PROCEDURAL SPECIFICATION

PLANT MODEL CONSTRUCTION AND REVIEW

DEP 30.10.05.11-Gen.

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DESIGN AND ENGINEERING PRACTICE

PREFACE

DEP (Design and Engineering Practice) publications reflect the views, at the time of publication, of:

Shell International Oil Products B.V. (SIOP)
and
Shell International Exploration and Production B.V. (SIEP)
and
Shell International Chemicals B.V. (SIC)

The Hague, The Netherlands,

and other Service Companies.

They are based on the experience acquired during their involvement with the design, construction, operation and maintenance of processing units and facilities, and they are supplemented with the experience of Group Operating companies. Where appropriate they are based on, or reference is made to, national and international standards and codes of practice.

The objective is to set the recommended standard for good design and engineering practice applied by Group companies operating an oil refinery, gas handling installation, chemical plant, oil and gas production facility, or any other such facility, and thereby to achieve maximum technical and economic benefit from standardization.

The information set forth in these publications is provided to users for their consideration and decision to implement. This is of particular importance where DEPs may not cover every requirement or diversity of condition at each locality. The system of DEPs is expected to be sufficiently flexible to allow individual operating companies to adapt the information set forth in DEPs to their own environment and requirements.

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1. INTRODUCTION

1.1 SCOPE

This DEP specifies requirements and gives recommendations for:

1. Block models.
2. 3D-CAD visualisation and use of 3D-CAD features.
3. Physical models.
4. Model review sessions.

This is a revision of the DEP of the same number, dated June 1988, which had the title "Model construction for processing units".

1.2 DISTRIBUTION, INTENDED USE AND REGULATORY CONSIDERATIONS

Unless otherwise authorised by SIOP and SIEP, the distribution of this DEP is confined to companies forming part of the Royal Dutch/Shell Group or managed by a Group company, and to Contractors nominated by them (i.e. the distribution code is "C", as defined in DEP 00.00.05.05-Gen.).

This DEP is intended to be used in oil refineries, chemical plants, gas plants, exploration and production facilities and supply/marketing installations and for specific items such as storage facilities and/or jetties, road/rail loading facilities and complicated manifolds.

If national and/or local regulations exist in which some of the requirements may 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 as regards safety, environmental, economic and legal aspects. In all cases the Contractor shall inform the Principal of any deviations from the requirements of this DEP which are considered to be necessary in order to comply with national and/or local regulations. The Principal may then negotiate with the Authorities concerned with the object of obtaining agreement to follow this document as close as possible.

1.3 DEFINITIONS

1.3.1 General

The **Contractor** is the party which 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 a part of the duties of the Contractor.

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

The **Principal** is the party which initiates the project and ultimately pays for its design and construction. The Principal will generally specify the technical requirements. The Principal may also include an agent or consultant, authorised to act for the Principal.

The word **shall** indicates a requirement.

The word **should** indicates a recommendation.

1.3.2 Specific definitions and Abbreviations

3D-CAD: Three Dimensional Computer Aided Design
CAD: Computer Aided Design
HVAC: Heating, Ventilation and Air Conditioning
PEFS: Process Engineering Flow Scheme
PFS: Process Flow Scheme
ROV: Remote Operated Valve

1.4 CROSS-REFERENCES

Where cross-references to other parts of this DEP are made, the referenced section number is shown in brackets. Other documents referenced by this DEP are listed in (10.).

2. GENERAL

In the course of conceptual engineering a block model should first be constructed. At a later stage a 3D-CAD model or a physical model should be constructed.

A block model should be used to establish the location of buildings, main equipment and main pipe routings in the unit.

The physical models and 3D-CAD models should provide a visual check on safety, operability and maintainability and facilitate the engineering and erection of the units, which may result in a cost reduction. They may also be used for the training of operators and for the planning of efficient maintenance schedules, and to assist construction work (e.g. handling of heavy or large equipment).

A 3D-CAD system is a design tool for the Contractor and an integral part of the design and engineering process.

The visualisation used for the 3D-CAD "model review" is only one of the features of a 3D-CAD system.

3. BLOCK MODEL

3.1 GENERAL

The block model should be used for evaluating different lay-out options and to establish the location of main equipment and the main pipe routings in the unit, taking into account the required safety distances and accessibility for construction, operation and maintenance. After approval of the lay-out by the Principal, it can be used as a basis for preparing a more detailed (initial) plot plan drawing.

The block model should be used as the basis on which a 3D-CAD model or a physical model will be developed.

For the scope and organisation of a block model review, see (6.2 and 7.2).

3.2 CONSTRUCTION

The block model should consist of wooden or plastic blocks, representing in a simplified form the equipment, e.g. columns, heat transfer equipment, vessels, reactors, heaters, pumps. The equipment numbers may be indicated. Main pipe racks, structures, the control centre, analyser houses, switch houses and other buildings should also be shown. The types of buildings should be indicated.

The scale should be 1:100. For offshore installations the scale should be 1:50 or 1:33$^{1}/_{3}$. Alternatives scales may be used if approved by the Principal.

Plant north, true north, scale and, if applicable, the table number of the block model shall be indicated on the base plate.

For the lay-out of the model, basic plant lay-out studies and piping studies shall be made if required. These studies will also establish pipe track widths, structures, etc.

The routing of main electrical and instrument cable trenches should be shown.

4. 3D-CAD MODEL

4.1 GENERAL

The 3D-CAD model is a collection of graphical data which describes the facilities of a plant for visualisation purposes.

The 3D-CAD model can be accessed via a 3D-CAD system. The graphical data is often an integral part of an engineering database supporting the design process.

An important advantage of a 3D-CAD engineering database is the possibility to maintain consistency between the produced documents and to assist the co-ordination of work between different disciplines. It enables the Contractor to integrate the different design stages and the different subjects, such as piping, foundations, table tops, steel structures, equipment, instrumentation, electrical equipment, and HVAC equipment into one 3D-model.

Typical deliverables of a 3D-CAD system include:

- Detailed engineering drawings such as plan and elevation drawings, bird's-eye views, etc.
- Piping isometrics.
- Material Take-off (Bills of Material).
- Shaded perspective views separated in logical areas, e.g. units (model review).
- Reports such as line lists, instrument data, interference checks (clashes), mock-ups.

4.2 SAFETY, OPERATIONAL AND MAINTENANCE ASPECTS

The CAD system shall be structured in such a way that all disciplines involved can check whether sound design and engineering criteria have been met with respect to safety, ergonomics, operability and maintenance. This should include accessibility for maintenance and fire fighting, location of valves, constructability, process instrumentation, routing of the piping adequate for the process, location of emergency shut-down stations, proper and safe location of vents and drains, location of fire protection and fire-fighting equipment and escape routes.

4.3 CONSTRUCTION OF THE PROCESS UNIT

A 3D-CAD system should be made available at 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.

4.4 INSTRUCTION

The 3D-CAD model may be used for training and instruction of plant operators, construction staff, maintenance staff and emergency response organisation.

4.5 MODEL REVIEW FEATURES WITH 3D-CAD TECHNOLOGY

The required features shall be agreed between the Principal and the Contractor before the set-up of the 3D-CAD system and engineering database is started.

The 3D-CAD system should be programmed to provide reports regarding situations where certain criteria are not met. This approach can substantially improve the efficiency of the model review.

Presently, the application of 3D-CAD technology allows for the following:

- Definition of classified 3D-shapes to indicate envelopes for:
  - Safety.
  - Area classification zones.
  - Head room/tripping hazards.
  - Access/escape corridors.
  - Valve hand wheels.
  - Reach/clearances for activities.

- Access envelopes for:
  - Maintenance equipment.
  - Operability.
- Identification of deviations from normal engineering practices.
- Modelling of foundations and underground systems.
- Consistency between the 3D-CAD model and the PEFS.

4.6 REQUIREMENTS

Where practical the colours used in the 3D-CAD model shall be in accordance with Appendix I. This colour convention shall be approved by the Principal.

5. PHYSICAL MODEL

5.1 GENERAL

A physical model should provide a visual check on safety, operability and maintainability and facilitate the engineering and erection of the units.

5.2 SAFETY, OPERATIONAL AND MAINTENANCE ASPECTS

The physical model shall allow all disciplines involved to check whether sound design and engineering criteria have been met with respect to safety, ergonomics, operability and maintenance. This should include accessibility for maintenance and for fire fighting, location of valves, constructability, process instrumentation, routing of piping adequate for the process, location of emergency shut-down stations, proper and safe location of vents and drains, location of fire protection and fire-fighting equipment and escape routes.

5.3 CONSTRUCTION OF THE PROCESS UNIT

The physical model shall be made available at site to provide information during construction for aspects as transport and erection of equipment, the routing of piping, positioning of structural steel, platforms, cable trenches, trunking and channels. It shall supplement, and not replace, other engineering information given on drawings (plot plans, structural details, pipe isometrics, etc.) and other documents.

5.4 INSTRUCTION

The physical model may be used for training and instruction of plant operators, construction staff, maintenance staff and emergency response organisation.

5.5 CONSTRUCTION REQUIREMENTS OF A PHYSICAL MODEL

Where practical, the colours used in the physical model shall be in accordance with Appendix I. Any alternative colour convention shall be approved by the Principal.

For construction requirements of physical models, see Appendix III.

6. MODEL REVIEW

6.1 GENERAL

The Principal shall perform formal model reviews to check that the arrangements meet the Principal's requirements. These reviews should be undertaken in detail, checking each system and using the PEFS to make item-by-item checks.

Any necessary changes shall be agreed upon and immediately recorded and shall be marked with tag numbers, wherever possible, to avoid misunderstanding.

The construction of the physical model shall follow the design work as closely as possible so that any modifications do not necessitate revisions to the drawings concerned.

The 3D-CAD model used during the formal reviews shall be a frozen copy of the live engineering data base being used for development of the project. The status date shall be indicated.

6.2 SCOPE OF A BLOCK MODEL REVIEW

6.2.1 Scope of a block model review.

A block model may be set up for a single process unit or for multiple process units.

A block model should include the following items:

6.2.2 Scope of a block model with overall site plan.

- Process units of the complex if the model is for multiple units.
- Buildings.
- Interceptors.
- Effluent treatment facilities.
- Flare stack area.
- Jetties and marine facilities.
- Rail and road loading facilities.
- Blending plants.
- Pump stations.
- Roads.
- Storage tanks and tank farms.
- LNG/LPG storage facilities.
- Indication of fences.
- Fire water pumps.

6.2.3 Scope of a process unit with its plot plan and main equipment.

- Furnaces.
- Stack locations.
- Columns.
- Transfer line(s) from furnaces to columns or reactors.
- Reactors and solids handling facilities (e.g. for catalyst).
- Plot area for pulling furnace tubes, convection bank tubes and heat exchanger bundles.
- Vessels.
- Heat exchanger areas, including horizontal or vertical reboilers and large individual heat exchangers and reboilers.
- Compressors and compressor buildings.
- Pumps.
- Pipe bridges and structures for air-cooled heat exchangers.
- Battery limit of incoming and outgoing lines per unit or complex of units.
- Main electrical and instrument cable routings.

6.3 SCOPE OF A 3D-CAD AND PHYSICAL MODEL REVIEW

Reviews of the model shall take place when the model is 30%, 60% and 90% complete.

The items listed below should have been completed for these model reviews:

Model 30% complete:

- Location and orientation of all equipment and all space consumers.
- Structures (steel and concrete).
- Major piping that determines equipment positions.
- Concrete slabs, paving and roads.
- Packaged unit location and orientation.
- Escape routes defined and marked.
- Pipe racks and main pipe support structures.
- Outline of underground electrical and instrumentation trenches.
- Main electrical and instrumentation cable trays.
- Underground sewer systems and collecting and separation systems.
- Buildings in outline, e.g. control room, analyser houses, switch rooms.
- Dropout/bundle pulling and laydown areas, mobile crane aprons.

Model 60% complete:

- The actions resulting from the 30% model review.
- All other piping largely completed.
- Orientation of ladders, stairs, platforms on vessels and columns.
- Platforms for valves and equipment and operation.
- Permanent cranes and hoisting beams.
- Final dimensions of table tops, structures and steel constructions.
- Secondary steelworks and bracing.
- Eye bath and safety shower locations.
- Major and special pipe supports.
- Local operation panels.
- Fire fighting systems (hydrants, monitors, water spray systems, etc.).
- Instrument transmitters and outlines of junction boxes, panels and cabinets.
- Electrical heat tracing boxes.
- Above ground instrumentation and electrical tray routing.
- Outlines of steam tracing manifolds.

Model 90% complete:

- The actions resulting from the 60% model review.
- The model shall be substantially complete, including instrumentation. Final comments shall be made at this stage.

7. ORGANISATION OF A MODEL REVIEW

7.1 GENERAL

Team review members shall be given adequate notice (approximately 3 weeks) before the review date, and they shall be informed of the type of review and the type and number of drawings which are the basic documents for the constructed model under review.

Before a model review starts, plot lay-out drawings shall be sent to the members of the review team for prior familiarisation.

7.2 BLOCK MODEL REVIEW

7.2.1 Tools

Plot lay-out drawings and all PFS and PEFS which have been used for the build-up of the model shall be present.

7.2.2 Team composition

A team leader shall be appointed who is fully familiar with the project and the block model. He shall guide the audience through the model. The team leader shall be responsible for the efficiency of the review process, for the adequate reporting of comments and for the subsequent follow-up.

Since the block model shows the main separation distances between plants, storage areas, buildings and main equipment inside plants which are the basis for a safe, operable and maintainable complex, the model should be reviewed during the earliest stage of the detailed engineering activities by a team representing at least the following disciplines :

- process technology.
- operations.
- maintenance.
- plant lay-out.
- technical safety and operability.
- construction.
- projects.

7.2.3 Handling of comments

After the block model review, the agreed comments shall be distributed to the representatives and implemented in the model. It should be agreed whether a second review is required.

7.3 3D-CAD MODEL REVIEW

7.3.1 Tools

A 3D-CAD model presentation for a group of people should be performed using a large projection screen having a high resolution. The system shall have sufficient capacity to allow the display of a complete model of at least one area or unit of a plant. The computer system should be of sufficient capacity to move easily through the model, rotate the view angle around the equipment and zoom-in almost instantaneously. Point-to-point distance measurements should be possible on request. Main computer manipulations such as switching to another process unit should not take more than 5 minutes. Reference items, mobile cranes, bundle pulling equipment, etc. and an operator the same scale as the model under review, shall be available. This model operator's dimensions should be representative for the applicable population.

The full model presentation should be given in a darkened room with sufficient dimmed light to enable drawings to be read and notes to be made without interfering with the presentation.

A sufficient number of laser pens should be available to point to items shown on the screen and to improve the efficiency of discussions.

Plot plan drawings, PFS and PEFS which have been used for developing the model shall be present in the room.

7.3.2 Team composition

A team leader shall be appointed who is fully familiar with the project, the model and the 3D-CAD system capabilities. He shall guide the audience through the model with the assistance of the system operator. The team leader shall be responsible for the efficiency of the review process, the adequate reporting of comments made and the subsequent follow-up.

The system operator shall be familiar with the technical content of the model and the computer system. He should understand the technical terms used in petrochemical and refinery technology.

To prevent specialist sub-meetings during a model review which distract the attention of other team members, teams should be formed of members with a common interest in the subject(s) under review. The number of required review teams depend on the progress of the model.

The progress of the model is expressed in percentage completed compared to the final installation after construction. For more details on required items to be reviewed in a model at a certain stage of completion, reference is made to (6.3).

At least the following disciplines shall be represented in a review team, depending on the progress of the model:

For a 30% review:

- process technology.
- operations.
- maintenance.
- plant lay-out and piping.
- technical safety and operability.
- civil.
- projects.

The team may occasionally be extended by a rotating equipment or mechanical representative, especially if extraordinarily large pieces of rotating or mechanical equipment need to be installed and maintained. Further, it is advisable to consult other relevant specialists at an early stage of model design if required (e.g. for solids handling, slurry transport).

The 30% model review shall be concluded with a statement describing which aspects are considered to be frozen at this stage. For a list of these aspects, reference is made to (6.3).

After the 30% review, the comments shall be handled in accordance with the guidelines given in (7.3.3).

For a 60% review, at least 2 teams should review the model from technical and technological viewpoints. Each team shall review the model independently, and at the end of the review the team leader shall discuss any conflicting recommendations made by each individual team. Two main review teams are distinguished: one for operability and safety, and the other for engineering and maintenance.

At least the following disciplines shall be represented:

Team No. 1 Operations and Safety.	Team No. 2 Engineering and Maintenance.
- process technology.	- instrumentation.
- operations.	- electrical.
- plant lay-out and piping.	- projects.
- technical safety and operability.	- maintenance.
- projects.	

More teams with additional discipline representatives may be formed depending on the nature of the process under review. These teams may include, for example, a representative from fire-safety and rotating equipment disciplines.

Agreed comments from the 30% reviews shall be part of the 60% model review.

A check of the design reflected in the PEFS should be avoided during the model review, but if the model review leads to more economically attractive solutions without jeopardising the design functionality or safety, this change may be implemented and the PEFS shall be made consistent with the 3D-CAD model. However, such proposals shall be brought to the attention of the project manager.

The 60% model review shall be concluded with a statement describing which aspects are considered to be frozen at this stage. For a list of these aspects, reference is made to (6.3).

After the 60% review, the comments shall be handled in accordance with the guidelines given in (7.3.3).

For a 90% review, the composition of the main review team should be identical as for the 60% review. The team shall review the model on the added details such as the location of junction boxes, instrumentation, sample point locations and steam manifolds (e.g. smothering and tracing). Further, agreed comments from the 60% reviews shall be reviewed.

7.3.3 Handling of comments

After each review, the team shall decide if the level of completion of the model is in line with the requirements defined in (6.3). 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.

The 3D-CAD tools shall have sequence tagging facilities to describe the comments given by each review team. The text of each tag shall be as complete and unambiguous as possible to avoid confusion in a later stage of the review process. The team leader shall co-ordinate the tag handling process. The tagged items shall be reviewed with the Contractor within 2 weeks and a record shall be produced showing which tag items will be implemented or rejected, with reasoning. The relevant specialist should be consulted before a tag item is deleted or significantly changed.

Before the next review starts, all agreed tag items should be implemented in the 3D-CAD model.

7.4 PHYSICAL MODEL REVIEW

7.4.1 Tools

Plot plan drawings and all PFS and PEFS which have been used for the build-up of the model shall be present in the room.

7.4.2 Team composition

A team leader shall be appointed, who is fully familiar with the project and the model, to guide the audience through the model. The team leader shall be responsible for the efficiency of the review process, the adequate reporting of comments made and the subsequent follow-up. The progress of the model is expressed in percentage completed compared to the final installation after construction. For more details on required items to be reviewed in a model at a certain stage of completion, reference is made to (6.3).

At least the following disciplines should be represented in a review team, depending on the progress of the model:

For a 30% review:

- process technology.
- operations.
- maintenance.
- plant lay-out and piping.
- technical safety and operability.
- civil.
- projects.

The team may occasionally be extended by a rotating equipment or mechanical representative especially if extraordinarily large pieces of rotating or mechanical equipment need to be installed and maintained. Further, it is advisable to consult other relevant specialists in an early stage of model design if required (e.g. for solids handling, slurry transport).

The 30% model review shall be concluded with a statement describing which aspects are considered to be frozen at this stage. For the content of these aspects, reference is made to (6.3).

After the 30% review, the comments shall be handled in accordance with the guidelines given in (7.4.3).

For a 60% review, at least the following disciplines should be represented in one team:

- process technology.
- operations.
- maintenance.
- plant lay-out and piping.
- technical safety and operability.
- projects.
- electrical.
- instrumentation.

Additional discipline representatives may be invited depending on the nature of the process under review. These may include for, example, a representative from fire-safety and rotating equipment disciplines.

Agreed comments from the 30% reviews shall be part of the 60% model review.

A check of the design reflected in the PEFS should be avoided during the model review, but if the model review leads to more economically attractive solutions without jeopardising the design functionality or safety, this change may be implemented and the PEFS shall be made consistent with the 3D-CAD model. However, such proposals shall be brought to the attention of the project manager.

The 60% model review shall be concluded with a statement describing which aspects are considered to be frozen at this stage. For a list of these aspects, reference is made to (6.3).

After the 60% review, the comments shall be handled in accordance with (7.4.3).

For a 90% review, the composition of the main review team should be identical as for the 60% review. The team shall review the model on the added details such as instrumentation, location of junction boxes, sample point locations and steam manifolds (e.g. smothering and tracing). Further, agreed comments from the 60% review shall be reviewed.

7.4.3 Handling of comments

After each review, the team shall decide if the level of completion of the model is in line with the requirements defined in (6.3). 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.

At the end of each review day, a meeting shall be held with all team members to arrive at a mutually agreed tag list of corrections and modifications. The text of each tag shall be as complete and unambiguous as possible to avoid confusion in a later stage of the review process. The team leader shall co-ordinate the tag handling process. The tagged items shall be reviewed with the Contractor within 2 weeks and a record shall be produced showing which tag items will be implemented or rejected, with reasoning. The relevant specialist should be consulted before a tag item is deleted or significant changed.

8. METHOD OF CHECKING 3D-CAD AND PHYSICAL MODELS

1. Check the model against the latest issue of the PEFS.
2. Follow the line-up systematically and pay strict attention to details, since many accidents are caused by seemingly minor items. Start, for instance, with the unit feed system, check furnaces as a separate block, then proceed to internal circulation and product rundown circuits and conclude with a check on safety, fire fighting and utility systems.
3. Mark on the 3D-CAD system or on the PEFS all the lines, equipment and instrumentation which have been checked and accepted.
4. Indicate the points which have not been accepted, to facilitate the review in follow-up checks.
5. Ensure that when a modification is proposed it suits its purpose, and does not conflict with other requirements. Ensure that it is practical, safe, in accordance with the PEFS and also economic. If in doubt, consult the appropriate specialists of other disciplines.
6. Use the checklist of Appendix II during the model review. Note that the checklist is not exhaustive and shall not overrule sound judgement.

9. ARCHIVING

Block model

If requested by the Principal, a block model shall be photographed from various angles upon completion and handed over to the Principal for archiving.

3D-CAD model

If specified by the Principal, colour prints-outs (screen dumps) shall be taken of the 3D-CAD model at 30%, 60% and 90% completion. Where applicable, comment tag items shall be visible on the print-outs.

If specified by the Principal, colour prints-outs (screen dumps) from various angles shall be taken of the 3D-CAD model upon completion. Close-up views shall also be taken if specified by the Principal.

The above print-outs shall be handed over to the Principal for archiving.

The 30%, 60%, 90% and final version of the 3D-CAD model shall also be handed over to the Principal for electronic archiving.

Physical model

If specified by the Principal, colour photographs shall be taken of the physical model at 30%, 60% and 90% completion.

If requested by the Principal, the physical model shall be photographed from various angles upon completion. Close-up photographs shall also be made if specified by the Principal.

Each photograph shall be given a drawing number which should be included in the drawing list of the unit.

The location and the angle from which each photograph has been taken shall be indicated by arrows on a plot plan drawing.

10. REFERENCES

In this DEP reference is made to the following publications:

NOTE Unless specifically designated by date, the latest edition of each publication shall be used, together with any amendments/supplements/revisions thereto.

SHELL STANDARDS

Index to DEP publications and standard specifications — DEP 00.00.05.05-Gen.

APPENDIX I TYPICAL COLOUR CODE FOR 3D-CAD AND PHYSICAL MODELS

1. PIPING

Process	Green
Steam/condensate	Red
Flushing oil	Black - Orange - Black
Fuel gas/fuel oil	Yellow
Hot oil	Brown
Cooling water	Blue
Instrument air/tool air	White
Nitrogen	White - Orange - White
Relief/drain/slops	Black
General purpose	Purple
Fire protection/fighting water	Blue - Red - Blue
Steam traced line (plastic arrow)	White - Red
Hot oil traced line (plastic arrow)	White - Brown

2. SEWERS, TRENCHES AND TRUNKING

Surface water sewer	Brown
Oil contaminated sewer	Black
Cooling water sewer	Blue
Electric cable trench	Green
Instrument cable trenches and trunking	Red

3. EQUIPMENT, STEEL, CONCRETE AND MAINTENANCE FACILITIES

Structural steel	Grey
Concrete	Grey
Mechanical equipment	Grey
Electrical equipment	Green
Hoisting beams, davits and other typical fixed maintenance facilities/equipment	Yellow

For all other items the choice of the colour coding is at the discretion of the model builder.

A plastic identification plate shall be fixed on the base plate of a physical model to show the colour codes used.

APPENDIX II CHECKLIST FOR THE MODEL REVIEW

1. SUMMARY

In this appendix checkpoints are given for the review of a block model, a 3D-CAD model and a physical model. The checklist will help to improve quality and to identify and eliminate potentially hazardous situations.

The scope of this checklist is applicable to oil refineries, chemical plants, gas plants, exploration and production facilities, supply/marketing installations and to specific items such as storage facilities and/or jetties, road/rail loading facilities and complicated manifolds.

The checklist is comprehensive but should not be considered to be fully exhaustive.

2. BLOCK MODEL

Include the following considerations for each item mentioned in the scope of a block model.

2.1 OVERALL SITE PLAN

General layout considerations:

2.1.1 Is the proposed set-up logical and optimal with respect to process integration?

2.1.2 Are roads properly defined with respect to their logical approach to unit(s)? Consider also the movements area, including its marine location and rail and road connections. Include road dimensions, considering main roads (unrestricted) and restricted access roads.

2.1.3 Is erection possible during construction: furnaces, columns, large vessels, reactors, air-cooled heat exchanger structures, flare header and flare plot?

2.1.4 Have area classification requirements been taken into account?

2.1.5 Is the location of the Utilities area logical and optimal in relation to the process units?

2.1.6 Is the location of the Movements area logical and optimal in relation to the process units?

2.1.7 Is the prevailing wind direction considered in relation to the location of tank farms, LPG storage or gas plants, buildings, stacks, flare and oil collecting systems, like sewers, oil catcher basins, air cooler banks and areas containing H_2S or HF?

2.1.8 Has a sterile area been provided around the flare stack?

2.1.9 Have appropriate separation distances been taken into account between units, storage areas and buildings as well as public fences?

2.1.10 Have interfaces for future extensions been considered?

2.2 PROCESS UNITS

2.2.1 Have separation distances within the plot area been taken into account? Consider furnace, column, main equipment, flare, any vent outlet to 'safe location', oil collecting area like sewers.

2.2.2 Is the routing of the main piping in bridges and via trenches defined?

2.2.3 Is the location of the battery limit specified (by unit or complex)?

2.2.4 Is a maintenance area available e.g. for pulling of heat exchangers bundles?

2.2.5 Is a maintenance area available for furnace tube pulling?

2.2.6 Is a maintenance area available for removal of large compressors? Is a protective compressor building required?

2.2.7 Is the area sufficient for e.g. catalyst or solid handling activities?

3. 3D-CAD AND PHYSICAL MODELS

3.1 GENERAL SAFETY AND OPERABILITY

3.1.1 Consider all equipment with respect to its ergonomic aspects. This includes accessibility, operability and maintenance as well as safety. This applies in particular for accessibility to pump suction and discharge valves and motor operated valves.

3.1.2 Check proper escape routes from elevated equipment and all platforms. Check that at least two exits are present on every platform which is regularly in use by operators. This applies for platforms at structures, around and underneath air-cooled heat exchangers, vessels, on top of furnaces and frequently used working areas by maintenance. Have ladders and staircases been installed on the outside of structures?

3.1.3 Check that there are no obstructions in the path of escape ways. Ensure the exit is directed away from a process area. All staircases should route at ground level to an open area to allow an unobstructed escape way.

3.1.4 Check that there are no head bumpers, shin splitters or tripping hazards.

3.1.5 Are remote shutdown panels of ROVs and depressuring valves installed at safe distances and can they be easily reached in case of emergency? Can the equipment concerned be seen from these locations?

3.1.6 Check for proper smooth connections between platforms and table tops.

3.1.7 Are emergency/smothering steam headers at a safe distance from the equipment to be protected, e.g. in hydrogen service or furnaces?

3.1.8 Check that operators manipulating drain valves of open drain systems can see the drained effluent. Provide tundishes as required.

3.1.9 Check that water seals trapped in goosenecks can be displaced by hydrocarbons, i.e. ensure enough static head of oil is available.

3.1.10 Check if utility stations have been provided at the main operational platforms,
especially at columns operating at high temperatures, so that steam lances can be connected to tackle small leaks.

3.1.11 Have platforms been provided at places where work is expected during shutdowns? Consider also access to spading at those places where scaffolding would be a nuisance, expensive or unsafe. (In such cases install additional platforms or adapt existing platforms).

3.1.12 Check that there are no open sewer pits near hot pumps, furnaces, etc.

3.1.13 Check that steam exhaust cannot cause personnel hazards, either from spraying droplets of hot water or by causing icy or wet surfaces.

3.1.14 Are steam rings provided where specified?

3.1.15 Be alert for the possibility of relative movement between connected equipment (e.g. due to different thermal expansion or wind load).

3.1.16 Check that inlet valves of silencers on steam lines for warming up or start up are operable in a safe manner without risk of pouring hot condensate from the silencer outlet on the operator below.

3.1.17 Are hot lines or other hot surfaces near walkways properly insulated for personnel protection?

3.1.18 Check that the suction of the air blower of an analyser house or control room is taken from a non-hazardous area.

3.1.19 Are hoisting devices provided for heavy parts (above 25 kg)?

3.2 FIRE PREVENTION AND SAFETY EQUIPMENT

3.2.1 Check the accessibility of the unit for manual fire-fighting operations.

3.2.2 Can fire water headers be safely accessed?

3.2.3 Can a fire truck manoeuvre easily?

3.2.4 Can all locations be reached by a fire truck whilst one road is blocked?

3.2.5 Pumps handling liquids above their auto-ignition temperature and LPG pumps should not be placed underneath pipe racks or air-cooled heat exchangers.

3.2.6 Can hot pumps be properly protected by fire water spray systems or monitors?

3.2.7 Check location of fire hydrants, fixed, mobile and portable fire fighting equipment. Consider this in relation to the equipment to be protected and the likelihood of a fire.

3.2.8 Check presence of fireproofing of steel structures with respect to credible fires. Protect vessels, columns, flare headers, main pipe racks, if required.

3.2.9 Check whether the layout of water spray lines and nozzles is adequate to cool LPG vessels.

3.2.10 Are fire detectors and tubing present on hot pumps and LPG pumps?

3.2.11 Are detectors for fire, gas, smoke and H_2S strategically located?

3.2.12 Are warning and alarm lights for fire, gas, smoke and H_2S strategically located?

3.2.13 Are fire water deluge manifolds safely located in relation to the equipment they protect?

3.2.14 Are TV cameras for plant monitoring strategically located to enable a good view of the high risk areas?

3.2.15 Check if emergency showers and eye bath showers are strategically located, e.g. near equipment handling caustic, ammonia, Adip and aggressive chemicals. Valves are not allowed between the main header and the safety equipment.

3.3 PIPING

3.3.1 Is piping entering and leaving the plant logically grouped together at the battery limit?

3.3.2 Are valves, spading positions, flushing and draining and instrument connections properly located, in relation to normal operations as well as shutdowns? Take special care of manifolds and large control valves.

If no spectacle blinds have been provided, is the piping system flexible enough to insert spades?

If spectacle blinds are fitted, are they accessible and can they be turned safely? Consider additional or adapted platforms where applicable.

3.3.3 Has the number of flanges been minimised? This is valid especially in systems above auto-ignition temperature and with toxic materials.

3.3.4 Check the elevation of piping and its clearance to walkways and maintenance equipment (e.g. lifting equipment). Avoid head bumpers.

3.3.5 Are start-up and circulation lines short? Have dead ends been avoided? Can the system be flushed and drained?

3.3.6 Do vapour lines, including steam lines, freely branch off from the top of main lines?

3.3.7 Can piping subject to thermal expansion indeed expand? Check that nozzles and branches (e.g. instruments) on expanding piping do not touch obstructions, such as support beams.

3.3.8 Look for pockets in vapour lines where condensation may occur. Has external heating been applied on those pockets which cannot be avoided?

3.3.9 Are long small diameter lines (e.g. instrument impulse lines) arranged such that supports can be provided to prevent breakage due to vibration?

3.3.10 Check for adequate space and jacking facilities to remove man-hole covers, especially for those with inserts.

3.3.11 Pipes should not pass through table tops. Where this cannot be avoided, ensure a protective kerb is provided around the open area to prevent any rainwater or oil entering the area below. All rain water disposal lines from a table top shall be extended to ground level.

3.3.12 Have dead end sections been avoided, e.g. in steam and water lines and in lines with high pour point material?

3.3.13 Has piping been designed for ease of drainage and/or venting?

3.3.14 Check the position of eccentric reducers. Normally the straight part is on the bottom of horizontal lines, except in pump suction lines where vapour pockets may cause cavitation of the pump.

3.3.15 Do compressor suction lines slope towards the knock-out drum? Each low point of the compressor suction should have a low point drain.

3.3.16 Check that small bore cooling water lines emerge from the top of the header.

3.3.17 Are stripping steam lines short and horizontal, or sloping from the last valve?

3.3.18 Verify that two-phase flow vertical piping has been checked for flow stability, also for the turndown case.

3.3.19 Check absorber gas feed inlets for pockets near the inlet to avoid absorbent entering the gas inlet line.

3.3.20 Is piping with instrument connections positioned such that these connections are easily accessible? Is the measurement point in the correct process location? Have the necessary platforms and walkways been provided?

3.3.21 Is there adequate straight length upstream and downstream of a flow meter or orifice flange.

3.3.22 Is there sufficient space around an ultrasonic flow meter to allow proper installation of the flow meter sensor in the horizontal plane without touching adjacent lines?

3.3.23 Is the straight length of inlet pipes as specified at column inlets, knock out vessels and cyclones?

3.3.24 Are maximum angles with the vertical as specified for piping containing solids adhered to?

3.3.25 Have special provisions for commissioning and initial start-up been properly addressed? (e.g. temporary large blow spools and silencers).

3.4 VALVES

3.4.1 Have valves in pipe bridges been avoided as much as possible?

3.4.2 Check for the presence of chain-operated valves (only allowed in exceptional cases).

3.4.3 Check that there are no valves installed with the stem pointing downward.

3.4.4 Are hand wheels easily accessible for operation and not obstructing walkways or platforms? (consider the stems, especially when in the open position).

3.4.5 Are valves for emergency operations operable from grade level? Are valves that need frequent attention easily accessible?

3.4.6 Check for valves in vertical lines which may accumulate liquid (e.g. water or condensate).

3.4.7 Check that control valve assemblies are located at ground level or on the first platform, except when otherwise required for process reasons.

3.4.8 Has installation of valves outside of platforms been avoided?

3.4.9 Have check valves or double-block and bleed valves been installed in utility connections to process equipment and lines?

3.4.10 Have spring-loaded and/or extra block valves been used where valves may freeze up when draining or sampling?

3.4.11 Check that stripping steam lines to columns have a drain line for condensate removal and a vent line near to the column.

3.5 HEAT EXCHANGERS AND REBOILERS

3.5.1 Is the piping arrangement and supporting acceptable with respect to removal of shell and channel covers as well as the withdrawal of tube bundles? Consider the removal of inlet and outlet piping. Has the bundle pulling device sufficient plot space?

3.5.2 Check whether bundles can be pulled and lowered safely from platforms and stacked exchanger arrangements.

3.5.3 Check stacked heat exchangers for the possibility of oil spills on hot heat exchangers or other equipment beneath, especially during maintenance work. In this case, consider a large oil collecting funnel underneath, or check the possibility to take both out of service.

3.5.4 Check if the drain and vent valves are correctly located as specified on the PEFS, hence drains at lowest points and close to the block valves if so specified.

3.5.5 Check whether cranes, bundle pulling equipment and cars can enter for pulling and transportation of bundles.

3.5.6 Check whether heat exchangers can be cleaned in situ. Are the required provisions present (e.g. valves, cleaning lines, etc.)?

3.5.7 Check that exchangers in LPG service have been provided on the water outlet side with a vent pipe to a safe location to allow gas to escape in case of tube leak.

3.6 PUMPS AND COMPRESSORS

3.6.1 Is valving around pumps and compressors accessible and operable?

Note that the hook-up around pumps provided with seal oil lines, steam lines, flush oil, steam tracing etc. needs considerable plot space. Usually these small size support lines are not indicated on the model. Ensure adequate pump accessibility.

Also, ensure start/stop poles are not obstructed.

3.6.2 Can the pump and compressor safely be handled for maintenance such as filter pulling? Pay special attention to spading-off possibilities and draining of the casing and the strainer.

3.6.3 Is removal of the pump and the electric motor practical?

3.6.4 Ensure that steam tracing around the suction and discharge lines can be dismantled to allow pump removal.

3.6.5 Is the flow in suction piping smooth? Check for the required straight length of the suction line for double-suction pumps.

3.6.6 Have high points in pump suction lines been avoided?

3.6.7 Check volumes which must be drained when a filter or the pump needs to be opened.
If the volume is very large, enlarge the size of drain valves to achieve a reasonable draining time. Also check that the drain piping of filters and casing is short and straight.

3.6.8 For pumps with a vertical suction line and an elevated strainer, check that opening of such a strainer does not result in spilling flammable liquid and possible ignition on nearby hot surfaces.

3.6.9 Are pump priming facilities adequate? Is the vent valve at the highest point at discharge and suction side?

3.6.10 Is location of the local compressor panel logical?

3.6.11 Are compressor seal oil tanks provided with their vents to the atmosphere at a safe location?

3.6.12 Are lube oil storage drums properly protected against ingress of rain water?

3.6.13 Are compressor recycle lines self-draining on both sides of the recycle control valve?

3.6.14 Are compressors with bottom inlet lines at the suction provided with liquid drains to a closed system?

3.6.15 Is instrumentation (e.g. panels) easily accessible for maintenance?

3.6.16 Has plant vibration been considered in the location of instruments and electrical equipment?

3.6.17 Is there space for cranes to enter and manoeuvre?

3.7 FURNACES AND BOILERS

3.7.1 Check that suction of air blowers is taken from a non-hazardous area.

3.7.2 Check that piping does not obstruct observation windows, access doors, header box covers, etc.

3.7.3 Is space available for withdrawing and cleaning tubes? Is there space for cranes to enter and manoeuvre?

3.7.4 Is piping at burners arranged in such a way that insertion and removal of ignitors and burner guns is not hampered?

3.7.5 With regard to the safety of fuel systems:

Are heavy fuel and LBF (low boiling fuel) systems sufficiently segregated?

Are adequate provisions made to prevent liquid fuels from entering atomising steam and steam-out lines ?

Are low-points in fuel gas lines avoided between the fuel gas knock-out vessel and the burners?

Are locations of flame arrestors, straight pipe lengths, etc. of low pressure and waste gas in accordance with specifications?

3.7.6 Are emergency/smothering steam headers at a safe distance?

3.7.7 Make sure that dry emergency or smothering steam is made available, with:
Outlet branches positioned on top of mains.
Steam lines without pockets.
Sufficient steam traps and drain points provided.

3.7.8 On manually started furnaces, are fuel valves of fuel oil and fuel gas within reach when looking at the burners through the observation windows?

3.7.9 Is the emergency shutdown switch at a safe location?

3.7.10 For multiple furnaces; check for a logical and clear layout of each furnace and its local start up panel.

3.7.11 Can a furnace be spaded off at its flue gas duct for furnace entrance and repair? This is required when multiple furnaces are connected to a common flue gas duct and one of the furnaces is required to continue to operate.

3.8 VESSELS AND COLUMNS

3.8.1 Check for unnecessary dedicated drain piping (e.g. where draining a vessel or column to grade can be done via existing piping such as drains of pumps).

3.8.2 Check that manholes are within reach of hoisting equipment? Ensure proper space on platforms for turning the manhole covers and for entering equipment.

3.8.3 Are instrument tappings and local instruments and level glasses readily accessible? Note that a levelglass on a vessel or column actually may protrude 500 mm into the platform area and thus form an unacceptable obstruction.

3.8.4 Check that instrument support poles, such as those used for pressure transmitters, are not obstructing a walkway of a platform around a column.

3.8.5 Has insulation for personnel protection been provided? Check especially hot vapour and product lines which can be easily touched from platforms.

3.8.6 Can the lines follow the expansion of the equipment when heating up and cooling down?

Pay special attention to supports on both hot and cold structures.

3.8.7 Check free movement of platforms (thermal expansion).

3.8.8 Check if specified elevations of vessels and columns on PEFS are adhered to.

3.8.9 Check that the barometric seals of vacuum equipment are at the specified height. This also applies for relative elevations of vessels belonging to a vacuum system.

3.8.10 For columns with structured packing, ensure there is a steam and water hose connection point nearby to fight any spontaneous fire when opening the manholes.

3.9 RELIEF SYSTEMS: FLARES AND VENT SYSTEMS

3.9.1 Flare lines shall have no pockets and shall slope continuously to the flare knock-out drum. If a low point is unavoidable, ensure a drain with adequate size is connected to a drain vessel.

3.9.2 Are flare headers provided with an end blind flange or manhole entry point to allow for inspection and internal cleaning?

3.9.3 If a platform is installed for spading a part of the flare line whilst the main flare line is still in use, ensure that there is enough space to do the work. Check that there is a proper escape way from this platform.

3.9.4 Check that inlet lines to relief valves are self-draining into process equipment. Relief valves should be located on the main process header.

3.9.5 Check that outlet lines from relief valves are self-draining into the flare header. An exception may be made for liquid DN 25*25 thermal relief valves which do not need to be self-draining on both sides if the lines would become too long. Check that connections are made on top or on the side of the flare header.

Ensure that process relief valves and process thermal relief valves are not routed to grade. They should end in a closed system.

3.9.6 Check the accessibility of relief valves sets for maintenance and inspection. Have relief valves been installed at proper elevations relative to the flare header? All relief valves should be accessible for removal (by hoisting equipment if necessary).

3.9.7 Is safety/relief valve piping as short as possible when discharging into a closed system?

3.9.8 Check relief valves discharging to atmosphere for safe location and direction. Ensure that hot equipment is not located below discharge points to the atmosphere if any hydrocarbons can be released. For a waste gas seal vessel, pay special attention to this check.

3.9.9 Can relief valves be blocked-in and drained?

3.9.10 Check relief valve outlet line arrangements such that supports can be provided to cope with reaction forces.

3.9.11 Is reactor vent gas safely routed during a regeneration?

3.9.12 Is the distance from the flame arrestor to the vent outlet as specified?
Ensure that flame arrestors in lines to the atmosphere can be accessed for removal and maintenance.

3.9.13 Check that the spindles of flare main block valves, if gate valves, are in a horizontal position. This prevents a blocked flare line if the wedge should fall down.

3.10 OIL MOVEMENTS

In addition to the above checkpoints, the following shall apply for oil movements installations.

3.10.1 Has the tankfarm been designed in accordance with the agreed specifications, inclusive of separation distances?

3.10.2 LPG storage: are safety requirements fulfilled, including distances, valves, piping, pressure relief provisions, civil aspects?

3.10.3 Tankfarms: is the layout logical in relation to battery limits, pipe tracks, blending and loading area?

3.10.4 Are tanks and bund areas accessible for fire fighting equipment?

3.10.5 Are tanks draining to an environmentally acceptable system?

3.10.6 Storage tanks with a blanketing system: is layout adequate, including its vapour routing?

3.10.7 Vapour recovery systems: consider layout and maintenance aspects.

3.10.8 Jetties: are adequate working envelopes provided for hoses and loading arms?

3.10.9 For tankfarms and pipe tracks: can rainwater and spilled oil be drained adequately?

3.10.10 Consider the elevation of movements facilities in case of large oil spills to surrounding plants.

3.10.11 For product blending facilities: see sections (3.3, 3.4 and 3.6).

3.10.12 For flares and vent pipes in movements area: see section (3.9).

3.11 ENVIRONMENTAL CHECKS

3.11.1 Check if any process liquid drained from equipment can be handled in an environmentally acceptable manner, in line with general approach of closed loops for liquid draining or vents. If required install funnels to the oil collecting system.

3.11.2 Check drainage from pump casings and pump strainers.

3.11.3 Check drainage from process filters and coalescers.

3.11.4 Check drainage from fuel filters of furnaces.

3.11.5 Are drains from sample points of plants and storage tanks minimised by, for example, closed loops?

3.11.6 Check drainage from instruments in analyser houses.

3.11.7 Check drainage from heat exchangers when opened for bundle cleaning or repairs. Consider also the effect of liquid spillage when opening both heads as well as when pulling the bundle.

3.11.8 Check drainage of sour or spent seal and lube oils from compressors.

3.11.9 Check drainage from lines at the battery limit prior to spading the unit.

3.11.10 Check vent to atmosphere from an analyser house.

3.11.11 Check that liquid collected in an open oil collecting pit inside the unit is prevented from evaporation, e.g. by covering with a closed plate.

3.11.12 Check where vents of seal chambers of reciprocating compressors are routed to.

3.11.13 Check that unloading and storage of chemicals, additives, caustic, ammonia etc. can be carried out without environmental impact.

3.11.14 Check that the distance around plants is in accordance with any local regulations, including noise limitations.

APPENDIX III CONSTRUCTION OF A PHYSICAL MODEL

1. GENERAL

The physical model shall be detailed and shall contain all items described in this appendix unless otherwise agreed with the Principal.

In consultation with the Principal the scale of the physical model should be either $1:33^1/_3$ or 1:25.

Certain complex situations could benefit from being modelled separately on a scale 1:10.

The dimensional accuracy shall be 3% or better. The construction will depend on the materials available. The material used for the physical model shall be such that damage will not occur during shipment or use in the field, irrespective of climate.

Plant North, true North, scale and, if applicable, table number of the physical model shall be indicated on the base plate.

All equipment including instruments and their process connections shall be identified by means of the (tag) numbers as shown on the relevant engineering drawing.

Pipelines shall be identified by white plastic arrows indicating the direction of flow and bearing the nominal line size, line number and piping class.

Pipe insulation shall be identified at suitable places but at least at each location where emergency escapes, maintenance and operational space could be affected by the insulation thickness.

Inclined pipes shall be labelled with the magnitude and direction of the slope. Pipe level elevations (top of structure or support) shall be labelled.

Platform and floor elevations shall be indicated.

The physical model shall be sectioned in vertical planes and, if necessary, also in horizontal planes as required to permit easy access for the installation of the piping and for model reviews. This will also facilitate packaging and transportation through doors and permit erection staff in the field to display the physical model close to the work site. Each physical model section shall be provided with dowels or other means for fitting sections accurately and solidly together.

2. EQUIPMENT

The equipment should be fabricated from plastic or alternative material. To reduce weight, built-up plastic or plywood may be used for large pieces. It shall be built with sufficient detail to define the overall dimensions and the location of all connections.

Heaters and related equipment shall be shown in outline only, but ducts, peepholes, platforms and heater support columns shall be shown in more detail.

For transportation purposes, stack(s) and other tall pieces shall be made removable.

3. PIPING

The following piping and piping components shall be shown:

- All process and utility piping regardless of size, unless otherwise agreed.
- Steam supply, to process and steam tracing and condensate manifolds, but not the tracers themselves.
- All valves, showing the proper type and overall dimensions. ROVs should also include their actuators (air, electric or hydraulic).
- Local panels for operating the ROVs.
- Miscellaneous piping accessories such as strainers, expansion joints, separators, pulsation dampers, flexible hoses, spectacle or spade blinds, fixed fire protection and fire-fighting equipment, etc.

- Routing of underground piping by indicating their position on the base plate by tape.
- All piping with a nominal size of DN 75 and larger shall be plastic tube true-to-scale. Smaller piping may be constructed with wire-reinforced plastic. Valves shall be of the snap-on type, moulded in plastic. Pipe supports shall not be indicated on the physical model.

4. STRUCTURES AND BUILDINGS

All elevated floors shall be made of transparent plastic, using the nearest commercially available thickness representing the actual slab thickness. Material thicker than 4 mm should not be used. It is not necessary to show complete floors.

Floor type shall be indicated, e.g. grating, corrugated plates, concrete, etc.

Staircases, platforms, ladders, hoisting beams and davits shall be shown. Hand rails and ladder cages shall not be shown unless needed to define limits for pipe runs, lighting and access.

Fireproofing on structural steel, where applicable, should be shown in full dimensions.

Buildings located in the plot area shall be shown in outline only, and should be made of transparent plastic. The position of ducts and vents shall be indicated.

5. INSTRUMENTS

The location of all instruments and instrument process connections, including the sample take-off and return points for on-line process stream analysers and, where applicable, the straight pipe length, shall be indicated.

All process connections for instrumentation shall be indicated on the equipment and piping by a tag or pin for identification.

Instrument impulse lines and instrument air tubing shall not be shown. Underground instrument cable trenches shall be indicated by tape. Aboveground instrument cable trunking and junction boxes shall be indicated by plastic strip. Local mounted instrument control panels, analyser cabinets, safety boxes, emergency shutdown control panels shall be shown.

6. ELECTRICAL EQUIPMENT

- The following equipment shall be shown:
- All major accessories, e.g. transformers, switch house(s), etc.
- Cable routing: if in trenches indicated by tape, if overhead by plastic strip.
- Electric motors together with start/stop switch position.

7. FIXED FIRE PROTECTION AND FIRE-FIGHTING SYSTEMS

The following shall be shown:

All major systems, e.g. spray, fog, dry risers, foam, etc.
Fire ring main routing, hydrants, block valves, fixed water monitors, hose boxes, fire points, steam lances.
Fire alarm push buttons.
Fire detector systems.
Close circuit TV cameras.
Deluge valve manifolds.