

DEP SPECIFICATION

PLANT 3D CAD MODEL BUILD AND DESIGN REVIEW

DEP 30.10.05.11-Gen.

February 2017

DESIGN AND ENGINEERING PRACTICE



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TABLE OF CONTENTS

1.	INTRODUCTION	4
1.1	SCOPE	4
1.2	DISTRIBUTION, INTENDED USE AND REGULATORY CONSIDERATIONS	4
1.3	DEFINITIONS	4
1.4	CROSS-REFERENCES	6
1.5	SUMMARY OF MAIN CHANGES.....	6
1.6	COMMENTS ON THIS DEP	6
1.7	DUAL UNITS.....	6
1.8	NON NORMATIVE TEXT (COMMENTARY).....	6
2.	GENERAL	7
2.1	BACKGROUND	7
2.2	GENERAL REQUIREMENTS.....	7
3.	CAD MODEL DEVELOPMENT.....	7
3.1	GENERAL.....	7
3.2	3D-CAD MODEL CATALOGUE SPECIFICATIONS	8
3.3	SAFETY, OPERATIONAL AND MAINTENANCE ASPECTS	8
3.4	MODEL REVIEWS.....	8
3.5	COLOURING USAGE	12
3.6	3D-CAD MODEL USAGE	12
3.7	3D-CAD MODEL HANDOVER	12
4.	DEFINE PHASE REQUIREMENTS	13
4.1	3D-CAD – DEFINE MODEL BACKGROUND	13
4.2	3D-CAD MODEL CREATION	13
4.3	3D-CAD DEFINE MODEL SCOPE.....	13
4.4	3D-CAD DEFINE MODEL REVIEW	13
4.5	3D-CAD DEFINE MODEL CHECKLIST	15
5.	EXECUTE PHASE (DETAIL ENGINEERING) REQUIREMENTS	17
5.1	3D-CAD MODEL GENERAL	17
5.2	3D-CAD 30 % EXECUTE MODEL SCOPE (DETAIL ENGINEERING)	19
5.3	3D-CAD 30 % EXECUTE MODEL REVIEW	19
5.4	3D-CAD 30 % EXECUTE MODEL CHECKLIST	20
5.5	3D-CAD 60 % EXECUTE MODEL SCOPE.....	20
5.6	3D-CAD 60 % EXECUTE MODEL REVIEW	20
5.7	3D-CAD 60 % EXECUTE MODEL CHECKLIST	22
5.8	3D-CAD 90 % EXECUTE MODEL SCOPE.....	23
5.9	3D-CAD 90 % EXECUTE MODEL REVIEW	23
5.10	3D-CAD 90 % EXECUTE MODEL CHECKLIST	23
5.11	AS-BUILDING	23
6.	3D-CAD TOOL REQUIREMENTS	24
6.1	GENERAL.....	24
6.2	FUNCTIONAL REQUIREMENTS.....	24
6.3	REFERENCE DATA	24
6.4	ACCESS	25
6.5	WORK SHARE	25
6.6	BACKUP REQUIREMENTS	25
7.	REFERENCES	26
APPENDIX A	TYPICAL COLOUR CODE FOR 3D-CAD MODELS	27
A.1	PIPING	27
A.2	SEWERS, TRENCHES AND TRUNKING	28
A.3	EQUIPMENT, STEEL, CONCRETE AND MAINTENANCE FACILITIES	28
APPENDIX B	CHECKLIST FOR THE MODEL REVIEW.....	29
APPENDIX C	3D-CAD MODEL STANDARD SETTINGS.....	41

1. INTRODUCTION

1.1 SCOPE

This DEP specifies requirements and gives recommendations for the Select (BFD), Define (BDEP) and Execute (detailed engineering) phase of projects for:

- 3D-CAD models development.
- 3D-CAD visualisation and use of 3D-CAD features.
- 3D-CAD Model review sessions.

The level of detail for the Select and Define Phase is described in (4).

Visualisation tools other than 3D CAD tools (e.g., virtual reality) are not covered by this DEP.

This is a revision of the DEP of the same number dated February 2015; see (1.5) regarding the changes.

1.2 DISTRIBUTION, INTENDED USE AND REGULATORY CONSIDERATIONS

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This DEP is intended for use in facilities related to oil and gas production, gas handling, oil refining, chemical processing, gasification, distribution and supply/marketing. This DEP may also be applied in other similar facilities.

When DEPs are applied, a Management of Change (MOC) process shall be implemented; this is of particular importance when existing facilities are to be modified.

If national and/or local regulations exist in which some of the requirements could be more stringent than in this DEP, the Contractor shall determine by careful scrutiny which of the requirements are the more stringent and which combination of requirements will be acceptable with regards to the safety, environmental, economic and legal aspects. In all cases the Contractor shall inform the Principal of any deviation from the requirements of this DEP which is considered to be necessary in order to comply with national and/or local regulations. The Principal may then negotiate with the Authorities concerned, the objective being to obtain agreement to follow this DEP as closely as possible.

1.3 DEFINITIONS

1.3.1 General definitions

The **Contractor** is the party that carries out all or part of the design, engineering, procurement, construction, commissioning or management of a project or operation of a facility. The Principal may undertake all or part of the duties of the Contractor.

The **Manufacturer/Supplier** is the party that manufactures or supplies equipment and services to perform the duties specified by the Contractor.

The **Principal** is the party that initiates the project and ultimately pays for it. The Principal may also include an agent or consultant authorised to act for, and on behalf of, the Principal.

The word **shall** indicates a requirement.

The word **should** indicates a recommendation.

The word **may** indicates a permitted option.

1.3.2 Specific definitions

Term	Definition
Battery Limit	A defined boundary between two areas of responsibility, which may be physical (i.e., flange on pipe) or represented by a map coordinate.
Facility	Process and utility plants, tanks, buildings, marine structures, pipe racks and roads located within a site boundary.
Formal model review	A review of the 3D model between Contractor and Principal at the milestone of 30%, 60% or 90% progress as applicable and in accordance with the contract
Layout	One or more of the following deliverables: site master plan, plot plans and mechanical general arrangement drawings.
Mechanical General Arrangement Drawings	Overall spatial arrangement of equipment within the available unit boundaries.
Plot Plan	Overall spatial arrangement drawing of one or more unit(s) and related general facilities within a plot boundary, showing the arrangement of equipment within units.
Site	Plot of land with defined boundaries.

1.3.3 Abbreviations

Term	Definition
3D-CAD	Three Dimensional Computer Aided Design
BDEP	Basic Design Engineering Package
BFD	Basis for Design
CAD	Computer Aided Design
GA	General Arrangement drawings (typically for equipment)
HFE	Human Factors Engineering
HSE	Health, Safety & Environment
HVAC	Heating Ventilating Air Conditioning
PFS	Process Flow Scheme
PEFS	Process Engineering Flow Scheme
TA	Technical Authority
VCA	Valve Criticality Analysis

1.4 CROSS-REFERENCES

Where cross-references to other parts of this DEP are made, the referenced section or clause number is shown in brackets (). Other documents referenced by this DEP are listed in (7).

1.5 SUMMARY OF MAIN CHANGES

This DEP is a full revision of the DEP of the same number dated February 2015. The following are the main, non-editorial changes.

Section/Clause	Change
3	Added model development aspect.
6	Added 3D CAD tool requirements.
Appendix A (previous)	Consolidated Define and Execute Scope & Checklist requirements and converted to standard form
Appendix A (was Appendix B)	Aligned colours with fluid codes defined in DEP 01.00.09.10-Gen.

1.6 COMMENTS ON THIS DEP

Comments on this DEP may be submitted to the Administrator using one of the following options:

Shell DEPs Online (Users with access to Shell DEPs Online)	Enter the Shell DEPs Online system at https://www.shelldeps.com Select a DEP and then go to the details screen for that DEP. Click on the "Give feedback" link, fill in the online form and submit.
DEP Feedback System (Users with access to Shell Wide Web)	Enter comments directly in the DEP Feedback System which is accessible from the Technical Standards Portal http://www.shell.com/standards . Select "Submit DEP Feedback", fill in the online form and submit.
DEP Standard Form (other users)	Use DEP Standard Form 00.00.05.80-Gen. to record feedback and email the form to the Administrator at standards@shell.com .

Feedback that has been registered in the DEP Feedback System by using one of the above options will be reviewed by the DEP Custodian for potential improvements to the DEP.

1.7 DUAL UNITS

This DEP contains both the International System (SI) units, as well as the corresponding US Customary (USC) units, which are given following the SI units in brackets. When agreed by the Principal, the indicated USC values/units may be used.

1.8 NON NORMATIVE TEXT (COMMENTARY)

Text shown in italic style in this DEP indicates text that is non-normative and is provided as explanation or background information only.

Non-normative text is normally indented slightly to the right of the relevant DEP clause.

2. GENERAL

2.1 BACKGROUND

A 3D CAD system is a multidisciplinary design tool and an integral part of the design and engineering process. The 3D-CAD system can generate the engineering drawings (i.e., plot plans, equipment GA's, Isometrics) and can generate the construction materials and equipment information. The 3D visualisation tool used for the 3D CAD "model review" is only one of the features of a 3D CAD system. The 3D model forms a crucial part of the digital asset for use by Operations and Maintenance.

2.2 GENERAL REQUIREMENTS

1. Where plot layout is critical, and affects feasibility, a 3D model shall be created as part of the BDEP (Define) Phase of the project.
2. As part of the Execute phase (detail engineering) a 3D CAD model shall be constructed.
3. The 3D CAD system shall provide a clash-free design for all engineering disciplines involved according to minimum clash settings agreed with the Principal.

See (Appendix C) and DEP 31.38.01.11-Gen., Section 3.8.

5. For brownfield projects the 3D CAD tool should be used in conjunction with laser scan data.

The new project elements can be built in an integrated laser scan/3D model.

6. When applying this DEP, refer to the 3D model content checklist and deliverables list as detailed in form DEP 30.10.05.90-Gen.

3. CAD MODEL DEVELOPMENT

3.1 GENERAL

1. The Contractor shall develop and share with the Principal a 3D CAD system strategy containing the following as a minimum:
 - a. The individual disciplines (e.g., piping, structural, civil, electrical, instrumentation) that will create their designs in the 3D CAD model.

A clash free design can only be ensured if all engineering disciplines build their designs in the same 3D CAD model
 - b. The deliverables that each discipline will create from the 3D CAD model.

Typical deliverables of a 3D CAD system are described in (DEP 30.10.05.90-Gen.).
 - c. The work process to build the 3D CAD Model, including reviews performed by the Contractor and by the Principal (i.e., internal and formal 3D model review)
 - d. The 3D CAD system used as agreed with the Principal;
 - e. Method of model handover at the end of the project.
2. Contractor shall propose the naming convention for data created in the 3D model, subject to agreement of the Principal.
3. 3D models of all equipment in the PFS should be represented in the 3D CAD system.

3.2 3D-CAD MODEL CATALOGUE SPECIFICATIONS

1. At the start of a project in the SELECT or DEFINE Phase, the Contractor shall use Principal's specifications where available.
 - a. Where Principal's specifications are not available, Contractor may start the first modelling work by using Contractor generic specifications of suitable pressure rating.

Usually no project-specific specifications are loaded in the 3D model catalogue early in design.

2. Until the project-specific component is developed, a substitute component should be used indicating the outline of the item.
3. Until the final dimensions of the project-specific components are known, conservative outline dimensions should be used in the model.
4. Status of component dimensions shall be identified within the 3D-CAD Model catalogue.

For example: Work in progress, Initial, Approved for Construction, As-Built.

5. DEP piping classes shall be used for detailed design (execute) stage.

3.3 SAFETY, OPERATIONAL AND MAINTENANCE ASPECTS

1. The 3D CAD system shall be structured and include the following to ensure sound design and engineering criteria have been met with respect to safety, operability, maintainability and facilitate the engineering and erection of the plant:
 - a. accessibility for maintenance & operations;
 - b. location of valves;
 - c. constructability;
 - d. process instrumentation;
 - e. routing of the piping adequate for the process;
 - f. location of emergency shut-down stations;
 - g. proper and safe location of vents and drains;
 - h. engine exhausts;
 - i. accommodation air intakes;
 - j. location of fire protection and fire-fighting equipment;
 - k. access egress and escape routes, including their soft boxes (clash volumes);
 - l. reserved volumes for materials handling (including soft volumes);
 - m. access for emergency response activities and casualty evacuation routes.
 - n. dropout/bundle pulling areas;
 - o. laydown areas;
 - p. platforms for valves and equipment operations;
 - q. manual handling allowances (e.g., trolley routes, lifting beams).

3.4 MODEL REVIEWS

3.4.1 General

1. Based on the timings agreed in the project schedule, the Contractor shall organise and host the needed formal model reviews to check that the arrangements meet the Principal's requirements.

The purpose of a model review in the SELECT Phase is to establish feasibility of the proposed basic plot layout and ensure that Plant layout meets the requirements of the selected Concept.

The purpose of a model review in the Define Phase is to agree the basic plot layout and ensure that all equipment is captured and the layout meets the requirement of DEP 80.00.10.11-Gen. (onshore) and DEP 80.00.10.12-Gen. (offshore) for DEFINE phase. A follow on comment incorporation verification session might be planned to ensure handover to EPC Contractor.

If required and sufficient supporting documents are available, a 60 % model review can be performed during the DEFINE Phase with the purpose to freeze the layout and confirm the design is in line with the process flow documents, Manufacturer/Supplier data and all other design relevant documentation at the end of FEED.

The purpose of a 30 % model review in the Execute (detail engineering) is to freeze the basic plot layout and to reach agreement on the proposed design to enable the Contractor to proceed with the detail design.

The purpose of the 60 % model review in the EXECUTE (detail engineering) Phase is confirm the comments from the 30 % review, to confirm the design is in line with the PEFS, project specific Manufacturer/Supplier data of all tagged items and all other design relevant documentation.

After the 60 % model review in EXECUTE, the Contractor is expected to be able to finalise the deliverables for construction.

The purpose of the 90 % model review in the EXECUTE (detail engineering) Phase is to confirm the comments from the 60 % review have been addressed and to finalise on the total design of the model.

2. The model reviews shall be conducted jointly between the Principal and the Contractor.
3. The Contractor shall ensure that all required personnel are available to attend and give adequate notice (typically 2 months) before the review date.
4. The review team shall be informed of the location, duration, participants, type of review and the type and number of drawings that are the basic documents for the constructed define model under review.
5. Model reviews should check each unit for the following:
 - a. safety routes;
 - b. operability;
 - c. maintainability;
 - d. accessibility;
 - e. constructability;
 - f. item-by-item checks per piping system in the unit using the PEFS as appropriate to the level of detail.
6. Prior to the formal model reviews, the Contractor shall perform and document in-house model checks with nominated key Principal representatives in attendance.
7. The modifications initiated during previous model reviews shall be implemented before the next official model review.
8. Any changes which impact the results from prior reviews shall be presented to the Principal at the start of the formal model review.

9. All items listed in DEP 30.10.05.90-Gen. for the relevant 30 %, 60 % and 90 % model reviews shall be part of the 3D model.
 - a. Any deviation from the lists shall be submitted to the Principal for approval at least 4 weeks in advance of the formal 3D review.
10. Any necessary changes shall be agreed upon and immediately recorded and marked with reference numbers and model pictures to allow follow up and to avoid misunderstanding.
11. From each formal 3D model review, an electronic copy of the presented model shall be saved by the Contractor and handed over to the Principal.
12. During the DEFINE Phase, when the Contractor constructs a 3D CAD model, model reviews shall be held to check that the arrangements meet the Principal's requirements, see (4).
13. For complex areas, separate review files of floors or smaller units should be set up to make detail review possible.
14. Before each model review, the Contractor shall issue a terms of reference document for Principal approval containing the following as a minimum:
 - a. the purpose of the model review;
 - b. the scope, the agenda;
 - c. the review process;
 - d. the documenting of comments;
 - e. indication of each equipments status;
 - f. model review checklist;
 - g. completed DEP 30.10.05.90-Gen. listing.

3.4.2 Review Support

1. A 3D CAD model presentation for a group of people should be performed using one or more large screens to allow the display of the 3D model and the relevant 2D drawings or documents.
2. Point-to-point distance measurements shall be possible, to be able to verify compliance to clearance and access requirements or approve slight deviations.
3. Reference items (e.g., mobile cranes, bundle pulling equipment) and a scaleman should be available in the 3D model.
4. The 3D model operator's dimensions shall conform to the regional or local anthropometric profile, with reference to the regional Human Factors Engineering Technical Authority (HFE TA).
5. The following shall be available in clear legible prints for reference by all participants, including clear identification of the development level:
 - a. Process flow schemes (30 % model review);
 - b. Process engineering flow schemes (60 % model review, 30 % as far as available);
 - c. Plot plan;
 - d. Mechanical general arrangement drawings;
 - e. Line list and critical line list (hard copy or through computer access to the project documentation system during review);
 - f. Individual equipment information, data sheets (on request);
 - g. Civil structural drawings (on request);

- h. Stress calculations (on request);
- i. Piping studies (through computer access to a dedicated electronic folder during review).
- j. Material (equipment) handling studies;
- k. Fire safety studies;
- l. HSE reviews;
- m. Listing of agreed standards;
- n. Existing drawings (i.e., underground, existing process units).
- o. Level of completeness of model (Clash report) and quality of catalogues.
- p. Workface planning (on request);
- q. Construction work areas/ packages (on request);
- r. Engineering work packages (on request);
- s. Procurement work packages (on request).

3.4.3 Team composition

1. A team leader from the Contractor shall be appointed who is fully familiar with the project, the model and the 3D CAD system capabilities to perform the following:
 - a. guide the team through the model with the assistance of the system operator;
 - b. be responsible for the efficiency of the review process, the adequate reporting of comments made and the subsequent follow-up;
 - c. coordinate the tag handling process.
2. A scribe shall be present throughout the full review to take meeting notes and take down any comments without discussion.
3. Both the system operator and scribe shall be fluent in the project language, and understand the technical terms used within the industry.

The efficiency of the model review largely depends on the experience and knowledge of the system operator and scribe.

4. The system operator shall be familiar with the technical content of the model to be able to clarify the design to the team members when necessary.
5. Team size should be minimised for efficiency and to prevent specialist sub-meetings during the model review, which distract the attention of other team members;
Team composition is address in (4.4.3, item 1), (5.3, item 4) and (5.6, item 2).
6. If a larger number of people are necessary for a model review, separate teams should be formed of members with a common interest in the subject(s) under review.
 - a. Each team should review the model independently.
 - b. At the end of the review, the team leader should attend a plenary discussion to share and resolve any conflicting recommendations made by the individual teams.

3.4.4 Handling of comments

1. The 3D model review minutes shall encompass all the comments made in the session and state each of the following:
 - a. the actions to be taken;
 - b. the responsibilities assigned to each action;
 - c. time frame of implementation for each action.

2. Shortcomings in the degree of completion shall be highlighted and, after correction, checked in the next review, or in an additional review depending on the degree of incompleteness and the project schedule.
3. The 3D CAD tools should have sequence reference facilities to describe the comments given by the review team, i.e.; individual comment numbering system, which connects the tag number with the applicable comment picture and/ or location in the 3D model.
4. The text of each reference shall be complete and unambiguous and include a 3D review snapshot to prevent confusion in a later stage of the review process.
5. Electronic tag files shall be archived as a permanent record of review comments.
 - a. A log list shall be applied for the review sessions in order to keep record for all comments.
6. Within 2 weeks of the model review, the Contractor shall produce a record of tagged items and send to the review team showing which tag items will be implemented or rejected, with reasoning.
7. The relevant specialist, or technical authority as appropriate, shall be consulted and other team members informed before a tag item is deleted or significantly changed.
8. Before the next review starts, all agreed tag items should be implemented in the 3D CAD model.

3.5 COLOURING USAGE

1. The colours used in the 3D CAD model should be in accordance with (Appendix A).
2. Colour coding shall be used to indicate the status of equipment, valves and piping during the various model reviews (i.e., built according to final information or indicative only).
3. Category 1 valves identified through the Valve Criticality Analysis described in DEP 30.00.60.20-Gen. shall be uniquely colour coded in the 3D model.

3.6 3D-CAD MODEL USAGE

1. The Contractor shall include a method of tracking the status of modelled content so that it can be reported and viewed graphically within a 3D model review system (e.g., equipment status, preliminary or Manufacturer/Supplier data).
2. The model should allow individual components to be locked once they have reached a given status.
3. A 3D CAD review system should be made available at the construction site.

To provide information during construction for aspects such as transport and erection of equipment, the routing of piping, positioning of structural steel, platforms, cable trenches, trunking and channels.
4. Contractor should check the availability of free space in the 3D model during construction before field routing of piping, instruments or electrical trenches.

3.7 3D-CAD MODEL HANDOVER

1. On completion of all modelling, at the end of the DEFINE and of the Detailed engineering and construction (as built) phases of the project, the Contractor shall send the full design model.
2. The model files and databases shall be a complete multidiscipline copy of the model that has the same functionality as the model used by the Contractor.
3. Databases shall include all graphics/configuration and support files, catalogues (e.g., pipe support, steel), specifications and report output files for all disciplines.

4. All files shall be in native format and be accompanied by a full set of user notes clearly stating the file paths and directory structures to enable new users to access the files and database.
 - a. This should include any foreign, catalogue or reference data required to maintain model integrity.
5. If work share has been used across multiple offices, the satellite databases shall be restored into the master project prior to handover.
6. All reports proving validation of model data shall be provided to the Principal.

4. DEFINE PHASE REQUIREMENTS

4.1 3D-CAD – DEFINE MODEL BACKGROUND

The 3D CAD Define model is used to optimise equipment layout for operability, maintainability, accessibility, safety, and dispersion of potential releases, high temperature due to flare radiation, and incorporate any operations and maintenance requirements into the equipment layouts.

After approval of the layout by the Principal, it can be used as a basis for preparing a more detailed (initial) plot plan drawing.

1. When a 3D CAD Define model has been made, it should be used as the basis on which further 3D CAD modelling will be developed.
2. When 3D CAD modelling is performed in an earlier project phase (SELECT), the phase naming "3D CAD SELECT Model" should be used.

4.2 3D-CAD MODEL CREATION

1. Plant layout studies and piping studies should form the basis of the model.

These studies will establish pipe rack/ track widths, equipment positions, structure dimensions, etc.
2. The routing of fire network, underground piping (main header), main electrical and instrument cable trenches and access ways / roads should be shown.

4.3 3D-CAD DEFINE MODEL SCOPE

1. A 3D Define model should be set up during the DEFINE Phase of a project, for one or multiple process units inclusive or exclusive of the neighbouring facilities, buildings and structures.
2. Refer to DEP 80.00.10.11-Gen. and DEP 80.00.10.12-Gen., as applicable, for the requirements for separation distances of the process and utility facilities.

This scope might be supported by a facilitating siting study and QRA.
3. The Contractor should agree the extent of the model with the Principal, using the 3D CAD Model Content checklist (DEP 30.10.05.90-Gen.) as a template.

4.4 3D-CAD DEFINE MODEL REVIEW

4.4.1 General

1. Before a Define model review starts, relevant documentation shall be made available to the members of the review team for prior familiarisation, i.e., plot layout drawings and Process Flow Sheets.
2. When model reviews are performed during the DEFINE phase or even earlier in the SELECT phase, the value to the project and quality level of the model should be indicated by the Contractor for the agreement of the Principal.