

STEAM JET VACUUM EJECTOR SETS

DEP 31.29.56.31-Gen.

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DESIGN AND ENGINEERING PRACTICE



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1. INTRODUCTION

1.1 SCOPE

This DEP specifies requirements and provides recommendations for the design, materials, engineering, fabrication, assembly, inspection and performance testing of steam jet vacuum ejector sets.

Only jet vacuum systems using steam as motive fluid are covered in this specification.

Excluded from the scope of this DEP is liquid ring vacuum equipment for which reference is made to DEP 31.29.42.30-Gen.

This DEP is a revision of the DEP of the same number dated December 1997; see (1.5) regarding the changes.

Note: Shell has proprietary requirements beyond those stated in this DEP for steam jet ejector sets and vacuum systems associated with Crude High Vacuum Units (HVUs); Shell GSI Distillation staff should be consulted in these applications.

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 oil refineries, chemical plants, gas plants, exploration and production facilities and supply/distribution installations.

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

1.3 DEFINITIONS

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, technical documents/drawings 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 (10).

1.5 CHANGES FROM PREVIOUS EDITION

This DEP is a revision of the DEP of the same number dated December 1997. The main changes are as follows:

Old section	New section	Change
-	-	This DEP is a revision of the DEP of the same number dated December-1997. This edition of the DEP now incorporates the technical content of the EGGS 20 EG-1 and 20 GS-1. It is impractical to summarize the differences here.

1.6 COMMENTS ON THIS DEP

Comments on this DEP may be sent to the DEP Administrator at standards@shell.com, using the DEP Feedback Form. The DEP Feedback Form can be found on the main page of "DEPs on the Web", available through the Global Technical Standards web portal <http://www.shell.com/standards> and on the main page of the DEPs DVD-ROM.

2. GENERAL

Data/requisition DEP 31.29.56.93-Gen. shall be used for the exchange of information between the Principal, Contractor and Manufacturer. Where the sheets show alternatives, those items which are not applicable shall be deleted.

The Manufacturer shall provide all drawings, design details, operation and maintenance manuals, and other information necessary for the design assessment, erection, operation and maintenance of the installation. All information shall be clear and not open to misinterpretation and shall apply specifically to the equipment supplied.

2.1 DATA AND INFORMATION TO BE SUBMITTED WITH THE TENDER

The Manufacturer shall submit with the tender sufficient drawings and detailed information to enable a full evaluation of the steam jet vacuum ejector sets, including as a minimum:

- Completed data/requisition sheet DEP 31.29.56.93-Gen;
- Fabrication and engineering documents schedule;
- Estimated mass of the completely assembled ejector set;
- A list of all recommended spare parts for initial and normal operation, as specified in DEP 70.10.90.11-Gen., with detailed prices and delivery times;
- Quality plan;
- A list containing all proposed deviations/exceptions from the requisition and this DEP;
- General arrangement drawing (lay-out sketch);
- Proposals for equipment test run programs, to be carried out both at Manufacturer's works and at site;
- Names of all proposed sub-Manufacturers of main equipment, e.g. pumps, condensers, silencer, instruments, with completed process and mechanical design data sheets being supplied by them as applicable. Materials of construction for all parts, using ISO/ASME material specifications when applicable, shall be listed on the data sheets;
- A process flow scheme showing all equipment, lines, valves and instrumentation and indicating limits of supply, the terminal points and sizes thereof;
- Noise requirements (see 6.2).
- Note that in some cases the Principal may also require some of the elements found in Section 9.3 as part of the tender (either in final or in "preliminary, estimated" form).

2.2 DATA AND INFORMATION TO BE SUBMITTED BY THE PRINCIPAL

- 2.2.1 For multi-stage steam jet vacuum ejectors, the Principal may provide the Manufacturer with curves of percent condensed vs. temperature and heat release (or enthalpy) vs. temperature at the preliminary selected condensing pressure. This assures that the manufacturer has the best process data so as to minimise the possibility of design error.
- 2.2.2 The installation equipment shall be listed by the Principal on a sheet entitled 'Scope of Supply' and the limits of supply on a sheet entitled 'Terminal Points', in accordance with the requirements of each project.
- 2.2.3 If necessary to define the terminal points (e.g. steam supply, etc.), a sketch should be attached to the Terminal Points list.
- 2.2.4 If there are space limitations it may be appropriate to specify the maximum tube length of condensers or maximum overall skid dimensions.

3. DESIGN AND ENGINEERING

3.1 ECONOMIC CRITERION

Steam jet vacuum ejectors shall be designed or selected such that an optimum is obtained between capital and operating costs.

The following criterion shall apply:

$[(F \times A) + (B \times G_s) + (C \times G_w)]$ shall be minimised

in which F = Capital charge percentage

A = Quotation price

B = Steam cost per tonne

G_s = Steam consumption in tonnes per year

C = Cooling water cost per 1000 m³

G_w = Cooling water consumption in 1000 m³ per year

The capital charge percentage shall be specified by the Principal on the data/requisition sheets DEP 31.29.56.93-Gen. together with unit costs of steam (B) and of cooling water (C) which shall be the costs of incremental/decremental quantities (not the average cost of supply).

Where the range of size of ejector options is such that changes may be required in the supporting structure, the appropriate differential capital costs should be accounted for in the calculation.

The most economical interstage pressures and temperatures shall be selected.

3.2 PROCESS DESIGN REQUIREMENTS

3.2.1 The design suction pressure affects the number of stages needed and the motive steam and cooling water requirements. Lower suction pressures require more stages, more utilities, and greater cost. Avoid overly conservative estimates of the pressure drop between the process system and the ejector. Also, do not apply safety or over-design factors to the design suction pressure. Lower than necessary design suction pressure can lead to system pressure control problems in addition to higher costs. Suction lines between the process vacuum vessel and the ejector can be located significant distance away. Criteria for acceptable pressure loss and flow velocity in suction lines are given in Appendix 2 and Appendix 3 for use in evaluating designs and assuring proper design suction pressure.

3.2.2 There is often a significant backpressure on a ejector system due to flame arrestors, long discharge lines, pressure of process or fuel system receiving the gas, air meter inclusion, or other factors. It is not unusual to specify a pressure of up to 210 mbar (ga) [3 psig] at the after-condenser vent. A minimum recommended value of specified discharge pressure is 70 mbar (ga) [1 psig]. The backpressure due to friction and to process head should be calculated to verify a reasonable specification. The discharge pressure of the ejector set (to be stated on the data/requisition sheets) should be selected to allow for the additional pressure drop of a flow measuring instrument located downstream of the ejector package.

3.2.3 When the process suction temperature is less than 0°C (32°F), or less than the solidification temperature of a process vapour component, or if the suction pressure is less than 7 mbar (abs) (5 mm mercury absolute), the first stage diffuser shall be specified as steam jacketed. Consideration should also be given to heat tracing the suction line. These precautions are to avoid equipment plugging.

3.2.4 All load components must be identified in order for the manufacturer to size the jets and condensers for acceptable operation. Any desired system safety factor should be applied to the design load, to handle recirculation (control) flows or process surge flows. An increase in design load flow will increase the design motive steam consumption.