The TBM-CA configuration management approach for the ITER test blanket module - application to the HCLL TBS

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ABSTRACT

The European Test Blanket Modules (EU-TBM) are first prototypes of a fusion reactor breeding blanket. They will be tested in dedicated equatorial ports n°16 of ITER. Technical developments are performed by a Consortium of European Associates (TBM-CA) and supported within the framework of F4E agency. Designing a complex nuclear system like TBM for ITER necessitates an organizational structure inside the consortium to manage in permanence the coherence between requirements (F4E technical and management specifications) and the TBM development through their life time. At the present stage, evolutionary nature of the design from the different teams is important. Highest priority is assigned to the Management support and Design Integration Team (MDIT) to perform an efficient control of the Configuration Management (CM). The TBM-CA CM comprises 4 main processes: a) identifying configuration of a product characteristics, including its interfaces (Configuration identification), b) controlling the evolution from agreed baseline (Configuration Control), c) creating the knowledge database in order to manage the information all along the lifecycle of the items (Configuration status accounting) and d) verifying the current configuration status of the items (Audits).

CM is then a powerful tool to link the requirements for engineering, safety, quality assurance and test & acceptance activities. The application of the CM approach is illustrated through the case of TBM-HCLL (Helium Cooled Lithium Lead). The result shows that the proposed methodology and tools are suitable and provide quality solution for the items with a complex configuration such as TBM HCLL.

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1. Introduction

The European Test Blanket Modules (EU-TBM) are first prototypes of a fusion reactor breeding blanket. They will be tested in dedicated equatorial ports n°16 of ITER. Technical developments are performed by a Consortium of European Associations (TBM-CA) and supported within the framework of F4E agency. For unique, complex and costly component such as Test Blanket Systems (TBS) for ITER, the European consortium TBM-CA developed an organization to define, monitor and control the compliance of the system according to the requirements and technical specifications all along the life cycle of the TBM sets. The MDIT is the group responsible for the Configuration Management tasks since 2009 in the framework of the grants awarded by F4E. The MDIT combines several units involved in these configuration tasks: a) the Configuration Officer who is responsible to control the configuration process, including the interface management, b) the Quality Officer in charge of the

change and nonconformance processes which can directly affect the design, c) and the Central Design Office that provides CAD models.

A Configuration Control Board (CCB) was created also to determine the configuration baseline. This baseline includes the approved requirements (functional and physical) per Configuration Items, interfaces, quality/safety requirements. . . The CCB is chaired by the Configuration Officer.

Due to the evolutionary nature of the present design of the TBS, it became very important for the Consortium to control the configuration items, because the products are shared among the different teams in 6 European Institutes. One can change a part, with a deep impact in another sub-system.

To be able to freeze the Configuration items as "baseline" is a prime importance for the functional behavior of the consortium. Then the Baseline can be shared by all the teams and the CCB can control the validated change and the distribution of information. In addition, the baseline established by the CCB includes the project control (schedule, risk, resource and cost) and documentation (Smarteam and Document Management System based on SharePoint 2007).

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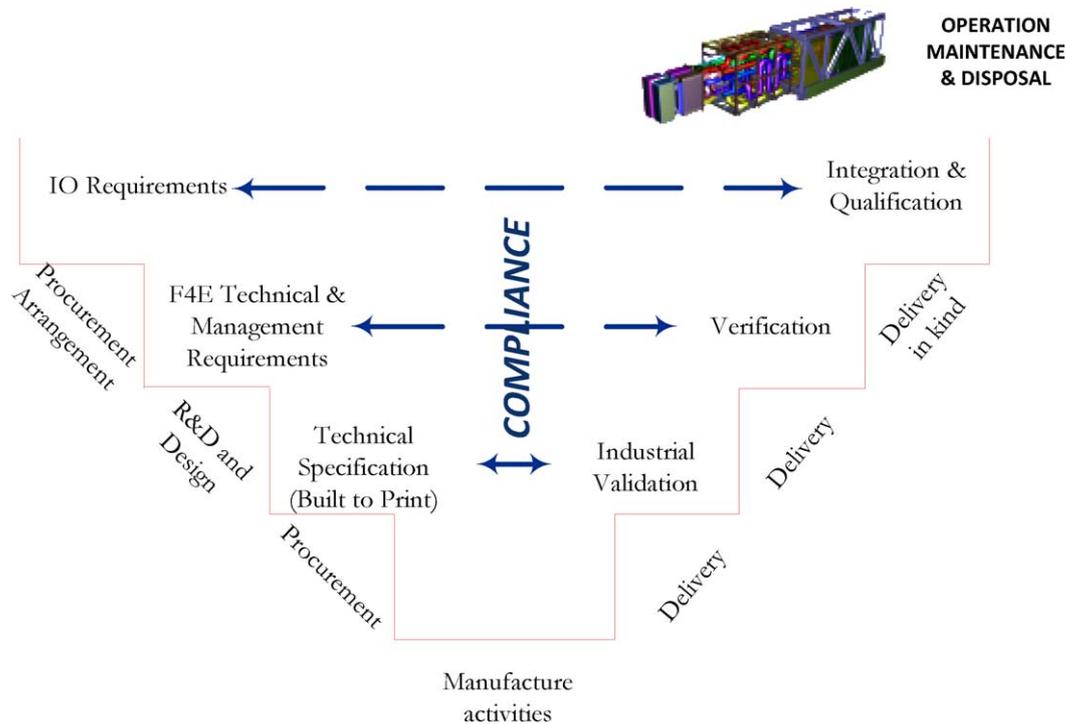
Fig. 1. CM in the life cycle of the TBS.

This paper aims to describe the TBM-CA configuration management through an example with one of the two TBS European types: the Helium Cooled Lithium Lead (HCLL) concept developed by CEA [1].

2. Principles of configuration and main characteristic of TBM-CA approach

The TBM-CA Configuration procedure is drawn according to the ISO 10007:2003 standard [2]. The Configuration Management (CM) is used for the establishment and the control of the product's functional and physical characteristics compared to its design and operational requirements. The CM will be applied throughout the entire life cycle of the product in the framework of the contract awarded by F4E or IO.

The CM allows the TBM-CA Team members to:

- access to the technical description of a Configuration Item using approved documentation by F4E and IO,
- control the internal interfaces and monitor the external ones;
- record the approved modifications of the technical description of a Configuration item;
- get an up-dated product definition from the baseline, in real time frame (Configuration Status Accounting),
- verify that technical description remains the exact products to be delivered to IO according to its requirements;

This approach is similar to the one presented in [3–5] for ITER or in [6,7] for other facilities.

3. Method

3.1. Configuration management plan

When the management requirements are applicable (Quality Plan approved), all the TBM-CA team members can use the configu-

ration process defined by the consortium. The Quality Plan includes a Configuration Management Plan. This configuration Management Plan must be executed also by all the Consortium's suppliers.

Interfaces Management is an integral part of Configuration Management. It is detailed in [8] (Fig. 1).

3.2. Implementation of configuration management

Implementation of configuration management comprises the following processes:

- the management of the requirements (Microsoft Excel files),
- the Configuration Identification that includes the selection of Configuration items and the record of the Documentation Configuration Baseline (Sharepoint),
- the Configuration Verification where the Configuration Control Board approve the baseline by reviews,
- the Configuration Control (change management and nonconformance processes; approval of the deliverables recorded in sharepoint)
- the Configuration Status Accounting (Configuration items definition and approved modification–change, nonconformance–new deliverables recorded in a Microsoft Excel files)
- the Configuration Audits (demonstration that each CI (Configuration Item) meets its documented functional, performance and physical characteristics and verify the efficiency of the TBM-CA Configuration Management)

The implementation is described in Fig. 2.

4. Results

4.1. HCLL EM-TBM configuration item

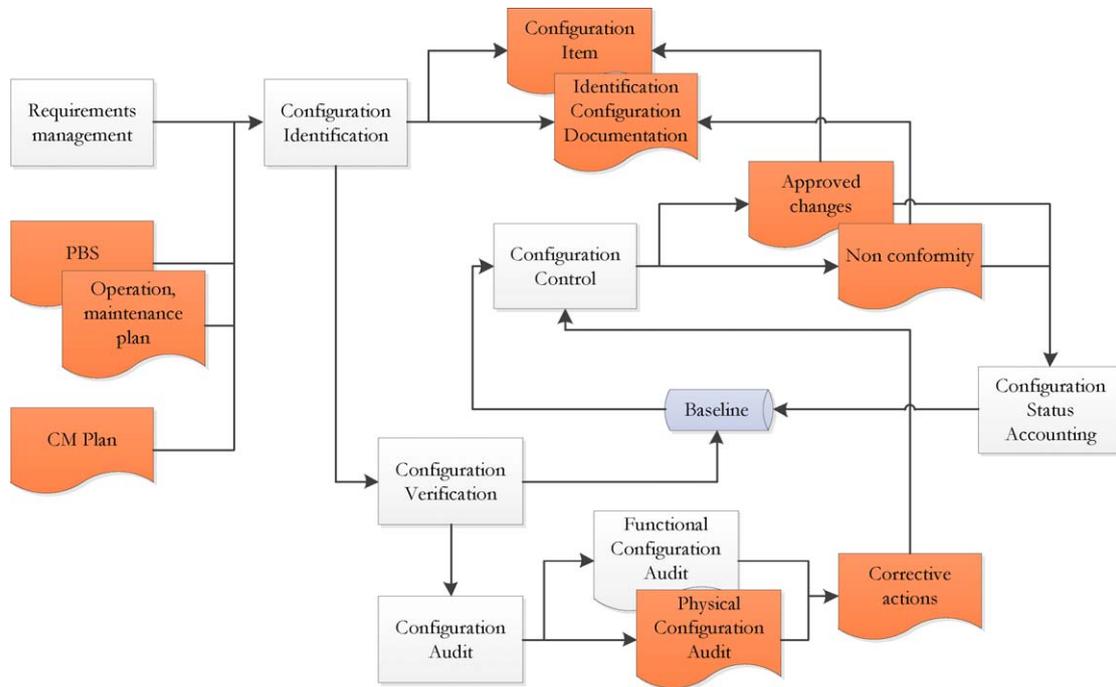For the Electromagnetic TBM (HCLL EM-TBM), the product tree provided by IO/F4E defines only the 3 first levels [9].

Fig. 2. CM implementation in TBM-CA.

From this input data, the consortium added several levels to achieve the work to be done in the framework of the contract. It's still a high level PBS, but it allows us to define the Configuration items.

There are four identified Configuration Items for the HCLL EM-TBM (Fig. 3):

- Breeder Zone (56.A1.M1.S1.X1)
- Generic Box (56.A1.M1.S1.X2)

Fig. 3. Configuration items of the HCLL EM TBM.

- Stiffening Grid (56.A1.M1.S1.X3)
- Manifold (56.A1.M1.S1.X4)
- Instrumentation (56.A1.M1.S1.X5)

4.2. Documentation configuration baseline

For each CI, the existing related documentation is identified and recorded (Fig. 4). For all CI, 54 documents constituted the baseline to start the tasks.

4.3. Configuration baseline

Configuration baselines represent the approved version of requirements and design. The configuration baseline is established during technical reviews. In the framework of a contract awarded by F4E, there must be two important milestones:

a) After the KoM, when input data are submitted by F4E, the first baseline can be established by the CCB and can be qualified "as required".
b) Before the final meeting, when all the deliverables with their acceptance data package are accepted by F4E, the second baseline can be established by the CCB and can be qualified "as defined" for the actual phase of the TBM project.

The configuration baseline describes the physical and functional characteristics of the configuration items issued from the Documentation Configuration Baseline and CAD data file.

One of the feedbacks from actual contracts is that the establishment of this baseline needs about a month to prepare the review, and has to be incorporated in the schedule from now on. The technical tasks cannot start prior the review process.

4.4. Configuration status accounting (CSA)

TBM-CA developed a data file to establish the Configuration Status Accounting to record, store and retrieve the following configuration data:
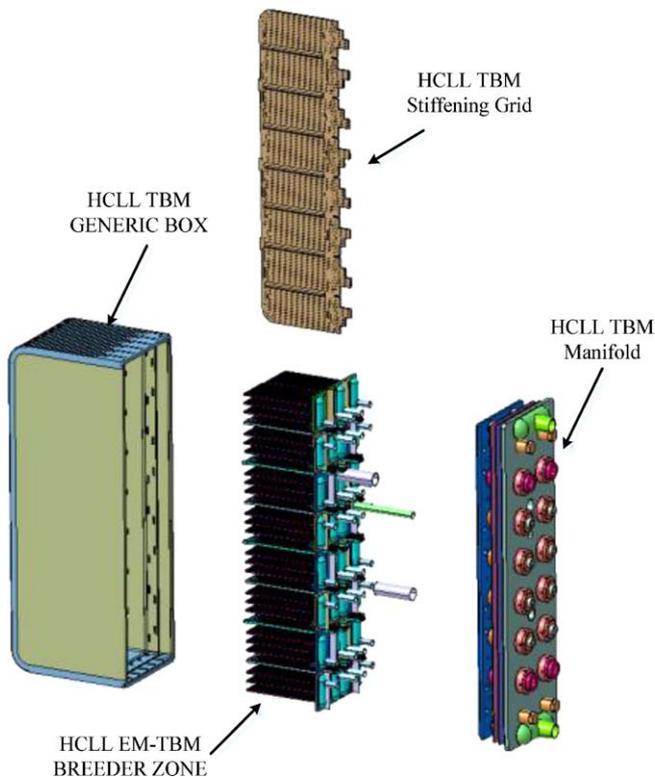
HCLL EM-TBM Documentation Configuration Baseline					
Technical			Management		
Specification		Safety	Scope	Time	Product
ITER (on IDM) — Council	Project Specification				Schedule	
ITER (on IDM) — Manag.	Plant description — Project Requirements — Iter PID — Iter Research Plan		Safety Files	WBS		
ITER (on IDM) — Dpt.	SRD-56 — Plant Control Design Handbook; Codes & Standards — ITER Vacuum handbook; Procurement Technical Specification — DDD; Interface Control Document — Load specification; TBM Test Plan Proposal — SDC — Drawings			SIC components	Schedule	PBS
F4E (on IDM) — Div.	Management specification — Input data, software/models, physical correlations and material properties for HCLL TBM generic box and shield design activities; Technical specification			WBS	Schedule	
			Detailed table of content of the HCLL TBS - (PrSR)	WBS	Schedule	PBS

Fig. 4. HCLL EM-TBM Documentation Configuration Baseline.

- status of F4E requirements;
- status of the HCLL TBM configuration baseline;
- design status of the configuration items (into Smarteam/Catia);
- status of HCLL TBM deliverables, once approved by F4E;
- status of HCLL TBM configuration documentation baseline and configuration data sets;
- status of approval of changes and deviations and their status of implementation;
- status of actions derived from technical reviews and configuration verification reviews.

Doing this, TBM-AC assumes to catch the complete design documentation of the HCLL EM-TBM. But the amount of data to manage is quite huge. The use of a simple tool such as Excel data file will limit the efficiency of the method. An improvement way could be to adopt a configuration management tool at the level of MDIT.

4.5. Configuration control

Change control procedures are applied following the establishment of the first baseline by the CCB.

Configuration control ensures that all changes or deviations to agreed configuration baselines, including their released and approved documentation are processed and controlled in a traceable manner.

When a new requirement is notified by F4E, an impact assessment on the task must be provided to the CCB by the technical staff. This assessment will help F4E and the CCB to approve the change. Then, the CSA is updated with the related documentation. In the case where the change is proposed by the consortium member team, there are two processes to manage it:

- Major deviation (when a F4E requirement is modified), through the prior F4E validation;
- Minor deviation (for other configuration baseline items) where the CCB must adopt the proposition.

Once approved, MDIT is in charge of the process for controlling the evolution of the baseline. It includes the preparation,
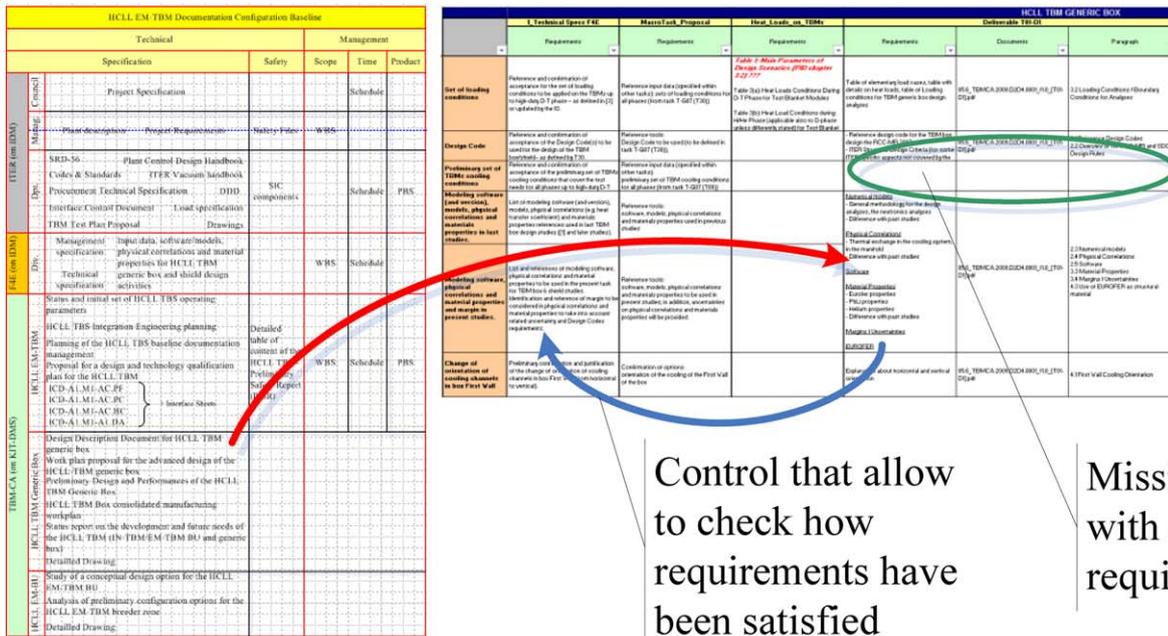
Fig. 5. This figure illustrates how the links are established for each CI between the Documentation Configuration Baseline (red arrow), the F4E requirements and the check of the compliance into the deliverables (blue arrow and green circle). (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of the article.)

justification, evaluation, disposition and implementation of engineering and contractual changes and deviations.

From each deliverable approved by F4E, the new characteristics of the HCLL issued from the results are included into the CSA. MDIT can also easily check the compliance with F4E requirements (Fig. 5).

The feedback of present contracts shows a lack of implementation of this configuration control process by both F4E and TBM-CA (no change or deviation recorded!). This is not critical in the preliminary conceptual design phase. But this issue must be tackled rapidly by a culture change. The advantage shown by the case study on HCLL TBM is a great step towards a better dissemination and acceptance of the method by TBM-CA member team.

5. Conclusion

After months of development during the first contract with F4E, the system that allows an efficient TBM-CA Configuration Control is established with the associated tools. The result shows that the proposed methodology is suitable and provides quality solution for the items with a complex configuration such as HCLL EM-TBS.

CM supply confidence in the system throughout its development and check that the system and all its parts do what is wanted, allow derivation coverage analysis, and prevent over design or omitted needs

This traceability allows analysis such as impact analysis, impact coverage analysis and derivation analysis before to submit it to F4E. The system shall be applied for future contract with F4E.

Possible improvements are foreseen: benchmark of Configuration Management tools in order to avoid working with MS Excel and a specific training program to help the team members to adopt the method.

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