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B	CHANGES IN ITEMS 3 AND 9.3.6 AND NEW ITEM 9.4
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SUMMARY

1 OBJETIVE

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

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

Define the levels of completeness, consistency and integrity expected for 30%, 60% and 90% design reviews and measurement criterion.

2 SCOPE OF WORK

This document defines minimum requirements for completeness, integrity, consistency, document extraction and handover of databases of CAE tools for BOT type contracts.

CAE tools shall be used throughout BOT type contracts to graphically model objects and define attributes on structured engineering databases.

3 DEFINITIONS

Detailed design: Set of activities, executed by several engineering disciplines, in such detail that results in required and sufficient information for procurement, construction and assembly and pre-operation of a production unit or industrial plant. It includes preparing and completing project specifications, datasheets, lists, drawings and procedures, according to international standards and design codes.

CAE tools: In the digital engineering context, it shall be understood as a database-based tools (2D and 3D) that usually provide a user interface for graphical modelling.

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

CAE 3D tool: Database based tool used for 3D modelling and automatic extraction of

design documents. Also known as, Plant Design 3D tools or BIM (Build Information Model).

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

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.

Model: The verb “model” is used throughout this technical specification, meaning both to graphically represent the object in the 3D model and to define all its attributes according Annex C.

4 ABBREVIATIONS

LV: List of Verification

BOT: Build-Operate-Transfer

CAD: Computer-aided Design

CAE: Computer-aided Engineering

P&ID: Piping and Instrumentation Diagram

BIM: Build Information Model

5 ELIGIBILITY CRITERIA

5.1 GENERAL ELIGIBILITY CRITERIA

5.1.1 SELLER shall only select currently commercial CAE tools.

5.1.2 If SELLER decides to use design tools other than SPPID, SPI, for 2D modelling or PDMS, E3D, S3D for 3D modelling, SELLER shall provide 03 licenses of each software to PETROBRAS for Project verification.

5.1.3 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 5.1.2.

6 ORGANIZATION REQUIREMENTS

6.1 ORGANIZATION REQUIREMENTS FOR CAE 3D TOOL

6.1.1 SELLER shall submit 3D model hierarchy at least 30 days prior to the 30% design review session. Annex A provides an example of information required to be provided within a 3D model hierarchy.

6.1.2 SELLER shall submit detailed description of 3D model hierarchy containing at least the following information:

a) Levels used to divide objects;
b) Scope of each level;
c) Options available within each level;
d) Objects contained in each option;
e) Terminology applicable to the 3D model hierarchy (see Annex B as reference).

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

6.1.4 If TOPSIDES and HULL are not modelled within the same database, SELLER shall guarantee there are no interferences between the two models.

6.1.5 SELLER shall divide TOPSIDES from HULL within the 3D hierarchy.

6.1.6 SELLER shall divide TOPSIDES first into MODULES and then DISCIPLINES within the 3D hierarchy.

6.1.7 SELLER shall divide the HULL at least into locations within the 3D hierarchy.

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

6.1.9 SELLER shall divide modelled objects into TYPES (i.e. equipment, piping, structure, HVAC ducts) in 3D model hierarchy.

7 COMPLETENESS REQUIREMENTS

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

7.1 COMPLETENESS GENERAL REQUIREMENTS

7.1.1 SELLER shall tag all objects modelled previously to each design review session.

7.1.2 SELLER shall evenly apply PETROBRAS tagging rules to all CAE tool databases to ensure tag consistency between these databases.

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

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

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

7.1.6 SELLER shall guarantee all weights and dimensions modelled on the CAE 3D tool comply with applicable industry standards and certified documents.

7.1.7 SELLER shall define engineering attributes on the 3D model according to the class library on Annex C.

7.1.8 Whenever the expression modelling is used it includes the graphical modelling and attribute definition according to the item 7.1.7.

7.1.9 SELLER shall issue 30 days prior to 30% design review session the following documents:

7.1.9.1 Piping specification used for CAE 3D catalogue.

7.1.9.2 Piping stress analysis requirements.

7.1.9.3 At least 80% of process and instrumentation diagrams.

7.1.9.4 Structure slamming calculation report.

7.1.10 SELLER shall issue a report after each design review session containing all comments and deadlines. SELLER shall implement all comments 30 days prior to the following design review event and submit for PETROBRAS approval.

7.1.11 Design review session may only occur after all previous comments have been approved.

7.2 COMPLETENESS REQUIREMENTS FOR 30% DESIGN REVIEW SESSION

7.2.1 GENERAL COMPLETENESS REQUIREMENTS

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

a) Equipment Operation;
b) Escape route;
c) Handling routes;
d) Hazardous area;
e) Closed room;
f) Door opening;
g) Helideck operation free span;
h) Draught;
i) Lay down areas.

7.2.1.2 When defining the purpose attribute for equipment operation/maintenance volumes, SELLER shall take into account the space required for use of special devices and tools.

7.2.2 COMPLETENESS REQUIREMENTS FOR ARCHITECHTURE

7.2.2.1 SELLER shall model all compartments, including ladders from all decks and the following items:

a) Coamings;
b) Thermo-acoustic insulation;

c) Passive protection on bulkheads, decks and roofs;

d) Lining panels;

e) Subfloor

f) Floor covering;

g) Ceiling lining;

h) Framed internal and external doors,

i) Windows and boxes.

7.2.3 COMPLETENESS REQUIREMENTS FOR SAFETY

7.2.3.1 SELLER shall model all ladders used for escape routes and to access safety and rescue equipment, including embarkation ladder.

7.2.3.2 SELLER shall model on CAE 3D tool safety and rescue vessels.

7.2.3.3 SELLER shall model on CAE 3D tool the following safety objects:

a) Firefighting equipment cabinet;

b) Hydrants;

c) fixed water/foam cannon;

d) emergency shower and eyewash;

e) breathing apparatus housing.

7.2.4 COMPLETENESS REQUIREMENTS FOR MECHANICS, TURBOMACHINERY AND MARINE SYSTEMS

7.2.4.1 SELLER shall model all mechanical equipment from hull and topsides, including nozzles and auxiliary system volumes.

7.2.4.2 SELLER shall model all package volumes.

7.2.4.3 SELLER shall model all access platforms for equipment maintenance.

7.2.4.4 SELLER shall represent in the CAE 3D tools the hull surface geometry.

7.2.4.5 In case of converted hull, SELLER shall not handover the 3D CAE model of the original hull.

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

7.2.5 COMPLETENESS REQUIREMENTS FOR PIPING

7.2.5.1 SELLER shall model 3D piping catalogue according to the issued piping spec.

7.2.5.2 Piping catalogue shall contain all pipelines, pipe components, accessories, blinds and blanks, spacers, inline instruments, manual valves (including operators) and instrumented valves (including actuators) that will be used in the project.

7.2.6 COMPLETENESS REQUIREMENTS FOR STRUCTURE

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

7.2.6.2 SELLER shall model all primary structures and floor plates.

7.2.6.3 SELLER shall model all ladders in between floors.

7.2.7 COMPLETENESS REQUIREMENTS FOR AUTOMATION, ELECTRICAL AND TELECOM

7.2.7.1 SELLER shall model local control panels and automation and electrical panels located inside central control room and panel room.

7.2.7.2 SELLER shall model electric motors with nominal voltage above 400V.

7.3 COMPLETENESS REQUIREMENTS FOR 60% DESIGN REVIEW SESSION

7.3.1 GENERAL COMPLETENESS REQUIREMENTS

7.3.1.1 SELLER shall implement all comments from 30% design review session.

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

a) Gas exhaust;

b) Flame detection cones;

c) Sprinkler coverage;

d) Meeting points

e) Access to equipment manhole;

f) Access to identification plates of equipment under NR-13 requirements.

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

7.3.2 GENERAL COMPLETENESS ARCHITECHTURE

7.3.2.1 There are no additional requirements for architecture discipline during 60% design review session.

7.3.3 COMPLETENESS REQUIREMENTS FOR SAFETY

7.3.3.1 SELLER shall issue APR and HAZOP studies prior to 60% design review session.

7.3.3.2 SELLER shall model on CAE 3D tool all topside and hull piping used for firefighting systems including its components and sprinklers as described in item 7.3.6.1.1.

7.3.3.3 SELLER shall model all CO2 flooding systems, including local ones and general layout.

7.3.4 SELLER shall graphically model fire proofing on the CAE 3D tool.

NOTE: SELLER shall define painting information on the 3D model database whenever intumescent coating is used for fireproofing.

7.3.5 COMPLETENESS REQUIREMENTS FOR MECHANICS, TURBOMACHINERY AND MARINE SYSTEMS

7.3.5.1 SELLER shall model coamings whenever required by the equipment.

7.3.6 COMPLETENESS REQUIREMENTS FOR PIPING

7.3.6.1 SELLER shall model on the CAE 3D tool 60% of topside and hull piping modelled on engineering diagrams of process, marine systems, safety and HVAC, including:

a) Lines that require flexibility analysis;
b) Routed lines that define equipment arrangement and nozzle position;
c) Larger size lines.

7.3.6.1.1 Whenever modelling piping, SELLER shall model pipelines, pipe components, accessories, blinds and blanks, spacers, inline instruments, manual valves (including operators) and instrumented valves (including actuators).

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

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

7.3.6.3 SELLER shall graphically model on CAE 3D tool the piping slope.

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

7.3.7 COMPLETENESS REQUIREMENTS FOR STRUCTURE

7.3.7.1 SELLER shall model all primary and secondary module structures using the CAE 3D tool.

7.3.7.2 SELLER shall model deck coamings not supplied with equipment within the structure discipline hierarchy.

7.3.7.3 SELLER shall model all structural supports using the CAE 3D tool.

7.3.7.4 SELLER shall model all equipment foundation using the CAE 3D tool.

7.3.7.5 SELLER shall model the main deck region volumes, offshore structures, structural tanks, inner hull compartments and draught.

7.3.7.5.1 The following offshore structures shall have its limits modelled on the CAE 3D tool:

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

7.3.7.6 All modelled structure shall have issued fatigue calculation reports both in the in-place condition and in-transit condition. All calculation reports shall have been previously approved by Classification Society.

7.3.7.7 Structure explosion calculation report.

7.3.8 COMPLETENESS REQUIREMENTS FOR AUTOMATION, ELECTRICAL AND TELECOM

7.3.8.1 SELLER shall model main cable-tray paths between automation and electrical panels.

7.3.8.2 SELLER shall model secondary cable-tray paths between local control panels and equipment/instruments.

7.3.8.3 SELLER shall model all control panels including its doors and supports.

7.3.8.4 SELLER shall model all hydraulic racks including its doors and supports.

7.3.8.5 SELLER shall model air distribution manifolds and supports in the final installation position.

7.3.8.6 SELLER shall model electrical, hydraulic and pneumatic paths for all instruments located on modelled piping and equipment.

7.3.8.7 SELLER shall model instrumentation trays located inside central control room and panel room.

7.3.8.8 SELLER shall model 60% of lighting posts, including supports and accessories.

7.3.8.9 SELLER shall model all junction boxes including supports and accessories.

7.3.8.10 SELLER shall model all inline instruments (flowmeters), pressure-safety valves, instrumented valves (SDVs, BDVs, XVs, control valves) and actuators located on modelled piping. These objects shall be modelled within the piping discipline hierarchy.

7.3.8.11 SELLER shall model all electrical equipment and its accessories.

7.3.8.12 SELLER shall define attributes for all telecom equipment scope of a one-line diagrams using the CAE 2D tool. Telecom one-line drawings may be generated using CAD tools.

7.4 COMPLETENESS REQUIREMENTS FOR 90% DESIGN REVIEW SESSION

7.4.1 GENERAL COMPLETENESS REQUIREMENTS

7.4.1.1 SELLER shall implement all comments from 60% design review session.

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

7.4.2 COMPLETENESS REQUIREMENTS FOR ARCHITECTURE

7.4.2.1 There are no additional requirements for architecture discipline during 90% design review session.

7.4.3 COMPLETENESS REQUIREMENTS FOR SAFETY

7.4.3.1 SELLER shall model all fire and gas detectors and detection cones in their final locations, after the gas dispersion analysis.

7.4.3.2 SELLER shall model all objects according to issued safety studies. These studies shall have been previously approved by Petrobras and Classification Society. The following safety studies shall be considered when modelling:

a) Fire Propagation and Smoke Dispersion Analysis;
b) Explosion Analysis;
c) Gas Dispersion Analysis;
d) Dropped Object Study;
e) Ship Collision Analysis;
f) Preliminary Risk Analysis;
g) Hazard and Operability Study;
h) Evacuation, Abandonment and Rescue Analysis;
i) Noise and Vibration Analysis;
j) Flare Radiation and Dispersion Analysis;
k) Safe use of Helideck.
l) Cryogenic effect of condensate (C3+) leaks in installations

7.4.4 COMPLETENESS REQUIREMENTS FOR MECHANICS, TURBOMACHINERY AND MARINE SYSTEMS

7.4.4.1 SELLER shall model and define attributes of all equipment inside SELLER packages.

7.4.5 COMPLETENESS REQUIREMENTS FOR PIPING

7.4.5.1 SELLER shall model on the CAE 3D tool all topside and hull piping modelled on engineering diagrams of process, marine systems, safety and HVAC.

7.4.5.1.1 Whenever modelling piping, SELLER shall model pipelines, pipe components, accessories, blinds and blanks, spacers, inline instruments, manual valves (including operators) and instrumented valves (including actuators).

7.4.5.1.2 All modelled lines shall be according to the issued flexibility analysis. These flexibility analysis shall have been previously approved by Classification Society.

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

7.4.6 COMPLETENESS REQUIREMENTS FOR STRUCTURE

7.4.6.1 SELLER shall model all platforms, stairs, operation and maintenance accesses, bases, supports and other structural objects, even if they belong to equipment skids.

7.4.7 COMPLETENESS REQUIREMENTS FOR AUTOMATION, ELECTRICAL AND TELECOM

7.4.7.1 SELLER shall model all electrical, automation and telecom cable-trays and their supports and accessories, including the ones located inside SELLER package modules.

7.4.7.2 SELLER shall model all lighting posts, including supports and accessories.

7.4.7.3 SELLER shall model local control stations.

7.4.7.4 SELLER shall model all offline instruments.

7.4.7.5 SELLER shall model all ESD push-buttons including its supports

8 INTEGRITY REQUIREMENTS

8.1 GENERAL INTEGRITY REQUIREMENTS

8.1.1 SELLER shall perform automatic interference verification and management of identified interferences using native features of CAE 3D tool or 3D visualization and navigation tool.

9 INFORMATION HANDOVER REQUIREMENTS

9.1 GENERAL INFORMATION HANDOVER REQUIREMENTS

9.1.1 SELLER shall handover to PETROBRAS the following information on a monthly basis:

a) At least CAE 3D tool database backups. If other CAE tools are used these shall be handed over as well;

b) 3D model visualization files;

c) Bulkload files of the 3D tool catalogue;

d) Customization files, such as files used to create/configure rules, filters, symbols and other customizations;

e) Digital Engineering Execution Plan (if there are changes).

9.1.2 SELLER shall handover all files used to import data into CAE 3D tool from other design tools (see NOTE). This includes:

a) Files in the export format from the origin design tool;

b) Files in the import format into the CAE 3D tool.

NOTE: The design tools mentioned in item 9.1.2 include, but are not restricted to, CAD 3D, mechanical modelling, structural detailed modelling, hull modelling, architecture design and other CAE 3D tools.

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

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

9.1.5 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.

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

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 with the names/identifiers of the attributes in the chosen CAE tools.

c) Description of the 3D hierarchy that will be used in the Project;

d) Describe the interference identification criteria that will be applied in the Project.

9.2 FINAL HANDOVER REQUIREMENTS

9.2.1 At the end of the project, after issuing all as-built documents, SELLER shall deliver the updated version of the CAE tools databases backups used.

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

9.2.3 Handover of all requested information shall be done 60 days prior to BOT contract conclusion.

9.2.4 SELLER shall deliver all other files listed in item 9.1.1 updated by the end of the project.

9.2.5 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.

9.3 CAE DATABASE MAINTENANCE

9.3.1 After BOT contract conclusion, SELLER shall maintain all CAE databases used in project development up to date with changes done during operation phase.

9.3.2 Final handover to Petrobras, after operation contract, shall be on the *as is* condition.

10 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