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Technical Specifications (In-Cash Procurement)

AB digitalization solution - Technical specfication

Technical specification for procurement of a solution able to provide an As-Built data base of the ITER facility

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1 Purpose

The purpose of this document is to define the technical specification for the procurement of a solution (software or suite of softwares) able to provide an As-Built 3D model of the ITER facility. The input data are point clouds from site 3D scans and high quality pictures used for colouring and bubble views.

2 Scope

The scope of this document is limited to a description of the desired final product and a listing of functionalities to be met by the software procured by the vendor. Expected functionalities will be listed and the corresponding priority and acceptance criteria defined.

3 Definitions

AB	As-Built
CAD	Computer Aid Design
CIO	Central Integration Office
CMM	Configuration Management Model
CoP	Cloud of Points
HDR	High Definition Rendering
IO	ITER Organization
PLM	Product Life Management
VR	Virtual Reality

For a complete list of ITER abbreviations see: ITER Abbreviations (ITER_D_2MU6W5).

4 Duration

The duration of the contract is for a firm period of 4 years with 1 optional period of 1 year.

5 Global project description

The goal of this project is to create an AB digital twin of the facility (As-Built 3D model). This model will be a complement of existing reference 3D model used for design phase. The project is facing challenges to capture all the changes identified during worksite erection and to ensure the conformity of the As-Built configuration with respect to the As-designed configuration. For several situations, considering the tight tolerances in many areas in Iter plant (especially in interface with the Machine), As-Built information is required for assembly purpose which could need stringent accuracy not available in the reference 3D model (mainly focused to the design and erection tolerances). As a final argument, not all components are represented in the reference 3D model and having an accurate picture of what is finally installed is also an asset for all stakeholders willing to retrieve the exact environment on site for various reasons.

The foreseen AB digital twin will be made from colorized point clouds providing several functionalities, which will be depicted in the following sections.

The following picture is illustrating the global process from data collection on site, passing through the filling of the CoP database and the different usage until the update of the reference 3D model.

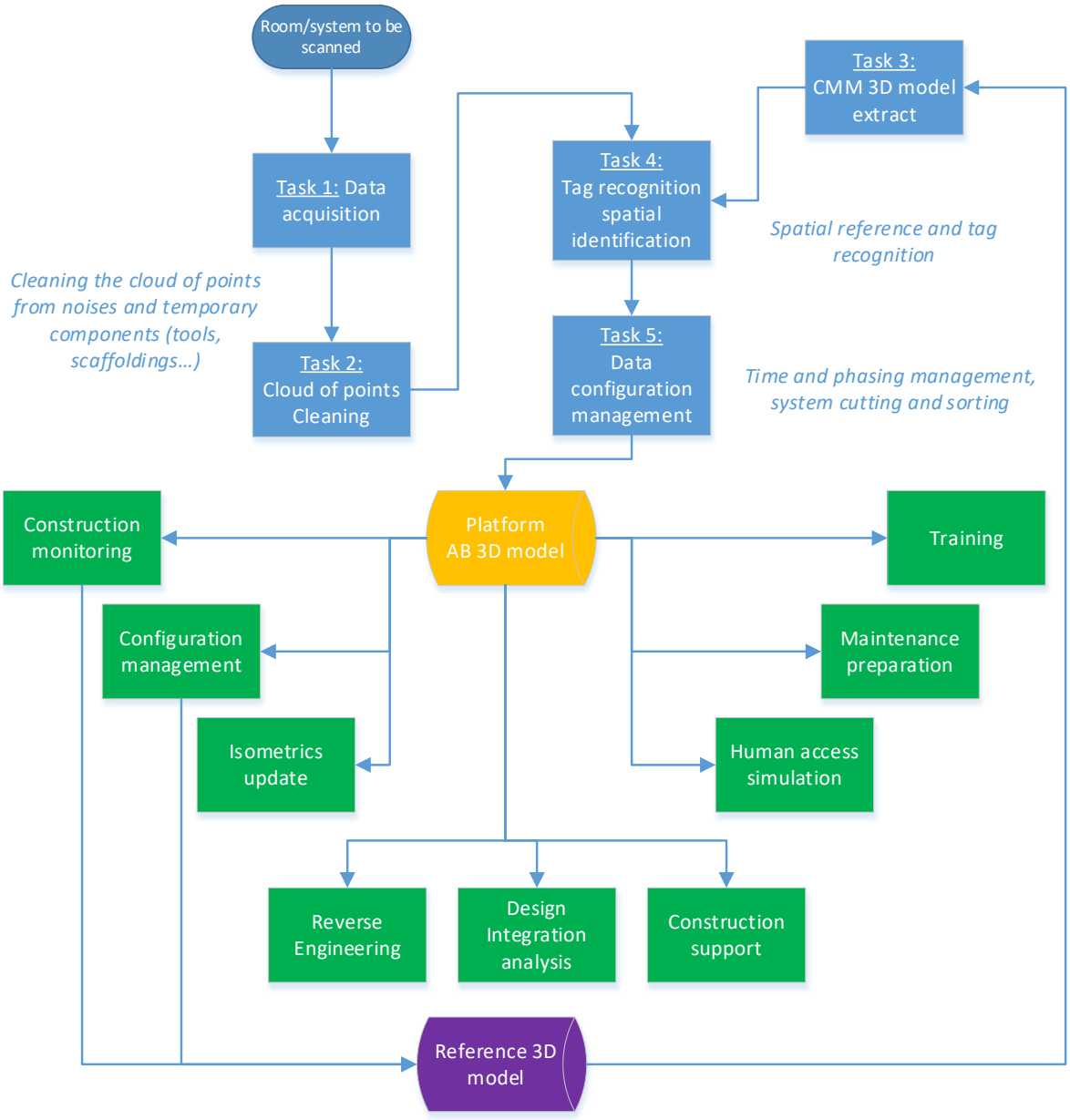


Figure 5-1 Global AB process

6 Final product description

IO has separated the Data collection from the AB 3D model. Data collection will be managed via a separated contract which will provide colorized CoP assembled per area. All the CoP will be integrated in the Tokamak Global Coordinate System. All the pictures taken during the surveys will be also listed and localized in order to provide to the Contractor the possibility to

generate bubble views, which can be viewed in the database. The user will be able to switch from the CoP to the bubble views (made of HDR pictures).

The AB CoP database shall be accessible via a software and/or a suite of software providing the following main functionalities as listed below:

- Register the input CoP enforcing various business rules and manage the history of the different surveys.
- Generate a model accessible per building (B11, B13, B14, B74…) based on colorized CoP with the functionality to switch from CoP to HDR pictures (360° bubble views) at the scanners' positions.
- Navigation in the model via 2D ground drawings on which scanners positions are registered. Navigation can be done also via search engine based on the Functional Reference of identified components such as tanks, pumps or in-line components like valves (implies the functionality to register and identify components in the CoP).
- Superpose for comparison the reference 3D model and the CoP (implies alignment to the ITER coordinate system). Identify the deviations between nominal and AB CoP for selected components. Generate report based on identified deviations. Possibility to set the comparison sensitivity (by default 10mm).
- Extract selected areas to be sent to other CAD software (export CoP or mesh in neutral format to Catia V5, AVEVA E3D, …).
- Measure distances and surfaces in the CoP. Possibility to generate reports with screenshots including written comments.
- Possibility to modify and add metadata on an identified component in the CoP.
- Possibility to connect the identified components with ITER's PLM system or other functional database.
- Possibility to perform simulation or analysis into the CoP with 3D model imported from the reference 3D model. The simulation envisaged are such as trajectory analysis with clash analysis.
- Possibility to compare 2 versions of the same area of the CoP (surveyed at different time).
- Possibility to simulate man access (with a manikin) in the CoP.
- Possibility to share the access to the CoP from different location and/or enable the collaborative work in the CoP.

This list is detailed in Appendix A.

7 Responsibilities

The contractor is responsible for the delivery of the solution on the ITER facility.

IO is responsible for providing the AB data input and connection to IO databases.

8 List of deliverables and due dates

8.1 Deliverables

- Main deliverables:

- Kick off meeting with agreed planning for deliverables.
- Deliver packages (file or Software) to ITER headquarters (Cadarache).
- Provide setup and training session to ITER headquarters in order to ensure all functionalities and proper usage to operate the model. Training session shall occur after (or during) delivery for the operators (5 people minimum). Training shall be provided within 1 week after the delivery. Training material shall be at least user manual and shall be added in the cost of the training. Duration of the training shall be 1 day minimum.
- In case of agreement of delivery stages for the different functionalities, the different packages deliveries shall be scheduled accordingly followed by corresponding training and period of assistance for the release launch.

Kick off meeting shall happen at T0+1month.

- Optional deliverable:
  - Software and Annual Maintenance shall be proposed for each year during the contract duration.
  - Consultation service after the go live could be proposed in addition to the running contract.

8.2 Due dates

The functionalities are proposed to be delivered by lots. The first delivery package is expected between T0+3 months and T0+6 months. The rest of the functionalities can be delivered as illustrated in section 11 and agreed at the kick-off meeting.

9 Acceptance criteria

The acceptance criteria are depicted in the table available in Appendix A.

Use cases are illustrated in Appendix B in order to provide some examples for the expected functionalities and guidance for the contractor.

10 Specific requirements and conditions

10.1 Generic context

No IT restrictions regarding the technical solution the provider may propose, as long as it shall demonstrate adequate security measures aligned with industry best practices.

10.2 Technical context

10.2.1 Inputs

Input data will be provided via another contract. The CoP will be colorized and be delivered in e.57 or native files from LEICA scanners (.pts) format. The pictures taken with the scanner will be also provided as .jpg or .pwg with the corresponding matrix (example of matrix is provided in Appendix) for the localization. All data will be delivered located in same global and common coordinate system.

Accuracy expected from survey input data is +/-2mm.

10.2.2 CAD environment

IO is working with Catia V5 (V5-6 R2021) as reference 3D model and ENOVIA (V5-6 R2021) for 3D model management.

IO is for several other system working with AVEVA E3D (2.1).

Exports from the contractor's software shall be compatible with the mentioned CAD software for the defined functionalities.

Related CAD guidance is available in the following document: ITER_D_249WUL - CAD Manual 07 - CAD Fact Sheet

Databases:

- SmartPlant Foundation v 10.00.38.0039
- 3DExperience R2021 x Hotfix 6

Additional information about environment can be given during tendering clarifications.

10.2.3 Data storage

The expected volume of input data managed per year will be 10 To.

A table representing the Tokamak Complex is provided with rooms number and volume in appendix C as information.

IO IT department have not yet defined the strategy or any restrictions about data storage if can be done on premises or on the cloud. The contractor can propose the most appropriate solution as long it follows the generic IT policy.

ITER is collaborating with 7 Domestic Agencies and with a community of experts which could benefit from the access to this database. Therefore, as illustrated in the functionalities and user cases, the software shall be able to share the access to the database for guest users or to be able to share a set of data with a guest user.

11 Work monitoring

Kick off meeting has to be held after signature of the contract within 1 month.

Monitoring meeting to be held every two weeks (remote meeting could be held depending on the distance) until the system is operational on site.

12 Delivery time breakdown

The main functionalities implementation are listed in the table hereafter by priority. The delivery can therefore been scheduled accordingly. The ranking stands as priority phases. The time for implementation can be proposed by the Contractor.

The following table is illustrating the phasing and priority for the main functionalities. The goal is to offer IO users a quick access to the software and functionalities.

Functional Domaine	Feature name	Description	Ranking (priority) Phases
AB data cartography	AB 3D Model navigation map	AB 3D model shall be built with a navigation system based on the block plan creating an interactive navigating map.	1
AB data cartography	Tagging	Being able to tag the components inside the cloud of points based on reference 3D model (extraction from reference is on IO scope)	1
Configuration Management	Data management	AB 3D Model data should be identified regarding its location on the model and the time reference it was uploaded into the database (history management).	1
Configuration Management	AB Model versioning	All AB 3D Model data versions are managed by the software and easy to access. The different versions models can be displayed in the AB 3D Model for comparison.	1
Configuration Management	Deviations analysis with reference model	Superpose reference 3D model with cloud of point and identification of deviations. Capability to export to CAD the area of interest (neutral format) identified.	2
Design Control & System Engineering	Design analysis or simulation	The software shall be able to import some nominal 3D data from the reference 3D model for clash analysis or trajectory simulations.	2
Design Control & System Engineering	Isometrics generation	Software capability to reconstruct pipes from CoP and to be compatible with E3D for Isometric generation	3
MetaData access	Connection to databases	Access the metada from PLM (or other database such as SPO), able to connect	3

The main achievement expected at the end of the phase 1 implementation is to get an operational database for which all users can navigate and perform all the basic functionalities.

At the end of phase 2, IO is expecting to be able to compare reference 3D model with AB cloud of points, identify deviations and be able to export back area of interest to CAD (in neutral format). Clash analysis between reference 3D model and CoP shall be operational.

At the final phase IO is expecting to get all requested features implying the advanced uses and in particular the isometrics generation from AB and the connection to PLM (or other functional databases) for metadata.

13 Licence number estimation

We will have standard users which will navigate in the CoP and will use basic tools such as measurements. And we will have advanced users using more complex functionalities. This profile will englobe the CAD designers, admins and persons involved in deeper analysis of the AB environment for configuration management, construction work package preparation, or maintenance activity preparation.

For the first year of use, we are expecting to have at least a minimum of 5 licenses.

The table below given as illustration is showing the foreseen need for the next years to come covering the 2 types of licence and based on the proposed development schedule of functionalities (see section 11). It is based on a floating licenses scheme. The number of licenses can evolve depending on project needs.

year	#standard	#advanced
Year 1	5	2
Year 2	5	2
Year 3	10	3
Year 4	10	3
Year 5	10	3

In case of the Contractor has a different proposal with more different types of licences covering the expressed need, the Contractor is able to propose an offer and licence configuration able to cover this approach distinguishing standard users and advance users.

14 Quality Assurance

The organisation conducting these activities should have an ITER approved QA Program or an ISO 9001 accredited quality system.
The general requirements are detailed in ITER Procurement Quality Requirements (ITER_D_22MFG4).
Prior to commencement of the task, a Quality Plan must be submitted for IO approval giving evidence of the above and describing the organisation for this task; the skill of workers involved
in the study; any anticipated sub-contractors; and giving details of who will be the independent checker of the activities (see Procurement Requirements for Producing a Quality Plan (ITER_D_22MFMW)).
Documentation developed as the result of this task shall be retained by the performer of the task
or the DA organization for a minimum of 5 years and then may be discarded at the direction of the IO. The use of computer software to perform a safety basis task activity such as analysis and/or modelling, etc. shall be reviewed and approved by the IO prior to its use, in accordance with Quality Assurance for ITER Safety Codes (ITER_D_258LKL).

15 Safety requirements

ITER is a Nuclear Facility identified in France by the number-INB-174 (“Installation Nucléaire de Base”).
For Protection Important Components and in particular Safety Important Class components (SIC), the French Nuclear Regulation must be observed, in application of the Article 14 of the ITER Agreement.
ITER_D_4KGBXK v2.1

In such case the Suppliers and Subcontractors must be informed that:
- The Order 7th February 2012 applies to all the components important for the protection (PIC) and the activities important for the protection (PIA).
- The compliance with the INB-order must be demonstrated in the chain of external contractors.
- In application of article II.2.5.4 of the Order 7th February 2012, contracted activities for supervision purposes are also subject to a supervision done by the Nuclear Operator.
For the Protection Important Components, structures and systems of the nuclear facility, and Protection Important Activities the contractor shall ensure that a specific management system is implemented for his own activities and for the activities done by any Supplier and Subcontractor following the requirements of the Order 7th February 2012.

Appendix A

Requirement				Related use case				Assessment	
Feature number	**Functional Domain**	**Feature name**	**Description**	**UC 1**	**UC 2**	**UC 3**	**UC 4**	**Acceptance criteria**	**Priority**
1	**AB data cartography**								
1.1	AB data cartography	Metadata	Data to be added to the AB 3D model				1	Once a component is identified in the AB 3D model possibility to - add metadata to the identified component and possibility (manual entry) - link to other data base for accessing information	Must
1.2	AB data cartography	Pictures data	Data collected in the "Photography" feature	1				At each scan survey point a High quality picture (360deg) shall be associated	Must
1.3	AB data cartography	Cloud of points data	Data collected in the "Laser scan" feature	1	1	1	1	The AB 3D model shall be created based on the cloud of points collected during on-site survey. The software shall be able to aggregate the cloud of points collected from IO metrology or its sub-contractors.	Must
1.4	AB data cartography	3D model viewer	Expresses the software capability of displaying the AB 3D model	1	1		1	the data collected (cloud of points and pictures) shall create a usable 3D model with colorized cloud of points on which we can switch between the picture representation and the 3D cloud of points.	Must
1.5	AB data cartography	AB 3D Model navigation map	The software is capable of display an	1			1	AB 3D model shall be built with a navigation system based on the block plan creating an interactive navigating map.	Must

Requirement				Related use case				Assessment	
Feature number	**Functional Domain**	**Feature name**	**Description**	**UC 1**	**UC 2**	**UC 3**	**UC 4**	**Acceptance criteria**	**Priority**
			interactive navigation map						
1.6	AB data cartography	AB Structuring management	The software manages the overlaying of different AB 3D model versions			1	1	The software is capable to manage different versions of the data acquired on site at different time and configuration. Ability to select the specific configuration.	Must
1.7	AB data cartography	Automated Tagging	Metadata (references, signs…) should be tagged in the AB 3D Model				1	The software shall be able to identify component tags. This can be performed via different means, The tag can be recognized from the high quality pictures taken on site. The tags could be signs letters or QR codes. The tags can be also automatically extracting by comparing reference 3D model or P&ID with the AB 3D model.	Must
2	**Data sharing & custody**								
2.1	Data sharing & custody	Cloud of points export	Point Cloud data should be stored and sharable with businesses for use in other software		1		1	selected areas of the AB 3D model (cloud of points) shall be sharable thus extractable in order to be shared and used for other purposes.	Must
2.2	Data sharing & custody	Deviation files	Deviation and clash data between the CM 3D Model and AB Model should be	1				Sharing of the report produced and the extracted points of the area deviating	Should

Requirement				Related use case				Assessment	
Feature number	**Functional Domain**	**Feature name**	**Description**	**UC 1**	**UC 2**	**UC 3**	**UC 4**	**Acceptance criteria**	**Priority**
			stored and sharable with businesses						
2.3	Data sharing & custody	AB Cloud of points measurements reports	Reports regarding Point cloud measurements and analysis should be stored and sharable with businesses	1			1	Reports to be sharable	Must
2.4	Data sharing & custody	Interfaces (PLM, CAD, Smart Plant, VR)	An interface should allow the user to navigate through the entire AB 3D Model software suite	1	1		1	Connectivity interface with the IO softwares (PLM, SPO, Catia V5, E3D, INTERACT/Unity, Polyworks, SA…)	Must
3	**Design Control & System Engineering**								
3.1	Design Control & System Engineering	Cloud of points selection	Software capability allowing the user to select a 3D model area for a more detailed view	1	1	1	1	The software shall be able to manage the display quality in order to optimize the rendering and the navigation performance.	Must

Requirement				Related use case				Assessment	
Feature number	**Functional Domain**	**Feature name**	**Description**	**UC 1**	**UC 2**	**UC 3**	**UC 4**	**Acceptance criteria**	**Priority**
3.2	Design Control & System Engineering	Superposition of CM 3D model with AB Model	The software is able to display the CM 3D model with the AB model	1				The software shall be able to superpose the reference 3D model for deviation analysis or to import some nominal 3D data from the 3D model reference for clash analysis or trajectory simulations.	Must
3.3	Design Control & System Engineering	Reverse engineering integration with CAD software	The software is able to export AB Model data to a CAD Software for reverse engineering		1			The software shall be able to select and export areas of the cloud of points for other usage in various software. For design purposes with Catia V5 and E3D or RE engineering (polyworks and SA).	Must
3.4	Design Control & System Engineering	Isometrics generation	Software capability to reconstruct pipes and to be compatible with E3D				1	The software should be able to automatically recognise pipe runs and to export it to E3D for isometrics production.	Must
4	**Configuration Management**								
4.1	Configuration Management	AB Model versioning	All historical AB Model data is easy to access, and can be displayed in the AB 3D Model for comparison	1	1	1		The software must be able to navigate and select the different versions of the scans recorded. Comparison shall be possible between versions.	Should
4.2	Configuration Management	Design authority	AB Model data should be identified regarding its location on the		1	1	1	The software shall be able to identify and register the cloud of points by location, time recorded and reference to the assembly phase (FP, PFPO1, PFPO2, DT).	Must

Requirement				Related use case				Assessment	
Feature number	**Functional Domain**	**Feature name**	**Description**	**UC 1**	**UC 2**	**UC 3**	**UC 4**	**Acceptance criteria**	**Priority**
			model and the time it was uploaded						
5	**Analysis & Simulation**								
5.1	Analysis & Simulation	Trajectory simulation	The software can calculate the path between 2 locations in the model and state whether an object (volume) can follow this path without conflict				1	The software should be able to perform clash analysis of an object (cloud of points or nominal 3D model) along a defined path. Ideally, the software could compute the clash free path and identify tight gaps.	Should
5.2	Analysis & Simulation	VR access simulation	Capability to connect to VR tools such as VR googles				1	The software should have the capability to connect to IO VR software and tools (Interact/Unity, VR Room broadcasting device Techviz and HTC vive pro)	Should
5.3	Analysis & Simulation	Hybrid training	The software can display the AB 3D model area in VR for IO staff training				1	The software could be able to propose to simulate any activity (assembly, maintenance…) in order to create an environment for training purpose. This functionality could be embedded in the software or proposed through another solution.	Could

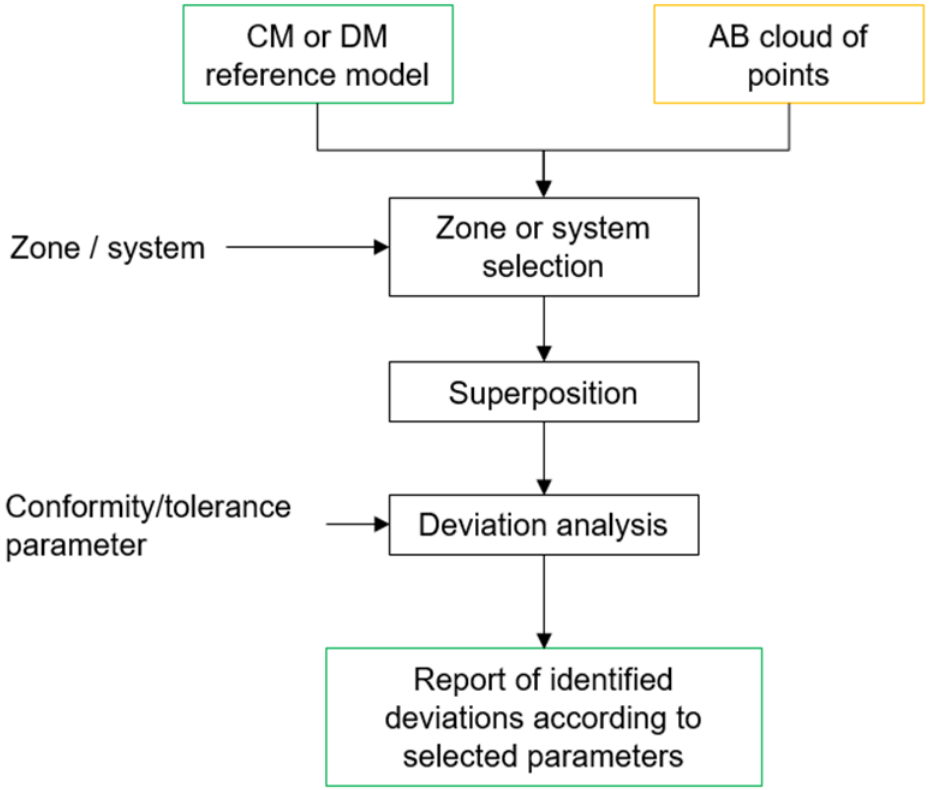
Requirement				Related use case				Assessment	
Feature number	**Functional Domain**	**Feature name**	**Description**	**UC 1**	**UC 2**	**UC 3**	**UC 4**	**Acceptance criteria**	**Priority**
5.4	Analysis & Simulation	Map superposition (radiation,fields)	Various analysis maps and fields can be overlayed onto the AB 3D Model (radiation, magnetic field...)				1	This functionality could be linked with 3D model superposition. This could be treated as an overlay with radiation map modelized in 3D. Another solution in line with Radio protection and more dynamic could be proposed.	Could
5.5	Analysis & Simulation	Distance measurement	Distance, Volume and Surface measurement can be done on the AB 3D Model				1	The software must be capable to measure directly distances and surfaces based on the could of points.	Must

OBJ

Appendix B

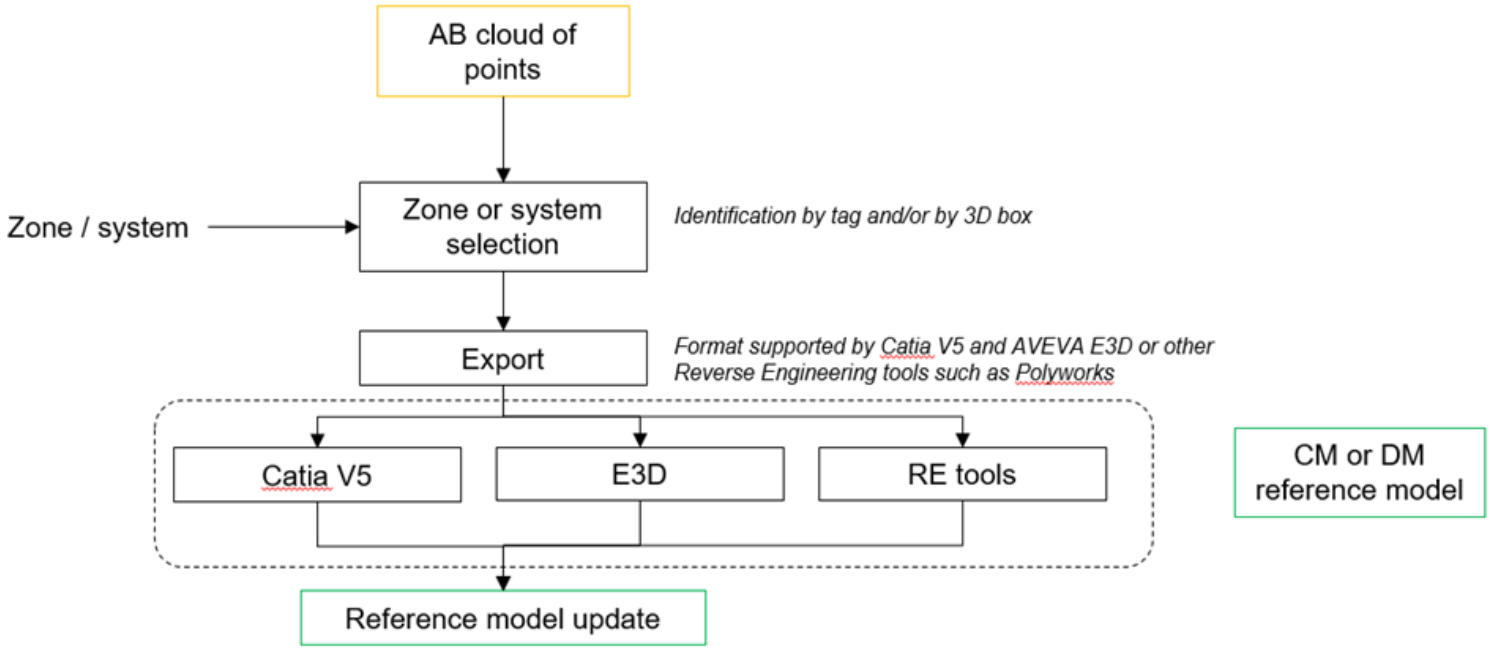
Use case1: UC.1 Deviation analysis between CMM reference and AB database

Step	User Actions	System Actions
1	Load one system or one area	The software is able to load the selected system or area from the CMM reference and to superpose with the corresponding system or area in the AB cloud of points database
2	Select the tolerance needed for the deviation analysis	The system will propose by default a 10mm tolerance and also offers the possibility to change the value for the deviation analysis
3	Launch the deviation analysis for the system or area	The software will identify and list all the deviations.
4	Navigate to the listed deviations	The software directly zoom on the selected deviation for overview or further action
5	Report identified deviation	A report will be proposed. The output will be a PDF report customizable with comments and illustration. The results could be exported on Excel spread sheet.
6	Comments and pictures adding to report	During the navigation to the listed identified deviation, possibility to add comments and to add several screenshots
7	Share report	Export report and Excel spread sheet



Use case 2: UC.2 CMM reference model update based on AB cloud of points database

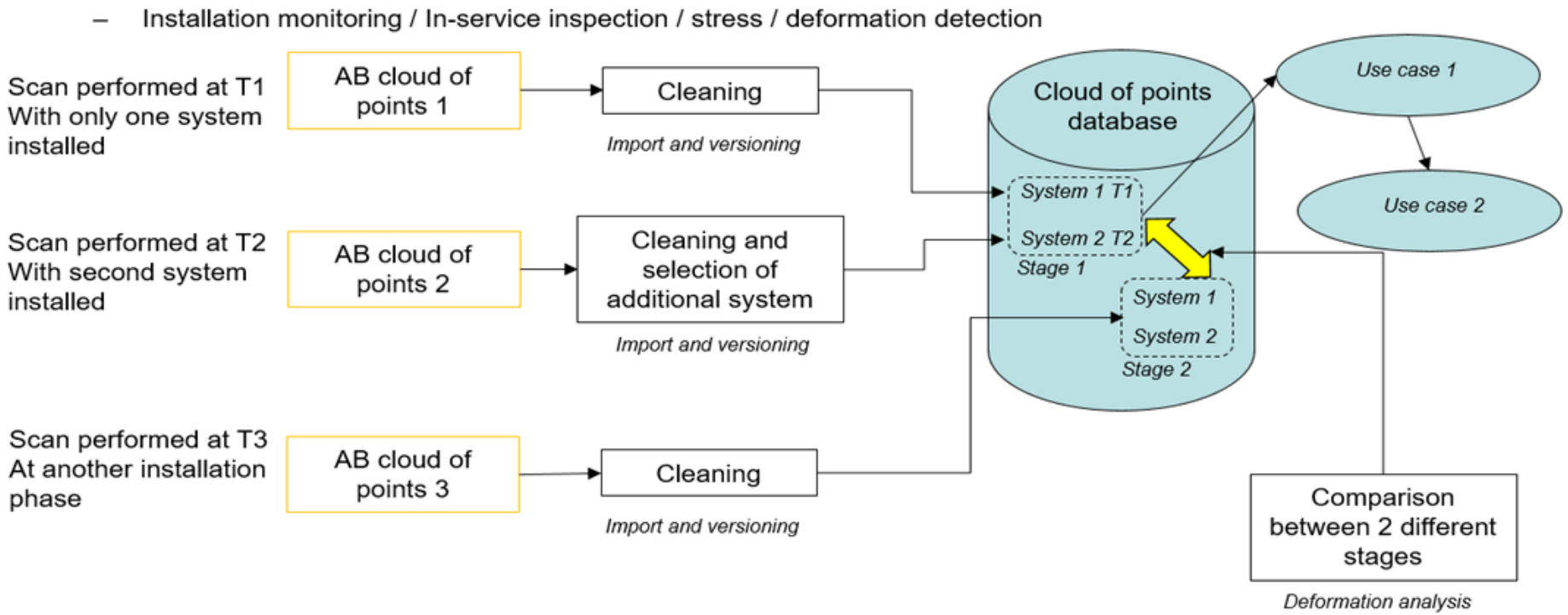
Step	User Actions	System Actions
1	Select an interface or a full component	Cloud of points selected
2	Select export function	Context window allowing to name the export and to select the format (STL, text file, other neutral format) can be a cloud of points or a mesh.



Use case 3: UC.3 Point cloud History monitoring

Step	User Actions	System Actions
1	Scan one system (System 1) at T1	Cloud of points recorded at T1
2	Stamp the cloud of points	After cleaning, given system (System 1) is stamped T1 construction stage and give possibility to implement comments in order to clarify the survey context

3	Be able to select this system (System 1) at this T1 configuration and to apply the functionalities from the use case 1	Use “UC.1 Deviation analysis between CMM reference and AB database”
4	Scan a second system (System 2) at T2 nearby System 1	Cloud of points recorded at T2
5	Stamp the cloud of points	After cleaning, given system (System 2) is stamped T2 construction stage and give possibility to implement comments in order to clarify the survey context
6	Aggregate the 2 clouds of points, System 1 and System 2	Manage the database by aggregation of the 2 systems surveyed at different time. System 1 could be partially not visible during the second scan at T2 (therefore not all system 1 will be available).
7	Scan the environment (System 1 and System 2) at a third time at T3	Cloud of points recorded at T3
8	Stamp the cloud of points	After cleaning, given system (System 1 and System 2) are stamped T3 construction stage and give possibility to implement comments in order to clarify the survey context
9	Aggregate the clouds of points, System 1 and System 2 at different times	Manage the database by aggregation of the different surveys performed at different time. System 1 could be partially not visible during the second scan at T2 and T3 (therefore not all system 1 will be available).
10	Compare different version of a given system version	Compare System 2 surveyed at T2 and T3. Be able to set the comparison sensibility.
11	Comparison report issuance	Issue a comparison report for the given system at the different periods.



Use case 4: UC.4 Direct usage of cloud of points database

Step	User Actions	System Actions
1	Navigate in the facility based on GA drawings	The database offers the possibility to navigate in the facility through a map based on GA drawings
2	Navigate in the database by searching FR	Ability to search in the database by FR and directly focus on the selected FR component.

3	Select the database history representation (configuration of the scan)	Select the needed time representation of the system of environment (needed for comparison purpose)
4	Measure distances in AB cloud of points	The system propose de possibility to measure directly in the cloud of points between components (distance and surfaces)
5	Add comments in the cloud of points	Ability to add comments in the database and to record it
6	Ability to generate reports	The system can offer the possibility to generate report with screen shots, comments and measures (PDF and word format)
7	Ability to access to metadata on each components	The cloud of point will be split by components and the system will enable the access to corresponding metadata (datasheets)
8	Possibility to add metadata on each components	Add metadata on each component for commissioning, operation or maintenance purpose
9	Component trajectory analysis	Simulate the trajectory inside the cloud of points with As-design component (import 3D models). Perform clash analysis along the path.
10	Human accessibility simulation	System able to be connected to ITER VR tools (Interact) for simulation purpose (human accessibility analysis, assembly simulation, training…)
11	Super position with rad map	Possibility to simulate the radiation map by superposing (import) the rad map 3D representation.
12	Coactivity analysis	Possibility to plug the database to 4D software or to be able to manage assembly coordination
13	Collaborative work	Be able to share access to the database or to extract some areas for expert advice.

Appendix C

Tokamak Complex rooms number, volume and floor surface.

GBS	Volume (m3)	Area (m2)	Nb rooms
11-B1	25685	3700	48
11-B2	32916	5634	17
11-B2M	5085	1356	7
11-L1	26887	4951	42
11-L2	25612	4944	41
11-L3	43883	5297	16
11-L4	73804	4931	9
11-L5	9650	870	8
11-R1	145140	6094	11
11-R2	11330	3926	4
74-B1	9570	1809	38
74-B2	12345	1810	28
74-L1	9730	1810	40
74-L2	9369	1809	42
74-L3	12171	1809	28
74-L4	44680	1767	12
74-L5	522	128	7
74-R1	46	15	1
14-B1	9873	2090	46
14-B2	12560	2090	45
14-L1	10118	2084	43
14-L2	12648	2060	39

14-L3	12756	2054	39
14-L4	14100	2022	36
14-L5	14442	1980	35
14-R1	19894	1830	17
TOTAL	604816	68870	**699**