the TA or PA.
Reviewer(s) and Technical Checker(s)	Perform Review and Technical Checks.
Performer's Manager	Approve deliverables.
DA TA or PA Responsible Officer	Organise an internal DA review (if necessary). Certify that the deliverables are in compliance with specifications. Approve the deliverables for transmission to IO.
IO TA or PA TRO	Accept the deliverables as compliant with the technical specifications and requirements of the TA or PA.
IO Analysis Co-ordinator	Organise an internal IO review Organise an Independent Peer Review and an alternative calculation (if necessary)
Independent Peer Reviewer(s)	Perform an Independent Peer Review of the Analyses and Calculations.
IO Analysis Co-ordinator	If the outcome of the Independent and internal IO review is positive, accept the report. Otherwise, request a revision of the report.
IO RO	Approve the final product to be part of the ITER baseline documentation.
IO Analysis Co-ordinator	Store deliverables into ITER archiving systems.

Table 3 - A&C performed under an ITER TA or PA.

6.2.2 A&C Performed Under an ITER Contract

Actor	Action
IO Analysis Co-ordinator	Define the analysis plan (schedule, cost, etc.). In collaboration with the ITER system RO ensure that budget for analysis is available. Prepare the technical specification. If the analysis is classified as PIA, ensure that the surveillance plan is prepared and implemented. Provide the requirements for A&C. Provide all the background information required to perform the work. Define the need for an Independent Peer Review and Technical Checking, for independent or alternative calculations (see definitions).
Contract Manager	Provide human resources (Performer(s) and reviewer(s)). Ensure that resources are qualified. Provide quality plan. Provide, in agreement with the Analysis Co-ordinator, the activity schedule.
IO Contract manager	Accept the Quality Plan from the Contractor.
Performer	Perform Analyses or Calculations and provide deliverables as specified in the contract.
Reviewer(s) and Technical Checker(s)	Perform Review and Technical Checks.
Performer's Manager	Approve deliverables.
IO Contract manager	Accept the deliverables of the contract as compliant with the technical specifications of the contract.
IO Analysis Co-ordinator	Organise an internal IO review. Certify that the deliverables comply with the specifications. Organise an Independent Peer Review and an alternative calculation (if necessary).
Independent Peer Reviewer(s)	Perform an Independent Peer Review of the Analyses and Calculations.
IO Analysis Co-ordinator	If the outcome of the Independent and internal IO review is positive, accept the report. Otherwise, request a revision of the report.
IO RO	Approve the final product to be part of the ITER baseline documentation.
IO Analysis Co-ordinator	Store deliverables into ITER archiving systems.

Table 4 - A&C performed under an ITER contract.

6.2.3 A&C Performed by IO Staff

Actor	Action
IO Analysis Co-ordinator	Define the analysis plan. Prepare the Technical Specification. Provide the requirements for A&C. Provide all the background information required to perform the work. Define the need for a peer review and technical checking, for independent or alternative calculations (see definitions).
Performer's Manager	Provide human resources. Ensure that resources are qualified. Define performer(s) and technical reviewer(s). Provide in agreement with the analysis co-ordinator the activity schedule.
Performer	Perform Analyses or Calculations and store deliverables in IO archiving systems.
Reviewer(s) and technical checker(s)	Perform review and technical checks.
Performer's Manager	Approve deliverables.
IO Analysis Co-ordinator	Organise additional internal or external IO review (if necessary). Certify that the deliverables comply with the specifications. Organise an Independent Peer Review and an alternative calculation (if necessary).
Independent Peer Reviewer(s)	Perform a peer review of the Analyses and Calculations.
IO Analysis Co-ordinator	If the outcome of the Independent and internal IO review is positive accept the report, otherwise request a revision of the report.
IO RO	Approve the final product to be part of the ITER baseline documentation.
IO Analysis Co-ordinator	Ensure that deliverables are stored into ITER archiving systems.

Table 5 - A&C performed by IO staff.

7 Responsibilities

Analyses and calculations (A&C) for ITER SSC are performed under different processes:

a) A&C under an ITER Task Agreement (TA) or Procurement Arrangement (PA) with DAs.
b) A&C under direct ITER contract.
c) A&C performed by IO staff.

If A&C are included in a Procurement Arrangement between IO and DA, specific roles and responsibilities will be defined in the PA. The PA shall specify the same level and quality of checking and verification as in the other listed processes.

Roles and responsibilities can be different depending on the process. Main actors and their main roles are in the following list.

IO Responsible Officer (IO RO): Is the person responsible in the ITER Organization for the design of the system (typically is the IO PBS RO). The IO RO corresponds to the Design Coordinator as defined in [R4], [R14] and [R15]. Analyses and calculations at Plant level may be managed by transverse functions or integration activities. In this case, the IO RO is the RO of the transverse function or of the integration activity. The IO RO approves the final product (she/he can delegate this to the Analysis Co-ordinator) to be part of the ITER documentation. She/he is responsible of nominating an Analysis Co-ordinator. In case no Analysis Co-ordinator is nominated, she/he will be acting as Analysis Co-ordinator.

IO Contract Technical Responsible Officer (IO C-TRO): Is the person in the ITER Organization responsible of the contract under which the analyses and calculations are performed. Accepts the deliverables of the contract as compliant with the technical specifications of the contract.

IO Procurement Arrangement (PA) or Task Agreement (TA) Technical Responsible Officer (TRO): Is the person in the ITER Organization responsible of the Procurement Arrangement or Task Agreement between IO-CT and DA under which the analyses and calculations are performed. Accepts the deliverables of the PA or TA as compliant with the technical specifications.

IO Analysis Co-ordinator or Requester: Represents the IO Responsible Officer in interface with the DA Responsible Officer (if analysis is under an ITER TA or PA), or with the Contract Manager (if A&C are performed under an ITER contract), or with the Performer's supervisor (if Performer is a member of IO). She/he ensures the appropriateness and adequacy of requested analyses or calculations. Specifies the requirements for the analysis or calculation. Participates as necessary in planning the analysis or calculation. Verifies that the specified requirements are met, including deliverables. Organises an IO internal review of the final products, an Independent Peer Review and an alternative calculation if necessary. IO C-TRO, IO PA and TA TRO can act as Analysis Co-ordinators in the case of a contract with an external company or a PA and TA.

DA TA or PA Responsible Officer: Is the DA TA (or PA) Officer responsible of the TA (or PA). She/he is the person that assigns personnel involved in preparing, technical checking, and reviewing the analysis or calculation. She/he verifies that the deliverables comply with the specifications. She/he may delegate some or all of her/his responsibilities related to analysis activities to a DA Analysis Co-ordinator.

Contract Manager: Is the person in the company (external to IO and DA) responsible for the contract. She/he provides the resources, provides the quality plan and guarantees that personnel are qualified. Transmit deliverables to IO or DAs.

Performer's Manager or Supervisor: Is the Performer's Manager or Supervisor. As a line manager, she/he ensures the technical quality of the analysis or calculation product, checking that the analysis or calculations have been performed according to the company's processes and that the deliverables comply with the specifications.

Performer: Performs and documents the analysis or calculation.

Reviewer or Technical Checker (see def.): Performs the reviewing or checking function for the analysis or calculation. She/he can be a member of IO, of DA or from the same company of the performer. For Protection Important Activities, the surveillance and checking of the activities must be undertaken by the operator according to Article 2.2.2 of INB Order [A3].

Independent Peer Reviewer (see definition in 3.7): Performs an Independent Peer Review of aspects of the analysis or calculation as it relates to design or evaluation.

8 Interactions with Other Processes

The Table 6 provides the list of documents that are linked to this one, and the reason for the link.

The linked instructions that propagate the requirements from this procedure to different analysis disciplines are listed in Appendix B.

Main reason for the link	Reference
This document requires that software used to run the models for the A&C are validated. The reference provides the requirements for the qualification.	[R11]
This document requires that analysis models are developed based on traceable input data. The reference defines the status of the CAD documents and with DET instruction provides the traceability in relation to the applicability for the use as input data for analysis.	[R5]
This document requires the development of the analysis plan. The reference provides the procedure on how to generate design planning (which includes the analysis plan) for any ITER SSC.	[R9]
The reference provides the procedure for the design development in relation to different phases of the design. A&C are used at every phase.	[R15]
The reference provides the procedure for the design verification and validation. The process of verification can require analyses and calculations. The procedure to be used when performing A&C is provided by this document.	[R14]
The reference describes how to conduct IO Design Reviews on ITER Systems. This document provides criteria for A&C for design reviews.	[R4]
This document provides the input for sign-off authority for documents related to the procedure.	[R13]

Table 6 - Documents that are linked with this document.

9 Records

The Analysis Co-ordinator shall ensure that:

- The analysis or calculation packages are approved (or accepted) by IO as part of the baseline.
- The analysis or calculation packages are uploaded to the ITER document archiving systems in a timely and proper manner, ensuring the correct sign-off authority.
- The documents are deposited in the appropriate location in the IDM folder structure.
- All superseded documents are made obsolete and a record of this is kept with the newly issued document.

Furthermore, the Analysis Co-ordinator shall ensure that the proper document type has been selected in IDM for each document following IO specification. Specific definition of the document types may be provided in the Instructions for specific analysis types (structural, electromagnetic, etc. – see Appendix B). She/he will archive the following:

On IDM:

- The current electronic versions of the documents.
- Electronic copies of supporting computer files, if applicable.
- Other pertinent documents that should be retained.

In the IO Analysis Model Database (see Instruction [A13] in Appendix B):

- All analysis models that support the calculation shall be stored in the IO Analysis Model Database[3] system, including all the specific software and subroutines that have been used to perform the analyses and extract the results.

The analysis report shall include a cover page that provides the following information:

- Identification of the document.
- Title.
- Abstract.
- Signatures of Performer or author, reviewer(s), Approver.

For documents uploaded in IO IDM, these data shall be stored in the document metadata including the electronic signatures. Signatures from individuals who do not have access to IDM can be provided by including scanned copies of signed cover sheets or checklists. These can either be included in the main documents, or can be uploaded to IDM in a manner that makes it impossible to modify it at a later stage in an untraceable manner.

The Analysis Co-ordinator shall verify that all referenced documents are retrievable or in the ITER document archiving system.

Requirements on the content and format of the analysis and calculation deliverables are provided in Section 5.2 and in the Instructions for specific analysis disciplines (see Appendix B).

[3] Link to the root folder of IO's Analysis Model Database: Analysis Database https://user.iter.org/?uid=2LER8C

Templates and checklists to certificate the performed revisions and technical checks are provided for reports and calculations for each specific analysis discipline. Appendix B lists the instructions for analyses in different disciplines.

The retention period may be governed by external standards and regulations. The responsible team in charge of records shall consult Legal, Safety and Quality division to ensure proper definition of retention periods. Typical retention period is up to the end of life of the project.

The following tables lists the documents that provide the evidence of the work performed as a result of the implementation of this procedure, and some important properties.

Record	Author(s) (Responsible)	Reviewer(s) (Consulted)	Approver (Accountable)	Informed
A&C report[4]	See Sections 5.5 and 6.2.	See Sections 5.3, 5.4 and 6.2.	See Sections 5.5 and 6.2.	Safety Responsible Officer in case the A&C is PIA.
Structural Integrity Report	See Appendix C.			
Load Specification	See [A7].			
Quality Plan for analysis	See Section 5.1.			As relevant.
Technical Specification for A&C	See Section 5.1.			As relevant.

Table 7 – RACI matrix for records required by this procedure.

[4] Note that requirements specified in the instructions listed in Appendix B take precedence over the content of this table.

Record	Template	Place to store	Document type	Naming convention	Retention period
A&C report[4] [5]	n/a[4]	IDM[6]	Calculations (9RSR3D, 9RSERS, 9RSHDC)	"Analysis" or "Calculation" and related PBS[4]	Project lifecycle
Structural Integrity Report	4GDQM6	IDM[6]	Structural Integrity Report (9RSRZG, 9RSH2P, 9RSUYR)	"Structural Integrity Report for …"	Project lifecycle
Load Specification	2PW74P	IDM[6]	Load Specification (9RTBK4, 9RRWZM, 9RTHUY)	"Load Specification" and related PBS	Project lifecycle
Technical Specification for A&C	See WBYZ5V				
Quality Plan for analysis	See [A5] and [R13]				

Table 8 - Properties of the records required by this procedure.

[5] It is recommended that A&C reports outside the scope of this procedure are uploaded to IDM using document type "Engineering Analysis".

[6] The Analysis Co-ordinator of each specific PBS and transverse function shall organise in their folders specific areas for the record of the design justification documents that are part of the engineering dossier.

Appendix A Requirements from INB Order [A3]

The following table provides the articles of INB Order [A3] that specify requirements for analyses classified as PIA following the guidelines in [A4]. The table also defines the chapter/sections where these requirements are addressed in the main text of this document.

Article In [A3]	Requirement	Covered by this document
2.2.1	The operator informs all external interveners of the provisions required for implementing the Ministerial Order hereof.	5.1 Planning and Preparing
2.2.2	The operator surveys external interveners.	5.2 Performing
2.5.3	Technical checking.	5.3 Reviewing and Technical Checking
2.5.5	Protection-important activities, their technical monitoring and the checking and assessment actions are carried out by individuals with the appropriate skills and qualifications.	5.1 Planning and Preparing
2.5.6	Protection-important activities, their technical monitoring and the checking and assessment actions are documented and are traced to demonstrate *a priori* and to …	5.1 Planning and Preparing 5.3 Reviewing and Technical Checking 9 Records
	… check a *posteriori* that they comply with defined requirements.	5.3 Reviewing and Technical Checking 5.4 Independent Peer Review
	The documents and corresponding recordings are kept updated, are easily accessible and legible, protected, kept under appropriate conditions and archived for an appropriate and justified period of time.	9 Records
3.8	Use of referenced, updated and validated input data.	5.2 Performing
	Use of controlled assumptions.	5.1 Planning and Preparing 5.2 Performing 5.3 Reviewing and Technical Checking
	Assessment of the uncertainties in input data.	5.2 Performing
	Establishment of a range of assumptions and sensitivity studies when assumptions include uncertainties.	5.2 Performing
	Verification of the consistency with safety demonstration.	5.1 Planning and Preparing
	Establishment of a list of validated and appropriate methods.	5.2 Performing
	Use of methods in their validation domain.	5.2 Performing
	Verification of the methods consistency with safety demonstration.	5.1 Planning and Preparing
	Sensitivity studies to be performed for covering methods uncertainties or additional safety factor in the results.	5.2 Performing

	Use of calculation software in their qualification domain.	5.2 Performing
	Intermediate and final results to be expressed in international units.	5.2 Performing
	The acceptance criteria to be substantiated and checked against potential safety limits and when applicable design margins brought by codes.	5.2 Performing

Table 9 - Compliance Matrix for the INB Order [A3].

Appendix B Instructions and Checklists for Specific Types of Analyses

For some analysis types, specific instructions are prepared to provide requirements and guidelines for the implementation of the analysis requirements.

The Table 10 reports the list of these instructions. Please note that this list is not exhaustive and other instructions may be provided as required. Instructions for thermal analyses are not available. For this discipline, it is recommended to refer to the Instructions for Structural Analyses as a guideline to cover the key aspects.

Ref	Document title
[A8]	Instructions for Structural Analyses
[A9]	Instructions for Seismic Analyses
[A11]	Instructions for Electromagnetic Analyses
[A12]	Instructions for CFD Analyses
[A13]	Instructions for the Storage of Analysis Models

Table 10 - List of instructions for specific analysis disciplines.

The certification of the performed revision shall be provided. The use of checklists is a recommended method to certify the performed review. Different checklists are provided for different types of analysis and are specified by the above-mentioned instructions.

The checklists shall be filled by the reviewers to certify and record the performed review.

Appendix C Structural Integrity Report

The Structural Integrity Report is a document summarizing all the structural assessments performed for a particular SSC, with the goal of:

- Ensuring that the whole SSC meets the required structural design criteria for all the applicable loading conditions and damages (see def.), and respecting all the functional requirements (see def.).
- Certifying that the structural design justification is based on the currently applicable SSC design (see def.), loads and design criteria.

The scope of the Structural Integrity Report shall be described, including at least the detailed definition of the geometry covered and its maturity.

The Structural Integrity Report shall be written in Microsoft Word based on the ITER template for general reports in [R17]. It shall be uploaded to IDM as document type "Structural Integrity Report". For review, approval, distribution and storage, the process described in [R16] shall be followed.

A list of revisions shall be included in the Structural Integrity Report at the beginning of the document unless changes are logged using the in-built feature in IO IDM.

The structural design criteria against which the system structural integrity is verified shall be listed.

All damages and other structural requirements relevant to the SSC shall be justified for all components and loads. This can be done by specific analyses or by reasoning in the Structural Integrity Report.

The Structural Integrity Report shall list all the structural assessments that verify all damages and functional requirements of the SSC. For every structural assessment listed, a description shall be given with information regarding:

- A reference to the related detailed structural assessment/examination test report. References shall be stored and approved following [R16].
- The version of the load specification and of the design that were used as inputs. If those are not consistent with the scope of the Structural Integrity Report, their applicability shall be justified.
- The main conclusions - if appropriate quantitative, e.g. minimum margin(s) to the structural design criteria. In case the structural design criteria have not been met, this shall be stated clearly.

All structural assessments that are missing or are incomplete for the complete verification of all damages and functional requirements shall be listed. No structural assessment shall be missing in the Structural Integrity Report if it is used for the Final Design Review of the SSC.

A guideline for Structural Integrity Reports is available in [R10]. This document offers recommendations on how to prepare this document and meet the requirements listed in this appendix.

The list of reviewers of the Structural Integrity Report shall include:

- The Design Coordinator (see [R4] for details), to ensure:
  - That the scope is correctly defined in terms of geometry.
  - That the list of damages and functional requirements is complete and correct.
  - That the list of design criteria is complete and applicable.
  - That all relevant structural assessments are listed.
  - That the SIR covers the required structural design criteria for all the applicable loading conditions, damages and functional requirements for all parts of the SSC.
- One or more reviewers from any department to ensure the consistency of the Structural Integrity Report with the referenced structural assessment reports, and the correctness of the related conclusion. If some damage or functional requirement is justified by reasoning in the SIR, the correctness of the justification shall be checked.
- The designated QARO to ensure that the QA requirements are met, according to the quality class of the SSC.
- One member of IEA to ensure that the requirements described in this document are implemented in the Structural Integrity Report.
- The Safety Responsible Officer of the SSC, to control the implementation of safety requirements. If no safety requirements apply to the SSCs covered by the SIR, the Safety Responsible Officer review is limited to confirming that no safety requirements apply.
- In case the system is located at least partly within the Cryostat: One member of the Science Division (SCD) as agreed with the head of SCD, to ensure that the structural integrity of the system is verified satisfactorily to allow the envisaged plasma operations.

The approver of the system load specification is the Design Approver, see [R4] for details.

The approver shall ensure that the selected reviewers that review the assessment summaries have the required knowledge and technical expertise to fulfil their duty.