TECHNICAL SPECIFICATION

# PREPARATION OF PROCESS FLOW SCHEMES AND PROCESS ENGINEERING FLOW SCHEMES

DEP 01.00.02.11-Gen.

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**DESIGN AND ENGINEERING PRACTICE**

USED BY

COMPANIES OF THE ROYAL DUTCH/SHELL GROUP

## PREFACE

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Shell International Oil Products B.V. (SIOP)
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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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All administrative queries should be directed to the DEP Administrator in SIOP.

NOTE: In addition to DEP publications there are Standard Specifications and Draft DEPs for Development (DDDs). DDDs generally introduce new procedures or techniques that will probably need updating as further experience develops during their use. The above requirements for distribution and use of DEPs are also applicable to Standard Specifications and DDDs. Standard Specifications and DDDs will gradually be replaced by DEPs.

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## 1. INTRODUCTION

### 1.1 SCOPE

This DEP specifies requirements and gives recommendations for the preparation of Process Flow Schemes (PFSs) and Process Engineering Flow Schemes (PEFSs). These schemes are prepared by the party responsible for the process design and process engineering design.

The requirements and recommendations in this DEP are independent of the tools with which the schemes are produced. If a Computer Aided Design (CAD) drafting system is used it shall be compatible with an intelligent drawing and database system and an Electronic Document Management System (EDMS) to be specified by the Principal.

This DEP is a revision of the DEP with the same number dated September 1984. This DEP was previously titled "Compilation of Design Books" but this has now changed since the requirements for design books are excluded from the scope and are to be included in project procedures.

PFSs and PEFSs shall not only be prepared for process units in a narrower sense, but also for utility units and for common facilities where such schemes are appropriate. Hence, PFSs and PEFSs replace the former Utility Flow Schemes and Utility Engineering Flow Schemes.

### 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 for use in oil refineries, gas plants and, where applicable in chemical plants, exploration and production facilities and supply/marketing installations.

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 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 with the object of obtaining agreement to follow this DEP as closely as possible.

### 1.3 DEFINITIONS

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 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, and on behalf of, the Principal.

The word **shall** indicates a requirement.

The word **should** indicates a recommendation.

### 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 (4.).

## 2. PROCESS FLOW SCHEMES (PFS)

### 2.1 GENERAL

A PFS is a schematic drawing of a process or utility unit showing all relevant physical and other process data, the main utility characteristics, the basic process control elements and the main dimensions of the process equipment. A PFS shall show a list of included equipment items identified by their tag numbers adjacent to the drawing title block.

PFSs are prepared under the responsibility of the process or utility engineer. No modifications to a PFS shall be made without his authorisation.

If the design provides for different modes of operation, such as different crudes, feedstocks or cut points, distinction shall be made by letter indication, e.g. mode of operation A, B, etc. For more complicated cases, separate PFSs shall be prepared for each mode of operation.

PFSs provided by process licensors or other third parties shall be redrawn using symbols and identifications in accordance with DEP 31.10.03.10-Gen.and DEP 32.10.03.10-Gen.

PFSs for pressure relief systems shall indicate relief quantities, physical characteristics and conditions for each relief valve and depressuring valve for each individual and general emergency case.

### 2.2 EQUIPMENT GENERAL

Equipment such as pumps, compressors and heat transfer equipment which are lined up identically (whether in parallel or in series) and operating in the same service shall be shown as one unit. All spare equipment shall be omitted.
However, pieces of equipment which have an identical line-up and which are operated in time sequence or in cyclical order shall be shown individually.

Internals of equipment shall only be shown if essential for a clear understanding of the working of the equipment.

### 2.3 EQUIPMENT IDENTIFICATION AND TYPICAL DATA

Equipment shall be identified by tag number in accordance with DEP 31.10.03.10-Gen. For all equipment shown on the PFS, there shall be a description and an indication of the key process data. For the equipment listed below, the data are as follows:

#### 2.3.1 Columns = C....

- Internal diameter and length between tangent lines
- Operating pressure
- Operating temperatures at inlet and outlet lines
- Tray columns: Number and type of trays. Number the trays from bottom to top. Show trays at which the feed or reflux enters or from which products or reflux are drawn with their tray numbers. Show internals schematically.
- Packed columns: Type, size and material of packing. Height and number of packed beds.

#### 2.3.2 Heat transfer equipment (unfired) = E....

- Total heat duty
- Heat exchange surface area
- Operating temperatures at inlets and outlets.

#### 2.3.3 Vessels = V....

- Internal diameter and length between tangent lines
- Operating pressure
- Total volume
- Operating temperatures at vessel inlet and outlet
- Approximate location of feed and draw-off lines

**2.3.4 Reactors = R....**

- Internal diameter and length between tangent lines
- Total volume
- Operating pressure
- Operating temperatures at inlet and outlet lines
- Jacket or internal heat transfer equipment, if required, with heating/cooling duty
- Internals (schematically)

**2.3.5 Heat transfer equipment (fired) = F....**

- Total heat duty

**2.3.6 Mixers = M....**

- Type of mixer
- Capacity of mixer (kW input)

**2.3.7 Separators = S....**

- Internal diameter and length between tangent lines
- Special internals (schematically)

**2.3.8 Packaged units and miscellaneous equipment = A....**

- Relevant features

**2.3.9 Pumps = P....**

- Actual operating capacity

**2.3.10 Compressors and blowers = K....**

- Actual operating capacity

**2.3.11 Tanks = T....**

- Maximum working volume
- Special features, e.g. blanketing, mixing, blending, heating, etc.

## 2.4 PROCESS, UTILITY AND DISPOSAL LINES AND INSTRUMENTATION

Process, utility and disposal flow lines and equipment shall be shown on the PFS with their essential automatic control systems or manual-control valves.

Utility and disposal flow lines shall be shown on process related PFSs only where they tie in to main process equipment and lines.

Lines and instruments shall not be identified by tag numbers. Block valves, vents, drains, by-passes, sample connections, etc. shall not be shown unless they are essential for understanding the scheme.

For each flow line, the direction of the flow and the following information shall be given, if applicable:

- condition of phase: vapour, liquid, solid or a combination thereof;
- operating temperature in ° C;
- operating pressure in bar (abs);
- medium, if necessary to clarify the process;
- flow rate under operating conditions in kg/s;
- density under operating conditions in $kg/m^3$;
- d 15/4 for liquid streams;
- molar mass (formerly molecular weight) for vapour streams in kg/kmol;
- any other relevant characteristic, e.g. dynamic viscosity (in mPa.s), concentration of components, second liquid phase.

Lines continuing within a unit shall end at the left or right side of a PFS sheet at the same height at which they continue on the next sheet. Streams that enter or leave the unit shall be drawn at the bottom of the PFS sheet or, in exceptional cases for the sake of clarity, at the top.

## 3. PROCESS ENGINEERING FLOW SCHEMES (PEFSs)

### 3.1 GENERAL

A PEFS is a pictorial representation of a process or utility unit which shows all the equipment, including installed spares and the associated piping and piping components, instrumentation, heat tracing and insulation. Normally an elevated view is shown, although tankfarms are usually shown in plan view. All piping and piping components shall be shown with their sizes, piping class and tag numbers.

The schemes shall show specific engineering requirements necessary for the design, e.g. sloping lines, minimum straight pipe lengths, equipment elevations, etc.

Process conditions and physical data shall not be shown on the PEFS.

A separate PEFS shall be made for each utility system, e.g. cooling water, steam (high, medium and low pressure), condensate, air, water, etc. For combining several systems on one PEFS the approval of the Principal is required.

PEFSs are prepared under the responsibility of the process or utility engineer in close consultation with the process control engineer. No modifications shall be made to a PEFS without the authorisation of the responsible process or utility engineer.

### 3.2 EQUIPMENT

Equipment shall be identified by tag number and description, design pressure, design temperature and trim (piping class of additional piping components, e.g. drain and vent valves, blind flanges). Equipment shall be shown in realistic proportions, with pumps at the bottom and aircoolers at the top of the PEFS.

The PEFS shall show all items listed below:

- All equipment with instrumentation. Major equipment shall be shown at one level, e.g. furnaces, columns, etc. If different levels are required the elevations shall be stated. Equipment and installed spares shall be shown in realistic proportions.
- All thermowells, sample connections, vents, drains, valves, flanges, spectacle blinds, spade blinds, relief valves (including size and set pressure data), etc.
- The actual number of banks of air-cooled heat exchangers and the actual number of cells and passes of fired equipment.

### 3.3 PROCESS, UTILITY AND DISPOSAL LINES AND INSTRUMENTATION

The PEFS shall show all items listed below:

- All piping with size, line number and piping class identification.

  Line numbering is explained in DEP 31.10.03.10-Gen. and piping class numbering is explained in DEP 31.38.01.10-Gen.
- All process, utility and disposal piping and piping components, including start-up and (emergency) shut-down lines, valves, check valves, bypasses, drain and pump-out lines, sample connections and sample lines, drain and vent points, reducers, flanges, blind flanges, spectacle blinds, spade blinds, relief valves, control valves, thermowells, etc.
- All instruments, both automatic control loops and manual controls, alarms and IPF loops (trip systems) with solenoid valves, push buttons, switches and auxiliary instruments.
- For each instrument, where the function is available: local, on a local panel, or on a control room panel.
- All instrument connections to process, including the connections to and from QMI sample loops, to identify by-passes of isolation positions for normal or emergency use.

- Heat tracing and other means to keep lines at a prescribed temperature or to prevent freezing. Insulation requirements will normally be indicated on the data sheet for piping only.
- Inside plot connections to drain, flare or blow-down systems etc., indentifying each separate system.
- The direction of flow with arrows on the lines.
- Sections of piping where no high or low points (i.e. pockets) are allowed on non-inclined lines. Where inclined lines are required, e.g. for process/operational reasons, indicate the required slope ratio and direction.
- Lines where gravity flow is required, indicating the direction.

Lines continuing within a unit shall end at the left or right side of a PEFS sheet at the same height at which they continue on the next sheet. Streams that enter or leave the unit shall be drawn at the bottom of the PEFS sheet or, in exceptional cases for the sake of clarity, at the top. The number of line crossings should be minimised.

## 3.4 SYMBOLS AND LEGEND SHEETS

Each set of PEFSs shall be accompanied by Symbols and Legend sheets.

The relevant symbols and identification shall be selected from the applicable DEPs as shown below. Common abbreviations are given in (3.5).

The Symbols and Legend sheets shall contain the following as a minimum:

- Piping symbols used, with a description, taken from DEP 31.10.03.10-Gen.
- Instrument symbols used, with a description, taken from DEP 32.10.03.10-Gen.
- All mechanical abbreviations, all instrument abbreviations, all process abbreviations, all utility abbreviations, all standard hook-up abbreviations, and all general abbreviations.
- A description and drawing of all standard hook-ups and typical piping arrangements.
- All other information required to understand the PEFS.

## 3.5 ABBREVIATIONS

### 3.5.1 Piping

Reference is made to DEP 31.10.03.10-Gen.

### 3.5.2 Instrumentation

Reference is made to DEP 32.10.03.10-Gen.

### 3.5.3 Utilities

All utility lines entering or leaving each PEFS shall terminate at any convenient location with a diamond symbol. The diamond shall contain the relevant abbreviation. Examples of abbreviations are:

| | |
|---|---|
| AOC | Accidentally oil-contaminated |
| C | Condensate |
| CD | Closed drain |
| COC | Continuously oil-contaminated |
| CWR | Cooling water return |
| CWS | Cooling water supply |
| DM | Demineralized water |
| F | Flare |
| FG | Fuel gas |
| FO | Fuel oil |
| FOR | Flushing oil return |
| FOS | Flushing oil supply |
| FW | Fire water |
| HOR | Hot oil return |
| HOS | Hot oil supply |
| HPS | High pressure steam |
| HWR | Hot water return |
| HWS | Hot water supply |
| IA | Instrument air |
| LPS | Low pressure steam |
| MPS | Medium pressure steam |
| N | Nitrogen |
| PA | Process air |
| PW | Potable water |
| SIA | Secure instrument air |
| TA | Tool air |

### 3.5.4 Standard hook-ups

Standard Hook-ups and typical piping arrangements shall be indicated by a hexagon symbol. A description and drawing of each type used shall be presented on the symbols and legend sheet(s). The hexagon shall contain the relevant abbreviation. Examples of abbreviations are:

| | |
|---|---|
| FOR | Flushing oil return |
| FOS | Flushing oil supply |
| PSS | Pump seal system |
| SAS | Secure air supply |
| SC | Sample connection |

### 3.5.5 Miscellaneous

| | |
|---|---|
| ATM | Atmosphere |
| BL | Battery limit |
| EL | Elevation |
| EDP | Emergency depressuring |
| ESD | Emergency shutdown |
| MIN | Minimum |
| TL | Tangent line |

## 4. 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. |
| Symbols and identification system - Mechanical | DEP 31.10.03.10-Gen. |
| Piping - General requirements | DEP 31.38.01.10-Gen. |
| Symbols and identification system - Instrumentation Part 1: Process (engineering) flow schemes | DEP 32.10.03.10-Gen. |