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ITER Engineering Basis Handbook Vol. 1: Genesis, Design and Evolution

Chapter 7 - ITER Design Evolution and Technology Maturation

Section 2 - Project and Configuration Control

CHIEF EDITOR

Dr. Gianfranco Federici

CHIEF EDITOR'S EMAIL

gianfranco.federici@euro-fusion.org

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About the ITER Basis Engineering Handbook

This handbook consists of two volumes which describe the ITER design from its inception up to the design, construction and assembly in 2025.

The handbook is not designed to be read as a continuous sequence of chapters. Instead, it is composed of focused, self-contained sections that address specific topics. Each chapter can be read and understood independently, allowing readers to engage with the material most relevant to their needs without requiring familiarity with preceding chapters. As a result, the reader will find certain overlapping content in chapters.

It is to be noted that at the time of writing, the design for some systems is still on-going. Therefore, the reader should consider that whilst there is significant value of this important point-in-time study, an update would be required as the Project progresses.

A broad Project overview is given in the first volume, to provide the reader with background information necessary to understand the context in the subsequent more-detailed chapters of the second volume, dedicated to the individual systems composing ITER.

For the overall table of contents of the Handbook and to access each one of the chapters, please refer to <https://www.iter.org/scientists/iter-technical-reports>.

Authors and Contributors of this Chapter

This chapter is authored by John How, Bill Spears and Barry Prescott.



Volume 1

GENESIS, DESIGN AND EVOLUTION

Chapter n. 7

ITER DESIGN EVOLUTION AND TECHNOLOGY MATURATION

Section 2

PROJECT AND CONFIGURATION CONTROL

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Chapter 7

ITER DESIGN EVOLUTION AND TECHNOLOGY MATURATION/

7.2 Project and Configuration Control

7.2.1 Introduction: Council and the Baseline

The endorsement by the 2001 ITER Council of the ITER Final Design Report, as a baseline for construction, provided a new beginning for the ITER team. The significant port access reduction compared to the 1998 design required a revaluation of many areas of the project. The team had become rather small, located in Garching and Naka, and each member of the design team carried a heavy responsibility to redesign their equipment within the constraints of the new Project Design Specification (PDS, later renamed Project Specification PS) developed by the Council. This description of scope, schedule, and cost was the basis of the ITER Agreement, owned by the Council, and changes could only be approved by the Council (the so-called level-0 of the baseline). For example, cost evaluation in support of procurement sharing occupied much of the Council and Participating Team Leaders (PTLs) time but had little impact on the IO design team's deliberations at that time. At the next level (level-1) of the baseline were the Design Requirements and Guidelines level-1 (DRG-1) and the Project Description, together with their annexes of Design Description Documents (DDD), Assessment and Background Documents (see Fig. 7. 2-1).

Working versions of these documents were approved by the ITER Director and distributed to the participating teams, but formal approval was only given at the release of the 2010 Council baseline. The master copies of these documents were kept and approval tracked by upper management, while live “drafts” were available to staff for proposing updates. Significant changes went through a formal “Design Change” procedure.

The first major update of the 2001 FDR baseline took place in 2004 in preparation for new incoming senior technical management. At least 30 of the top-level documents (levels 1 & 2), such as the DDDs, were modified to address known issues and were approved by the Interim Director and widely circulated to Interim Council members and Participating Teams. Formally during the negotiation phase, ITER had no possibility to introduce changes, but the updated set of documents was referred to internally as the 2004 baseline for convenience even if it lacked a formal status. By the second Interim ITER Council meeting in November 2007, the participating teams had grown to seven and the Domestic Agencies (DAs) were being established, the site selection had taken place and there were very significant updates presented to Council, though these were again not consolidated into a formal baseline as the new technical management considered the implications of the technical details and licensing in the French setting. A new version of the level-0 Project Specification, outlining scope, schedule and cost, was finally presented and approved by the third ITER Council (IC-3) in 2010, who also formally “took note” of the updated mid-level documents of Project Requirements (formally DRG-1 and then PID) and Plant Description (PD), together with their numerous annexes.

Hence, historically speaking, the ITER baselines are referred to as the 2001 and the 2010 baseline, even though approval was regularly given to most of the mid-level documents by the ITER Director. As an example, the DRG-1 evolved into the Project Integration Document in 2004. The PID went through three major approved updates (Sept.2004, Sept 2005, and Jan.2007 before being rewritten as the Project Requirements (PR) for the IC-2 and IC-3.

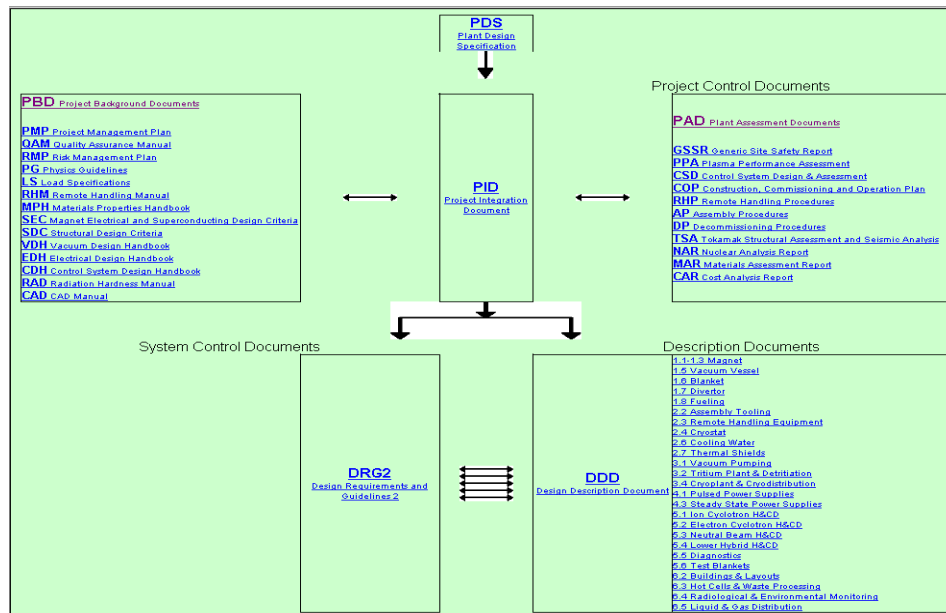


Fig. 7.2-1 The Top Levels of the ITER Baseline 2004 (from the Technical Web Site)^[1].

Between 2001–2002, under DG Aymar, Garching and Naka IO staff worked on the redesign of the generic site and machine, and ten Technical Coordination Meetings (TCMs) were held in Garching, with rudimentary online telecommunications with Naka, for the technical discussion and approval of the new design features (See section 7.2.7.1). 2003–2005 saw a major increase in resources with the addition of new ITER members. This created new challenges that were not addressed by the Council, and whose implementation was left up to the ITER Director. These challenges were firstly, the diffusion of information to a team working across the world, and secondly, the structure and management of the team, with its new wider involvement, together with the necessary meetings to propose and approve advances in design.

In June 2005, the decision was taken to build ITER in Cadarache, and the Joint Work Site was established there in early 2006, with the official creation of ITER Organization in January 2007. By the time of IC-3 in 2010, the baseline had significantly evolved and was more specific and targeted, reflecting the transition to a construction project from a design project. Fig. 7.2-2 shows the status of the baseline at the 2010 Council meeting:

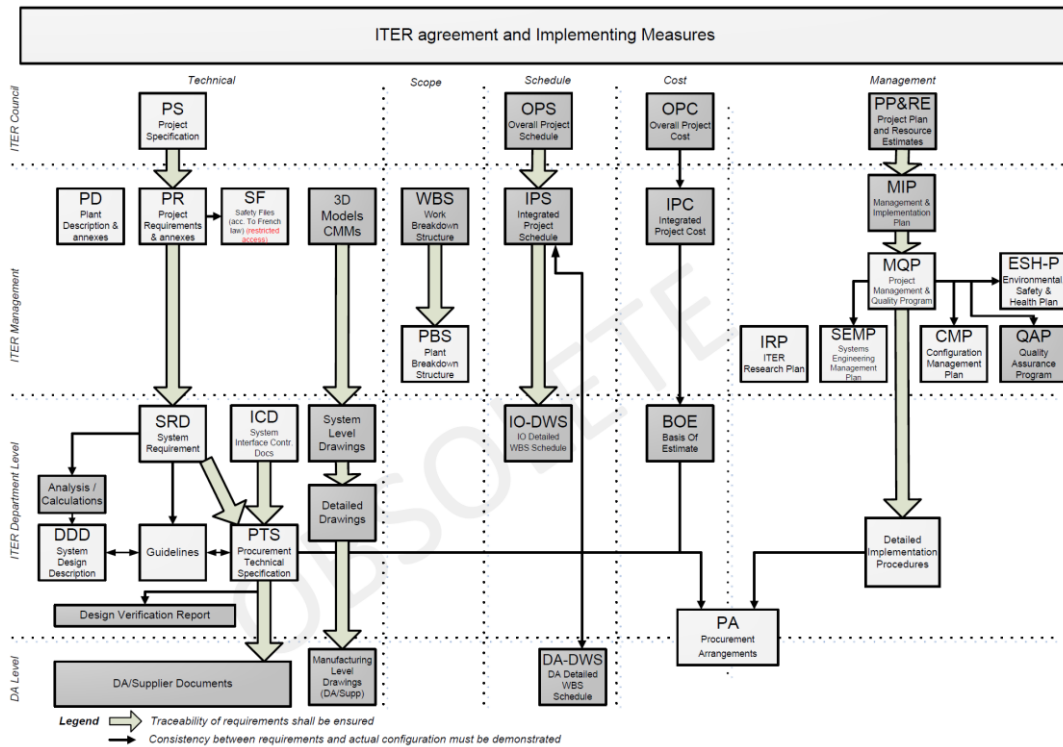


Fig. 7.2-2 ITER Baseline Chart from 2010^[2].

At the top level-0 of “Council-Owned Documents” instead of just the PS-Project Specification, three more documents were created — the OPS-Overall Project Schedule, the OPC-Overall Project Cost, and PP&RE Project Plan & Resource Estimate. The developmental changes and additions to the Project Specification^[3] were as follows:

- (i) the concept of First Plasma is included;
- (ii) the aim of the hydrogen phase is defined in terms of the requirements to assure satisfactory commissioning of all (non-nuclear) systems with plasma;
- (iii) the sections relating to the ITER Design Principles and Engineering Design have been integrated and updated to provide an improved description of the important design principles for all key elements which will ensure high availability, reliability, maintainability and safety of the ITER device;
- (iv) safety requirements are limited to high level considerations, since the Project must meet French licensing requirements — detailed aspects of safety implementation are provided in the Project Requirements;
- (v) following selection of the Cadarache site, site specifications have been removed and replaced by a brief statement of site capabilities, including reference to the relevant design documentation;

- (vi) in line with the structure of the ITER Project Baseline Documentation 2007, considerations of Cost and Schedule are now dealt with in the Overall Project Schedule and Overall Project Cost documents.

At the level-1 ("owned" by the DG but endorsed by Council), the PID was replaced by the Project Requirements (PR) and Project Description (PD). There are 10 new level-1 documents in the baseline chart (Fig. 7.2-2) included to cover the needs and expanded structure of the growing project.

At the 2&3 levels of the baseline chart (controlled within ITER Integration) the evolution of configuration management's application to the detailed design can be clearly seen in the baseline chart of Fig. 7.2-2 above.

This baseline structure served the project well, and was understood by all, down to the lower levels of detailed component design. The biggest changes to the baseline over the ensuing years were the necessary inclusion of the safety case with the French Autorité de Sureté Nucléaire (ASN). The charts in Fig. 7. 2-3 and Fig. 7. 2-4 show respectively the document hierarchy of the Baseline 2016 and the detailed content of the top 2 levels (charts published^[4] 2019). Note that these charts, with links to the current ITER baseline documentation, are available on the present ITER Technical Web Site. One can see the correspondence between the 2010 baseline chart above (Fig. 7.2-2) and the new pyramidal structure presented from 2016 onwards (Fig. 7. 2-3 and Fig. 7. 2-4). The ITER Council Framework in Fig. 7. 2-3 corresponds to the top level-0 in Fig. 7.2-2. ITER Project Top Level Requirements in Fig. 7. 2-3 correspond to the level-1, "ITER management" in Fig. 7.2-2, etc.

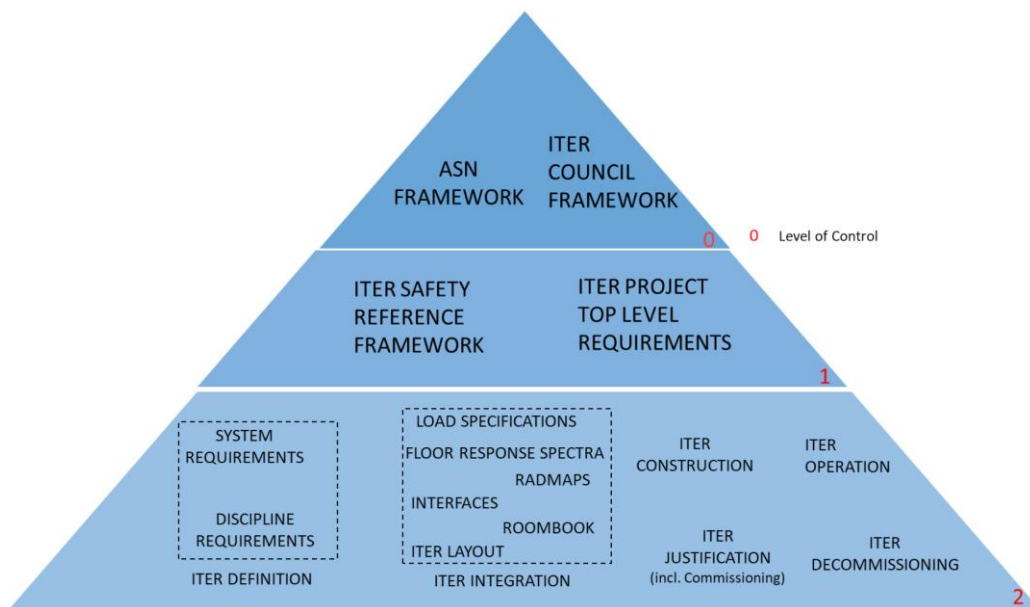


Fig. 7. 2-3 Documents map of the Baseline 2016.

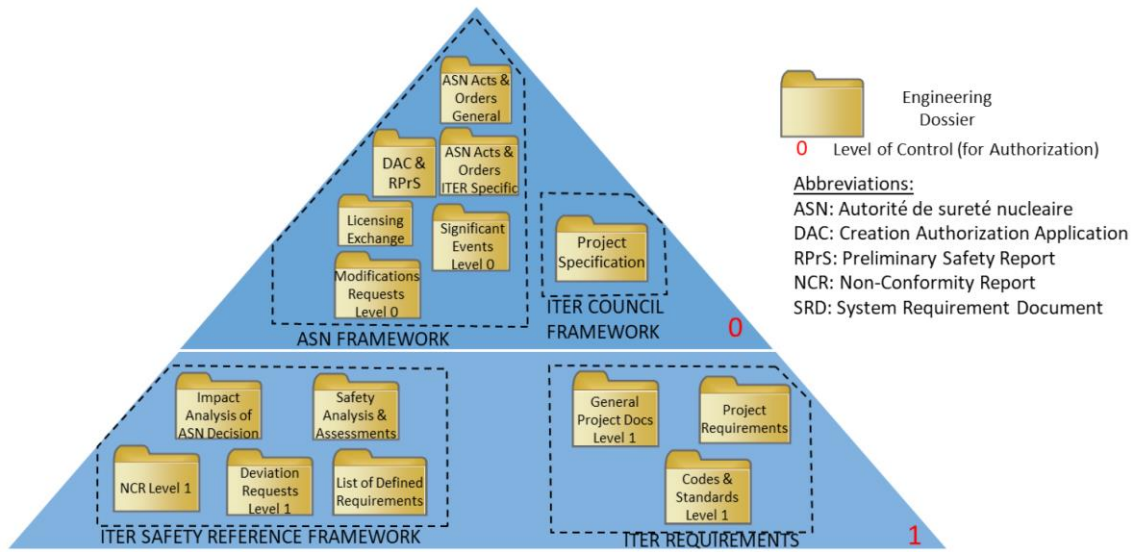


Fig. 7. 2-4 Detailed content of Levels 0 and 1 of Baseline 2016.

The responsibilities for the management of the baseline in the period 2023–2025 are shown in Fig. 7. 2-5 from 2025. As before, the level-0 is owned by Council, the next level by the DG, in consultation with the Executive Project Board (EPB) and the level-2 is the remit of Central Integration Division.

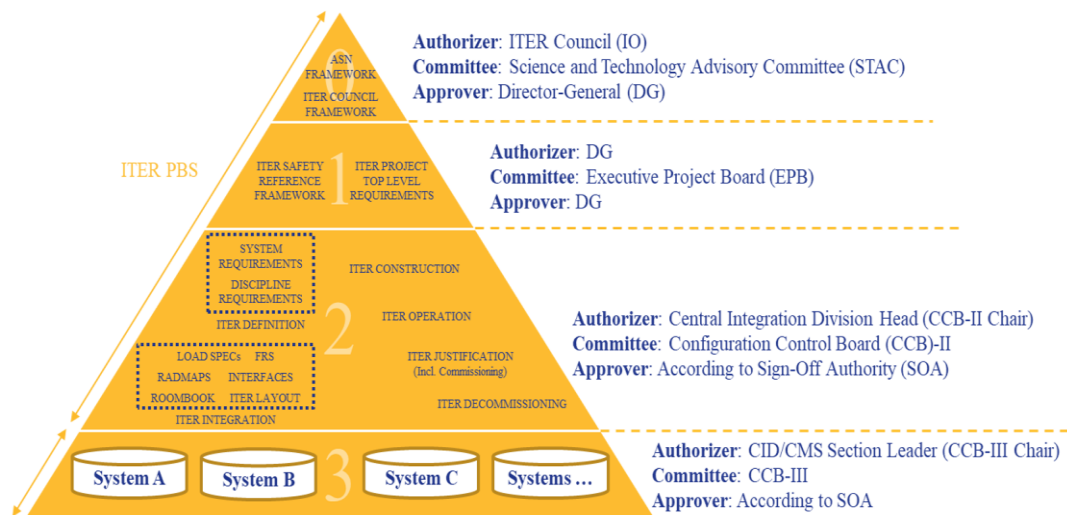


Fig. 7. 2-5 ITER Technical Baseline Management 2025^[5].

7.2.2 Project Integration Document (PID)

Between 2001–2003, there was a substantial effort to update the main DRG-1 (Design Requirements and Guidelines) to the parameters required for the reduced ITER-FEAT machine. However, the resulting document provided insufficient context to understand the sources of the

requirements or the key drivers for some key architectural choices and did not help the process to finalize the interfaces among different areas under different Work Breakdown Structure (WBS) designations. The difficulty that staff encountered while working with DRG-1 parameters was understanding why these parameters had been accepted, and what impact would occur if they were changed. The full impact of changing a parameter, either to the system or to other systems, was not evident. Further, the Plant Description Document (PDD) did not keep up with the rapid changes of design necessitated by the design reduction to ITER-FEAT. Hence in 2003, an amalgamation of the DRG1 and the PDD that were prepared for the 2001 Final Design Report was proposed, with later addition of the Plant Safety Requirements (PSR). The aim was to collect together all the top-level design parameters (as in the DRG-1) but also explain the rationale behind these numbers and tables and additionally provide a comprehensive description of the machine architecture and the characteristics of its main parts, to help the designers in the assessment of the impacts in case of changes and definition of interface requirements. The first edition of the new PID (Project Integration Document) in September 2004 proved extremely popular and revealing. Not only did it highlight numerous inconsistencies but also led to major discussion about design solutions, with many workshops formed to investigate design choices.

A copy of the then current “annotated” PID was kept on the restricted technical website (see below), with proposals and discussions shown within the pages, with highlighted red and yellow sections for update-consideration. A second PID version was released in September 2005, and a version showing the change tracking was also stored. Likewise, a third version was approved in January 2007. The PID was fully supported by the ROs, with regular text clarifications and requirement queries. The working draft kept highlighted notes and queries for clarification, and approved Project Change Requests were immediately added to the draft. This PID approach has been adopted by other projects (e.g. since 2007 in JT-60SA) to control requirements propagation and interfaces.

In 2007, advice was sought from key European project managers whether this integrated consolidation of requirements and description (PID) was acceptable to the construction industry, instead of the usual separation of requirements and description. In Europe, it was deemed acceptable due to the first-of-a-kind nature of ITER. However, as the Project moved towards the start of the construction, with the progressive issue of Procurement Arrangements that transferred responsibilities of the design from the central team to the Domestic Agencies, there was a strong request, in particular from the US DA, for a comprehensive system to manage the Design Requirements, including the separation of requirements and plant description. Hence in early 2009, the PID was again separated out to a new edition of the Project Requirements (PR), and the description was re-released in the form of a major manual; the “Plant Description” (PD) of October 2009^[6], for inclusion in the 2010 baseline.

Subsequently, although IO Systems Engineering Unit concentrated on the management of Project Requirements, there were insufficient resources to maintain the Plant Description within the

Baseline. Hence the PD was removed from configuration management and has not been updated since this time. Instead of which, the project relied on the Systems Descriptions Documents (SDDs), together with the drawings, models, specifications, bills of materials etc; these documents are strictly controlled and any approved change to them is immediately communicated to those that use them as input. Nevertheless, there have been over 1000 PCRs issued since the PD was released, and any future baseline should reflect these in the PD and SDDs.

7.2.3 Dynamic Object-Oriented Requirements System “DOORS”

As an alternative approach to ensuring that requirements were respected, their tracking via database was considered. This needed the selection and implementation of commercial software to reference the requirements contained in the PS and PR down through the System Requirements Documents (SRDs) together with sub-system and annex documents, with verification checking at the formal design reviews (CDR, PDR and FDR). With most of the procurement for ITER being in the hands of the Domestic Agencies and their industries, with very wide cultural and engineering backgrounds, it was not possible to extend the use of requirements software into the DAs as would normally be done in other major projects. In any case, at that time the ITER Procurement Documents (both conceptual and build-to-print) were fundamentally regarded as collaboration protocol documents that stated the scope of the delivery and the main conditions and were to be used to manage the further detailed design work to be done by the DAs and IO to produce contractual procurement documentation. SRDs were included in the final signature of some Procurement Agreements, and so these carried the design requirements with them as applicable documents. Changes were managed through PCRs and propagated to the DAs via amendments to the PAs. The DAs were responsible for the flow down of requirements to their procurement contracts with industry.”

In an attempt to regularise this approach, a pilot project had been introduced in 2007 using the “IBM Rational” (formerly Telelogic) utility, DOORS (Dynamic Object-Oriented Requirements System), for this work, since it allowed linking of requirements in individual document paragraphs (i.e. PR and SRDs) via a database. This system was routinely in use in industry (for example, in the USA, NASA used it to track the propagation and achievement of the requirements from the top-level General Requirements down to the procurement specification and contract requirements at component levels).

At ITER, by the time the top-level PS, PR and system level SRDs had been fully implemented in DOORS a large part of the Procurement Agreements documents had already been issued and signed by the Parties. Application of DOORS in ITER was thus limited to supporting the IO in its responsibility of integrator of the project rather than to track the full propagation of the requirements. Some systems Responsible Officers (ROs) were trained in the use of DOORS, and the system was particularly beneficial in preparing the design reviews (CDR, PDR, FDR). Independently, the European DA (F4E) was the only DA to adopt DOORS (not linked to the IO

version), and considerable resources were allocated. By 2016 F4E had ~450 specification documents, 52,000 requirements and 2,200 deviations handled in DOORS, with considerable investment and many staff and contractors trained in their usage.

The early use of DOORS within ITER provided useful experience, while also highlighting several practical areas requiring further adaptation to project workflows. The editing in DOORS was rudimentary, and line-editor text-based; either the RO typed the modifications directly into DOORS, or as edits to the previously exported Word document which was then emailed to the DOORS RO to input. Thus, most system ROs chose to ask the DOORS RO to input their data for them, and they did not see much benefit from the effort.

Furthermore, ownership of the software changed, and ITER usage evolved. In 2016 the database was moved to the IDM-RMF ("Requirements Management Framework") system with further disruption to the programme. Currently (2025), efforts are underway to move the database to the in-house ITER Collaborative Platform (ICP) independent from external influence and contract restrictions (see Chapter 8.3.2). ICP is also becoming much closer linked to the DA computer platforms with further added benefit, together with opening new opportunities for cross-referencing of ITER Design Parameters

7.2.4 ITER Technical Web - the Key Information Source

When Yasuo Shimomura was appointed Interim Director in 2003, there was a high-level request from the Participant Team (PT) Leaders to improve the transparency of ITER meetings and to make all documentation available, including the presentations of the Technical Coordination Meeting (TCM) and Design Review Meetings (DRMs) described later, in line with the sharing principles of the ITER Agreement. Up until mid-2003, the ITER documentation was stored in an Apple Hypercard IDoMS database, with much of the lower order detailed documentation stored in the restricted areas of the WBS responsible officers, on shared servers synchronised daily between the Joint Work Sites.

At that time, discussion about a new central documentation database began, to replace the evidently obsolescent IDoMS, that could be extended to the CATIA Drawings and the workflow tracking throughout both the construction and the entire life of the machine. However, having dismissed the capability and liability of commercial systems for this long timescale purpose (see also Chapter 6), the decision was taken to develop an ITER document management (IDM) system "in-house". Nevertheless, it was recognized that such a system would take at least a year to implement. Hence, the ITER Design Integration Section proposed a series of temporary low resource solutions to meet the needs of the project, whilst aiming at more sophisticated major utilities in the longer term.

During that period there was a major push to improve remote participation in telecommunications and meeting management. Europe (through the European Fusion

Development Agreement (EFDA) and its already developed and distributed programme of participation in JET) had a “Remote Participation” programme with two permanent coordinators connecting all the many European fusion sites via the DFN (Deutsche Forschungsnetz). ITER adopted many of the lessons learnt from that effort and the utilities used. Remote Participation servers were set up in Garching allowing instant live access to meeting presentation screens, and video conferencing was provided for participation, always with conference telephone backup to cope with the then unstable international network outages. Citrix servers were set up in Garching, and later Cadarache, allowing international users to log-on directly to Garching and Cadarache computer networks (the Citrix system shared only the screen with the remote user and hence was considered a secure and centrally controllable facility). In the 20 years since 2004, the international networks and video conferencing utilities have dramatically improved and are incorporated in many commercial packages (e.g. Microsoft SharePoint) so most of that pioneering work is now obsolete, but ITER certainly “led the way”!

At the heart of the daily ITER work management tools, a new *ITER Technical Web* was created in 2003 encompassing the existing baseline web (www.iter.org/bl) with new sections for information:- diary, meeting interface, work breakdown, abbreviations, time zone calculator, user directory, video-conferencing booking, and more (Fig. 7. 2-14). This ITER Technical Web was intended to answer the daily needs of the ITER workflow. For a short time, until IDM became operational, all daily work documents were temporarily stored on the new web server in Garching. All documents could be accessed via simple HTML web pages with document links. The Technical Web was managed for five years by the Design Integration group within the ITER Project Office.

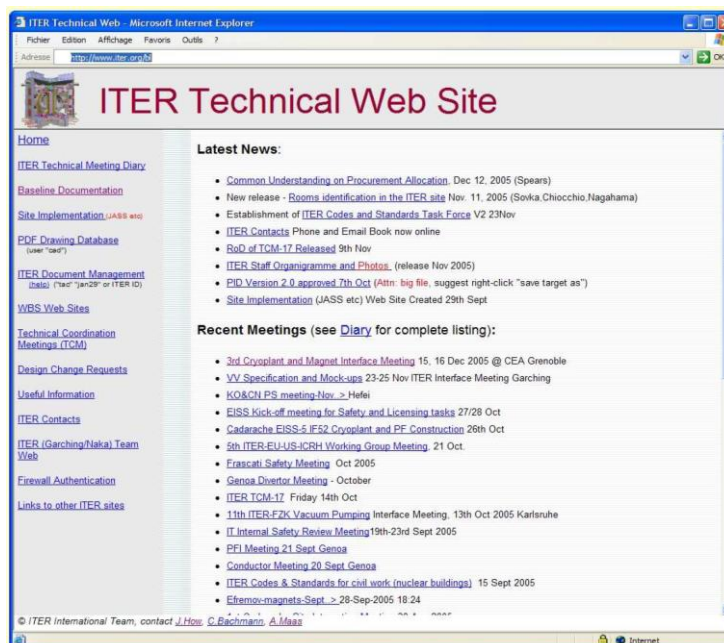


Fig. 7. 2-6 The ITER Technical Web – Front Page – 2005.

Access to the ITER baseline was a prominent part of the Technical Web, and initially all documents were stored in the web server. The baseline access web pages were written to mirror the frozen baseline chart shown in Fig. 7. 2-1. However, it was decided to also maintain a “Current Baseline” web page (including the partial baseline update from the 2004 FDR through to 2010) showing updated baseline documents that were approved by the ITER Director but waiting endorsement by Council. The Council-endorsed baseline pages carried only frozen PDF copies of the documents, whilst the “current baseline” showed both PDF and the raw editable binaries (e.g. “Word” files) that Responsible Officers (ROs) could download and update to propose changes.

It was also recognized in 2003 that Technical Coordination Meeting discussions took some time to digest, especially for the new Partners, so detailed minutes and a Record of Decisions (RoD) were produced including hyperlinks to presentations, and a webpage was created devoted to each meeting. The minutes and RoD of each meeting were circulated to all partners inviting comment before signature by the ITER Interim Director, and an important subset of the ITER Technical Web was devoted to following the TCM evolution.

The Technical Web structure was very simple, with pages being written in raw HTML without database tools. It was intended as a low resource “stop-gap”, and it was always recognized that it would be replaced by more sophisticated integrated utilities when more resources became available. In the meantime, there arose an urgent need for database management tools, such as Action Tracking, Design Change Requests and Issues Management. Another stop-gap low-resource solution was found, using Microsoft’s Access database application. The key elements in the Access database were classified by WBS numbering, later moved to PBS (Project Breakdown Structure) numbering, and all elements such as Responsible Officer names, action titles, Design Change category, etc., were linked to the master WBS list. The advantages of this system were that it allowed hyperlinks into the web site and emails and was very flexible in accessing subsets for particular lists (e.g. status of Design Change Requests (DCRs)). Again, the disadvantage was the time-consuming expert maintenance required.

The simple ITER Technical Web structure proved very effective, such that within a year it was holding information for hundreds of ITER meetings, and thousands of

DI-DO Meetings

The Design Integration – Drawing Office (DI-DO) regular meetings were a very efficient part of ITER life at the Cadarache site after 2006. It was at this meeting that all the detailed designs were presented, and integration and interface issues considered. This was the place where design maturity was advanced up to the point where an independent design review was held to give each design the go-ahead. The meeting worked closely with the Change Control Boards (see 8.3.2.1.3) for any significant changes. The agenda reviewed the outstanding Issues and Design Change Requests.

Pre-2006 these responsibilities were handled by TCM, but this became impracticable with the rapid growth of the project.

documents, well-structured by meeting titles and ITER WBS standards, with a major “DI-DO” section from the Design Integration and Drawing Office (see box). Security access to the Technical Web was changed to named users instead of the generic user and password system. Named access allowed for restricted access to certain areas, as agreed with the Director and PT Leaders. Maintaining the personnel access name lists was a challenge. It was agreed that the PT Leaders could provide the list of access names for each partner provided these were reviewed by management once per year. Of course, these lists were used as the user templates when IDM was fully implemented.

By late 2004, the first implementation of IDM was in place, and the long job of moving all the documents stored in the Technical Web was undertaken. Not only did the documents have to be moved to IDM but the links embedded in the meeting minutes and webpages had to be copied across to IDM. This migration problem was foreseen some years before but recognized as inevitable. The baseline documentation from the 2001 FDR in IDoMS and the then current baseline stored on the web were given priority to migrate to IDM. This was closely followed by the move of all documents and presentations for all TCMs and the other main top-level meetings, but the job proved too exhaustive for every single meeting. Hence to maintain an historic archive, an image of the whole technical web was stored, and the technical web was maintained for continuity. A similar strategy was used with a mass upload of IDoMS to IDM in 2005–2006, allowing later cleanup. As of 2025, some cleanup activities associated with this large historical archive migration remain to be completed.

As soon as the skeleton staff and management structure of the ITER Organization was established in temporary buildings on the Cadarache site in late 2006, even prior to the formal establishment of the ITER Organization, the ITER Director-General and the PDDG began regular reporting of progress to the stakeholders at the top management level^[7]. These reports gave monthly insights on the work going on within each project division, and reported the state of budget expenditure, staffing, accommodation, and the progress in earned value overall. The Monthly Report continued to be a visible window to life at ITER until June 2010, informing IO and DA senior management about project progress.

By late 2007, the rapid growth of the ITER project required a more scalable information-management platform than the original Technical Web structure, so after five years of intensive use, a new web structure based on Microsoft SharePoint was installed, which would allow distributed upkeep by the WBS officers and divisions. In 2008, ITER made the transition from a simple HTML web structure to SharePoint to manage the growing project's needs (Fig. 7. 2-7, Fig. 7. 2-8, Fig. 7. 2-9). **A full-time webmaster was appointed, with each division nominating a local web manager.** SharePoint's flexibility allowed groups to publish content, collaborate, and consolidate data from disparate sources, addressing challenges like knowledge loss, difficulty finding information, and duplication.^[8]

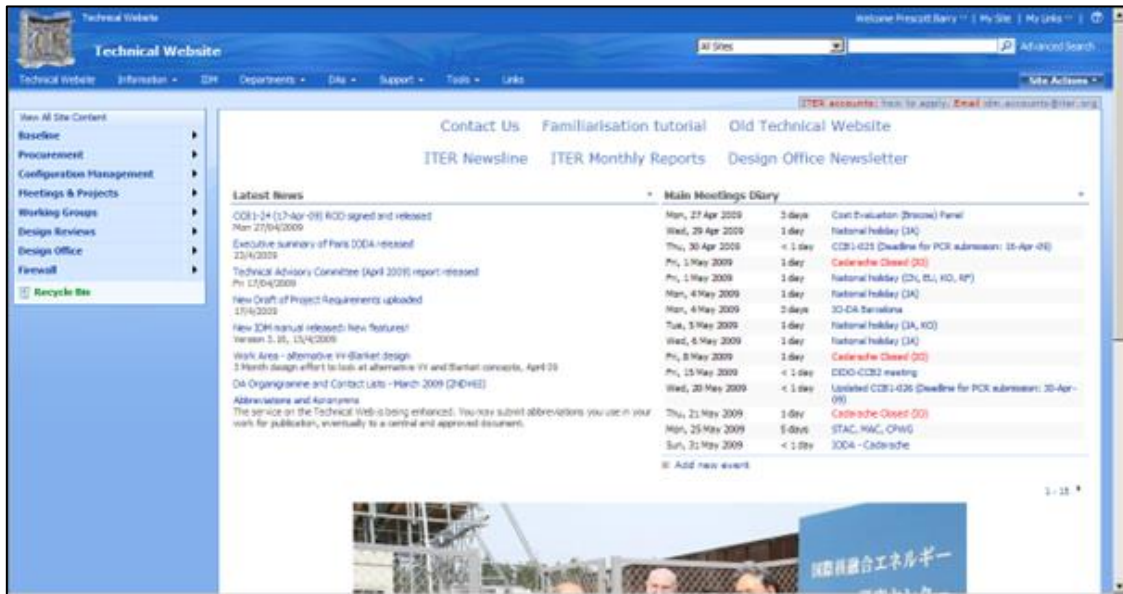


Fig. 7. 2-7 TechWeb front page 2009.



Fig. 7. 2-8 Tech Web Front page 2010 with navigation elements to other intranet portals

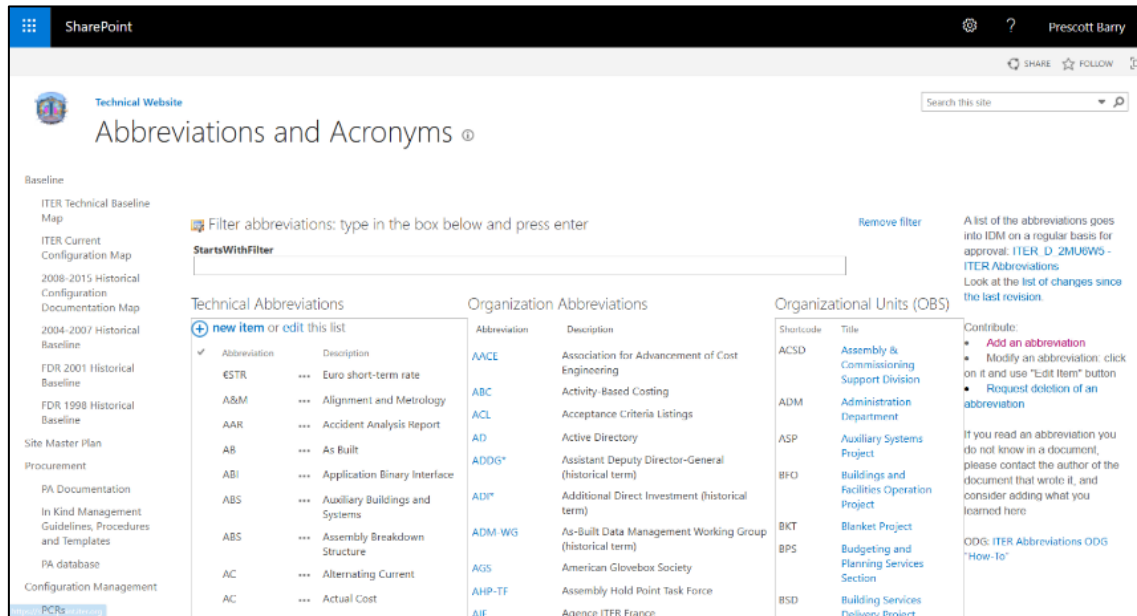


Fig. 7. 2-9 The Abbreviations page in 2025 is a valuable reference consulted daily by ITER project collaborators.

SharePoint provided a central and searchable platform to share technical updates, departmental progress, and project news, along with tools for calendars, task tracking, and document workflows integrated with Microsoft Office. It enabled better data management by replacing spreadsheets with centralized lists, demonstrated by a successful pilot project in the Diagnostics Division, which improved data quality and workflow control.

Challenges included a steep learning curve for content authors unfamiliar with SharePoint tools and workflows, and technical limitations in storing large datasets, list performance, and connecting data across sites without custom solutions. Despite these issues, SharePoint significantly improved collaboration and data sharing, serving as a temporary solution while ITER developed a dedicated Engineering Database system. The Engineering Database (EDB) project which was implemented alongside and linked to IDM in the ITER Collaborative Platform (ICP) aimed to create a centralized repository for ITER engineering data and processes. It was designed to manage historical, current, and planned data, enabling quick design processes and facilitating data exchange between systems. The EDB focused on managing Product Breakdown Structure (PBS), Geographical Breakdown Structure (GBS), and System Breakdown Structure (SBS) data, as well as interface management, 2D/3D navigation, CAD data visualization, and design review management. The project involved integrating and enhancing existing software tools such as ENOVIA V5, ICP, Primavera, and DOORS (see 8.3.2.3).

Whilst keeping SharePoint for document collaboration in the 2010s, the IO started to transition to Atlassian Confluence with its lower learning curve for creating webpages. When, by the end of the 2010s, ITER needed a robust organizational framework to enhance collaboration, the transfer of expertise, and to improve knowledge sharing of “Lessons Learned” among its members^[9] a

novel framework, consisting of four-pillars and implemented in Confluence, was created as the platform for knowledge transfer (see Fig. 7. 2-10). For a first-of-a-kind megaproject it was crucial to take advantage of detailed lessons learned and to ensure the organization habitually documented them. (The IO “lessons learned” database is mainly focused on the detailed design and construction, whereas those covered in Chapter 10 of this handbook address global observations, with little overlap with the IO utility.)

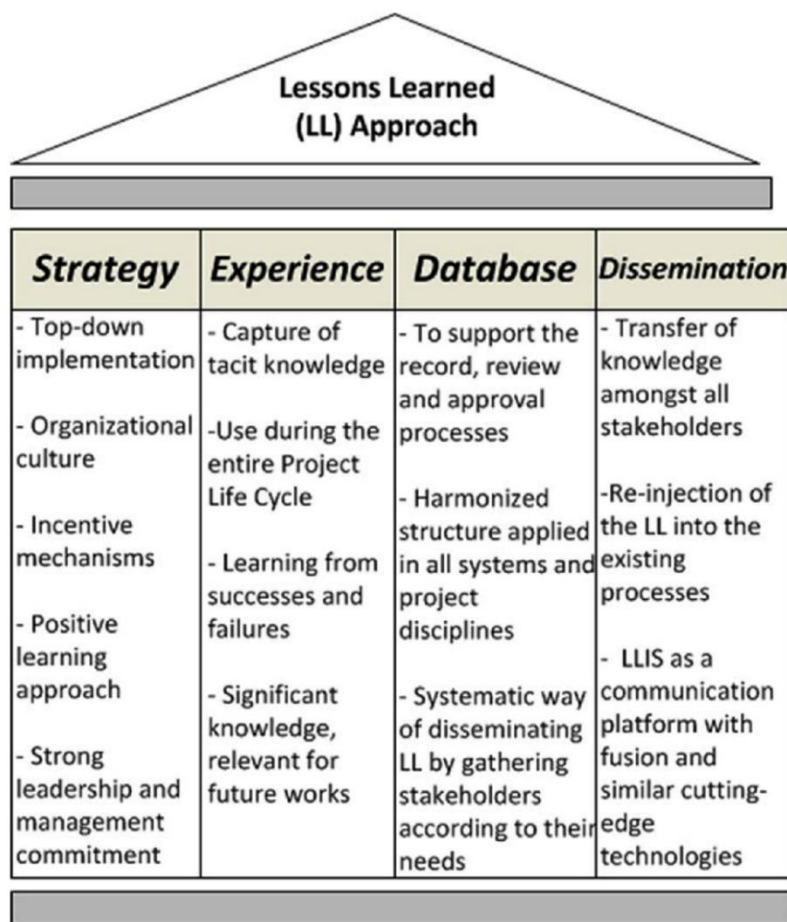


Fig. 7. 2-10 The Four Pillars of the ITER “Lessons Learned Information System (LLIS)” Project.

The need to choose a new collaboration framework was rendered more urgent in the 2020s when the IO began to transition to cloud computing with Microsoft Teams replacing earlier integrated communication systems (Skype for Business). Presently, in 2025, the SharePoint on-premises content is being migrated to Teams and SharePoint Online for collaboration, and Confluence for Intranet webpages. Digital Asset Management of photos and videos, from the Communications Division, to training material and more technical audiovisual records, can be performed in Alchemy Phraseanet. Meanwhile Document Management remains in IDM which has been augmented with an Artificial Intelligence search capability called “Lucy” (see Fig. 7. 2-11). The ITER

Engineering Database is being consolidated in the latest iteration of the ITER Collaborative Platform (ICP4) based on the latest web application architectural principles.

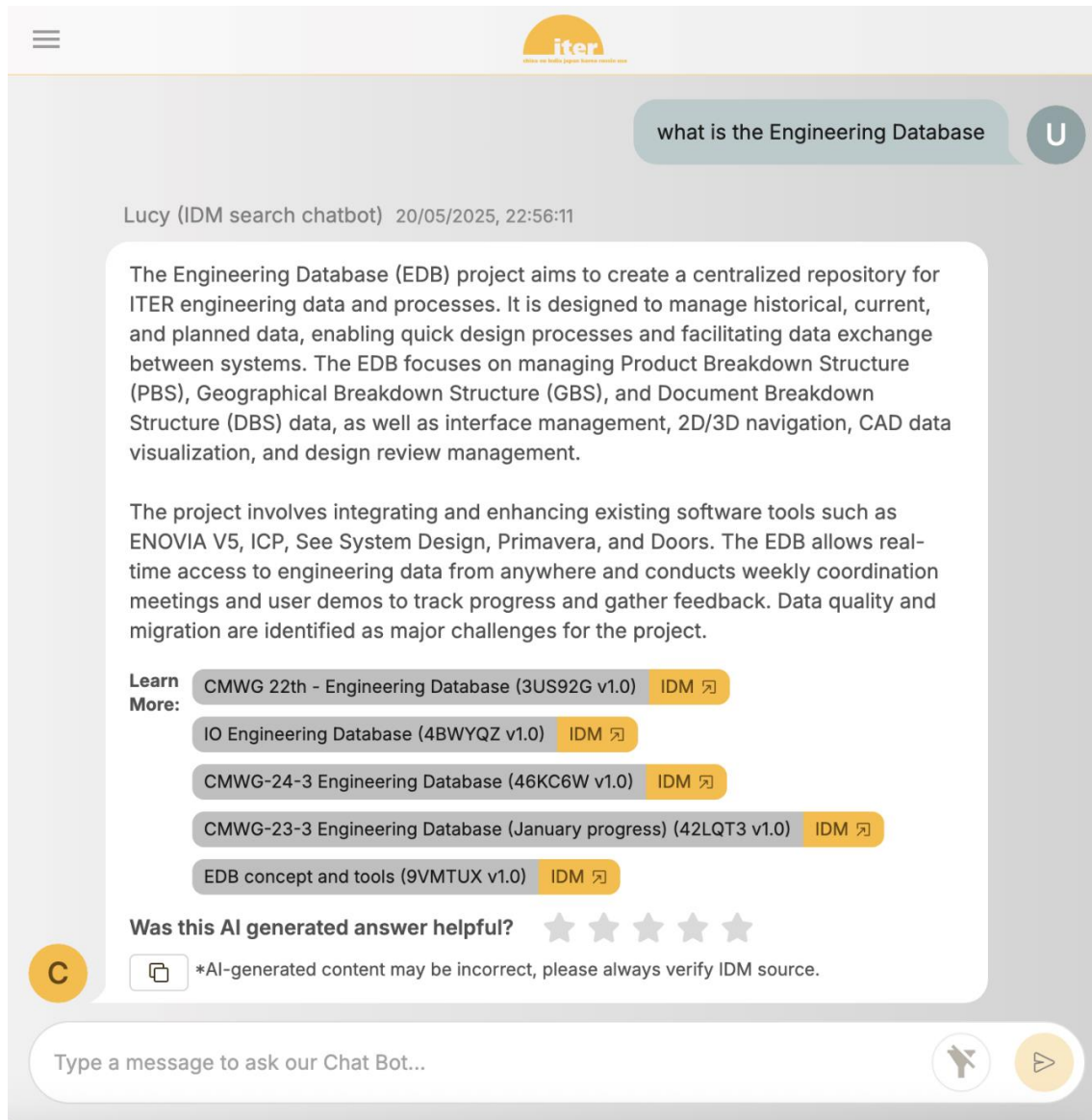


Fig. 7. 2-11 "Lucy", an AI Chatbot for IDM documents.

7.2.5 Design Management Tools

7.2.5.1 Design Change Requests DCRs & Project Change Requests PCRs

From the 2001 baseline onwards, major changes to the design were handled at TCM and formally tracked. In 2004, a Design Change Tracking database utility was introduced, and all the DCRs from 2001 were added. Regular lists of DCRs were produced at TCM and widely circulated. All open

DCRs were tabled, together with their status, at every coordination meeting, and subsequently at IO-DA Meetings (see below).

From 2004 onwards, it was recognized that many proposals for change were not well enough defined to introduce formal DCRs. Hence, they were classified as “Issues” (see below). In 2006 this system was extended to cover changes to scope, safety, cost and schedule, and the DCRs were renamed Project Change Requests (PCRs).

Between 2004–2010, many PCRs were raised as the detailed design took shape. The 2007 Design Review gave rise to a four-fold increase in PCRs as shown in Fig. 7. 2-12. Indeed, the TAG (see 7.2.6.3) of April 2009 expressed concern that there were 50 open unresolved PCRs, and a major effort was required to close these before the IC-3 and baseline acceptance (end 2009/beginning 2010).

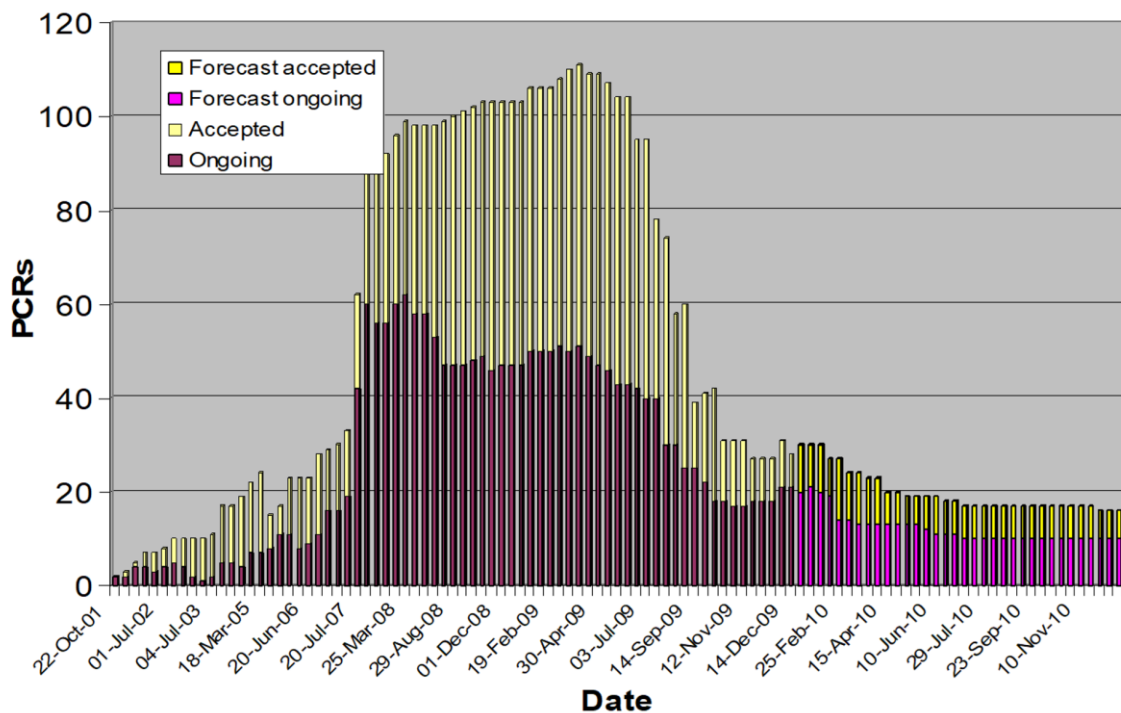


Fig. 7. 2-12 Status of Project Change Requests before 2010 Council.

PCRs formed one of the main configuration management tools right up to the present, with their handling being the main business of the Configuration Control Boards (CCBs, see section 8.3.2.1.3). From 2015, the approval, including financial attribution, was handled by the Directors Executive Project Board (EPB). The record of PCRs is a comprehensive record of all the changes to the ITER design, schedule, and cost throughout the lifetime of design and construction. The number of PCRs raised provides an indicator of the extent of the ongoing design evolution. After the “Design Review” sudden growth, shown above in 2007, there was a second notable growth

mostly from the PA finalization before assembly in the period 2014–2025. Nevertheless, 1,000 PCRs were raised and handled from 2015 to 2025. A great deal of effort was applied to resolve the open PCRs to allow the manufacture to proceed unhindered, and to staunch the trend of new PCRs. This resulted in the downturn from 2024 shown in the next diagram. In 2025 MAC held a “Special Meeting of MAC on the Monitoring of the Configuration Management (MAC-S16)” to review the current ITER Configuration Management where the PCR process and numbers were closely examined.

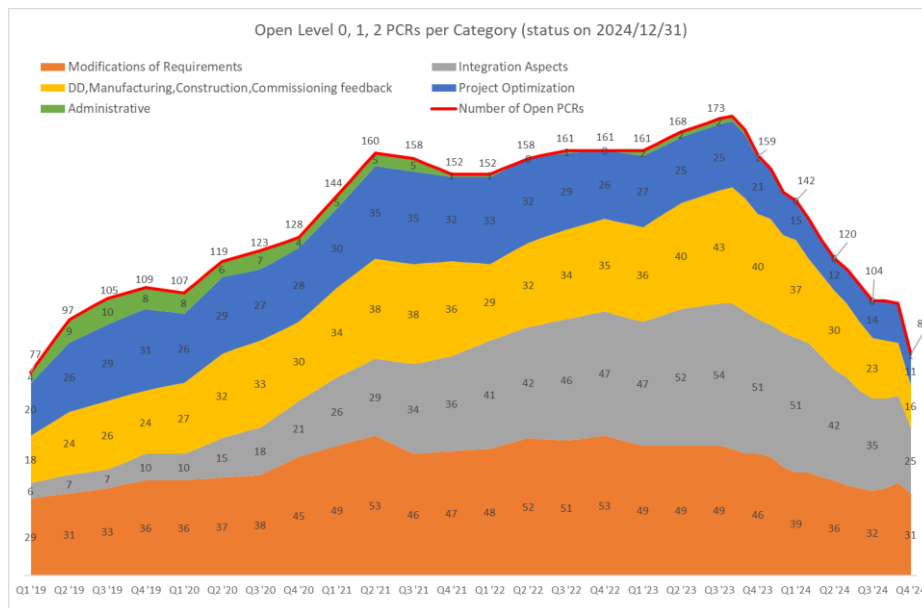


Fig. 7. 2-13 PCR Trends from 2019–2024^[10].

7.2.5.2 Issues Management

With the long preparation of the new PID in 2004, it was evident that there was an urgent need to track technical “Issues” raised during the PID production. The concept of an “Issues Card” was introduced and the tracking added to the Access Database. In late November 2004, there was a week-long “Issues” meeting where all WBS officers were invited to present their “Issues” and a second meeting in early 2005. These meetings proved invaluable to identify many design unknowns, anomalies and inconsistencies; and actions, both short and long term, were proposed to resolve these. Each identified “Issue” was given three ratings: impact on “Cost” “Schedule” and “Design”. An example of an “Issue” was the grounding of the buildings and site equipment, and the use of insulating breaks, where many inconsistent approaches were taken by the individual WBS officers. The usual eventual outcome of an “Issue” was either to propose a “Design Change” or to drop the issue as either rejected or incorporated in a wider issue card.

Eventually the Access database proved both too time consuming and inadequate to track and link DCRs and Issues. Fortunately, by then IT was in the process of introducing the new major IDM

database, and they proposed to move the small Issues, Actions and DCR Access database to the Zope platform allowing full integration into IDM and the ITER Project Management utilities then forming an early version of the ITER Collaborative Platform (ICP).

7.2.6 Information Gathering

7.2.6.1 Additional Direct Investment

From the arrival of the Principal Deputy Director General (PDDG) in 2006, a regular feature of all configuration management meetings was a review of the "missing Items". In effect, these were items that were not covered by the 2001 FDR, and hence responsibility for their design, procurement and finance had to be attributed. Many "Issues" and DCRs were raised to cover items that were not listed or costed in the 2001 baseline or procurement arrangements.

At the completion of the FDR in 2001 significant parts of the project mainly in the support and auxiliaries' areas were still in a conceptual design state, but to underpin the joint implementation agreement it was necessary to list the whole project and assign indexed monetary values for procurement attribution and cost sharing (see sections 6.12 and 8.3.3 for more details). Inevitably during the following years of detailed design and construction many so called "missing items" were identified that were not included in that early costing, and these formed a major part of the management meetings for several years. Such items arose in all areas of the project such as buildings, vacuum vessel, cubicles, pipework, waveguides, busbars etc, and often the interface area between two procurement responsibilities led to further such items.

In addition to such "missing items" identified during detailed design, there was also a major class of additional items identified by subsequent physics advances from the worldwide fusion programme. These included the necessity to procure ELM and vertical stabilization coils to help control instabilities of the plasma, the addition of ferromagnetic inserts in the vessel to reduce toroidal field ripple, and the extra cost to redesign and procure full tungsten divertor targets when the project abandoned the initial plan to start with full beryllium plasma-facing components. These latter "physics" items were treated as major policy decisions at Council with properly attributed cost and resources. A further major item agreed at Council was the need to procure a second-sector sub-assembly frame to accelerate the construction phase.

Nevertheless, the majority of "missing items" had additional implications (often major) on the cost and schedule. To accommodate this, the Design Change Procedure^[11] was upgraded in 2008 to include cost and schedule implications and change requests renamed PCRs (Project Control Requests). In fact, by far the majority of PCRs in 2008–2012 arose from these identified additional project needs and required a general policy decision from MAC and Council. The "missing items" were renamed "**Additional Direct Investment**" and were discussed in detail in IO-DA and MAC meetings.

The total cost for these Additional Direct Investment (ADI) items was significant. At the 2008, 2009 and 2010 MAC meetings these ADI lists were at the forefront of business and MAC formulated “guidelines”^[12] in 2009 and 2010 to the ITER Director-General for the treatment and allocation of this ADI. Thereafter, most of these items were accepted into Procurement Arrangements and careful lists kept to ensure that additional costs were shared equitably.

ADI continued to feature during the detailed design in 2010–2014. At the extraordinary meeting held in March 2015 the ITER Council agreed on the establishment of a separate ITER Reserve Fund to deal with the uncertainties in the definition of the scope of the project and with the goal of ensuring a clear and efficient decision procedure. The reserve fund came into existence in the second half of 2015 and replaced the IO reserve and the other instruments to deal with ADI and Cost risks not yet included in the Baseline. The Terms of References of the RF^[13] and the ITER Reserve Fund Management Plan^[14] defined which additional scope could be considered eligible for the RF. This is discussed in more detail in section 8.3.

7.2.6.2 Project Schedule Development

The 2001 Final Design Report Schedule and its adoption by the ITER Organization at IC-2 in 2008 indicated an 8-year period from the then recently granted License to Construct until first plasma, thus projecting it to be in 2016.

A major review of this timing was carried out in the 2008–2009 Design Review. The considerable work looking at viable target dates and risk factors were presented to TAG-6 in early 2010 by the PDDG (see section 7.2.6.3 “Technical Advisory Group” below), and the new schedule was incorporated into the 2010 baseline (see Chapter 8.3) by IC-3, with a first plasma in 2018, 10 years after the license to construct (IC-3 was the first baseline approval from Council since FDR-2001). While this was only a 2-year slippage from the 2001 FDR schedule chart, the presentations at TAG-6 show this was considered an optimistic, high risk, high-cost estimate. It was assumed there was no cost limitation in the IO or the DAs (e.g. priority from manufacturers, parallel construction lines, shift work, design stability, minimum bureaucratic loss during tendering process, etc.) and no more major design issues to solve.

By 2014, a new schedule was proposed to the ITER Council with a first plasma projected date of 2022. Nevertheless, the Council Chair, Bob Iotti, was not convinced this was viable and requested the IO to make further projections.

The first request in early 2014 was for the IO to carry out a “bottom-up” staffing estimate of the IO based on achieving the 2022 first plasma. A task force was formed, and a very thorough review was made, group-by-group, division-by-division, of the 8-year forward plan of the human resources necessary to achieve plasma by that date. The results^[15] show a build-up to over 1,700 IO Staff and Contractors in 2019–2020.

IO management's initial assessment was that the proposed staffing levels were approximately one third above what could be accommodated at the time. However, this report, together with Procurement Agreement (PA) progress reports from the DAs, gave the Council Chair considerable misgivings whether even the 2022 first plasma target was possible. Hence, the Council did not approve the proposed schedule with the 2022 first plasma date. Instead, the Council Chair requested a second "bottom-up review" task force together with the DAs to establish what was achievable.

The "Achievable Schedule Task Force"^[16] (ASTF) was aimed to deliver results at the June 2015 Council. By 2014–2015, most of the PAs had been signed, and the DAs were well into the tendering and construction phases, with most of the main manufacturing companies already selected. Thus, it was considered that a well-supported bottom-up schedule estimate at that time should give considerable confidence for achievement.

The objective of this Task Force was to assure development of the Achievable Time Schedule consistently with IC requirements. Amongst the twenty-four steps listed in the Terms of Reference^[17] the following principal goals are included:

- i) Evaluate the current status of the Achievable Time Schedule developed without any specific constraints in terms of "target dates" through a bottom-up approach.
- ii) Coordinate the completion of the Achievable Time Schedule.
- iii) Coordinate the development of draft Integration/commissioning time schedule.
- iv) Identify the governing process duration of the critical path and implement a top/bottom approach to get valuable and feasible target dates.
- v) Carry out an independent investigation on the governing process duration of the critical path and evaluate recovery actions to get improved achievable dates for an early reliable completion of the ITER Project.
- vi) The Task Force assumes that the updated long-term schedule and the associated assumptions on budget and scope will be delivered.
- vii) Issue within March 2015: the draft integrated resource-loaded schedule to Independent Assessment group.

The Task Force held 26 intensive joint meetings of the IO and DAs from November 2014 until May 2015. The progress of development of the task force can be tracked through these meetings, with close concentration on the critical path items. Not only did the members report their progress, but also the Task Force became a solid driving force for the many critical path items. Additionally, the most fragile or marginally critical items were given extra resources to maintain their schedules.

The final meeting of ASTF was held in May 2015 and subsequent work to present the schedules to 2015 STAC and MAC was followed at CCB-II. Nevertheless, the DG recognised that ASTF had achieved good momentum to drive and monitor critical schedule progress. Hence, it was then

integrated into a new “Project Team” (PT), the “Resource Loaded Schedule and Baseline (RLSB) PT”, and recommendations passed to CCB-II for action tracking and review and inclusion in EPB (Executive Project Board).

The ASTF and subsequent RLSB-PT Chair (G. Janeschitz) presented the two ASTF developed strategies to STAC 2015^[18]:

- a) Baseline Strategy; Early first plasma (2026): “1st Assembly provides a minimum of systems to perform integrated commissioning of tokamak, leading to 1st Plasma. This is followed by 2nd Assembly for rest of systems and leads to the first H/He experimental campaign”.
- b) Parallel Second Assembly Strategy with first plasma combined with start of H/He operation in late 2028: “Go straight from 1st Assembly to 2nd Assembly. Commission in cryostat in parallel then commission complete machine and go straight to the first H/He experimental campaign, which would then incorporate 1st Plasma”.

It was noted to STAC that the latter scenario had the major advantage of a gain of >18 months on the start of the full exploitation of ITER, and it was the favoured scenario of ASTF.

Among the many risks, both political and technical, listed for the STAC in 2015, cold leaks from the thermal shields were identified as having the highest impact on schedule. Also, the fact that the manufacturer of the vacuum vessel sectors found the tolerance requirements too stringent was also identified. Both these issues had major project schedule impacts in 2023.

The new schedules and options shown above were presented to the 2015 November Council but were not approved. Instead, Council called for an independent review of the schedule and resource estimates as well as any outstanding technical issues. The recommendations of ASTF, with the two scenarios, “Early First Plasma” or “Direct path to DT” were used as a starting point for further schedule development, launched in late 2015. This effort widened the issues raised by ASTF, and they requested more details from DAs about their manufacturing schedules, with the aim to quickly focusing on any critical path items.

The newly formed “Resource Loaded Schedule and Baseline (RLSB) PT” recommended to integrate the schedule into the new Baseline which was presented and approved at IC-19 in November 2016. This included the OPS (Overall Project Schedule), the IPS (Integrated Project Schedule) and a new very detailed, “master schedule” for the management of the overall project, extending the concept of phases from assembly to the whole project. The essential points of the new schedule are shown in Figure 7.1.10.1-1. The primary aim was a first plasma in 2025.

The Resource Loaded Schedule Project Team, including DA membership, remained very active over subsequent years, as a driving force to maintain the formal schedule and apply resources to critical areas. Only when the above-mentioned non-conformances in the vacuum vessel and

thermal shield surfaced in 2023, was it necessary to recognize the inevitable delay and implement the new schedule shown in Figure 7.1.11-1.

7.2.7 ITER Project Coordination, Progress and Advisory Meetings

In most large organizations, there is a well-established structure of project coordination meetings. However, the meeting structure at ITER evolved substantially as the project grew in maturity, scale and complexity. The project has evolved from a small design team through to a major nuclear building project, with an annual budget that has grown a hundred-fold since the 2006 project signature. It has been the job of the ITER Director General and his team to meet these growing needs through the years. Succeeding ITER DGs had widely different management approaches and changed the staff and meeting structures of IO accordingly. Each new organigramme required senior staff to re-apply for positions within the organization, and the change in meeting names and structures required new Terms of Reference and member hierarchy to be reissued. These developments are covered in the following sub-sections on the various high-level engineering and management meetings and methods during those early times and up to the present.

7.2.7.1 Technical Coordination Meeting

At the time of the 2001 FDR, the Technical Coordination Meeting (TCM) was the top-level design review for technical design advancement. Issues and Design Changes were recorded or approved by the Director via that meeting. TCM-01 was held in October 2002 with Robert Aymar as the Chair. The minutes record:

- *The purpose of the Technical Coordination Meeting is to review all proposed major design changes and to keep track of all decisions that affect the design baseline documents.*
- *The object of TCM-1 was the review of the main issues related to the allocation and design of the Vacuum Vessel lower ports.*

The integrated design team of European, Japanese and Russian Federation staff, were centered at Garching and Naka. Remote participation was in its infancy and world networks slow, so the meetings alternated between Garching and Naka, occasionally with phone contact when possible. The presentations at the meetings were not archived systematically, and minutes were short and succinct. For each meeting there was a Record of Decisions (RoD), but as the Director emphasized, these were his decisions, as empowered by Council, and not necessarily a consensus of the meeting.

There was a major change in this system in August 2003 when Yasuo Shimomura took over as Interim-Director. This period also was marked by new Participants, Korea, China, the return of the US, and eventually India by 2005, with a major increase of staff. There was a strong request from the Participant Team (PT) Leaders to make TCM more transparent. Resources were still minimal, and the projected ITER Document Management System was still under study, so the new ITER Technical Web was used as the vehicle to make all TCM information available also to the PTs. In addition, Yasuo Shimomura circulated detailed minutes and an executive summary to all partners

and a consensus was agreed before the final versions were approved. Also contributing to the success of the TCM was the afore-mentioned high level of technical “Remote Participation” now available through EFDA, IPP Garching and the DFN.

The TCM thus became the decisional body for endorsing design change requests after design review meetings with all the interface ROs and management. Fig. 7. 2-14 shows TCM being central to the design process. However, in the period 2007–2020 the rapid growth of the project necessitated the division of TCM and the DI-DO, and the Change Control Boards were created to focus on this work.

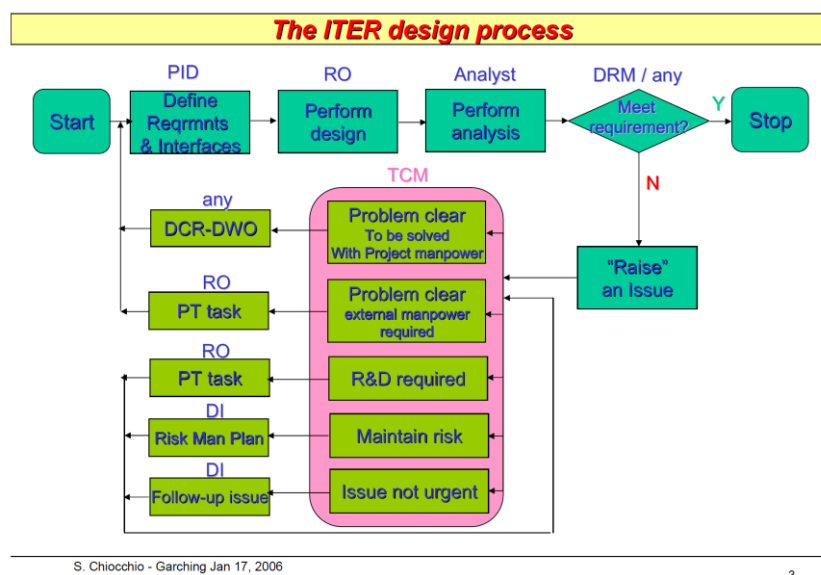


Fig. 7. 2-14 Summary of the ITER Design Process in 2006.
(DCR= Design Change Request, DWO=Design Work Order,
RO=Responsible Officer, DI=Design Integration)

When DG Ikeda and PDDG Holtkamp were appointed in 2006, a new high level Member meeting, IO-DA, was established (see following section, 7.2.6.2) and it became apparent that there was a lot of overlap between the TCM and IO-DA Meetings. Hence the TCM was abandoned after TCM27 in December 2007, and the top-level technical management was passed to the Change Control Boards.

The TCM was revived in December 2009 under the chairmanship of E. Tada, in the face of a number of design issues and the preparation for the 2010 baseline. (TCM numbering also changed to the format TCMyear-No., such as TCM09-01, and TCM9-02 both held in December 2009.) The following were listed as the new objectives of TCM:^[19]

- 1) Coordinate and resolve technical and interface issues related to integration and engineering activity within IO and with DAs, covering all processes from design to commissioning.
- 2) Monitor the progress of the CAD and engineering activities and take necessary actions to manage the activities in accordance with the plan defined.
- 3) Assess and formulate proposals for the improvement of process/procedure and tools related to implementation of integration and engineering activities, such as configuration management, risk management, systems engineering and DWO management.
- 4) Upon request of the Change Control Boards, execute technical assessments for specific issues and provide the assessment results for the technical endorsement of change requests.

The TCMs continued in this format until the end of 2013. In 2013, most of the scheduled TCMs were cancelled for lack of suitable material, and it became evident that most of the remaining design questions were being handled at the Change Control Boards. Any higher-level issues were handled at IO-DA, so the TCM was eventually discontinued as most remaining technical issues were addressed through other established channels

The TCM has recently been restarted by DG Barabaschi in the form of a 3-day technical meeting together with the DAs approximately every six months. The aim is to review technical progress and current major issues, with an agenda carefully prepared well in advance. After the first meeting in April 2023 the DG noted that it is a good vehicle for improving transparency within the project.

7.2.7.2 Project Progress Meeting - PPM 2007–2013

The PDDG, Norbert Holtkamp, introduced informal Project Progress Meetings shortly after arriving in early 2007, and the series ran for six years until 2013. It was initially held weekly, and attendance was Section Heads and above. The meeting was not minuted, and the staff were encouraged to be open and honest about all topics. However, because many staff were travelling, a memo was distributed after each meeting. These “notes” were subsequently made more formal, and recorded in IDM, but each was headed “Rough Notes for Guidance only. NOT TO BE FORWARDED OR QUOTED, Restricted Distribution”. Nevertheless, these notes^[20] form a valuable record of the day-to-day workings of the project “warts and all”.

In terms of content, the meeting usually followed an introduction of project news by the Chair, followed by short presentations by each of the division heads, plus any expert presentations requested. Staff were then invited, and indeed encouraged, to raise topics, queries, contentions, or suggestions for discussion. Staff took advantage of the informality of the meeting to raise points that may not have been acceptable in formal meetings. Many “Issues”, IO-DA items, and even workshops were topics first raised informally in PPM.

The meeting continued to be a valuable project window after Holtkamp left in 2011, and was subsequently chaired by the Technical Director, Rem Haange, and held monthly until 2013. By 2013 the project had grown to a size that made the PPM impracticable, and it was abandoned in favour of individual divisional meetings.

7.2.7.3 Technical Advisory Group (TAG)

It rapidly became apparent during the first six months of the PDDG appointment in 2006–2007 that ITER was not yet ready to launch procurement at full scale, and significant challenges remained in aligning cost, scope and schedule with Council expectations. At ITER the PDDG recognized that there was a disjoint between the official cost and schedule and the likely cost and schedule based on the project current position, and he and the DG set up a panel of external and independent fusion and industry technical experts, the Technical Advisory Group, in 2007, to advise them on how to balance the expectations of the stakeholders and the practical reality.

STAC and MAC and their many subcommittees and working groups were there to advise the ITER Council, and there had not been a single external committee to advise the ITER Management. Further, the PDDG wanted a platform where the ITER Division Directors could present the progress of their departments and seek further advice on issues such as organization and staffing, design, safety, cost and schedule.

The TAG was formed by no more than 12 experts selected by the DG and PDDG among leading fusion scientists and technical managers from industries and laboratories who have been involved in projects comparable for size and scope to ITER. The TAG was initially organized into subgroups, covering technical and scientific issues, cost, schedule and staffing, management, and QA/safety/licensing. The TAG members were chosen both for their impartiality, their background, and to cover most of the main project areas including management. The TAG meetings were a major event at IO, usually running for three days, and included sub-committees and study groups especially for major “issues”. It was intended to meet twice per year.

The first TAG-1 meeting was in April 2007, and the final TAG-6 in January 2010. During the time the TAG was in place it gave advice to the IO management on several issues. These ranged from the review and recommendations regarding the project schedule and the project resources and their lack of contingencies, to technical and organizational matters such as the assessment of alternative proposals for the VV and Blanket. It also addressed the speed of resolution of major DCRs and PA delays caused by DA formalities, and the worth of establishing field teams versus the alternative of more effective IO-DA communication plus local inspectors, or the creation of integrated product teams. It pointed to the fact that a proper quality organization had to be assured from the start of each contract and supported early IO audit of the relevant quality organizations in the DAs. In particular it noted some difficulties of IO quality inspection visits to DAs and DA industries which were sufficiently serious to bring to the attention of the ITER Council.

7.2.7.4 PTL & IO-DA and UIT Coordination Meetings

From 2001, the Director General had regular meetings with the Participating Team Leaders (PTLs). These were formalized in early 2006 and increased in frequency with the arrival of the PDDG in June. The principal topics were the PTLs work plans (they were all in the process of establishing their DAs), and the procurement sharing and cost. There was also much discussion about the possible implementation of Field Teams. Cost and work-sharing were recurring and often contentious themes in these PTL and early IO-DA meetings. The projected size of the central ITER team was then 200 professional staff, and it was expected to use its direct budget (10% of the overall budget) for IO procurements and to fund its own staff. The PDDG repeatedly defended the need to move much of the detailed design to the DAs, particularly those responsible for the relevant procurement packages. The only alternative would be a substantial increase in IO staff and the direct budget from the Members. Detailed design done by those also doing the procurement had the significant advantage of reduction of duplication.

Debate was again raised about the Field Teams foreseen in the ITER Agreement, with discussions at the IIC-2 Preparatory Meeting (March 2007). The field teams were intended to be IO staff permanently attached to the DA sites. This raised several objections, including the financial load, and the split responsibility. It would have added at least 200 permanent IO staff attached overseas with significant cost implications. The DAs were reluctant to have these two classes of IO and DA staff on their sites (especially after the problems such a division created at JET). As a result, the Field Teams concept was abandoned.

In 2007, the PDDG expanded the role of the PTL meetings and renamed them to IO-DA Coordination Meetings.

This concept was formally presented and accepted in July 2007. The formal participants were the Chair (PDDG) and Secretary, the seven DA Leaders, the ITER DDGs, and invited experts. The first IO-DA Coordination Meeting was held in November 2007, replacing the planned PTL-16. Concurrently TCM (TCM-27) was replaced by the Change Control Board meeting. The IO-DA was planned to meet monthly for three hours.

The IO-DA monthly meetings were technically run from Cadarache, with the Secretary, videoconference hub and presentations shown from there. However, occasionally (approx. every three months) the PDDG Chairman and IO experts travelled to a DA headquarters site for the meeting and the visit was expanded to three days of local meetings between the site DA and the PDDG.

During the last year of PTL meetings and the first year of IO-DA these meetings were often contentious and confrontational, especially when examining the fringes, limits and interfaces of the procurement packages. Not only were the interfaces poorly defined, but there was a growing list of “missing items” that were not costed anywhere, and there were sustained discussions on

how responsibility and funding for these items should be allocated (later renamed Additional Direct Investment (ADI) – see section 7.2.6.1). From 2007, onwards for the next 15 years discussions on “spares and missing items” were a regular feature of IO-DA, MAC, STAC and Council, and led to the many “issues cards” and “Project Change Requests” (see section 7.2.5).

The principal early IO-DA issue that was addressed was the finalization of procurement. Much of the design research had been done by global expert groups, whereas the specific procurement packages did not necessarily involve the experts from other parties (especially for the Functional Design procurement packages). During the first year of IO-DA meetings in 2008 a proposal was made to set up global “Integrated Product Teams” (IPTs) to cover specific topics, such as Magnets, and Diagnostics, (see section 7.2.8).

7.2.7.5 Unique ITER Team UIT 2013–2015^[21]

The IO-DA meeting remained as the main technical interface meeting between IO and the DAs up until the last 3-day meeting in April 2011. The meeting management structure again changed with the new Director General. Increasingly in this period, the issues between IO and the DAs became more specific and needed a more targeted response. Hence, the DG created the “Unique ITER Team” (UIT) to replace the IO-DA meeting. This was carefully named to emphasize that design and construction were a global responsibility and should not be separated between IO and DA, and that the joint work was continuous. The UIT meeting formulation also changed. The UIT meetings were usually held quarterly, for a week, broken out into several sub-meetings for specific topics. Minutes and actions were recorded separately for each of these sub-meetings and a plenary session summarized the topics, actions and recommendations.

7.2.7.6 Joint Project Coordination (JPC) and Executive Project Board (EPB) 2015–Present

In 2015, the new DG, Bernard Bigot, took the reins of ITER, and presented his “Action Plan For A New Phase of ITER” to its Council. He established an Executive Project Board (EPB) as the highest integrated consultative body between the IO and the DAs. At the same time the Unique ITER Team week, which has been taking place since 2013, was readjusted to support the EPB and the newly integrated organization. For this purpose, a Joint Project Coordination (JPC) meeting between the IO and DAs was established in early 2016 to replace the UIT-week long meetings, with a mandate formed to prepare and support the DG’s decision-making at the EPB meetings through top-level coordination and integration. Notable is that the JPC was not a decisional body itself but made recommendations to EPB.

The Terms of Reference for JPC (2015, revised 2018^[22]) lists the responsibilities of JPC:

The JPC will be working to:

- Represent at all times the best interests of the Project;
- Facilitate and help to improve the DG's effective and rapid decision making on critical issues;
- Increase the effectiveness in communication and mutual understanding on issues between the IO and the DAs and/or between the DAs;
- Discuss in depth, exchange information with, and advise the DG about key issues related to the Project Baseline, project performance, management, advancement and requests for changes;
- Ensure efficient information exchange and communication among senior managers of the IO and the DAs;
- Improve collaboration with the DAs and the IO within the EPB and Project Teams, and put forward solutions for improving teamwork in the best interests of the Project by providing a forum outside the EPB for elaboration of issues and for seeking consensus solutions;
- Resolve issues which do not require the approval of the EPB;
- Further enhance the overall coordination of the IO and DAs to foster the ITER Project as scheduled.

Weeklong meetings were held every month, with many “breakout” meetings. When MAC was held, the JPC meeting was reduced to two days before MAC and the IO and DA papers and strategy for the MAC agenda were discussed, followed by one day of JPC post-MAC discussion.

Since the decisional body is the higher-level Executive Project Board, and from 2023 almost all JPC topics were contained within the ITER Departments, JPC management is now devolved down to the departments and managed by the Department Heads. Any global business is managed by EPB. (Notable also was that the TCM restarted in 2023 – see TCM section above). Nevertheless, the JPC format has continued to be an effective forum to manage technical work between IO and the DAs up to the present.

7.2.8 Integrated Product Teams (from 2007 onwards)

After the signing of the ITER Agreement and move to Cadarache, one of the prime goals of the IO was to launch the Procurement Agreements (PAs) to the Domestic Agencies (DAs). Although the central team had proposed and coordinated the design solutions, much of the research and development in key technologies for the design of ITER in the 1990s and up to 2006 was done by worldwide expert groups, either covered by Task Agreements or by the local programmes of the fusion community. Indeed, the thinking in ITER was that by the time ITER construction started,

there should be no more need for such groups. In reality, the situation in 2007 was far from this. There was a long list of “issues” and PCRs to resolve, with new issues being raised daily. It had also been assumed that coordination work would be taken up by the “Field Teams” as planned in the 2001 FDR, but these were abandoned (as mentioned above). The formal ITER design structure pre-2007 is shown below. Although there were already “Project Teams” for the administration of the Procurement Arrangements, these had little or no design expertise.

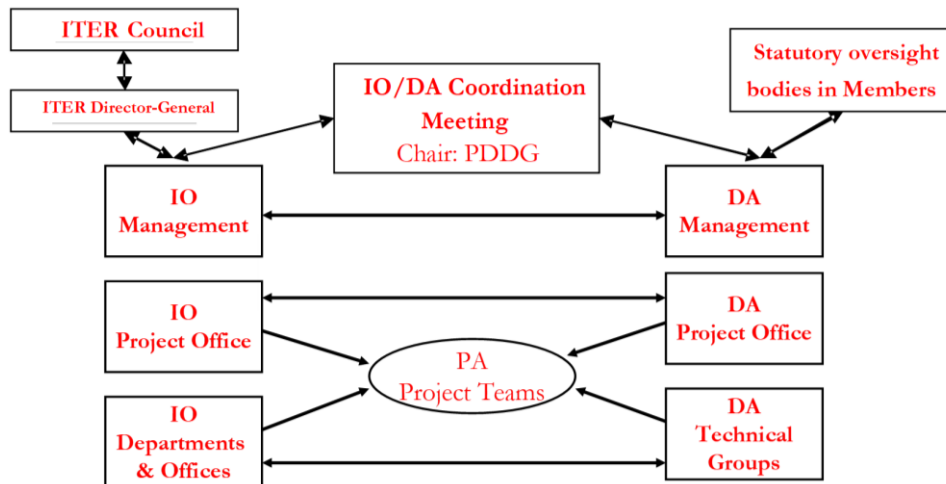


Fig. 7. 2-15 Lines of communication between the ITER Organization and the DAs^[23].

The new PDDG proposed a method, as used by the US Department of Defense, to reformulate the expert groups into “Integrated Product Teams” (IPTs), and to immediately create three pilot teams for blanket, vacuum vessel and power supplies. The new proposed management structure is shown in Fig. 7. 2-16.

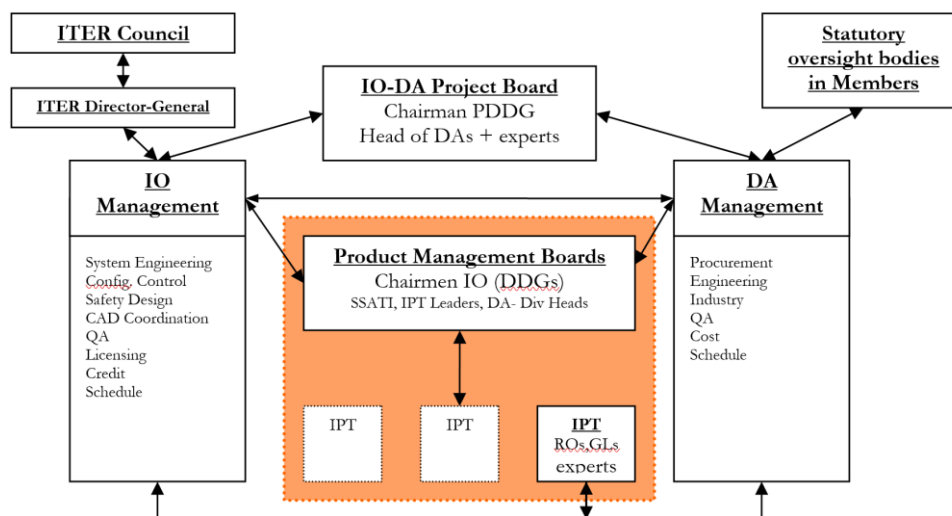


Fig. 7. 2-16 Integration of IPTs, as proposed to IC-3.

The IPTs would develop a work plan, coordinate the work of the different organizations, and propose necessary actions to implement the work plan on schedule. The work would be implemented in accordance with the approved work plan. The IPTs would be in charge of components and systems. By providing common management structures that coordinated the work between the IO RO for a particular component and those DAs which shared in the procurement, the product team leader and their group would take care of the whole range of work for the component or system in question. Thus, it would be responsible for coordinating the work for the completion of the design, interface integration, and preparation and execution of the PA.

The top-level management for the IPTs would be the IO-DA Project Board chaired by the PDDG. In an expansion of the role of the IO-DA meeting described in section 7.2.7.4, the members of this Board would be the PDDG (chairman) and their support staff, the DDGs and the Head of the Project Office on the side of the IO, the Heads of the DAs, and experts as appropriate. The IO-DA Project Board would meet at least once a month either by video conference or in person, elaborating general strategic decisions as well as decisions on large modifications to the design, cost or schedule of a component or system, for presentation to the MAC and IC.

Notable in the above IPT management chart is that QA/QC remains the remit of IO and the individual DAs. The IPTs facilitated the application of QA/QC into the work programmes but they were not responsible for driving it (see also section 8.2). This is in contrast to the original proposal for field teams, which would have IO QA/QC staff allocated into the DA sites.

The three pilot IPTs were deemed a major success with very significant contributions to the progress of the ITER effort, often resolving serious technical issues in the production of the PAs.

By 2011 there were 13 IPTs in operation or proposed:

Pilot Study IPTs 2007-2008

Blanket	Vacuum Vessel	Power Supplies
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New IPTs, May 2009-2011

Magnets	Cooling Water System CWS
Heating and Current Drive	Fuel Cycle
Divertor	Remote Handling
Cryogenics	Instrumentation and Control
Diagnostics	Buildings

IPT leaders were initially proposed to be from the IO, however this was not always practicable, and some IPT leaders were either joint with IO or directly from DAs. A very strong ethic of accountability was accepted by the IPTs, and regular reports of aims, resources and planning were made to IO-DA. The accepted IPT team structure is shown in Fig. 7. 2-17.

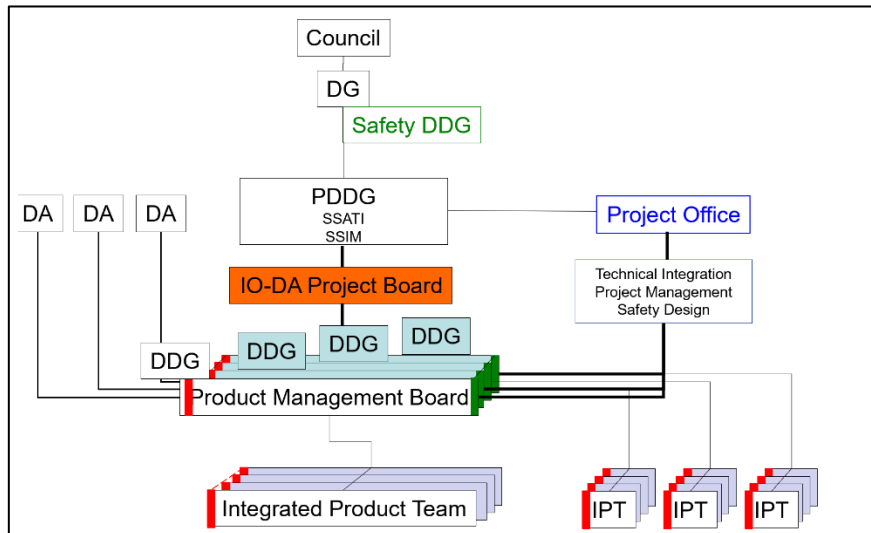


Fig. 7. 2-17 Integrated IO-DA Product Team Structure.

Some of the IPTs were quite complex. For example, Heating and Current Drive encompassed three sub-IPTs for NB, RF and ECRH, with many further sub-groups, as show in Fig. 7. 2-18. Even the relatively simple Blanket IPT reported a challenging process (there were about 180 contributors at various levels to the Blanket Final Design Review prior to start of manufacture) but the time and effort invested in building a team spirit and providing a common sense of design ownership were well invested resulting in a productive collaboration on the design and also during procurement.

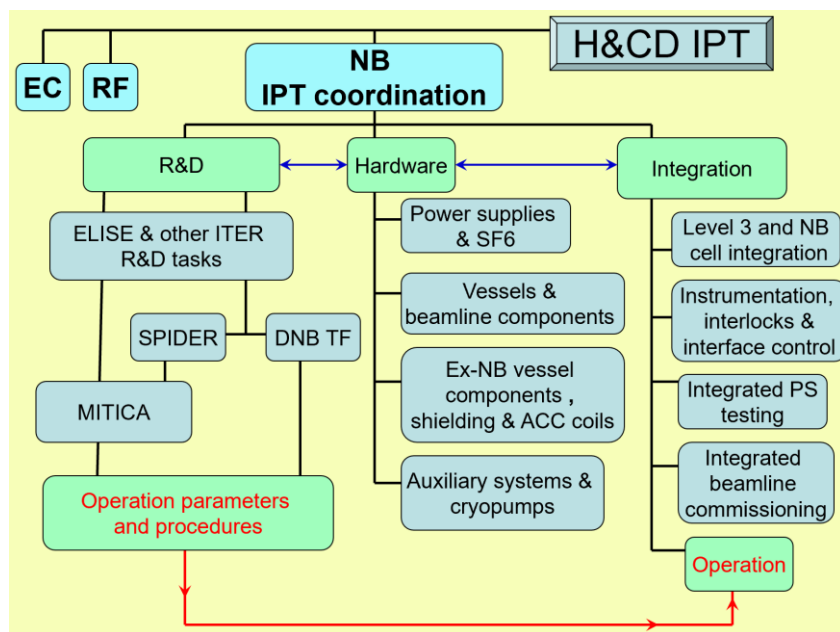


Fig. 7. 2-18 NB Sub-IPT structure within the H&CD IPT[24]

Most of the IPTs had well defined goals, to finalize and launch the build-to-print PAs, and to resolve design and interface issues for the functional specification PAs. Hence, many of the IPT sub-groups disappeared in 2012–2014 as PAs were launched. However, several of the IPTs survived into the construction phase, especially those with widespread responsibilities such as Diagnostics and Remote Handling. The administration and reporting of these groups became routine parts of ITER Configuration Management (see Chapter 8.3).

The Blanket IPT was a particular example of success in the way the IPTs operated, with an exemplary consensus between IO and DA members. In 2014 they reported on their “Lessons Learned from a Successful IPT”^[25], a short excerpt of which is shown below:

- Clear management responsibility to avoid ambiguities between IO and DAs, and inside IO (since the IPT Leader should have the authority to manage the concerned IO staff and IO resources)
- The IPT Leader should be from IO
- The IPT Leader should be the first line of management of the system concerned (typically, the Section Leader and not the Division Head)
- IPTs should be established at the maximum at a [highest] PBS level. Two different PBS's should not be included into the same IPT
- Clear goals (milestones and schedule) for the Team to focus on CDR, PDR, FDR [conceptual, preliminary and final design reviews], PA signature and SMP [senior management plan] milestones
- IPT Framework Task Agreements, with Task Orders digitally signed in IDM and approved by the IPT Leader, proved to be an excellent tool to ensure fast, flexible and effective implementation of activities, within the agreed financial ceiling. This entitled a prompt allocation of resources where needed.
- Internal Change Request system (BICR in the case of the Blanket) proved to be a very efficient way to keep track of changes with the DAs thus speeding the design progress (then all the BCIRs are formally approved via a Deviation Request or a PCR). This applies mostly to pre-PA design changes.

The effectiveness of the Blanket IPT was also due to it being established during the early phase of the design process (conceptual design) with clear possibilities of fully involving the procuring DAs in the design and with enough time until PA (3–4 years) to build up understanding, trust and team spirit among the IO and DAs. This could have been more difficult at a later stage.

They (Blanket IPT) also note in their “Lessons Learned” that IPT's are most effective during the design phase with the focus of IO and all DAs toward a common design objective. When a system enters into the fabrication phase (PA), the emphasis is more on IO-DA bilateral communications while the role of the IPT should be adjusted to help overall general exchange of information (in

particular on design changes involving Deviation Requests or PCRs and on similar components being procured by different DAs) and to keep a level of trust and understanding as a team.

7.2.9 Project Teams (2015 – present)

The formal IPT structure was not part of the reorganization that occurred when DG Bigot took office and most of the IPTs were not active or had reverted to expert committees by then. However, it rapidly became apparent that such a global structure was needed in many areas of the project in order to formulate the new Baseline and Project Schedule. Hence, the DG took the decision in the EPB of March 2015, to create **Project Teams (PTs)** to facilitate the production of the Resource Loaded Schedule and Baseline. Initially it was decided to create PTs for Buildings, VV, TF coil and Cryogenics, and Terms of Reference were written and leaders appointed. A further PT was created, the “Resource Loaded Schedule and Baseline (RLSB) PT” to take the place of the ASTF (See section 7.2.5.2)

Many Project Teams were created through 2015–2020. Some examples:

- 1) Vacuum Vessel PT (pilot PT early 2015)
- 2) Buildings, Infrastructure and Power Supplies Project Team (BIPS-PT 2015);
- 3) Resource Loaded Schedule and Baseline (RLSB-PT 2015 to replace ASTF)
- 4) TF Coil PT (2015)
- 5) Cryogenics PT (Early 2016)
- 6) Safety and Quality Working Group (SQAWG);
- 7) Nuclear Shielding Integration Project Team (early 2016)
- 8) Test Blanket Module Project Team (TBM-PT Early 2018)
- 9) Diagnostic Port Integration Project Team (DPI-PT 2018),
- 10) Blanket Remote Handling System Project Team (BRHS-PT 2019)

A further PT was formed in 2023 to handle the “Non-Conformance” of the delivered Vacuum Vessel sectors and those still in fabrication.

Examples of the success of the IPT and subsequent PT global groups and their contribution to design and construction occur throughout this handbook, emphasizing this essential structure for any global project.

In January 2023, DG Barabaschi decided to delegate his role of Chair for Project Teams Boards to Heads of Departments to govern them with a proper level of responsibility, and in 2024 the IPTs were integrated into the structure of the new Construction Project. In addition, the DG also encouraged the integration of those DAs that wished into the basic structure of the ITER project and launched a number of initiatives to do this. Firstly, he created a single "ITER Project Team" to encompass all the joint work allowing DAs to nominate staff for this joint work; the Terms of Reference for the Project Teams were obsoleted, except for the TBM-PT (in view of the specific

nature of the TBMs and the associated responsibilities). Secondly, he extended the concept of Seconded Staff at IO, for DA-delegated staff at the IO, paid by the DA but under the IO administration. Thirdly the ITER Collaboration Platform and data vaults would be extended into the DA organisations. This work is ongoing and will hopefully result in a unified major international team in ITER Cadarache, with staff, both permanent and seconded, from all the DAs.

Glossary

ADI	Additional Direct Investment
ASN	Autorité de Sûreté Nucléaire
ASTF	Achievable Schedule Task Force
BIPS-PT	Buildings, Infrastructure and Power Supplies Project Team
BRHS-PT	Blanket Remote Handling System Project Team
CCB	Change Control Board
CDR	Conceptual Design Review
CWS	Cooling Water System
DA	Domestic Agency
DAs	Domestic Agencies
DCR	Design Change Request
DDD	Design Description Document
DFN	Deutsche Forschungsnetz
DG	Director General
DI	Design Integration
DI-DO	Design Integration – Drawing Office
DOORS	Dynamic Object-Oriented Requirements System
DPI-PT	Diagnostic Port Integration Project Team
DRG-1	Design Requirements and Guidelines, Level 1
DRM	Design Review Meeting
DWO	Design Work Order
EDB	Engineering Database
EFDA	European Fusion Development Agreement
EPB	Executive Project Board
FDR	Final Design Report
GBS	Geographical Breakdown Structure
H&CD	Heating and Current Drive
IC	ITER Council

ICP	ITER Collaborative Platform
IDM	ITER Document Management
IO	ITER Organization
IPS	Integrated Project Schedule
IPT	Integrated Product Team
IT	Information Technology
JPC	Joint Project Coordination
LLIS	Lessons Learned Information System
OPC	Overall Project Cost
OPS	Overall Project Schedule
PA	Procurement Arrangement / Procurement Agreement
PBS	Project Breakdown Structure
PCR	Project Change Request
PD	Plant Description
PDD	Plant Description Document
PDDG	Principal Deputy Director General
PDR	Preliminary Design Review
PDS	Project Design Specification
PID	Project Integration Document
PP&RE	Project Plan & Resource Estimate
PPM	Project Progress Meeting
PR	Project Requirements
PS	Project Specification
PSR	Plant Safety Requirements
PT	Project Team / Participating Team (depending on context)
PTL	Participating Team Leader
QA	Quality Assurance
QC	Quality Control
RF	Reserve Fund

RLSB-PT	Resource Loaded Schedule and Baseline Project Team
RO	Responsible Officer
RoD	Record of Decisions
SBS	System Breakdown Structure
SDD	Systems Description Document
SQAWG	Safety and Quality Working Group
SRD	System Requirements Document
TAG	Technical Advisory Group
TBM-PT	Test Blanket Module Project Team
TCM	Technical Coordination Meeting
UIT	Unique ITER Team
VV	Vacuum Vessel
WBS	Work Breakdown Structure

References

- [1] Fifth IAEA Technical Meeting on Control, Data Acquisition, and Remote Participation for Fusion Research 12- 15 July 2005 Budapest, Hungary. <http://tm2005.rmki.kfki.hu/>; J. How et al., “ITER Informatics Support for Design Integration.”
- [2] ITER Organization, “ITER Baseline Diagram and Documentation Plan,” Version 1.2, Document No. ITER_D_2XWZEK, Jun. 2010.
- [3] ITER Organization, “Project Specification,” Document No. IDM-D-2DY7NG.
- [4] ITER Organization, “ITER Baseline Diagram V3,” Document No. IDM-D-2XWZEK, 2019.
- [5] ITER Organization, “MAC-S16 Configuration Management,” Document No. ITER_D_CXRC24, 2025.
- [6] ITER Organization, “Plant Description (PD),” Document No. ITER_D_2X6K67.
- [7] ITER Organization, “Document UID 29G9DV.” [Online]. Available: <https://user.iter.org/?uid=29G9DV>.
- [8] B. Prescott, J. Downing, M. Di Maio, and J. How, “ITER Informatics Support for Design Integration,” Fusion Engineering and Design, vol. 85, nos. 7–9, 2010, doi: 10.1016/j.fusengdes.2010.04.068.
- [9] S. Sanz, K. Haupt, A. Maas, R. Jober, and B. Prescott, “Design integration and configuration management at ITER,” Fusion Engineering and Design, vol. 146, 2019, doi: 10.1016/j.fusengdes.2019.02.088.
- [10] ITER Organization, “MAC-S16 Configuration Management,” Document No. ITER_D_CXRC24, 2025.
- [11] ITER Organization, “Document No. ITER_D_22F4E5.”
- [12] ITER Organization, “MAC-10 Guidelines procedure 2012,” Document No. ITER_D_G7SQQT.
- [13] ITER Organization, “Document No. ITER_D_WXPLA3,” Version 1.5.
- [14] ITER Organization, “Document No. ITER_D_RZ2YUL,” Version 1.0.

^[15] ITER Organization, “Bottom-up Manpower Resource: Terms of Reference,” Document No. IDM_Q3Y4YJ, 2014.

^[16] ITER Organization, “Achievable Schedule Task Force (ASTF), November 2014–May 2015,” Document No. IDM_Q5RLQK.

^[17] ITER Organization, “Terms of Reference, Achievable Schedule Task Force (ASTF),” Document No. IDM_Q3Y4YJ.

^[18] ITER Organization, “Schedule Development,” Document No. IC_STAC-18_2.2_Schedule_Development_R5S8VY_v1_3.

^[19] ITER Organization, “TCM Terms of Reference,” Document No. ITER_D_2ZTY6F.

^[20] ITER Organization, “ITER Document,” Document No. 2ENBDP.

^[21] ITER Organization, “IDM Folder for UIT and JPC,” Document No. EGVJAZ.

^[22] ITER Organization, “Terms of Reference of the Joint Project Coordination (JPC),” Document No. ITER_D_SRTVQ7.

^[23] ITER Organization, “Proposal on Integrated Product Teams between the ITER Organization and the Domestic Agencies,” Document No. ITER_D_2EHK9U.

^[24] ITER Organization, “Heating and Current Drive (H&CD) IPT,” Document No. IDM_34M66A, Nov. 2009.

^[25] ITER Organization, “Blanket IPT Lessons Learnt,” Apr. 2014. [Online]. Available: <https://user.iter.org/?uid=PAVNL8>.