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CAD Manual 04-6 Mechanical Design Configuration Models Management

This document describes the Design Process for Mechanical Design Configuration Models Management (CMM).Previously included in Section 4 - Design Processes

Approval Process			
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Change Log			
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CAD Manual

Section 4-6 Mechanical Design Configuration Models Management

Abstract

This document describes the design processes for the Mechanical Design – Configuration Models Management in the IO DO.

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Major Changes

Version	Date	Location	What

Table of Contents

List of Figures

List of Tables

4.6 Mechanical Design Configuration Models Management (CMM)

The ITER plant will be composed of complicated, heavy and sensitive components that have to be assembled on site with a high accuracy. Each of these components will have its own specifications and tolerances according to its manufacturing, assembling and operational status.

Technical Integration (TI) has to ensure from the start of design the consistency between all components and with the buildings. This will be realised by establishing 3D CAD models called “Configuration Models” (CM) which represent the structure and geometry of the components.

The CM will be used to perform:

- Collision analysis and comparison with the Detailed Model (DM) and Alternative design Model (AM)
- Interface definition and checking between systems
- Space allocations for systems to be designed considering supports and penetrations
- Tolerance studies
- Assembly simulations
- Top level drawing

As design evolves the CM shall be updated by the detail design data during the life-cycle of the data.

In addition, the CM shall be used to deliver technical data to the Domestic Agencies (DA). The CM is used as a reference model for any technical monitoring and surveillance to IO and DA side.

The CM shall:

- Be created and structured according to the PBS
- Allow identification according to the PBS and functional reference
- Allow filtering according to:
  - The PBS
  - Location (GBS)
  - Representation (CM,DM,AM, CMD)
  - Level of detail
- Be optimized for loading time:
  - optimized data size
  - optimized tree structure
  - reduced level of detail
  - minimized number of faces
- Be maintainable with a reasonable effort but with controlled associativity/links to the detailed model (DM)

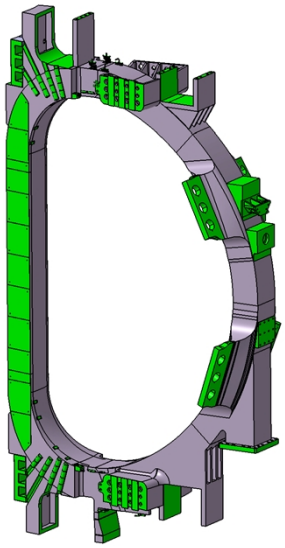

Figure 4.6-1 Example of a TF CM with interfaces indicated by colour

Abbreviations used in this document

AM	=	Alternative design Model
BREP	=	Boundary REPresentation (CATIA)
CAD	=	Computer Aided Design
CCB2	=	Configuration Control Board 2 meeting
CCP	=	Copy/Cut/Paste
CDC	=	CAD and Design Coordination division
CGR	=	CATIA Graphical Representation
CIE	=	Office for Central Integration and Engineering
CM	=	Configuration Model
CMD	=	Configuration Model Detailed
CMM	=	Configuration Model Management
CMPC	=	CAD Manual and Processes Coordinator
CMS	=	Configuration Model Skeleton
CSKE	=	Component SKEleton
CV5	=	Catia V5
DA	=	Domestic Agency
DIN	=	Design INtegration
DM	=	Detailed Model
DMU	=	Digital Mock-Up
DO	=	Design Office
DOSL	=	Design Office Section Leader
EV5	=	Enovia V5
IDM	=	ITER Document Management system
IO	=	ITER Organization
LCA	=	Life-Cycle Application (ENOVIA)
PBS	=	Plant Breakdown Structure
PRC	=	Product Root Class
RE	=	Responsible Engineer
RO	=	Responsible Officer
RSKE	=	Reference SKEleton
SKE	=	SKEleton
TI	=	Technical Integration

4.6.1 CM Methodology

4.6.1.1 CM Method introduction

In CATIA mechanical components and plant system components are designed using different workbenches and methodologies. Therefore the methodology for the related CM is also different.

Mechanical components (inside cryostat)	Comment	Methodology	Functional reference	Sub-chapter
In DM skeleton based		CM skeleton linked to DM skeleton	NO	4.6.1.2
In DM not skeleton based to be transformed	DO should update the DM methodology before the CM SKE is build	CM skeleton linked to DM skeleton	NO	4.6.1.2
In DM not skeleton based and not to be transformed	SKE does not make sense for all components, has to be decided case by case	New reference from DM, no link, manual update	NO	4.6.1.2
Standard parts		Separate subassembly as leaf instance with CMD representation	In certain cases (ex. robot)	4.6.1.7

Table 4.6-1 CM classification according to methodology

4.6.1.2 CM creation process

The CM creation method for the majority of the mechanical components is based on CM component skeletons and Master parts that are specifically made for the CM usage.
In order to be isolated from the Detailed Models, the CM parts and Master parts must not be directly linked (through CCP) to any Detailed Model.

<table>
<tr><th colspan="2">General use</th><th colspan="3">DI dedicated use</th><th colspan="2">General use</th></tr>
<tr><th colspan="2">Detailed Models</th><th colspan="2">CM Skeleton</th><th colspan="2">CM Master part</th><th>CM Structure</th></tr>
<tr><td>Reference SKE</td><td>CCP links</td><td rowspan="2">CM CSKE</td><td rowspan="3">CCP links</td><td rowspan="3">CM Master part</td><td rowspan="3">CCP links</td><td rowspan="3">CM parts in the PBS structure</td></tr>
<tr><td>Component SKE</td><td>No link</td></tr>
<tr><td>Specific part</td><td>New reference If needed</td><td>CM CSKE</td></tr>
</table>

Table 4.6-2 CM creation process

4.6.1.3 CM dedicated skeleton and interface creation

The CM skeleton should be used to group all interfaces that are required to build up the CM Master.
All the interface information has to be brought from the detailed model reference skeleton. This means that DIN has to create their own skeleton using the elements taken from the detailed model reference skeleton through the publications and CCP links process.
The use of these links allows DIN to keep control of the CM SKE history.
Only the elements that are required for the CM creation will be taken into account and used to produce CM interfaces and 3D models.

Particular case:

If no skeleton exists for a group of parts, the DIN will have to build a skeleton using the sketches and elements used in the detailed model. This only makes sense if the part has a complex feature tree. Otherwise the data size is not significantly reduced.
This DIN created skeleton should not be linked by CCP or any type of link to the detailed model part, in order to respect the link hierarchy and the maintainability of the CM.
The DIN could also create a new reference from a DM part in order to get a CM skeleton in deleting all the elements of the parts that are not needed for the CM creation.

Note:

- No 3D Part Bodies are allowed inside a CM component skeleton.
- In any case, once the CM skeleton is created, all the requested elements shall be published in order to be used in the CM Masters.
- The DIN could create more than one CM skeleton per PBS if a single skeleton does not satisfy all the requests.
- The link hierarchy shall not be deeper than 2 levels inside the CM: SKE-MASTER-Component
- The CM skeleton must not be sent outside of the IO database.

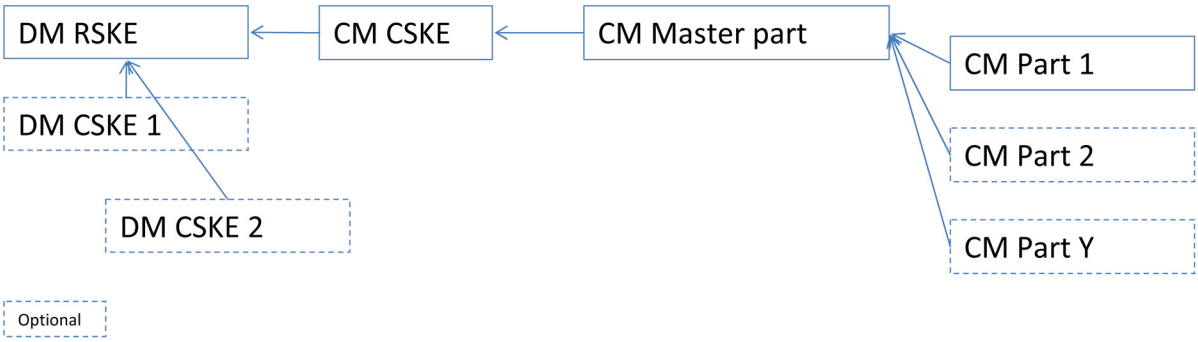

Figure 4.6-2 Skeleton link hierarchy

4.6.1.4 CM Master Part Creation

The Master part is the next step in the CM creation process.
This Master part should contain 3D bodies that are built with appropriate external references from the CM component skeleton through the CCP link procedure.
All the bodies should contain 3D features with pads, pocket, sketches and other elements compliant with the Section **Error! Reference source not found. Error! Reference source not found.**
The body colour property should be set to Automatic, green colour should be applied to set up all the proper physical interfaces.

The body features created inside the Master part can be simplified in comparison with the DM; this will allow the resultant bodies to be lighter than the detailed bodies.
All the resultant bodies shall, after creation be published with proper names in order to be used in CM parts.
The Master part is only to be driven by a CM DECO or PBSA; this will grant the history and maintainability of the Master part.
The Master part must not be sent outside of the IO database.

4.6.1.5 CM parts creation

After the CM CSKE and Master parts are created and the Master part bodies are published, the CM Designer can create the CM parts according to the DIN PBS structure.
These CM parts can be either multi-body or single body parts.
After CM part creation, the bodies must not be published.
This level is the only one that can be used by the designers and domestic agencies; this means also that this structure will be the only one that can be sent outside of the ITER organization database.

4.6.1.6 Example using the CM methodology

This example shows the CM creation method steps.
Step 1: Creation of the CM dedicated skeleton and interface.
The DM skeleton is used as the reference for the creation of the CM skeleton. All required published elements will be copy/pasted using the CCP procedure into the CM skeleton.

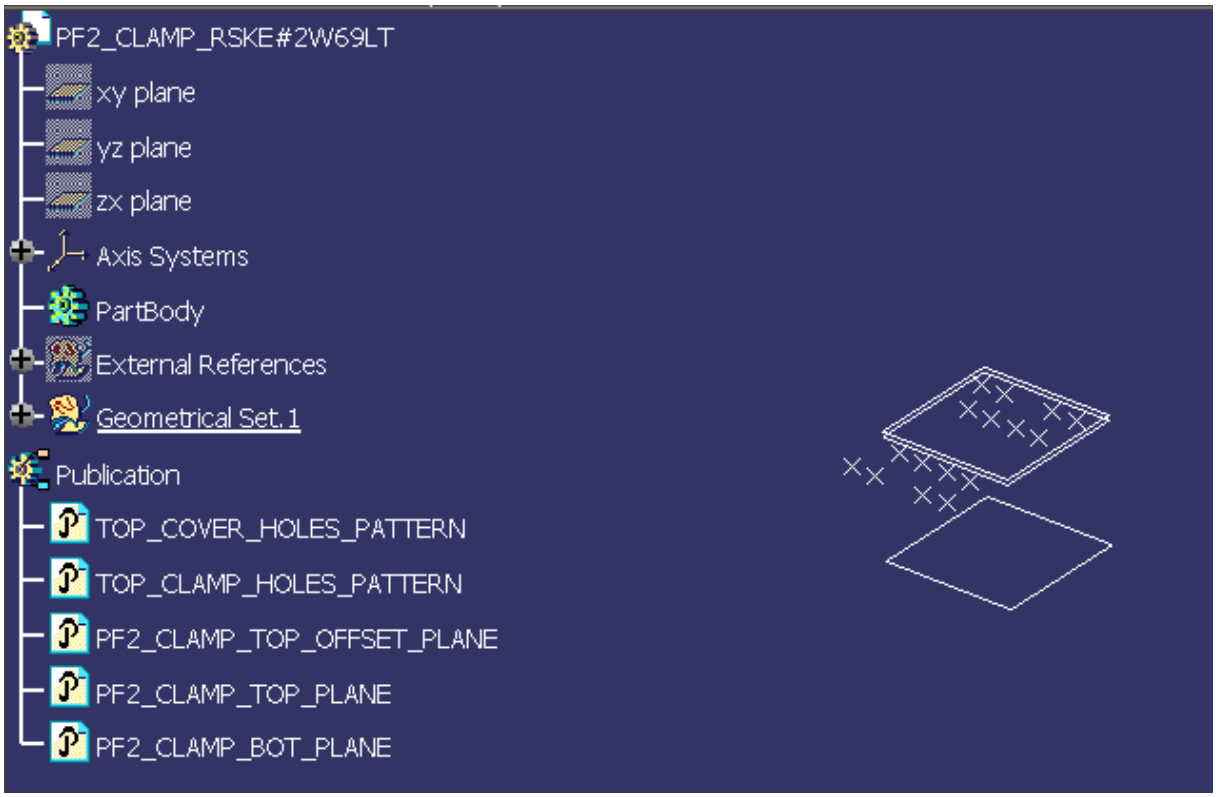

Figure 4.6-3 Example for DM reference skeleton

After the CM skeleton reference has been created, all the required published elements can be pasted into the DM skeleton.

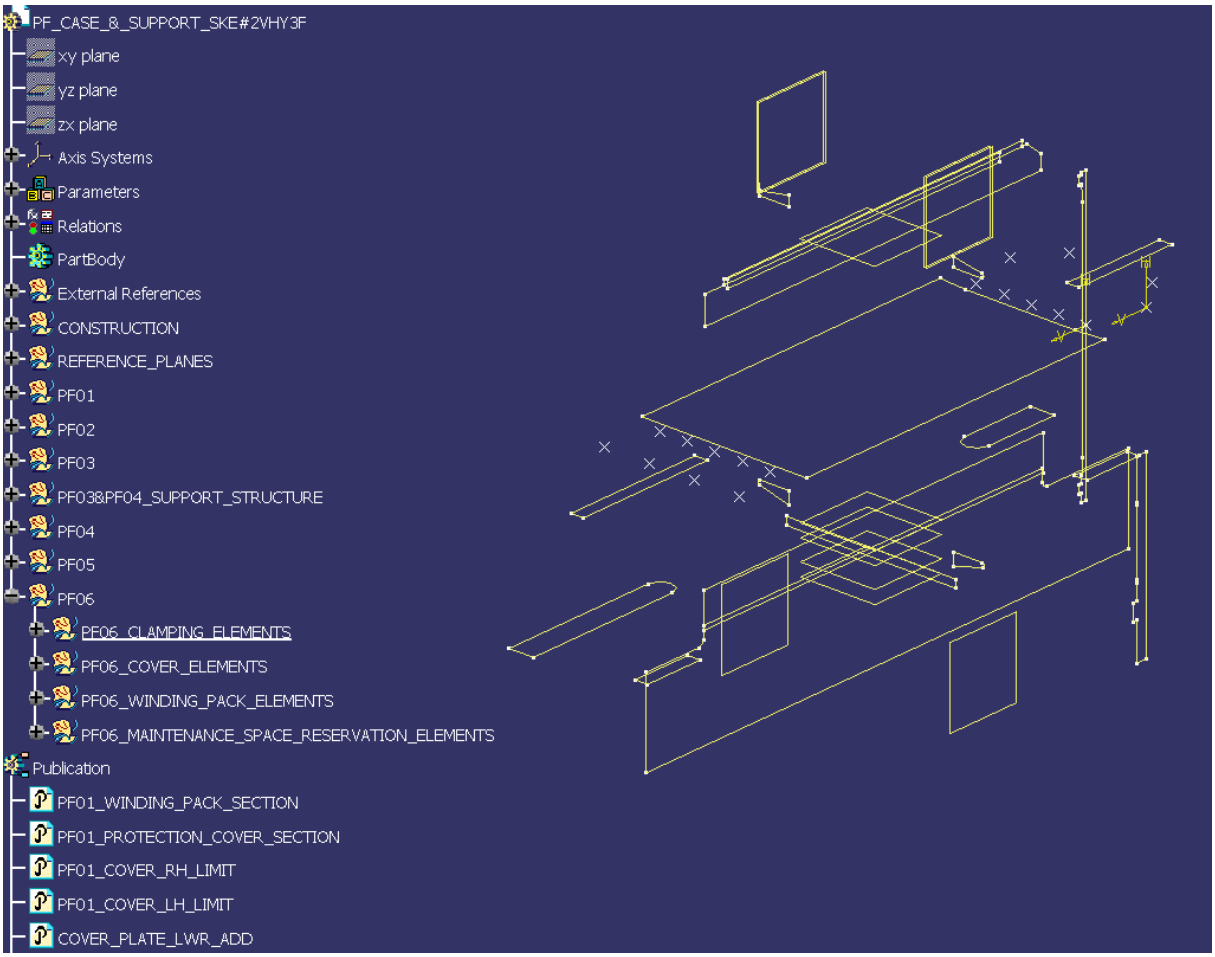

Figure 4.6-4 External references from DM in CM component skeleton

Once all the required geometry and elements have been created inside the CM skeleton, this means that sketches and elements present in the geometrical sets have been simplified for CM purpose, all the resultant required elements shall be properly named and published.

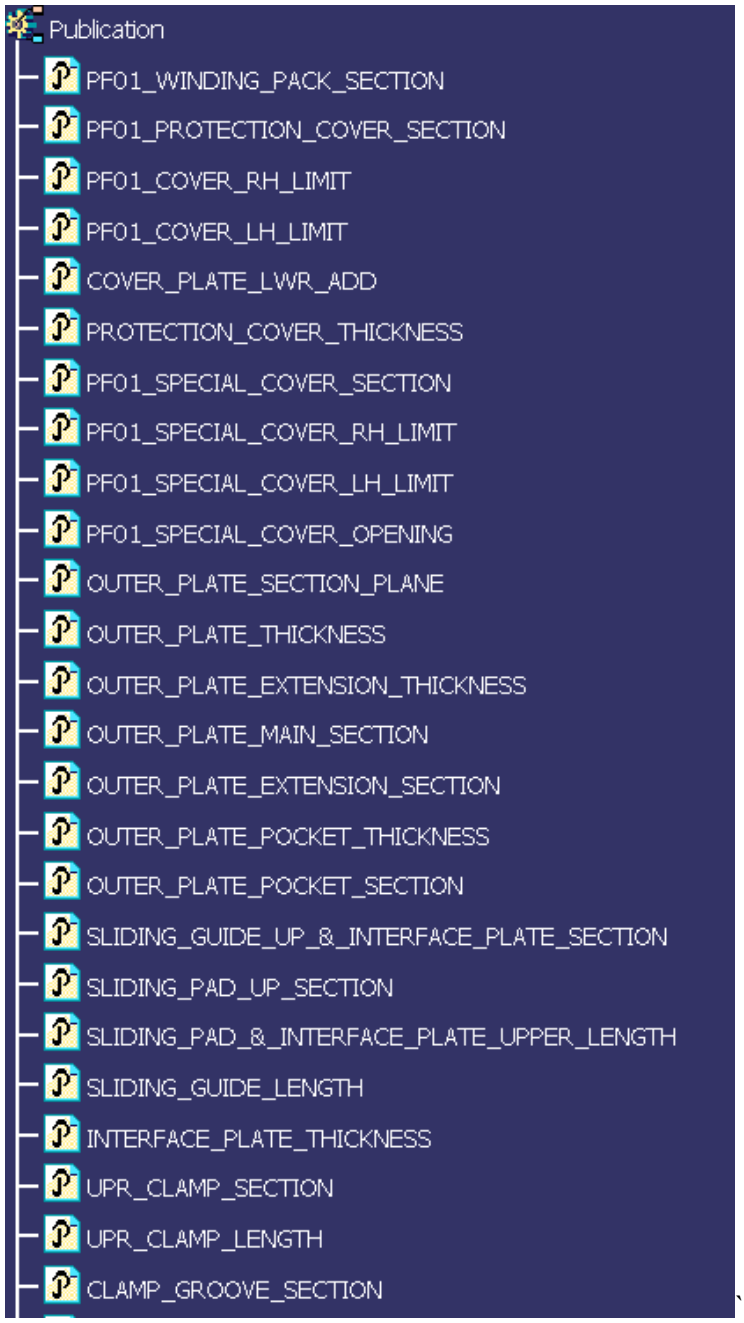

Figure 4.6-5 Example for CM component skeleton publications

Step 2: Creation of the CM Master part.

After the CM CSKE has been created, the CM Master part can now be constructed. The bodies are created using 3D features linked to external references that are coming from the CM CSKE.

There should be no feature without a link to external references inside the CM Master.

No new feature or function should be added on the part in the CM.

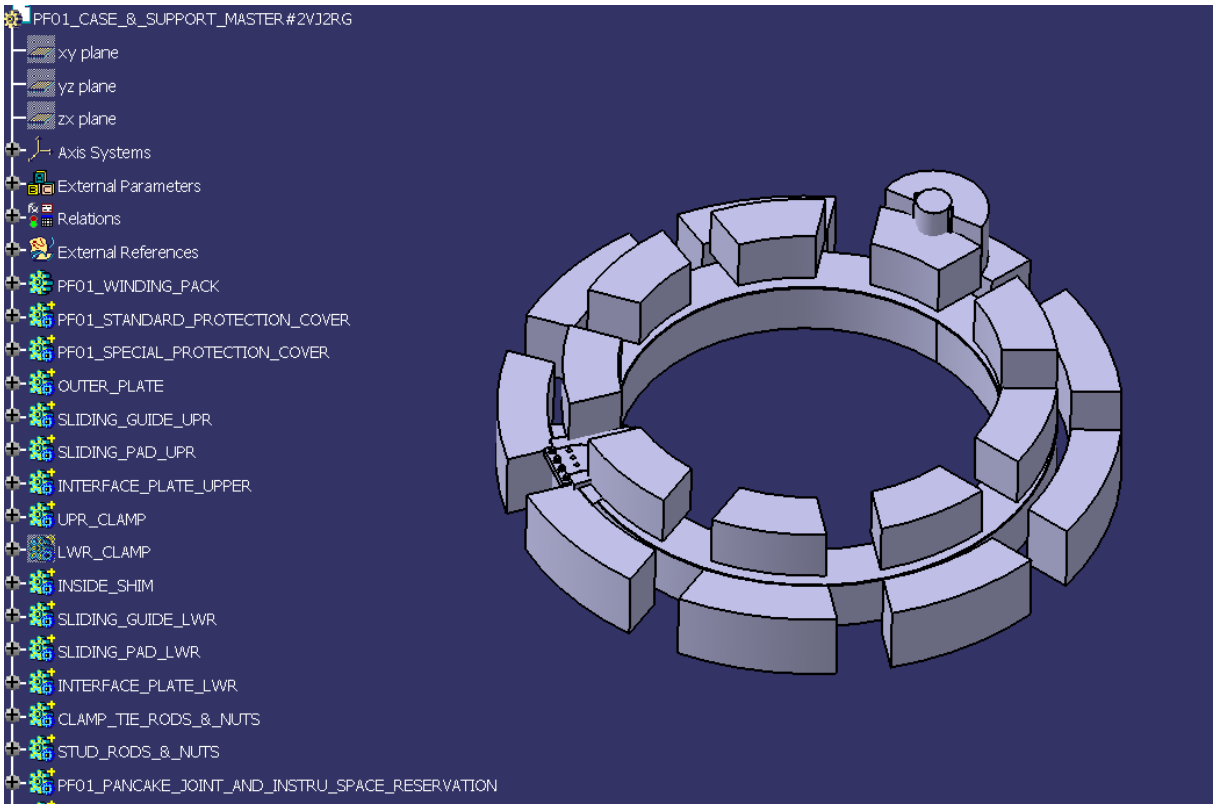

Figure 4.6-6 CM Master part

When all the resultant bodies have been created, they have to be published in order to be used in the CM component which occurs in the tree structure.
The bodies have to be clearly named, as they will not necessarily be pasted into the same final part.

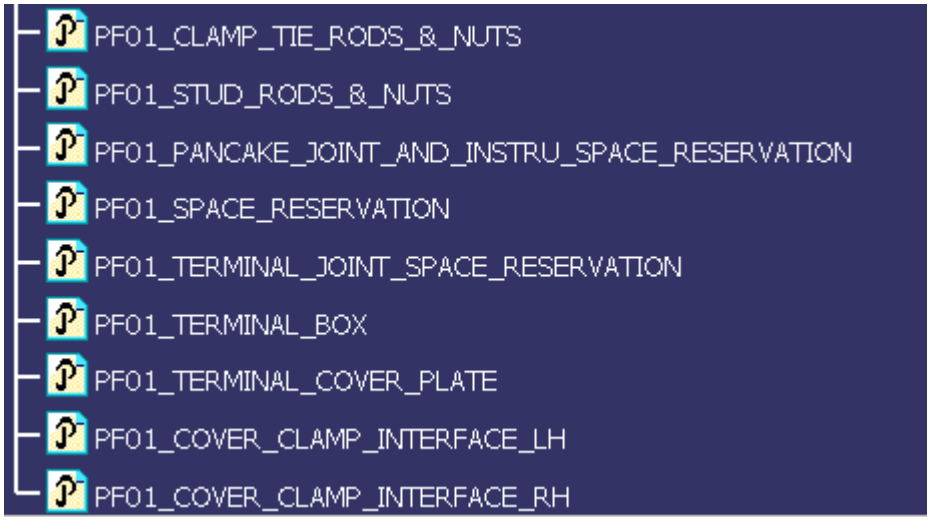

Figure 4.6-7 CM Master Publications

Step 3: Creation of CM parts.

After the creation of all CM skeletons and related Master parts, the tree structure can be developed according to the PBS requirements.
Groups of parts will be created; these parts will contain all the required bodies copied from the Master parts using the CCP link procedure.
Instances are to be used as often as possible, mainly for parts, in order to reduce the data size.
In this final step, publication of elements is not allowed.

All solids must be linked solids, regardless of whether the referenced geometry (SKE) is loaded or not.

Figure 4.6-8 CM Parts creation

In the assemblies, the positioning skeleton should be used as much as possible.

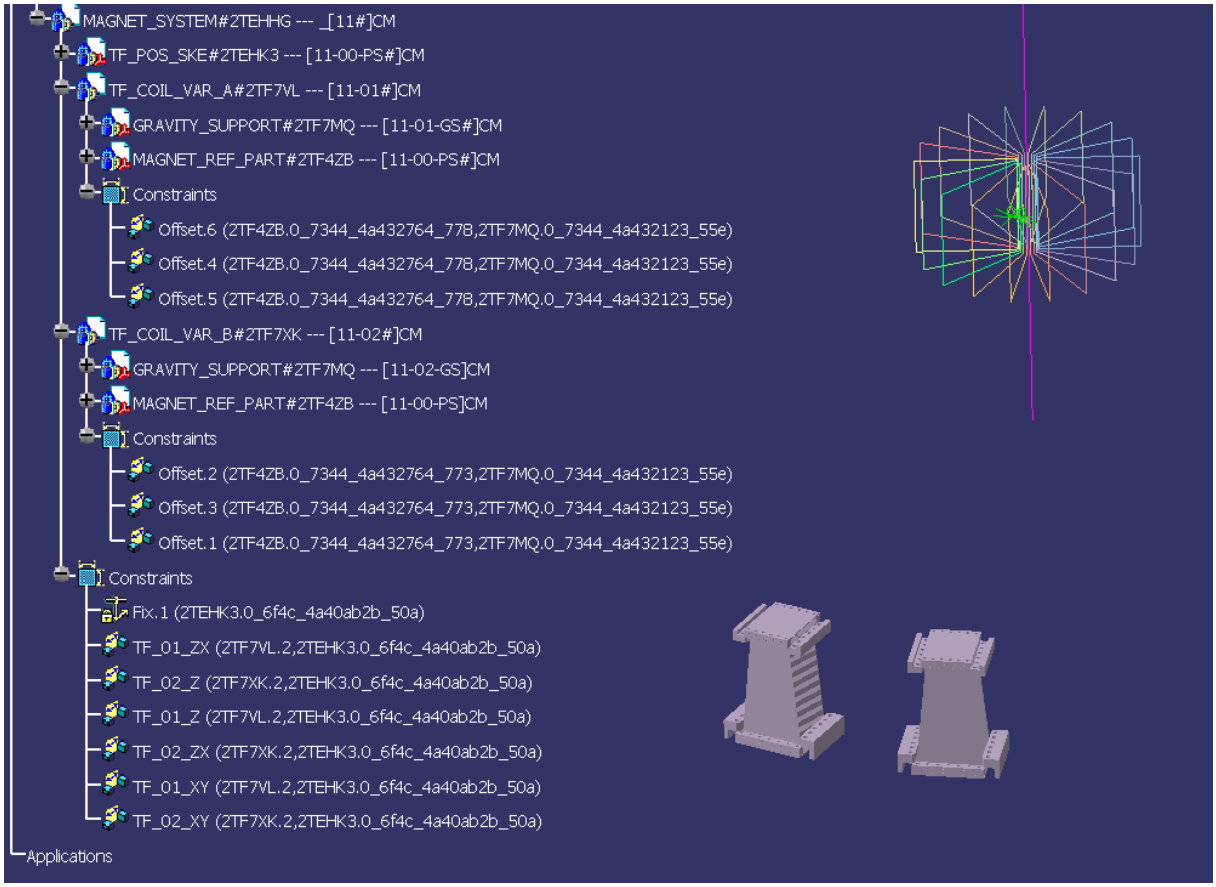

Figure 4.6-9 CM Tree structure management

4.6.1.7 Level of detail and standard parts

To meet the requirement of reduced data size, the geometry of the CM shall be simplified in comparison to the DM as long as relevant envelope and interfaces are unchanged.
Standard parts that are only needed for specific studies like assembly simulation shall be separated on the leaf instance level in a dedicated CATPart or work package with the representation attribute value CMD.
Details like washers shall not be used.

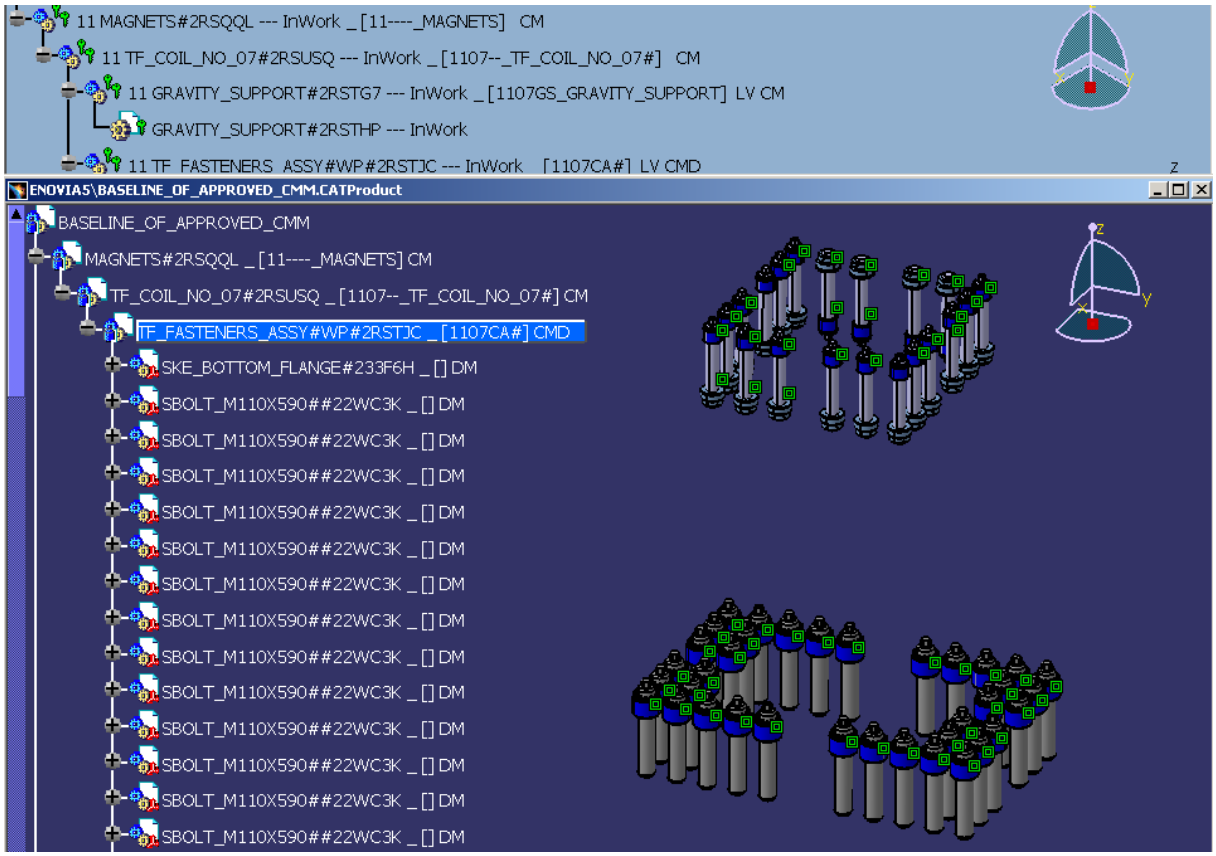

Figure 4.6-10 Example for standard parts in detailed CM (CMD)

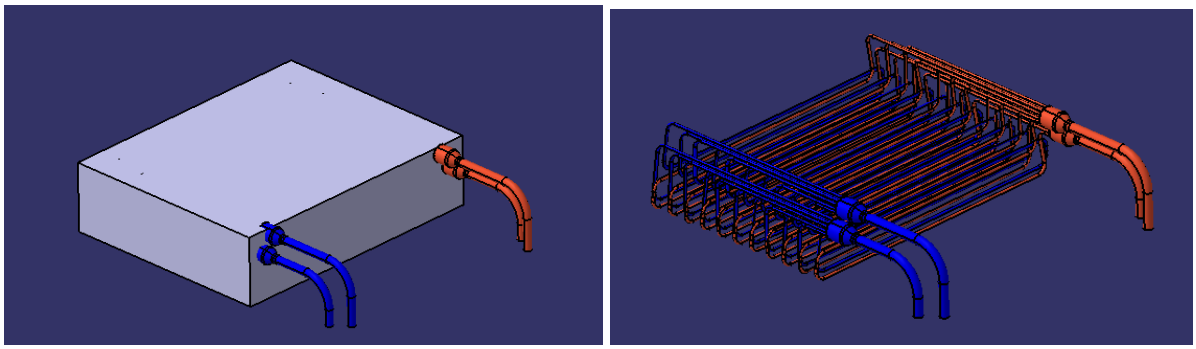

Figure 4.6-11 Example for simplified CM and detailed model DM

4.6.1.8 CM colour coding

As a first step for in-cryostat components it has been agreed to use special colours to indentify the interfaces to adjacent components on the CM.
Magenta = clash
Green = interface

The colour will be applied to faces and other elements in the final CM part not in the skeleton.

4.6.2 CMM Data Structure (EV5)

4.6.2.1 CMM PRC tree structure

As already mentioned in the methodology see 4.6.1.6, the Configuration Models are built in three steps:

Step 1 - CM skeletons
Step 2 -CM masters
Step 3 - CM final tree structure

During the build up period, all in-Work CM data will be kept inside WBS_75_CONFIGURATION_MANAGMENT PRC handled by Design Integration Section. This means that each kind of data (Skeletons, masters and final tree structure) will be created in independent branches:

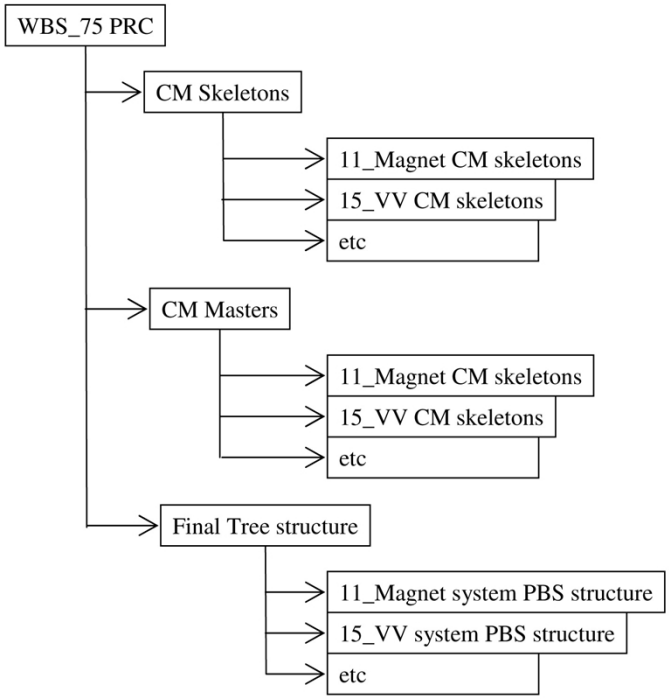

Figure 4.6-12 CMM tree structure

After the Final Tree structure elements are approved, they can be instantiated in the PRC BASELINE_OF_APPROVED_CMM and in the TOKAMAK_COMPLEX by system at the same level as the detailed model node for each system.

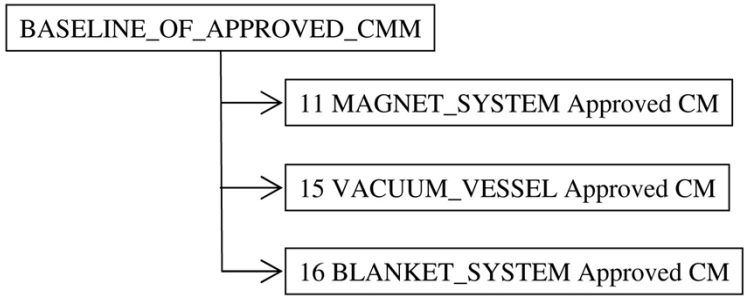

Figure 4.6-13 CM instance in BASELINE_OF_APPROVED_CMM

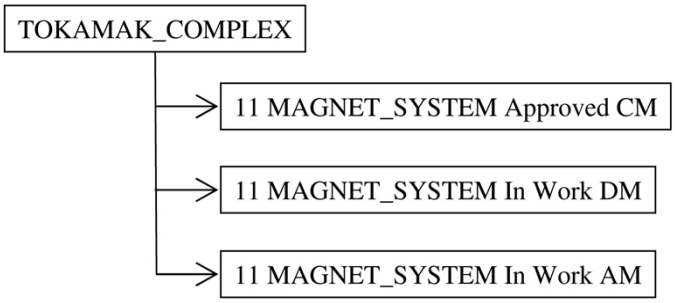

Figure 4.6-14 CMM tree structure in DMU PRC

4.6.2.2 CMM subassembly structure

In the majority of the cases PBS level 1 and 2 are structure exposed assemblies and are unique references. PBS level 3 contains the geometry and is normally a CATPart or a work package. On PBS level 3 instances of the same reference can and shall be used, if the geometry is identical.
In specific cases the geometry can be on higher or lower levels.

Figure 4.6-15 CMM tree structure PBS 1 to 3 in VPMNavigator

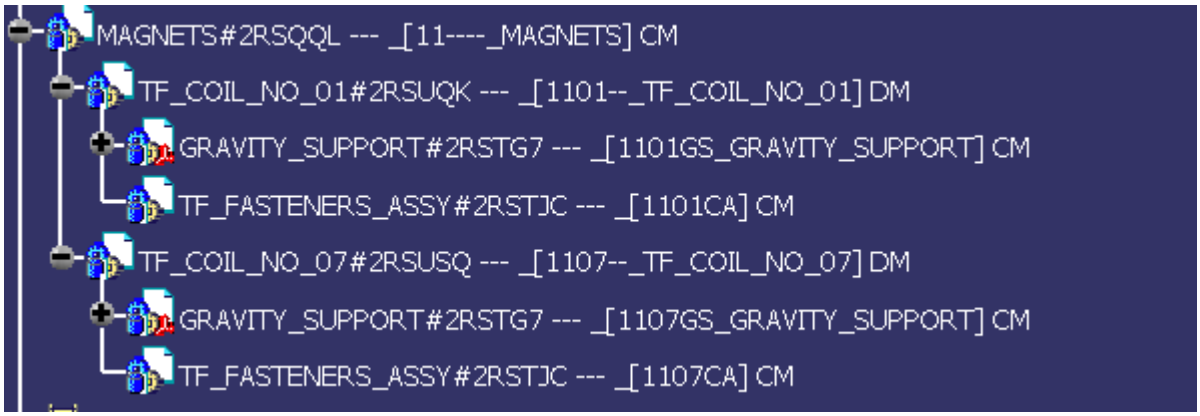

Figure 4.6-16 CMM tree structure PBS 1 to 3 in CATIA V5

PBS level 3 can be split into several WP or parts to allow filtering according to the location. In this case the PBS values will be the same.
The separation of envelope and detail is handled in the same way.

4.6.2.3 CM identification and numbering

PBS levels 1 to 3 and the description values shall be entered in the ENOVIA attributes for part reference and in the Instance description to allow searching and filtering on instances. This approach shall be used down to the leaf instance (normally PBS 3).

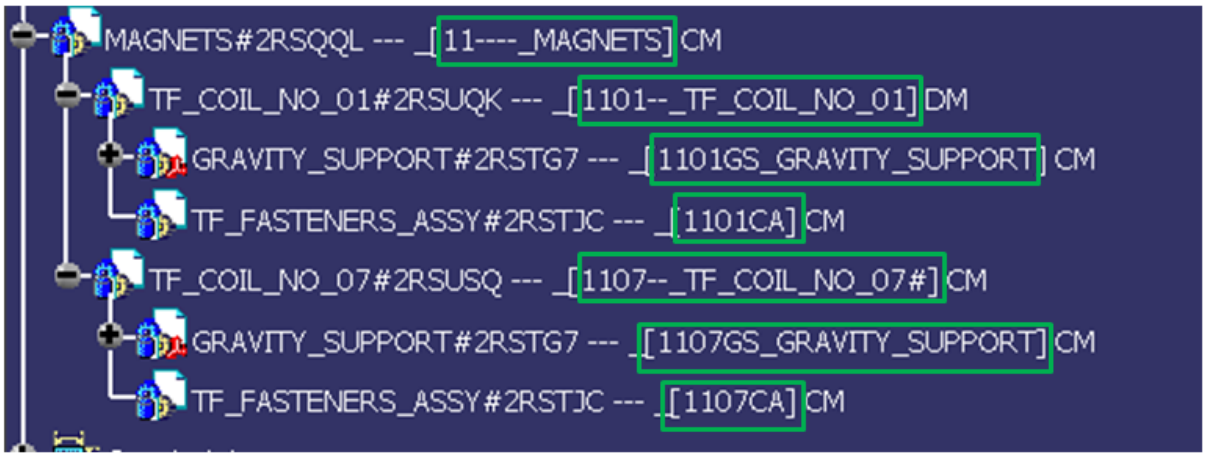

Figure 4.6-17 Unique PBS and description on ENOVIA instance level

For components inside a work package the CATIA instance description shall be used for functional reference if it exists.

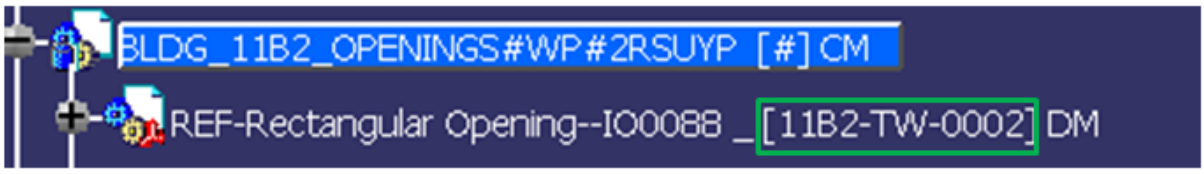

Figure 4.6-18 Functional reference on CATIA instance level

Inside a CM CATPart the bodies shall be renamed according to lower PBS description if suitable or follow the body naming of the DM.

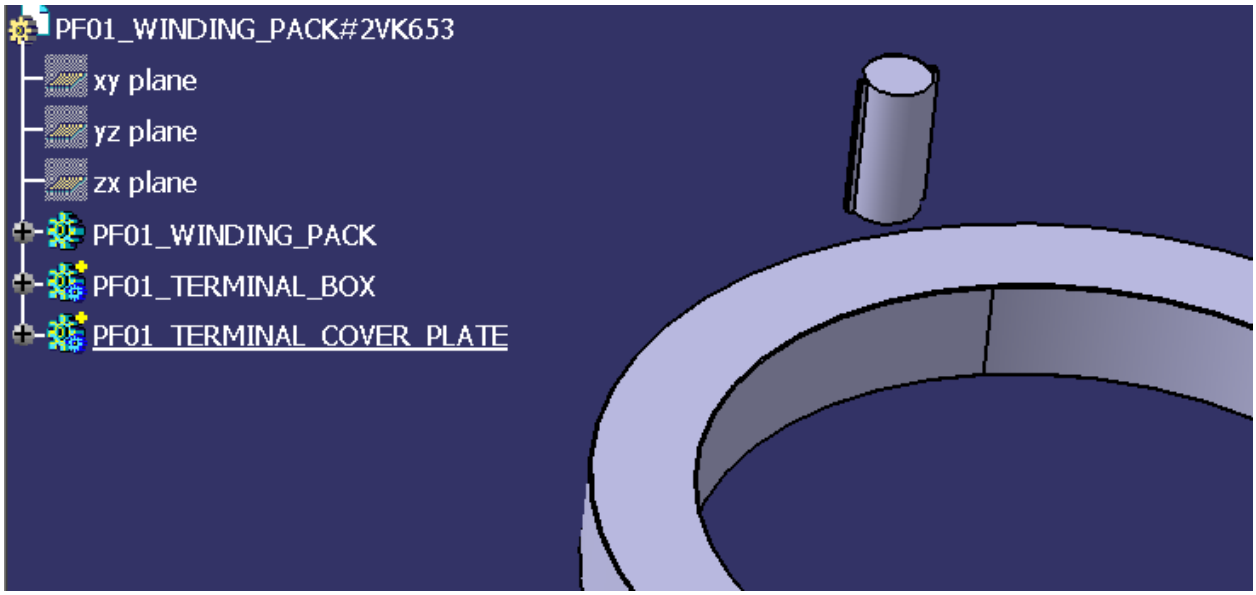

Figure 4.6-19 Example of identification on body level

4.6.2.4 Representation attribute

To allow filtering on ENOVIA trees the following representation attribute values shall be applied:

- CM = **C**onfiguration **M**odel
- CMD = **C**onfiguration **M**odel **D**etailed
- CMS = **C**onfiguration **M**odel **S**keleton

4.6.3 CM Change Control Process

4.6.3.1 CM change and updates procedure

The CM change and update procedure is dependant on the status or advancement of the Detailed Models.
Design Integration is free to decide if the CM has to be updated according to the DM changes or not.
If the DM has been modified and approved, the DI could update the CMS, Masters and parts according to the original DMS or interfaces.
The CMS are the first to be modified.
The DI can choose to which DM document revision the links have to be synchronized.
Once the update to the CMS has been done, the Masters will be updated according to the new CMS document revision.
Then all the CM parts and CMM PBS structure will be updated with the new CM Masters document revision.

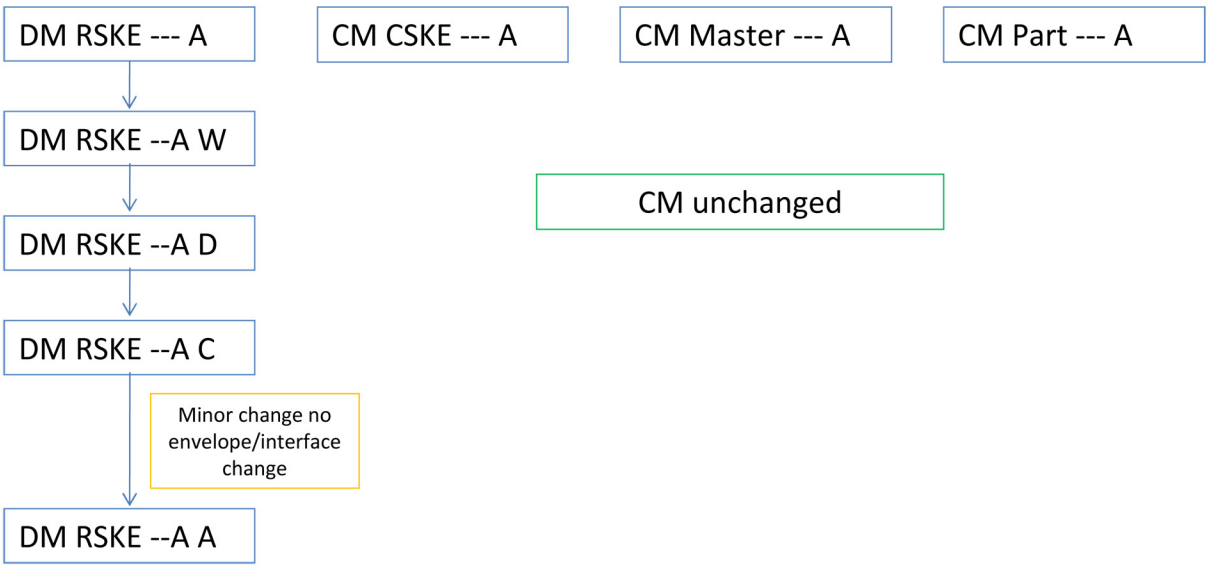

Figure 4.6-20 Change Management: case 1 - minor change

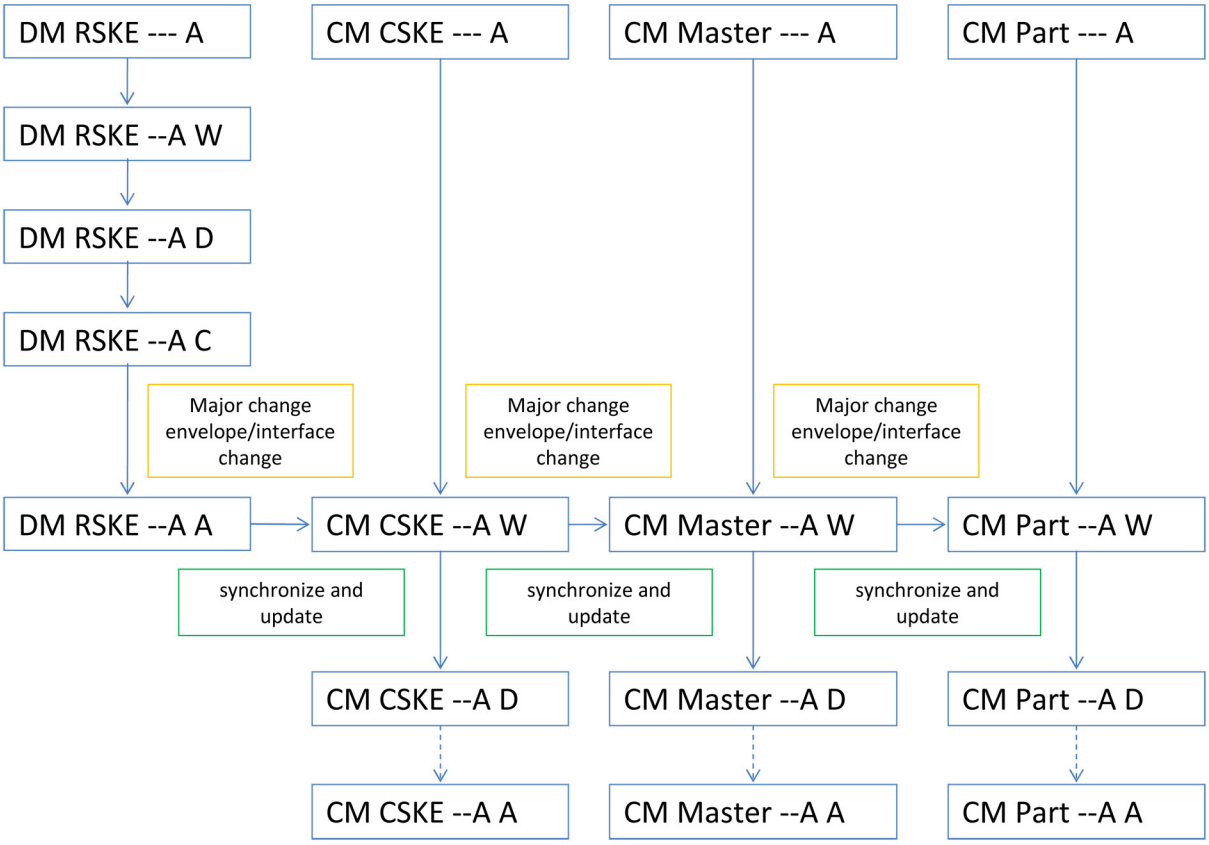

Figure 4.6-21 Change Management: case 2 - major change approved

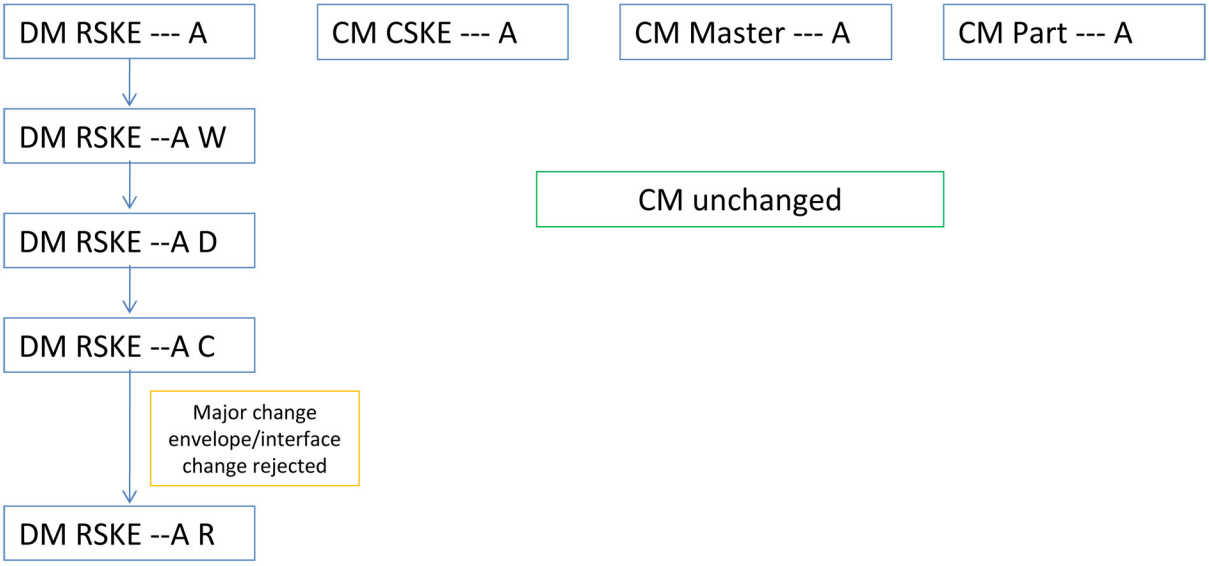

Figure 4.6-22 Change Management: case 3 - major change rejected

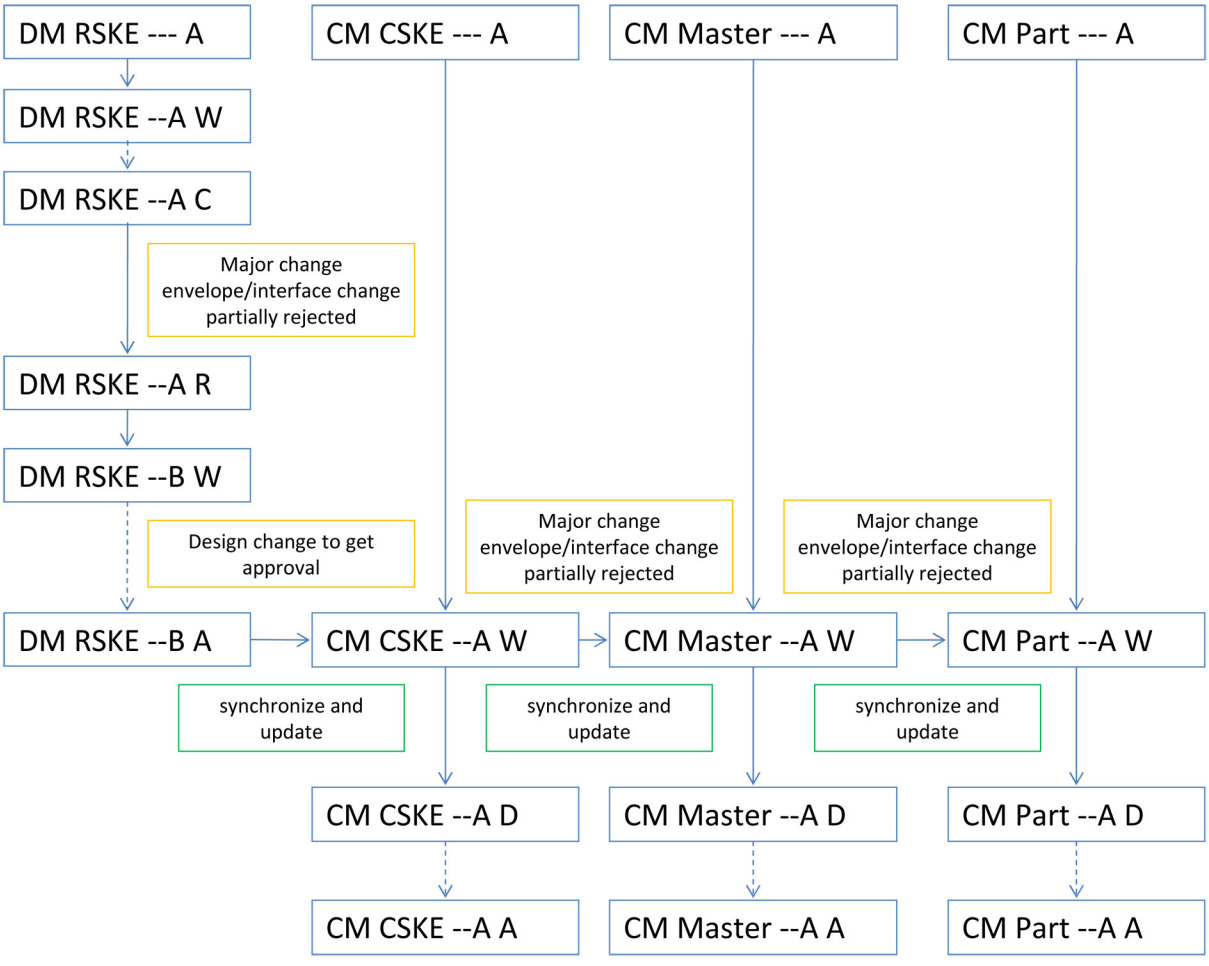

Figure 4.6-23 Change Management: case 4 - major change partially rejected

The important point is that DIN total control of the CMS, Masters versioning and updates. Only the DIN will be able to see, use and handle the CMS and Masters, these two kinds of elements will never be sent outside of the ITER Organization database. The approval process

shall be applied on the CMS but this kind of data shall not be visible outside DIN organization. To achieve this, the representation value CMS (- S for skeleton) must be used.
If the CM evolves in such a way that geometrical differences for 2 occurrences have to be implemented, one instance has to be replaced with a new reference. In this case the version index will be reset to ---.

4.6.4 CM Usage Rules

The CM is created in order to use a lighter environment for other systems creation and checking.
Once the CM has been sent outside of the ITER database, no modified CM will be reconciled into the database; this rule is valid for all CM.