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1 OBJECTIVE

Define the minimum technical requirements SELLER shall comply with to select computer-aided engineering tools for use during the Engineering Detailed Design phase.

Define guidelines and mandatory technical requirements for use of computer-aided engineering tools and engineering databases during the Engineering Design phase.

Define the handover specification requirements for computer-aided engineering databases and other documents issued by SELLER.

2 SCOPE OF SUPPLY

This document is applicable to FPSO SELLERS to select, organize and define attribute values in databases of CAE design tools.

It defines minimum requirements for completeness, integrity, consistency and handover of these databases to PETROBRAS along with design documentation extracted from CAE tools.

3 DEFINITIONS

Collaboration feature: Feature that allows teams geographically apart to simultaneously model and define attribute values in CAE tools, assuring all engineering information occur on a main location database (hub) and are replicated to other locations (satellites), in a way that the entire team has access to updated information.

CAE tools: In the digital engineering context, it shall be understood as database-based tools that usually provide a user interface for graphical modeling.

CAE 2D tool: Database based tools used for 2D modeling and defining engineering attribute values, from which is possible to extract documents, lists and schematic drawings.

CAE 3D tool: Database based tools used for 3D modeling and automatic extraction of design documents. Also known as, Plant Design 3D tools or BIM (Build Information Model).



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Mechanical modeling tool: Synonym for mechanical CAD (or CAM).

Tie-in: Connection point between pipelines or electrical, instrumentation or telecom trays.

As built: Last revision of databases and design documents containing all changes executed on the field during construction and assembly phase.

Tag: Object unique identification

Package or Package unit: It is defined as an assembly of equipment supplied interconnected, tested, and ready to operate, requiring only the available utilities from the Unit for the package operation.

4 ABBREVIATIONS

LV: List of Verification

CAD: Computer-aided Design

CAE: Computer-aided Engineering

P&ID: Piping and Instrumentation Diagram

SPDA: Atmospheric Discharge Protection System

C&A: Construction and Assembly

BIM: Build Information Model

5 ELIGIBILITY CRITERIA

5.1 GENERAL

5.1.1 SELLER shall only select CAE tools which comply with the eligibility criteria as specified in items 5.2, 5.3, 5.4 and 5.5.

5.1.2 All CAE tools databases shall be delivered or converted for Petrobras Standard CAE tools prior to final Handover.

5.1.3 Petrobras Standard CAE tools are:



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5.1.3.1 For Automation Design, Petrobras Standard CAE 2D tool is Smart Instrumentation (SPI);

5.1.3.2 For Process, HVAC, Safety and Marine Systems Design, Petrobras Standard CAE 2D tool is Smart P&ID (SPID);

5.1.3.3 For Electrical Design, Petrobras Standard CAE 2D tool is Smart Electrical (SEL);

5.1.3.4 For 3D modeling, Petrobras Standard CAE tool is Smart 3D (S3D);

5.1.3.5 SELLER shall deliver to PETROBRAS in the final handover the Petrobras Standard CAE tools according to the following definitions:

- a) SPI, SPEL, SPID and S3D databases shall be delivered in the most recent versions when the SELLER starts working with Petrobras Standard CAE tools;
- b) Use SPI, SPEL, SPID and S3D versions that allow integration through a single version of Smart Foundation;
- c) During detailed design SELLER may perform upgrades to the Version, Service Pack or Hotfix, as long as they are previously informed to Petrobras;
- d) SELLER shall also use the most recent versions of auxiliary programs, including Database Management System (DBMS) and Operational System (OS), as long as they are compatible with the CAE tools used.

5.1.4 If SELLER decides to use design tools other than SPID, COMOS, SPI, SPEL, Aveva Diagrams, Aveva Instrumentation, Aveva Electrical for 2D modeling or PDMS, E3D, S3D for 3D modeling, the selected design tool shall have commercial representation and support team in Brazil.

5.1.5 If design tools used are different than those listed in item 5.1.4, SELLER shall also provide 03 licenses of each software to PETROBRAS for Project verification.

5.1.6 SELLER shall also provide training to PETROBRAS for use and administration of each selected tool if design tools used are different than those listed in item 5.1.4.

5.2 ELIGIBILITY CRITERIA FOR CAE 2D TOOL

5.2.1 Provide user interface to define and query attribute values.



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- 5.2.2 Provide native feature to create object groups.
- 5.2.3 Provide native feature to assign colors to objects and object groups.
- 5.2.4 Provide native feature to model connectors between drawings.
- 5.2.5 Provide native feature to customize symbols according to the I-ET-3000.00-0000-940-P4X-002 - SYMBOLS FOR PRODUCTION UNITS DESIGN.
- 5.2.6 Provide native feature to customize connection rules between objects.
- 5.2.7 Provide native feature that allows attribute propagation between connected objects.
- 5.2.8 Allow user to customize features.
- 5.2.9 Provide native feature to identify inconsistencies between attribute values of connected objects.
- 5.2.10 Provide native feature to identify modeling inconsistencies (“clashes”).
- 5.2.11 Provide native feature to customize attributes.
- 5.2.12 Provide native feature to create and edit codelists to define attribute values.
- 5.2.13 Provide native features to generate reports.
- 5.2.14 Provide native feature to verify database integrity.
- 5.2.15 Provide collaboration features.
- 5.2.16 All data used by the provided system shall be stored within a relational database that shall be queryable by SQL or by another well documents query language.
- 5.2.17 For Process, HVAC, Safety and naval systems design the CAE tool shall:
- 5.2.17.1 Provide user interface for graphical modeling of process, engineering and utility diagrams.
- 5.2.17.2 Provide native version control feature for diagrams.
- 5.2.18 For Automation design the CAE tool shall:



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5.2.18.1 Provide user interface for graphical modeling of diagrams.

5.2.18.2 Provide native feature datasheet generation.

5.2.18.3 Provide native feature for valve sizing.

5.2.18.4 Provide feature for identification of equipment or line to which instruments are connected.

5.2.18.5 Provide feature to relate instruments and documents in which instruments are represented.

5.2.19 For Electrical design, the CAE tool shall:

5.2.19.1 Provide native feature for datasheet configuration and extraction or feature that allows links with online manufacturer datasheet.

5.2.19.2 Provide user interface for graphical modeling of diagrams.

5.3 ELIGIBILITY REQUIREMENTS FOR CAE 3D TOOL

5.3.1 Provide user interface for graphical 3D modeling.

5.3.2 Show object hierarchy on user interface.

5.3.3 Provide user interface to define and query attribute values.

5.3.4 Provide specific features for piping modeling.

5.3.5 Provide specific features for equipment modeling.

5.3.6 Provide specific features for HVAC modeling.

5.3.7 Provide specific features for tray modeling.

5.3.8 Provide specific features for topsides structure modeling.

5.3.9 Provide specific features for hull structure modeling.

5.3.10 Provide specific features for space reservation volumes modeling.



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- 5.3.11 Provide native feature to assign material properties to model objects for weight calculation purposes.
- 5.3.12 Provide collaboration features.
- 5.3.13 Provide native feature to assign colors to objects and object groups.
- 5.3.14 Provide native feature to create customized catalogue items.
- 5.3.15 Provide native feature to create manage catalogue items.
- 5.3.16 Provide native feature to identify differences between model and catalogue items.
- 5.3.17 Provide native feature to export catalogue information.
- 5.3.18 Provide native feature to customize connection rules between objects.
- 5.3.19 Provide native feature to customize attributes.
- 5.3.20 Provide native feature to create and edit codelists to define attribute values.
- 5.3.21 Provide native feature to allow configuration of rules to extract 2D drawings.
- 5.3.22 Provide native feature to extract 2D drawings.
- 5.3.23 Provide native feature to define spools.
- 5.3.24 Provide native feature to export formats for 3D model visualization.
- 5.3.25 Provide native feature to load point cloud data sets generated on a laser scanner.
- 5.3.26 Provide native feature for importing objects modeled on other tools.
- 5.3.27 Provide native features to generate reports.
- 5.3.28 Provide native feature to verify database integrity.
- 5.3.29 Provide native feature to identify errors and inconsistencies, from modeling and/or defining attribute values.
- 5.3.30 Provide native feature to automatically check interferences.



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5.3.31 Provide native feature to customize rules for automatic interference check.

5.3.32 Allow user to customize features.

5.3.33 All data used by the provided system shall be stored within a relational database that shall be queryable by SQL or by another well documents query language.

5.4 ELIGIBILITY REQUIREMENTS FOR 3D VIZUALIZATION AND NAVIGATION TOOL

5.4.1 Show object hierarchy on user interface.

5.4.2 Show attribute values for model objects on user interface.

5.4.3 Provide native feature to simulate changes in position of model objects.

5.4.4 Provide native feature to allow identification of coordinates.

5.4.5 Provide native feature to measure distances and angles between points.

5.4.6 Provide native feature to record videos.

5.4.7 Provide native feature to define object groups either by selecting it directly or using its attributes.

5.4.8 Provide native feature to assign colors to objects and object groups.

5.4.9 Provide native feature to load point cloud data sets generated on a laser scanner.

5.4.10 Provide native feature to automatically check interferences.

5.4.11 Well documented API for customizing the tool.

5.5 ELIGIBILITY CRITERIA FOR ARCHITECTURAL DESIGN CAE TOOL

5.5.1 Provide user interface to define and query attribute values.

5.5.2 Provide native feature to automatically check interferences.

5.5.3 Provide native feature to generate and automatically update plants and section drawings.

5.5.4 Provide native features to generate reports.



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5.5.5 Provide native feature to customize attributes.

5.5.6 Provide native feature to create customized catalogue items.

5.5.7 Provide native feature to create and edit codelists to define attribute values.

5.5.8 Provide native feature for importing objects modeled on other tools.

5.5.9 Provide native feature for modeling doors, bulkheads, floors, linings and coatings.

5.5.10 Provide native feature to automatically calculate volumes and surface area of modeled objects.

6 ORGANIZATION REQUIREMENTS

SELLER shall comply with the organization CAE tools requirements on item 6.1.

6.1 ORGANIZATION REQUIREMENTS FOR CAE 3D TOOL

6.1.1 3D model hierarchy shall be according to Project standard, as defined in Annex A - 3D model Standard Upstream Hierarchy.

6.1.1.1 In case any changes are necessary on the hierarchy herein defined, SELLER shall seek approval from PETROBRAS.

6.1.2 SELLER shall define the 3D model hierarchy in English.

6.1.3 Within 3D model hierarchy, SELLER shall separate nozzles and supports from the rest of the equipment components to which they are connected.

6.1.4 If the selected CAE 3D tool allows, SELLER shall separate all pipeline, duct and tray supports, from the objects they are supporting in the 3D model hierarchy. If that separation is not possible, the SELLER shall model supports on the same hierarchy level as the supported objects.

6.1.5 SELLER shall segregate and identify in the 3D model hierarchy all objects, volumes and hierarchy levels created for studies and alternative evaluation purposes.



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7 COMPLETENESS REQUIREMENTS

SELLER shall prepare the databases according to modeling completeness scope specified in this chapter for objects and for defining engineering information values in CAE tools.

7.1 COMPLETENESS GENERAL REQUIREMENTS

7.1.1 SELLER shall not use notes in replacement of modeling or graphical representation of objects, even if these objects do not have a geometry.

7.1.2 SELLER shall Tag objects according to rules defined on I-ET-3000.00-1200-940-P4X-001 - TAGGING PROCEDURE FOR PRODUCTION UNITS DESIGN or according to specific rules defined by each discipline.

7.1.2.1 SELLER shall evenly apply tagging rules to all CAE tool databases to allow consistency verifications between these databases.

7.1.3 SELLER shall model all tie-in identification identically on both sides of the interface.

7.1.4 SELLER shall use names and attributes in English, to allow easy identification of the engineering information it stores.

7.1.5 In case the SELLER team does not have access to a single network, a collaboration feature shall be used, as per items 5.2.15 and 5.3.12.

7.1.6 Even though engineering attributes described in Annex C - Petrobras Class Library for Upstream and mandatory to be defined in CAE tools, the specific tables, fields and codelist options listed in this annex are optional and may be used by SELLER. If used, SELLER is responsible for defining any missing fields, including new codelist options and making any other adjustments to guarantee it does not compromise any integrations and internal processes.

7.2 COMPLETENESS REQUIREMENTS FOR CAE 2D TOOLS

7.2.1 SELLER shall model all process, safety, commissioning, HVAC and marine systems diagrams using a CAE 2D tool that complies with the eligibility criteria stated on item 5.1.



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- 7.2.2 SELLER shall customize all symbols used on P&ID drawings according to the I-ET-3000.00-0000-940-P4X-002 - SYMBOLS FOR PRODUCTION UNITS DESIGN.
- 7.2.3 SELLER shall graphically represent using CAE 2D tool all objects scope of a drawing category, according to the item 8.2.2.
- 7.2.4 SELLER may use typical drawings when modeling in the CAE 2D tool as long as its implied attributes are defined in the CAE 2D tool database, according to the item 7.2.7.2.
- 7.2.5 SELLER shall define FROM/TO information for lines in the CAE 2D tool database.
- 7.2.6 SELLER shall graphically represent modules and package units in CAE 2D tools.
- 7.2.7 SELLER shall graphically represent tagged objects part of a set, separately.
- 7.2.7.1 Item 7.2.7 is applicable to items part of a package unit or part of a skid (main equipment and its auxiliaries).
- 7.2.7.2 SELLER shall graphically represent using CAE 2D tool objects and its implied attributes in such manner that allows extraction of Material Take Off (MTO) and other engineering information from the tool database.
- 7.2.8 SELLER shall define attributes for all telecom equipment scope of a one-line diagrams using CAE 2D tool. Telecom one-line drawings may be generated using CAD tools.
- 7.2.9 The label for the Tag of any given piperun shall be graphically represented in the CAE 2D drawing whenever its Tag could not be determined, with full certainty, based only on the drawing graphical information.
- 7.2.10 SELLER shall also model on CAE 2D tool all chemical injection piping and all piping with working pressures above 150 bar that use tubing piping specifications for construction.
- 7.2.11 Mandatory engineering information as per Annex C – Petrobras Class Library for Upstream shall be defined in the CAE 2D database.



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**7.2.12 COMPLETENESS FOR CAE 2D TOOLS – REQUIREMENTS FOR AUTOMATION
DESIGN**

7.2.12.1 SELLER shall draft the automation design using a CAE 2D tool that complies with the eligibility criteria stated on item 5.2.

7.2.12.2 SELLER shall define using CAE 2D tool all mandatory automation design items as indicated in Annex C – Petrobras Class Library for Upstream.

7.2.12.3 SELLER shall model using CAE 2D tool all control loops of instruments represented on engineering diagrams, representing components and connections from the instrument (physical, logical or virtual) to the operation screen, including logic components (CLP, SDCD etc.) and remote networks.

7.2.12.4 SELLER shall model using CAE 2D tool all instrument typical details. The identification of these items shall be according to applicable design standards.

7.2.12.5 SELLER shall model using CAE 2D tool all terminals, strips and junction boxes.

7.2.12.6 SELLER shall link using CAE 2D tool I/O signals to an I/O card channel.

7.2.12.7 SELLER shall model using CAE 2D tool all spare cables.

**7.2.13 COMPLETENESS FOR CAE 2D TOOLS – REQUIREMENTS FOR ELECTRICAL
DESIGN**

7.2.13.1 SELLER shall draft the electrical design using a CAE 2D tool that complies with the eligibility criteria stated on item 5.2.

7.2.13.2 SELLER shall define on the CAE electrical tool database all mandatory attributes necessary for issuing electrical design documents listed in item 8.2.4.

7.3 COMPLETENESS REQUIREMENTS FOR CAE 3D TOOLS

7.3.1 SELLER shall follow the Projects definition of origin and global coordinate system axis for 3D modeling.

7.3.2 SELLER shall organize all objects and volumes according to the 3D model hierarchy, as per item 6.1.



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7.3.3 SELLER shall guarantee all weights and dimensions modeled in the CAE 3D tool comply with applicable industry standards and certified documents.

7.3.4 SELLER shall define using CAE 3D tool the modeling status of each object.

7.3.4.1 The codelist for modeling status shall be at least comprise of the following options:

- e) Preliminary;
- f) Drafted;
- g) Future (only for equipment, where applicable);
- h) According to flexibility calculation report (only for piping);
- i) Verified;
- j) Approved;
- k) As built.

7.3.4.2 SELLER shall only use the “Drafted” status for piping when all inline components, i.e., accessories, valves (including actuators and operators), instruments, are modeled, including all weights and dimensions according to the item 7.3.3.

7.3.5 SELLER shall model package units allowing all tagged objects on engineering diagrams to be identified.

7.3.6 SELLER shall graphically represent tagged objects part of a set, separately.

7.3.6.1 Item 7.3.6 is applicable to items part of a package unit or part of a skid (main equipment and its auxiliaries).

7.3.7 SELLER shall model the items below using volume objects or primitive geometries and define its purpose using one of the following codelist options:

- a) Future;
- b) Operation/Maintenance;
- c) Handling;
- d) Escape route;
- e) Hazardous area;
- f) Closed room;
- g) Gas exhaust;
- h) Flame detection cones;



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- i) Sprinkler coverage;
- j) Door opening;
- k) Limit;
- l) Helideck operation free span;
- m) Draught;
- n) Access to equipment manhole;
- o) Access to identification plates of equipment under NR-13 requirements.

7.3.8 When modeling equipment, SELLER shall model all related volumes according to options listed in 7.3.7.

7.3.8.1 SELLER shall define these volumes as primitive geometries in the parent equipment hierarchy.

7.3.8.2 SELLER shall segregate these volumes from other equipment components on the parent equipment hierarchy.

7.3.8.3 SELLER shall define the purpose attribute for equipment operation/maintenance volumes according to the item 7.3.7 b).

7.3.8.4 SELLER shall define the purpose attribute for gas exhaust volumes for equipment according to the item 7.3.7 g).

7.3.8.5 SELLER shall define the purpose attribute for volumes modeled for future equipment expansion according to the item 7.3.7 a).

7.3.8.6 When defining the purpose attribute for equipment operation/maintenance volumes, SELLER shall consider the space required for use of special devices and tools.

7.3.9 When applicable, SELLER shall model in the CAE 3D tool any future equipment indicated on engineering diagrams using primitive geometries. In this case SELLER shall:

7.3.9.1 Define the status attribute for these equipment according to the item 7.3.4.1 g).

7.3.9.2 Define Tag identification for future equipment in the CAE 3D tool, whenever required.



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7.3.10 SELLER shall use volumes to model the physical limits of the production facilities regions, as defined in the following items:

7.3.10.1 SELLER shall model all the objects existing within the volume limits of a production facility region, in this region's hierarchy, as defined in Annex A - 3D model Standard Upstream Hierarchy.

7.3.10.2 SELLER shall define the purpose attribute for volumes modeled for represent the physical limits of 3D model regions according to the item 7.3.7 k).

7.3.10.3 SELLER shall model limits to determine each region elevation/deck/section as defined in hierarchy level 5 of Annex A - 3D model Standard Upstream Hierarchy

7.3.10.4 SELLER shall model volumes representing modules, lay down areas and meeting points.

7.3.10.5 For FPSO designs, SELLER shall also model the main deck region volumes, offshore structures, structural tanks, inner hull compartments and draught.

7.3.10.5.1 Offshore structures that shall have its limits modeled in the CAE 3D tool are:

- a) Upper riser balcony;
- b) Lower riser balcony;
- c) Hard pipe;
- d) Piperack;
- e) Riser piperack;
- f) Pull-In;
- g) Diving station;
- h) Mooring balcony;
- i) Fairlead;
- j) Vent-post;
- k) Well stimulation support;
- l) Helideck;
- m) Flare base;
- n) Rescue vessel platform;
- o) Caisson.



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7.3.10.5.2 SELLER may import structural tank volumes and inner hull compartments into the 3D model from other design tools.

7.3.10.5.3 The purpose attribute for draught volume shall be defined according to the item 7.3.7 m).

7.3.11 SELLER shall define all tie-in points for piping, trays and HVAC ducts in the 3D model. These include:

7.3.11.1 SELLER shall model tie-in points according to the item 7.1.1.

7.3.11.2 SELLER shall model each tie-in point in a way that allows identification of its objects using the database. This applies to piping, trays and HVAC duct parts on the interface.

7.3.11.3 SELLER shall define all tie-in Tag identification in the 3D model.

7.3.11.4 SELLER shall model tie-in point in their exact position.

7.3.12 SELLER shall use specific features of the CAE 3D tool to model each type of objects.

7.3.12.1 SELLER shall use specific equipment modeling features for equipment and outline instruments according to the item 5.3.5.

7.3.12.2 SELLER shall model volumes unassociated to equipment using features that allow modeling space reservation volumes according to the item 5.3.10.

7.3.12.3 SELLER shall model piping and accessories, manual valves (and operators), instrumented valves (and actuators) and inline instruments using specific piping modeling features according to the item 5.3.4.

7.3.12.4 SELLER shall model ducts and HVAC accessories using specific HVAC modeling features according to the item 5.3.6.

7.3.12.5 SELLER shall model trays using specific tray modeling features according to the item 5.3.7.



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7.3.12.6 SELLER shall model structural objects using specific structure modeling features according to the items 5.3.8 and 5.3.9, except as described on items 7.3.19.2.3 e 7.3.19.3.3.

7.3.12.7 SELLER shall comply with item 7.3.26.14 when modeling the hull surface.

7.3.13 SELLER shall model supports for all objects modeled in the CAE 3D tool.

7.3.14 SELLER shall graphically model fireproofing in the CAE 3D tool for all piping components and define all its associated properties including specification, area of fireproofing material used and thickness as indicated in Annex C – Petrobras Class Library for Upstream.

7.3.14.1 SELLER shall define painting information in the 3D model database whenever intumescent coating is used for fireproofing.

7.3.15 SELLER shall define engineering attributes in the 3D model according to class library on Annex C – Petrobras Class Library for Upstream.

7.3.16 Specific modeling requirement for individual disciplines are listed on items 7.3.19, 7.3.20, 7.3.21, 7.3.22, 7.3.23, 7.3.24, 7.3.25, 7.3.26 and 7.3.26.14.

7.3.17 SELLER shall represent the colors in the CAE 3D tool according DR-ENGP-I-1.15-R.4 – Color Coding.

7.3.17.1 For volumes, when applicable, SELLER shall define colors according to its purpose.

7.3.17.2 The definitive color representation on the CAE 3D tool, does not exempt SELLER from using color on visualization files for construction and assembly control, according Exhibit XVI - Computational Tools and Integrated Management System.

7.3.17.3 SELLER shall also define the color attribute with the color information and the Munsell specification according DR-ENGP-I-1.15-R.4 – Color coding.

7.3.18 SELLER shall register all catalogue components (e.g. piping, HVAC, Structure, etc.) and define its dimensions and weights. All catalogues supplied during bid phase, are limited to basic design scope and, if SUPPLIER decides to use this catalogue,



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SUPPLIER is responsible for any updates necessary to guarantee its completeness, accuracy, and consistency. SELLER is also responsible for any impacts in pipping supports, pipe rack, structural reinforcement, bulk material and specifications.

7.3.19 SPECIFIC COMPLETENESS REQUIREMENTS FOR MECHANICS, TURBOMACHINERY AND MARINE SYSTEMS

7.3.19.1 SELLER shall model all mechanical equipment from hull and topsides.

7.3.19.2 SELLER shall model outfitting items supplied with mechanical equipment.

7.3.19.2.1 SELLER shall model outfitting items within the parent equipment hierarchy.

7.3.19.2.2 SELLER shall segregate outfitting items from other equipment components on the parent equipment hierarchy when modeling.

7.3.19.2.3 SELLER shall model outfitting items using specific features for equipment modeling.

7.3.19.3 SELLER shall model coamings whenever required by the equipment.

7.3.19.3.1 SELLER shall model coamings within the parent equipment hierarchy.

7.3.19.3.2 SELLER shall segregate coamings from other equipment components on the parent equipment hierarchy when modeling.

7.3.19.3.3 SELLER shall model coamings using specific features for equipment modeling.

7.3.19.3.4 SELLER shall model other coamings according to the item 7.3.20.1.

7.3.19.4 SELLER shall model handling routes and monorails in the 3D model.

7.3.19.4.1 When modeling handling routes, SELLER shall use volumes and define its purpose attribute according to the item 7.3.7 c).

7.3.19.4.2 SELLER shall model monorails using structural shapes in the 3D model.

7.3.19.5 SELLER shall model the identification plates and access volumes to the identification plates of equipment under NR-13 requirements. The identification plates shall be modeled in an easily accessible position.



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7.3.20 SPECIFIC COMPLETENESS REQUIREMENTS FOR STRUCTURES

7.3.20.1 SELLER shall model using the 3D tool the following topsides structures:

- a) Primary and secondary module structures;
- b) Module outfitting items, stairs and platforms not supplied with equipment;
- c) Deck coamings not supplied with equipment;
- d) Equipment Foundation;
- e) All structural supports.

7.3.20.2 SELLER shall model using the 3D tool the following hull structure:

- a) Structures and internal hull compartments;
- b) Offshore structures;
- c) Accommodation structural objects;
- d) Hull outfitting items, including stairs and platforms not supplied with equipment;
- e) Deck coamings not supplied with equipment.

7.3.20.3 SELLER shall model deck coamings not supplied with equipment within the structure discipline hierarchy, using specific features for structure modeling.

7.3.20.4 SELLER shall detail structural profiles when modeling the interconnections between structural objects (structural nodes).

7.3.20.5 SELLER shall comply with the structural design requirements when modeling the cardinal points for structure profiles.

7.3.20.6 SELLER shall model all voids on structural objects for piping, trays and other objects passing through.

7.3.20.7 SELLER shall model equipment foundations within the parent equipment hierarchy.

7.3.20.7.1 SELLER shall segregate equipment foundations from other equipment components on the parent equipment hierarchy when modeling.

7.3.20.8 SELLER shall model platforms, stairs, accesses, bases, supports and other structural objects, even if they belong to package units or skids, using specific features for structure modeling.



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7.3.20.9 SELLER shall take into account crops and changes in thickness when modeling model floor plates and floor grids.

7.3.21 SPECIFIC COMPLETENESS REQUIREMENTS FOR ELECTRICAL

7.3.21.1 SELLER shall model electrical motors with nominal voltage above 400V separately from the mechanical equipment it powers.

7.3.21.2 SELLER shall model all electrical equipment including, but not restricted to, push-buttons, switches, power socket-outlets, junction boxes, busbar trunkings, cable passage sealing devices, lightning arresters, lamp post, lighting panels, switchboard, frequency converter, soft-starter, electrical system control panel, electrical motor, floodlights and lighting fixtures. SELLER shall also model all electrical cable-trays and their supports.

7.3.21.3 SELLER shall model all electrical panels inside the panel rooms, modeling and identifying its cubicles, when applicable.

7.3.21.4 It is not required that SELLER models in the CAE 3D tool the electrical equipment installed inside panels or housings.

7.3.21.5 Trays identification shall be according to the I-ET-3010.00-5140-700-P4X-001 - SPECIFICATION FOR ELECTRICAL DESIGN FOR OFFSHORE UNITS.

7.3.22 SPECIFIC COMPLETENESS REQUIREMENTS FOR HVAC

7.3.22.1 SELLER shall model all HVAC equipment and HVAC ducts and its supports.

7.3.22.2 SELLER shall model all piping belonging to HVAC P&IDs, in the piping 3D hierarchy.

7.3.23 SPECIFIC COMPLETENESS REQUIREMENTS FOR PIPING

7.3.23.1 SELLER shall model in the CAE 3D tool, all topsides and hull piping modeled on engineering diagrams of process, marine systems, safety and HVAC.

7.3.23.2 Whenever modeling piping, SELLER shall model pipelines, pipe components, accessories, inline instruments, manual valves (including operators) and

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instrumented valves (including actuators). Item 7.3.7 is applicable to all piping objects.

7.3.23.2.1 SELLER shall also model chemical injection piping and all piping with working pressures above 150 bar that use tubing piping specification for construction, including all their accessories and supports. The isometrics of these tubings shall be extracted from the 3D model.

7.3.23.3 SELLER shall define the purpose attribute for piping components operation/maintenance volumes according to the item 7.3.7 b).

7.3.23.3.1 SELLER shall define the purpose attribute for volumes required for bolt assembly of flanged connections as operation/maintenance, according to the item 7.3.7 b), whenever there is limited space for bolt removal.

7.3.23.4 SELLER shall model in the CAE 3D tool all piping including its supports and components.

7.3.23.5 SELLER shall not model piping and accessories as primitive geometries, even if they belong to a package unit.

7.3.23.6 SELLER shall indicate using proper attribute in the CAE 3D tool the piping section that require isolation or heat tracing. Graphical modeling of these components shall include additional thickness.

7.3.23.7 SELLER shall graphically model in the CAE 3D tool the piping slope.

7.3.23.8 SELLER shall model in the CAE 3D tool corrosion coupons and probes corrosion and its access connections.

7.3.23.9 SELLER shall define attribute that uniquely identifies all piping spools.

7.3.24 SPECIFIC COMPLETENESS REQUIREMENTS FOR SAFETY

7.3.24.1 SELLER shall use volumes and define its purpose attribute according to the item 7.3.7 d), when modeling escape routes.

7.3.24.2 SELLER shall model the volumes reserved for escape routes.



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7.3.24.3 SELLER shall model all safety equipment including, but not restricted to, alarms, equipment cabinet, windsock, push-buttons, horns, life jacket box, fixed water/foam cannon, emergency shower and eyewash, detector, breathing apparatus housing, embarkation ladder, manual CO2 triggering remote station, fire extinguisher cabinets, hydrant, floodlight, illumination, foam proportioner, floor marking and emergency phone.

7.3.24.4 SELLER shall model in the CAE 3D tool, all piping modeled on engineering diagrams of safety within the piping hierarchy.

7.3.24.5 SELLER shall not model safety equipment installed inside cabinets, panels and other housings.

7.3.25 SPECIFIC COMPLETENESS REQUIREMENTS FOR AUTOMATION

7.3.25.1 SELLER shall model inline instruments, instrumented valves and actuators, according to the item 7.3.23.2 within the piping discipline hierarchy.

7.3.25.2 SELLER shall model all automation equipment.

7.3.25.3 SELLER shall model all outline instruments and all automation trays and its supports.

7.3.25.4 SELLER shall not model automation equipment installed inside panels and other housings.

7.3.26 SPECIFIC COMPLETENESS REQUIREMENTS FOR TELECOMMUNICATIONS

7.3.26.1 SELLER shall model all telecom PAGA equipment including, but not restricted to, loudspeakers, emergency lamp, page party station, page party in acoustic booth, desk access unit and amplifier.

7.3.26.2 SELLER shall model all telecom radio equipment including, but not restricted to, UHF, AIS, VHF, MF/HF, LTE, SART, EPIRB, gateway – Bluetooth low energy, beacons – Bluetooth low energy, microwave and console.

7.3.26.3 SELLER shall model all telecom antennas equipment including, but not restricted to, parabolic, omni, yagi, panel, sector and antenna coupler.



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- 7.3.26.4 SELLER shall model all telecom data equipment including, but not restricted to, router, switch, access point, firewall, servers, videoconference and wan controller.
- 7.3.26.5 SELLER shall model all telecom satellite equipment including, but not restricted to, antenna controller, modem, VSAT Antenna, Inmarsat C, Inmarsat FBB and GPS compass.
- 7.3.26.6 SELLER shall model all telecom telephony equipment including, but not restricted to, telephone set, buzzer and light signaling, telephone in acoustic booth and PABX.
- 7.3.26.7 SELLER shall model all telecom TVRO equipment including, but not restricted to, TV decoder, TV server, TV encoder, TV modulator, TV amplifier, TV receiver and set top box.
- 7.3.26.8 SELLER shall model all telecom CCTV equipment including, but not restricted to, cameras, encoder, NVR and CCTV workstation.
- 7.3.26.9 SELLER shall model all telecom special monitoring systems equipment including, but not restricted to, weather sensors, motion sensors, workstations, fanbeam, artemis and DARPS.
- 7.3.26.10 SELLER shall model all telecom towers.
- 7.3.26.11 SELLER shall model all telecom panels.
- 7.3.26.12 SELLER shall model all telecom attributes, according to the Annex C – Petrobras Class Library for Upstream.
- 7.3.26.13 SELLER shall model all telecom trays and its supports.
- 7.3.26.14 SELLER shall not model telecom equipment installed inside consoles and racks.
- 7.3.27 SPECIFIC COMPLETENESS REQUIREMENTS FOR MARINE SYSTEMS
 - 7.3.27.1 For FPSO type production facilities projects, SELLER shall represent in CAE 3D tools the hull surface geometry.



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7.3.27.1.1 SELLER may use other tools to model the hull surface geometry as long as it is possible to import its shape into the 3D model of the Project, even if it doesn't store engineering attributes.

7.4 COMPLETENESS REQUIREMENTS FOR ARCHITECTURE DESIGN CAE TOOLS

7.4.1 SELLER shall use CAE tool for architecture design.

7.4.2 SELLER shall model the architecture 3D design using a CAE tool that meet the eligibility requirements according to the item 5.5.

7.4.3 3D model shall include false-floor (where existent) of Accommodation module rooms.

7.4.4 SELLER shall model in the Accommodation module all hatches to access the HVAC equipment as dampers and duct fans for maintenance and inspection.

7.4.5 SELLER shall model all architecture items according to the Annex C – Petrobras Class Library for Upstream.

7.4.6 SELLER shall define all architecture attributes in the architecture tool database.

8 REQUIREMENTS FOR DOCUMENT EXTRACTION**8.1 GENERAL DOCUMENT EXTRACTION REQUIREMENTS**

8.1.1 SELLER shall ensure all drawing and documents extracted from CAE tools are according to standards applicable to the project.

8.1.2 SELLER shall stamp drawings and the cover page of reports extracted from CAE tools with a remark that clearly states:

8.1.2.1 It was generated from a CAE tool;

8.1.2.2 Name and version of CAE tool it was generated from;

8.1.2.3 Any modifications shall be done using the same CAE tool so that following revisions are also generated with the same CAE tool. Under any circumstances changes shall be made using CAD tools.



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8.1.2.4 This stamp shall use Title Block feature, or similar, in such a way that all the information on the stamp is stored in the CAE tool database.

8.2 CAE 2D DOCUMENT EXTRACTION REQUIREMENTS

8.2.1 SELLER shall extract from CAE 2D tools the following documents:

8.2.1.1 Line list;

8.2.1.2 Valve list;

8.2.1.3 Equipment list;

8.2.1.4 Special item list;

8.2.1.5 Tie-in list.

8.2.2 According to the item 7.2.1, SELLER shall extract from CAE 2D tool the following documents:

8.2.2.1 Process flow diagrams;

8.2.2.2 Utility diagrams;

8.2.2.3 Process and instrumentation diagrams;

8.2.2.4 Commissioning diagrams.

8.2.3 According to the item 7.2.12, SELLER shall extract from CAE 2D tool the following automation documents:

8.2.3.1 Instrument list;

8.2.3.2 Cable list;

8.2.3.3 I/O list;

8.2.3.4 Datasheets for Instruments, sensors and instrumented valves;

8.2.3.5 Loop diagrams;

8.2.3.6 Wiring diagrams;



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8.2.3.7 Hookup diagrams;

8.2.3.8 Materials list;

8.2.3.9 Set Point list;

8.2.3.10 Alarm list.

8.2.4 SELLER shall extract from CAE 2D tool the following electrical documents:

8.2.4.1 Datasheets for critical equipment (i.e. Low and Medium Voltage Generators, Medium-Voltage Electrical Motors, Battery chargers, batteries and transformers);

8.2.4.2 One-line diagrams;

8.2.4.3 Material lists;

8.2.5 SELLER shall define all information listed on items 8.2.2, 8.2.3 and 8.2.4 to allow these documents to be extracted from the CAE 2D tool database.

8.3 CAE 3D DOCUMENT EXTRACTION REQUIREMENTS

8.3.1 SELLER shall extract all scale drawings, structural drawings, isometrics and spool drawings using CAE 3D tool's native features. Spool drawings may exceptionally be generated using other tools as long as all information is defined in the CAE 3D tool database.

8.3.1.1 SELLER shall define all information available on extracted documents in the CAE 3D tool database.

8.3.2 SELLER shall extract instrumentation, electrical and telecommunications tray drawings using CAE 3D tool's native features.

8.3.3 SELLER shall not make any changes on automatically extracted drawings that may potentially cause interferences that will not be contemplated in the CAE 3D tool.

8.3.3.1 SELLER shall not make any position or dimension changes on objects represented on automatically generated drawings after document extraction.



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- 8.3.3.2 SELLER shall not include on automatically generated drawings any objects that are not represented CAE 3D tool after document extraction.
- 8.3.4 SELLER may make superficial adjustments in the CAE 3D automatically extracted drawings, only to facilitate understanding and interpretation, as long as it still complies with item 8.3.3.
- 8.3.4.1.1 SELLER may include or exclude distances, instructions and annotations in the CAE 3D automatically generated drawings, as long as it still complies with item 8.3.3.
- 8.3.4.1.2 SELLER may change the position of distances, instructions and annotations in the CAE 3D automatically generated drawings.
- 8.3.4.1.3 SELLER may change the font of distances, instructions and annotations in the CAE 3D automatically generated drawings.
- 8.3.5 If the chosen 3D tool allows, automatically extracted drawings shall remain available for search and update in the CAE tool interface.
- 8.3.6 SELLER shall extract all material lists containing quantities, descriptions and weights of modeled objects, using the information available in the CAE 3D tool database.
- 8.3.7 SELLER shall extract the following electrical, instrumentation and telecom documents from CAE 3D tool:
- 8.3.7.1 Tray list, including discipline, location, material and dimension;
- 8.3.7.2 Tray list including cable Tags and percent fill for each tray section;
- 8.3.7.3 Tray list for each discipline including weights for trays, cables, supports and accessories, for each discipline, location and section;
- 8.3.7.4 Tray tie-ins.
- 8.3.8 SELLER shall extract the following structural documents from CAE 3D tool:
- 8.3.8.1 Weight and center of gravity;



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8.3.8.2 List of material;

8.3.8.3 Level of material;

8.3.8.4 Sections;

8.3.8.5 Number of plates.

8.3.9 SELLER shall extract the following equipment documents from CAE 3D tool:

8.3.9.1 Weight and center of gravity;

8.3.9.2 List of Tags;

8.3.9.3 List of equipment nozzles;

8.3.9.4 List of electrical accessories.

8.3.10 SELLER shall extract the following piping documents from CAE 3D tool:

8.3.10.1 List of materials;

8.3.10.2 List of Supports;

8.3.10.3 Weight of components per status.

8.4 ARCHITECTURE DOCUMENT EXTRACTION REQUIREMENTS

8.4.1 SELLER shall extract all architecture blueprints using native features of the architecture design CAE tool.

8.4.1.1 Items 8.3.2, 8.3.3 and 8.3.4 also apply to automatically generated drawings from architecture design CAE tool.

8.4.2 SELLER shall extract all material lists containing quantities, descriptions and weights of modeled objects, using the information available on the architecture design CAE tool database.

9 CONSISTENCY REQUIREMENTS

9.1 GENERAL CONSISTENCY REQUIREMENTS



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9.1.1 SELLER shall ensure Tag consistency between databases.

9.1.2 Whenever verifying consistency between two databases, SELLER shall at least:

9.1.2.1 Compare Tag codes of tagged objects listed in both databases.

9.1.2.2 Compare values of mandatory attributes in both databases, according to the Annex C – Petrobras Class Library for Upstream.

9.1.3 SELLER shall ensure consistency between interconnected objects within the same CAE tools databases. This consistency shall be verified for all common engineering information defined in attributes listed as mandatory in Annex C – Petrobras Class Library for Upstream.

9.1.4 Whenever collaboration feature is used for design in CAE tools, SELLER shall verify consistency in all satellite and host sites.

10 INTEGRITY REQUIREMENTS

10.1 GENERAL INTEGRITY REQUIREMENTS

10.1.1 In addition to completeness and consistency requirements described in items 7 and 8.4.2, SELLER shall use CAE tools native features specified in item 5 ELIGIBILITY CRITERIA and applicable engineering rules to ensure the accuracy of the data.

10.1.2 SELLER shall ensure integrity between connections of objects graphically modeled.

10.1.3 Whenever collaboration feature is used for design in CAE tools, SELLER shall verify integrity in all satellite and host sites.

10.1.4 SELLER shall perform automatic interference verification and management of identified interferences using native features of CAE 3D tool or 3D visualization and navigation tool described in 5.3 e 5.4.

10.1.5 If SELLER uses different CAE design tools for 3D modeling and architecture design, SELLER shall be able to import or integrate both models with minimum required information to perform automatic interference verification and make all required changes to the original models.



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11 INFORMATION HANDOVER REQUIREMENTS

11.1 GENERAL INFORMATION HANDOVER REQUIREMENTS

11.1.1 SELLER shall handover to PETROBRAS the following information during the Project:

- a) CAE tool database backups, except CAE 3D database that should be accessible using collaboration feature according to the item 11.2;
- b) 3D model visualization files;
- c) Bulkload files of the 3D tool catalogue;
- d) Files used to import content into CAE 3D tool from other tools;
- e) Configuration and customization files, such as, files used to create attributes, create/configure rules, filters, symbols and other customizations;
- f) Attribute mapping containing name and reference on the selected tool database, for all engineering attributes on Annex C – Petrobras Class Library for Upstream;
- g) Digital Engineering Execution Plan.

11.1.2 SELLER shall handover all files used to import data into CAE 3D tool from other design tools. This includes:

- a) Files in the export format from the origin design tool;
- b) Files in the import format into the CAE 3D tool.

11.1.2.1 The design tools mentioned in item 11.1.2 include, but are not restricted to, CAD 3D, mechanical modeling, structural detailed modeling, hull modeling, architecture design and other CAE 3D tools.

11.1.2.2 SELLER shall define at the beginning of the Project, the export format from the origin tools most appropriate for handover.

11.2 WORKSHARE ENVIRONMENT

11.2.1 SELLER shall implement collaboration feature for CAE 3D tool as specified in 5.3.12 and allow PETROBRAS to access by workshare the 3D model database in an environment synchronized with SELLER's design team.

11.3 DIGITAL ENGINEERING EXECUTION PLAN

11.3.1 SELLER shall issue the first revision of the Digital Engineering Execution Plan prior to Project start containing at least the following information:



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- a) Name and version of CAE tools that will be used in the Project and, when applicable, name and version of the tool used to model the hull surface;
- b) Tables relating all mandatory engineering information in Annex C – Petrobras Class Library for Upstream with the names/identifiers of the attributes in the chosen CAE tool;
- c) Describe the interference identification criteria that will be applied in the Project;
- d) If using collaboration feature between its sites, SELLER shall provide the following information, (i) host location; (ii) Satellite locations; (iii) minimum update frequency between satellites and host; (iv) activities that will be centered at the host location; (v) Deadlines for execution of processes centered at host location.

11.3.2 SELLER shall handover all the databases in the tools and versions pre-defined in the Project's Digital Engineering Execution Plan.

11.3.3 If SELLER identifies any requirements within this technical requirement that are not applicable to the Project's scope, it should be clearly stated in the Project's Digital Engineering Execution Plan.

11.3.4 SELLER shall consider a weekly frequency for visualization files handover and a monthly frequency for CAE tool database handover, when elaborating the Project's Digital Engineering Execution Plan.

11.3.5 SELLER shall revise and issue at the end of the project the Digital Engineering Execution Plan to include the following information in addition to item 11.3.1:

- a) Identification of all customizations (rule names and files) used for automatic generation of each drawing category, including schematic drawings and scale drawings;
- b) Identification and queries used for automatic generation of each type of document;
- c) Identification of the customizations (rule names and files) used for automatic tagging of each type of object;
- d) Identification of the customizations (rule names and files) containing the rules for interference check.

11.4 PARTIAL HANDOVER REQUIREMENTS



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11.4.1 SELLER shall consider the frequency for visualization files handover according to the Digital Engineering Execution Plan as stated in item 11.3.4.

11.4.1.1 SELLER shall make 3D visualization files available in cloud services that allows access by mobile devices (smartphones and tablets) and web browsers.

11.4.1.2 Visualization files shall be subdivided to allow exhibition and storage in conventional devices. This subdivision shall be agreed between PETROBRAS and SELLER during the Project kick-off meeting.

11.4.2 In each partial handover milestone, SELLER shall deliver the following information:

- a) Backups of the CAE tools databases used in the Project;
- b) Other files listed in item 11.1.1.

11.4.3 For each Design Review, SELLER shall deliver and archive each backup from CAE tool databases, as well as 3D model visualization files.

11.5 POINT CLOUDS HANDOVER REQUIREMENTS

11.5.1 PETROBRAS can use point clouds as an acceptance criterium for as built 3D model final handover or any other delivery containing information related to point clouds. The acceptable position deviation tolerance is 150 mm for all scanned items.

11.5.2 SELLER shall deliver point clouds files in a format compatible to Petrobras Standard 3D modeling CAE tool according to the item 5.1.2.

11.5.3 SELLER shall make sufficient scenes for point clouds to achieve precision of 50 mm for all scanned items, so that it is possible to compare the position of the constructed items with the design 3D model ones. Scanner accuracy shall match this requirement. Point clouds scope is described in Table 1.



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Table 1 Point clouds scope.

Item	Point Clouds Description
Piping	Point clouds shall contain process piping and its flanged, welded and or threaded components, such as bends, elbows, branches, retainers, valves, flexibles, hoses, cables and supports including brackets, clamps, pedestals and other piping components.
Equipment	Point clouds shall contain equipment such as pumps, tanks, vessels, compressors, heat exchangers, towers, motors and others, including their nozzles, manholes, platforms, stairs, ladders, handrails, guardrails, vents, drains, connections and piping including the ones smaller than 2" Ø.
Structure	Point clouds shall contain beams, columns, braces, plates, slabs, pipe-racks, piping support, guardrails, handrails, walkways, fire hydrants, stairs, ladders, floor grating, floor plates and other primary, secondary and tertiary structures.
Electric	Point clouds shall contain light fixtures, passage boxes, distribution boxes, lighting posts, transformers, motors, control panels, generators, trays and conduits equal to or greater than 2" Ø.
Industrial Automation	Point clouds shall contain tubings, instruments, panels, boxes and trays.
HVAC	Point clouds shall contain all HVAC items, such as panels, ducts with their components and equipment.
Safety	Point clouds shall contain all industrial safety items, such as fire extinguishers, hydrants, foam monitors and emergency eye-washers.

11.5.4 SELLER shall deliver point clouds after a cleansing process of scenes (this criterium is valid for all the delivers) to eliminate unnecessary points that make visualization more difficult or that pollute the model.



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11.5.5 SELLER shall deliver point clouds in a density that allows the correct visualization of the scanned items. The point clouds shall be complete, with no distortions or mends, to allow easy identification of scanned items.

11.5.6 PETROBRAS shall consider invalid deliveries in which point clouds are not dense enough, or have distortions or mends, or is incomplete, or does not follow the requirements listed in this document. And SELLER shall redo the services.

11.5.7 Delivery of Field Verification:

The final product of scanning shall be a database containing the point clouds referenced using the design coordinate system. If a point cloud file is greater than 1GByte, the file shall be divided in smaller parts, with each part files never being greater than 1GByte.

11.5.8 Point clouds, shall be delivered in a physical media in the following formats:

- Scanner native – To assure the original file quality;
- Extension “.ptx” – To assure interoperability and convertibility;
- Extension “.rcp” – For using in visualization tools;
- Extension “.lfd” – To assure direct visualization in the CAE 3D tool.

11.6 FINAL HANDOVER REQUIREMENTS

11.6.1 At the end of the project, SELLER shall deliver the updated version of the CAE tools databases backups used.

11.6.1.1 Only one backup of each CAE tool shall be issued for final delivery, each of them consolidating HULL and TOPSIDES scope.

11.6.2 SELLER shall deliver the databases in the as built condition.

11.6.2.1 SELLER shall use laser scanning (point clouds) as means to identify and correct modeling deviations to guarantee the as built condition of the 3D model.



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11.6.2.1.1 On sail away, SELLER shall deliver point clouds used for comparison together with the as built model. If any changes are made to the as built model, they should be implemented and delivered on the comparison report according item 11.6.2.2. Point clouds handover requirements are described in item 11.5.

11.6.2.2 SELLER shall also deliver a comparison report between the as built model (CAE 3D tool defined on item 5.1.3.4) and the point clouds, attesting the verification. SELLER shall submit this comparison report for PETROBRAS approval. This report shall contain a map indicating the areas corresponding to each point cloud file.

11.6.3 Handover of all requested information shall be done at least 30 days prior to contract conclusion.

11.6.4 SELLER shall deliver all other files listed in item 11.1.1 updated by the end of the project.

11.6.5 SELLER shall exclude all objects and hierarchy levels used specifically for studies and alternative evaluation in the 3D model prior to final handover of the databases.

11.6.6 In the final handover, the databases backups delivered (item 11.6.1) shall be complete and according to Petrobras Standard CAE tools (item 5.1.3), therefore, these databases shall contain all the documents (such as 2D drawings, isometrics, datasheets and others) created in each CAE tool.

11.6.6.1 Isometrics that represent changes of piping specification from FRP to another material and vice versa shall present the rotation and inclination of the flange.

12 ANNEXES

Annex A - 3D model Standard Upstream Hierarchy

Annex B - Terminology applicable to the 3D model Standard Upstream Hierarchy

Annex C - Petrobras Class Library for Upstream