

DEP SPECIFICATION

DESIGN CLASS TABLES

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DESIGN AND ENGINEERING PRACTICE



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1. INTRODUCTION

1.1 SCOPE

This DEP contains the Design Class Select Table which is applied in projects during the select phase of the Opportunity Realization Manual (ORM). The Design Class Detail Tables referenced by this DEP are maintained as separate DEP Standard Forms.

This DEP describes the application of both the Design Class Select Table and the Design Class Detail Tables. Design Class Tables are maintained by the engineering disciplines to support the project Design Class process. Regular updates/maintenance of the Design Class Tables will be administered through future revisions to this DEP and the referenced DEP Standard Forms.

The Design Class tables are organized into five performance categories:

- Capacity
- Expandability
- Capacity Utilization
- Operability / Maintainability
- Energy Efficiency / Carbon Management

Within each category, three design classes are defined:

- Design Class 1 (least complex facilities with minimum initial investment)
- Design Class 2 (most latitude for range of choices)
- Design Class 3 (highest initial investment with maximum flexibility)

For details on implementation of the project Design Class process, refer to Project Guide 08c "Design Class Value Improving Practice", which is maintained on Shell iPMS (<http://swm-ipms.shell.com/iPMS/Welcome.aspx>).

1.2 DISTRIBUTION, INTENDED USE AND REGULATORY CONSIDERATIONS

Unless otherwise authorised by Shell GSI, the distribution of this DEP is confined to Shell companies and, where necessary, to Contractors and Manufacturers/Suppliers nominated by them. Any authorised access to DEPs does not for that reason constitute an authorization to any documents, data or information to which the DEPs may refer.

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. Application in other facilities may also apply.

When DEPs are applied, a Management of Change (MOC) process should 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 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 with regard 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.

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 (9).

1.5 SUMMARY OF MAIN CHANGES

This DEP is a revision of a DEP with the same title dated September 2010 with the following changes:

- Section 5 has the reference to the Project Standards updated.
- Appendix C has a number of design class tables added.

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- Deleted withdrawn Standards Forms from the Reference Section and Appendix C.

1.6 COMMENTS ON THIS DEP

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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://sww.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.

2. PROJECT DESIGN CLASS PROCESS AND OPPORTUNITY REALIZATION MANUAL

The project Design Class process integrates fully with the Front End Development (FED) process of the Opportunity Realization Manual (ORM). The applicability and specifics of how the Design Class process is to be followed for an individual project is agreed in the Project Assurance Review (PAR1) and documented in the Opportunity Assurance Plan (OAP).

Although Design Class impacts the project throughout its life cycle, there are three key events in FED to ensure Design Class is effectively incorporated into the project:

- Design Class Select
- Design Class Detail
- Design Class Implementation

Design Class Select is done during the Select phase of the ORM, and can either be done in a workshop format or as a focused meeting. For Design Class Select, the project facility is sub-divided into the appropriate level of detail for effective assessment. The Design Class Select table can be found in Appendix A of this DEP.

Design Class Detail is done during the Define phase of the ORM, either in pre-FEED or early FEED, and can either also be done in a workshop format or as a focused meeting. The project team must first determine which Design Class Detail tables are applicable for the project. Once determined, these tables are completed by the discipline leads assigned to the project. The starting point for development of the Design Class Detail tables are the tables contained in Appendix C of this DEP.

Design Class Implementation is done during the Define (FEED) phase of the ORM. The project team reviews, challenges and confirms that the design and engineering solutions are consistent with the selected design classes.

Upon completion and verification of the Design Class Detail tables, discipline leads cross-reference the table selections with the DEP's and identify any incompatibilities

3. DESIGN CLASSES

3.1 GENERAL

Design Classes are used to describe key performance categories and influence the size, type and cost of new or revamped facilities. Refer to Design Class Value Improving Practice – Project Guide 08c for a complete description of the project Design Class process. This document is maintained on Shell iPMS (<http://sww-ipms.shell.com/iPMS/Welcome.aspx>).

Class 1 facilities are the least complex, require minimum initial investment and result in minimum flexibility. Very few facilities are entirely Class 1. Conversely, Class 3 facilities tend to be complex, involve the highest initial investment and result in maximum flexibility. Very few facilities are entirely Class 3. Class 2 facilities have the greatest latitude for a wide range of choices resulting in intermediate flexibility and initial investment. Most operating facilities are Class 2.

Design Class choices set the tone and foster understanding between project and business team members. The product resulting from the Design Class process is viewed as a high level contract between the business, operating facility and the project organization that defines the project design objectives and guides all decisions on future project scope.

Decisions on Design Class may involve a balance between reduced CAPEX as related to the chosen Design Class selected and potentially increased OPEX associated with increased use of personnel to operate and maintain the facility.

3.2 DESIGN CLASS 1

Class 1 facilities will meet the business and project objectives with the minimum amount of hardware and equipment. As a result of reduced scope, the facility's cost will be lower than the other classes. Facilities designed to Class 1 will include minimum engineering service factors and allowances consistent with recognized design codes and standards. This class of facility will meet the business and project premises at the design operating conditions; but, will not be expected to meet off design operating cases.

3.3 DESIGN CLASS 2

Class 2 facilities typically have been selectively upgraded to accommodate off design conditions and ensure higher performance/availability. Selected streams and systems may have added pieces of equipment, increased complexity and/or greater engineering allowances to assure that they meet the business requirements. Since more equipment and hardware will be necessary to meet the Class 2 requirements, the cost of this facility is higher than Class 1 facilities. The project schedule may be longer.

This class can also be used to selectively upgrade certain pieces of equipment to assure a higher level of performance and/or availability than that in Class 1 facilities.

3.4 DESIGN CLASS 3

Class 3 facilities will meet all of the business and project requirements at design and most off design operating conditions. Industry accepted engineering practices will be used to assure that the systems and equipment are capable of meeting these requirements. Much of the mechanical equipment and many systems will be spared to ensure that the new facility will meet all of the premises essentially all of the time. The cost of this facility will be higher than the other two lower class facilities because of the increase in scope. The project engineering and construction schedule may be longer.

4. PERFORMANCE CATEGORIES

4.1 GENERAL

Performance categories broadly describe the physical capabilities of the new facilities and are used by the project team to clearly describe the size, type and cost of facility to be constructed.

The five performance categories are:

- Capacity
- Expandability
- Capacity Utilization
- Operability and Maintainability
- Energy Efficiency and Carbon Management

These performance categories are described in more detail in this section.

As the design class is increased within a given performance category, the cost of the new facility increases. A Class 1 facility is considered to be the base cost. The cost of Class 3 facility is typically higher and could be by a significant percentage depending on the scope and hardware. Class 2 facilities can range in cost between Class 1 and Class 3 depending on the number of enhancements over Class 1.

4.2 CAPACITY

4.2.1 Capacity - General

Capacity determines a facility's throughput, taking account of scheduled shutdowns for including schedule shutdowns for plant maintenance. This category describes the level of certainty that the feed and product capacities will be met at given specifications.

4.2.2 Class 1

The facility will be designed to meet the desired capacity at the premised conditions with no added engineering service factors. The facility is not expected to meet the design capacity at non-premised operating, the worst climatic conditions and/or utilities' systems upsets. Feed pumps, vessels, exchangers and control valves will be sized for the maximum premised flow rate with no overplus. Piping sizes will be rounded down based on preliminary hydraulics and increased in size only if needed to deal with hydraulic shortcomings which prevent reaching the desired capacity.

Facility will have an actual capacity range of -20% / +0%.

This facility is the Base Cost.

4.2.3 Class 2

Except for identified process streams and systems, the facility will be designed to meet the desired capacity at the premised conditions with no added engineering service factors. Shell or contractor engineering allowances may be used on the identified streams, equipment and systems. The facility will meet the design capacity under normal operating conditions but may not make capacity under non-premised operating, the worst climatic conditions and/or utilities' systems upsets. The size of selected pieces of equipment will be increased to assure that the desired capacity of certain systems will be met. The piping in these selected systems will be sized based on final hydraulics and the rounding up to the nearest nominal pipe size.

Facility will have an actual capacity range of -10% / +10%.

This facility will range in cost from just over Base Cost to 6% over the Base. The cost of the Class 2 facilities will depend on the number of enhancements made over Class 1 facilities. As the scope increases, the costs will increase, up to the cost of a Class 3 facility.

4.2.4 Class 3

The facility will be designed to meet the desired capacity at all premised conditions. Shell, contractor or industry accepted sizing methods, which includes engineering service factors, will be used to determine the size of the equipment. The piping systems will be sized based on final hydraulics and rounding up to the nearest nominal pipe size.

Facility will have an actual capacity range of -0% / +20%.

This facility will typically cost 6% over the Base.

4.3 EXANDABILITY

4.3.1 Expandability - General

Expandability determines how easily the new facility can be expanded to meet future capacity requirements. In revamp, modification projects or Brownfield expansion projects, the degrees of freedom for expansion will be dictated by surrounding plot constraints

Cost break down is not provided for this performance category since the level of expandability depends on business strategies.

4.3.2 Class 1

No provisions for future expansion will be included.

4.3.3 Class 2

Future expansion will be considered on selective streams and systems. Provisions for future equipment within these systems will be included in the plant's layout and design. Selected pieces of equipment will be purchased with future expansion capabilities without major modifications.

4.3.4 Class 3

Future expansion will be considered in the facility's layout and design. Provisions for future equipment will be included. Major pieces of stationary equipment and piping will be sized and selected for the future conditions. Business evaluations will determine how to best meet the future requirements of other equipment.

The cost increase over the base facility depends on the amount of expansion capability desired. An increase in cost of 2+% over the base cost is typical a minimum amount of expansion capability.

4.4 CAPACITY UTILIZATION

4.4.1 Capacity Utilization - General

Capacity utilization is measured by the actual annual capacity (including planned and unplanned outages).

Capacity Utilization Factor (CUF) = Actual Annual Capacity / Design Annual Capacity

A capacity utilization factor is established by the project team, consistent with availability assurance modeling. Additional hardware may potentially be justified based on its impact on capacity utilization. To understand the benefits of sparing equipment, which requires additional Capex, availability assurance/reliability modelling is used to validate Design Class decisions before implementation.

4.4.2 Class 1

The equipment will be selected to operate up to vendor design limits. Spare equipment is limited to services necessary for a safe shutdown or to meet the project's environmental requirements. Unscheduled shutdowns are likely for repair and/or cleaning of equipment to maintain plant design capacities. Unscheduled shutdowns are also likely from upset in utility systems.

Capacity Utilization Factor $\leq 85\%$

This facility is the Base Cost.

4.4.3 Class 2

In general, the equipment will be selected to operate up to vendor design limits. On a selected basis, some equipment may be selected based on Shell, industry or contractor design limits. Spare equipment is limited to services necessary for safe shutdown, to meet the project's environmental premises and to improve reliability in process systems known to be unreliable. Unscheduled shutdowns may be required for repair and/or cleaning of equipment to maintain design capacities. For identified process systems, unspared vital equipment will be selected and specified for high reliability.

Capacity Utilization Factor >85 and $< 95\%$

This facility will range in cost from just over Base Cost to 6% over the Base. In general, a higher capacity utilization factor is achieved by adding or enhancing equipment. The cost increase of the Class 2 facilities will depend on the number of enhancements made over Class 1 facilities. As the scope increases, the costs will increase, up to the cost of a Class 3 facility.

4.4.4 Class 3

The equipment will be selected to operate up to Shell, industry or contractor design limits. Data has shown that these application limits have proven to increase equipment reliability throughout the industry. Spare equipment is applied in most applications to maintain plant