TECHNICAL SPECIFICATION

ROTARY-TYPE POSITIVE DISPLACEMENT COMPRESSORS
(AMENDMENTS/ SUPPLEMENTS TO API STANDARD 619)

DEP 31.29.40.32-Gen.

September 1983
(DEP Circulars 27/92, 21/97 and 25/99 have been incorporated)

DESIGN AND ENGINEERING PRACTICE

USED BY

COMPANIES OF THE ROYAL DUTCH/SHELL GROUP

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.

When Contractors or Manufacturers/Suppliers use DEPs they shall be solely responsible for the quality of work and the attainment of the required design and engineering standards. In particular, for those requirements not specifically covered, the Principal will expect them to follow those design and engineering practices which will achieve the same level of integrity as reflected in the DEPs. If in doubt, the Contractor or Manufacturer/Supplier shall, without detracting from his own responsibility, consult the Principal or its technical advisor.

The right to use DEPs is granted by SIOP, SIEP or SIC, in most cases under Service Agreements primarily with companies of the Royal Dutch/Shell Group and other companies receiving technical advice and services from SIOP, SIEP or SIC. Consequently, three categories of users of DEPs can be distinguished:

1) Operating companies having a Service Agreement with SIOP, SIEP, SIC or other Service Company. The use of DEPs by these Operating companies is subject in all respects to the terms and conditions of the relevant Service Agreement.

2) Other parties who are authorized to use DEPs subject to appropriate contractual arrangements.

3) Contractors/subcontractors and Manufacturers/Suppliers under a contract with users referred to under 1) or 2) which requires that tenders for projects, materials supplied or - generally - work performed on behalf of the said users comply with the relevant standards.

Subject to any particular terms and conditions as may be set forth in specific agreements with users, SIOP, SIEP and SIC disclaim any liability of whatsoever nature for any damage (including injury or death) suffered by any company or person whomsoever as a result of or in connection with the use, application or implementation of any DEP, combination of DEPs or any part thereof. The benefit of this disclaimer shall inure in all respects to SIOP, SIEP, SIC and/or any company affiliated to these companies that may issue DEPs or require the use of DEPs.

Without prejudice to any specific terms in respect of confidentiality under relevant contractual arrangements, DEPs shall not, without the prior written consent of SIOP and SIEP, be disclosed by users to any company or person whomsoever and the DEPs shall be used exclusively for the purpose for which they have been provided to the user. They shall be returned after use, including any copies which shall only be made by users with the express prior written consent of SIOP and SIEP. The copyright of DEPs vests in SIOP and SIEP. Users shall arrange for DEPs to be held in safe custody and SIOP or SIEP may at any time require information satisfactory to them in order to ascertain how users implement this requirement.

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.

TABLE OF CONTENTS

PART I. INTRODUCTION

This specification, which is an upgrading and revision of Standard Specification K-3-2/3 dated April 1976, contains the minimum technical requirements for rotary-type positive displacement compressors for use in oil refineries, chemical plants, gas plants and, where applicable, in exploration, production and new ventures.

This specification gives SIPM/SICM amendments and supplements to API Standard 619, First Edition, September 1975,`Rotary-Type Positive Displacement Compressors for General Refinery Services'.

It shall be used in conjunction with data/requisition sheet DEP 31.29.41.93-Gen.

As a rule the requirements of this specification shall be adhered to.

However, national and/or local regulations may exist in which some of the requirements are more stringent.

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, economic and legal aspects.

In all cases the contractor shall inform the principal of any deviation from the requirements of this specification 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 specification as closely as possible.

Unless otherwise authorized by SIPM, the distribution of this specification is confined to companies belonging to or managed by the Royal Dutch/Shell Group and to contractors and manufacturers/suppliers nominated by them.

All publications referred to in this specification are listed in Part IV.

PART II. GENERAL INFORMATION

This specification is written in four parts of which Part III, the principal part, gives SIPM/SICM amendments and supplements to API Std 619, First Edition, September 1975.

Problems stemming from the publication of revisions or amendments to the above standard by the American Petroleum Institute in 1983 or subsequent years shall be referred to the principal.

Helical, spiral and straight lobe rotary compressors used for vacuum or pressure shall conform to API Std 619 as amended/supplemented by this specification.

For ease of reference, the clause (or paragraph) numbering of API Std 619 has been used throughout Part III of this specification. Clauses (paragraphs) in API Std 619 not mentioned remain unaltered. Where cross references are made, the number of the section/sub-section/clause **of this specification** referred to is shown in brackets.

A bullet (•) in the margin against certain clauses (paragraphs) in API Std 619 indicates that a decision by the principal is required. These decisions shall be indicated directly on the relevant data/requisition sheet when provisions are made for them; otherwise they shall be indicated on the data/requisition sheet(s) under the heading `Additional Requirements' or stated in the purchase order.

DEFINITIONS

For the purpose of this specification, the following definitions shall hold:

Shall and **Should** - the word `shall' is to be understood as mandatory, and the word `should' as strongly recommended to comply with the requirements of this specification.

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, authorized to act for the Principal.

* For Group operating companies having a service agreement with SIPM or SICM, the term Principal shall be taken as referring to SIPM-MFEE/21.

The **Contractor** is the party which carries out all or part of the design, engineering, procurement, construction and commissioning for the project. The Principal may sometimes undertake all or part of the duties of the Contractor.

The **Purchaser** is the party which buys the rotary compressor and its auxiliaries for its own use or as agent for the owner. The Purchaser may be either Principal or Contractor.

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

The term **`Vendor'** is considered to be synonymous with the term Manufacturer/Supplier as defined above.

Pipe sizes: The international nomenclature **Diameter Nominal** written as DN 15, 25, 40, 50, etc., has been used for pipe sizes in this specification; the inch sizes have also been retained and are shown in brackets.

PART III. AMENDMENTS/SUPPLEMENTS TO API STANDARD 619

SECTION 1 GENERAL

1.1 SCOPE

Delete first sentence of this clause and replace by:

This specification covers the minimum requirements for helical, spiral, and straight lobe rotary compressors used for vacuum or pressure or both.

1.3 CONFLICTING REQUIREMENTS

Delete this clause and replace by:

In the case of conflict between documents relating to the inquiry or purchase order, the following priority of documents shall apply:

- first priority : purchase order and variations thereto
- second priority : data/requisition sheets and drawings
- third priority : this specification.

1.4 DEFINITION OF TERMS

Delete terms 4. and 5. from this clause and replace by:

4. *Maximum allowable temperature* is the maximum temperature for which the manufacturer has designed the compressor when handling the specified gas at the specified pressure, with particular regard to rotor clearances.
5. *Rated discharge temperature* is the predicted actual operating temperature resulting from rated service conditions, and shall be at least 20 °C below the maximum allowable temperature.

Add new terms to this clause:

21. *Built-in compression ratio* is the degree of compression achieved internally in a screw compressor, and is dependent on the position of the leading edge of the outlet orifice when handling the specified gas.
22. *Hazardous service* is defined as a service for process streams containing:
    - hydrogen sulphide above 600 mg/kg
    - toxic or lethal products (for information on these products, reference is made to DEP 30.10.02.31-Gen.). In cases of doubt the principal shall be consulted
    - hydrogen plus hydrocarbons, when partial pressure of hydrogen is in excess of 0.7 MPa (7 bar).

1.5 REFERENCED PUBLICATIONS

1.5.1 Delete from this clause:

API Std 615: `Sound Control of Mechanical Equipment for Refinery Services'.

Add to this clause:

The publications referred to in this specification are listed in Part IV.

SECTION 2 BASIC DESIGN

2.1 GENERAL

2.1.1 Add to this clause:

Compressor ratings shall not exceed the limits of the vendors design but shall be well within the manufacturer's actual experience. Only equipment which has proven its reliability is acceptable.

2.1.2 Add to this clause:

The number of casings shall be as specified in the data/requisition sheet.

Two-stage screw compressor units shall consist of two casings in parallel arrangement with a common gearbox.

The built-in compression ratio of screw compressors shall be chosen to suit the pressure conditions existing at normal operation, and shall be stated by the manufacturer in his proposal.

2.1.3 Delete this clause and replace by:

The cooling water system including compressor cooling water jackets shall be designed for the conditions as specified in the data/requisition sheet but not less than for 5 bar working pressure. Provisions shall be included for complete draining and venting of the jackets.

2.1.7 Delete first sentence and replace by:

The combined performance of the compressor and its driver shall be the responsibility of the manufacturer.

2.1.8 Delete this clause and replace by:

All electrical components and installations shall be suitable for the area classification, gas grouping and temperature classes specified by the principal in the data/requisition sheets.

2.1.9 Delete this clause and replace by:

Noise control

Compressors shall be designed to minimize the generation of noise and shall not exceed the noise limits given in the supplementary clauses below.

2.1.9.1 *General*

All definitions, notations, measuring equipment, measuring procedures, test reporting, calculation methods and calculation procedures shall be in accordance with OCMA publication NWG-1.

2.1.9.2 *Noise limits*

Unless otherwise specified, the following limits shall be met at any measuring location not less than 1 m from the equipment surface:

Sound Pressure Limit in dB re 20 µPa	
Compressor	87 dB (A)
Compressor + driver	90 dB (A)

If the equipment produces impulsive and/or narrow band noise, the above limits shall be taken 5 dB (A) lower, thus 82 dB (A) for the compressor and 85 dB (A) for the compressor + driver.

Noise levels shall have an upper tolerance of + 0 dB.

The above requirements apply in the absence of reverberation and background noise from other sources, and for all operating conditions between minimum flow and rated flow.

In the event that more stringent limits apply, then these will be indicated on the

data/requisition sheet DEP 31.10.00.94-Gen., which forms part of the requisition. In such cases, the equipment shall not exceed the sound power or sound pressure limit stated on the requisition.

2.1.9.3 *Noise abatement*

Where excessive noise from equipment cannot be eliminated by low noise design, corrective measures should, preferably, take the form of acoustic insulation for pipes, gearboxes, etc. Where noise hoods are proposed, prior approval of the principal shall be obtained regarding construction, materials and safety requirements.

Noise control measures shall cause no hindrance to operations nor any obstruction to routine maintenance activities.

2.1.9.4 *Information to be submitted with the tender*

The manufacturer shall state on data/requisition sheet DEP 31.10.00.94-Gen., as requested, either the sound pressure level not less than 1 m from the equipment surface in octave bands and in dB (A), or the maximum sound power level of the equipment (the total noise emitted) in octave bands and in dB (A).

The vendor shall also indicate what special silencing measures, if any, have been applied in order to obtain these levels.

2.1.11 Insert new clause:

The use of liquid injection into the gas stream to control the discharge temperature and/or to prevent fouling requires the explicit approval of the principal.

2.1.12 Insert new clause:

For variable-speed drive, the manufacturer shall state the minimum allowable speed of the compressor, and shall include in his proposals a suitable safeguarding system.

2.2 CASINGS

2.2.3 Delete this clause and replace by:

Materials for casings shall be as specified in the data/requisition sheet.

2.3 CASING CONNECTIONS

2.3.3 Delete this clause and replace by:

When the following items are required or specified, flanged connections not less than DN 20 ($^3/_4$ in.) shall be provided:

- vents
- pressure and temperature gauge connections at suction and discharge nozzles
- liquid injection, only when liquid injection is approved by the principal, see (2.1.11) of this specification
- water cooling
- lubricating and seal oil
- flushing
- buffer gas
- casing drains.

2.3.7 Add to this clause:

Amended per Circular 21/97

Flange facing finish shall be in accordance with ASME/ANSI B16.5.

2.5 ROTATING ELEMENTS

2.5.1 Rotors

2.5.1.1 Delete this clause and replace by:

Rotors shall be stiff enough to prevent contact between the rotor bodies and the casing and between gear-timed rotor bodies at the most unfavourable specified conditions including 110% of the relief valve set pressure. Rotors and shafts shall be of one piece.

For non-corrosive duties, rotors of built-up construction may be used. Rotor bodies not integral with the shaft shall be permanently fixed to the shaft to prevent relative motion under any condition. Keyways shall have 1.5 mm minimum fillet radii. Structural welds on rotors shall be stress-relieved, preferably through a minimum of two heating and cooling cycles.

2.5.1.3 Delete this clause and replace by:

Rotors and shafts shall be heat-treated forged steel or alloy steel, unless otherwise specified.

2.5.1.5 Insert new clause:

Screw compressors shall be designed in such a way as to ensure that the female rotor always absorbs enough power to avoid gear flutter.

2.5.1.6 Insert new clause:

Seal strips shall be integral with the rotor bodies unless otherwise approved by the principal.

2.7 DYNAMICS

2.7.3 Lateral vibration criteria

2.7.3.1 Delete this clause and replace by:

Rotor balance shall be such that during shop test and field operation of the compressor, when operating at maximum continuous speed or at any other specified speed within the specified operating range, the overall unfiltered peak-to-peak amplitude of vibration, including run-out*, in any plane measured on the shaft adjacent and relative to each radial bearing does not exceed 65 µm or the value obtained from the following formula, whichever is less:

$$100\sqrt{\frac{1500}{n}}\ \mu m$$

in which n = maximum continuous speed in revolutions per minute

When non-contacting vibration probes are not specified for measuring shaft vibration, and shaft vibration cannot be measured, the rotor balance shall be checked by measuring the effective velocity of vibration of the casing, filtered at the frequency of rotor speed(s). In such cases, the measured velocity shall not exceed 4.5 mm/s rms.

* See sub-note to paragraph 2.7.3.2 in API Std 619.

2.7.3.2 Delete this clause and replace by:

At the trip speed of variable-speed drivers, the vibration shall not exceed the value calculated from (2.7.3.1) of this specification plus 20%.

2.9 VIBRATION AND POSITION DETECTORS

2.9.1 Mounting and location

2.9.1.2 Delete this clause and replace by:

Mounting of the probes shall be in accordance with API Std 670. Provisions for mounting radial probes shall ensure that:

- oil spill is minimized on probe change-out

- installation shall be suitable for external mounting as described in paragraph 2.9.2 of API Std 619 with the single exception of the axial position on a drive-through casing.

2.9.2 Probes and readout equipment

Delete the whole of this paragraph and replace by:

For probes and oscillators/demodulators, if specified, see DEP 32.31.09.31-Gen.

2.10 LUBRICATION

2.10.1 General

2.10.1.3 Delete this clause and replace by:

The lubricating oil system, and the seal oil system, if applicable, shall be in accordance with API Std 614 as amended/supplemented by DEP 31.29.60.32-Gen.

2.11 MATERIALS

2.11.1 General

2.11.1.1 Delete this clause and replace by:

Materials of construction shall be as specified in the data/requisition sheet(s). The manufacturer may suggest alternative materials where proven experience indicates better performance.

2.11.1.3 Add to this clause:

Materials for components in contact with gas containing hydrogen sulphide, including trace quantities, shall conform to the requirements of NACE Standard MR-01-75, 1980 revision.

2.11.1.5 Insert new clause:

For pressure-containing parts operating at temperatures of 0 °C or below, selected material shall have an impact strength sufficient to qualify under the minimum impact energy requirements specified in DEP 30.10.02.31-Gen.

2.11.2 Castings

2.11.2.4 Delete this clause and replace by:

The repair of leaks and defects in pressure-containing castings by peening or burning-in, or by impregnation with plastics or cement compounds is prohibited.

Repair by welding or by plugging shall be undertaken only when permitted by the material specification, and then only in accordance with the procedure detailed in (2.11.2.5) and (2.11.2.6) of this specification.

2.11.2.5 Delete this clause and replace by:

Repair by welding

Weldable grades of castings may be repaired by welding subject to the following criteria:

1. Approval by the principal shall be obtained before any major* weld repair is carried out.

   * Refer to definition included after item 6.

2. All repairs shall meet the inspection requirements and acceptance standards for the original material.

   Castings subjected to a major repair shall be inspected by purchasers representative who shall be notified in accordance with paragraph 4.1.3 of API Std 619.

3. For steel castings the repair welding procedure and the repair welder's qualifications shall both be in accordance with ASTM A 488. For aluminum or aluminum alloy castings see `Recommended practice for the welding of aluminum and aluminum alloy castings', available from SIPM. Repair procedures are subject to approval by the principal.

4. The total quantity of weld metal deposited shall be less than 10% of the mass of the casting.
5. After weld repair, castings shall be suitably heat-treated if this is specified in the relevant material specification. A major* weld repair shall always be followed by a suitable heat treatment.
6. Details of all major weld repairs, and of the heat treatment where applicable, shall be recorded and reported to the principle.

* The definition of a major weld repair is to be taken as either a removal of more than 50% of the wall thickness. or a length of more than 150 mm in one or mere directions. or a total surface area of all repairs exceeding 20% of the total casting surface area.

2.11.2.6 Delete this clause and replace by:

Repair by plugging

Cast gray iron or nodular iron may be repaired by plugging within the limits specified in ASTM A 278, ASTM A 536, or ASTM A 395 respectively. The drilled holes for plugs shall be carefully examined by dye penetrant to ensure removal of all defective material.

All necessary repairs not covered by ASTM shall be subject to approval by the principal.

Details of all repairs shall be recorded and reported to the principal, who shall be informed of the need for plugging before any repair is carried out.

2.11.2.7 Insert new clause:

Fully enclosed cored voids including voids closed by plugging are prohibited.

2.11.4 Material inspection (change of title)

2.11.4.1 Delete this clause and replace by:

All cast steel casing parts shall be examined visually by the manufacturer and shall be free of adhering sand, scale, cracks and hot tears.

Other surface discontinuities shall meet the visual acceptance standards specified in

MSS SP-55.

Following visual inspection, magnetic particle inspection shall be carried out on all surfaces after final machining.

Magnetic particle inspection method shall be in accordance with ASTM E 709.

Acceptability of defects shall be based on a comparison with the reference photographs given in ASTM E 125. For each type of defect the degree of severity shall not exceed the limits in the following table:

Type	Degree
I	1
II	2
III	2
IV	1
V	1
VI	1

Irrespective of these generalized limits, it shall be the manufacturer's responsibility to review the design limits of all castings in the event that more stringent requirements are specified.

Dye-penetrant inspection shall be used only when magnetic particle inspection is not feasible.

Dye-penetrant inspection method shall be in accordance with ASTM E 165.

Acceptability of defects shall be based on a comparison with the reference photographs given in ASTM E 125. For each type of defect, the degree of severity shall not exceed the limits given in the table above.

When specified, full non-destructive inspection shall be carried out on all critical areas, such as abrupt changes in section, weld ends, at the junction of risers, gates or feeders to the casting, and areas of high stress. Prior to inspection, the purchaser and the manufacturer shall agree the critical areas and the type of non-destructive testing which shall be applied. Radiographic inspection shall be applied wherever possible.

Radiographic inspection procedure shall be in accordance with ASTM E 94.

The interpretation of radiographs shall be in accordance with ASTM E 186, ASTM E 280 or ASTM E 446, whichever is applicable. For each type of defect, the degree of severity shall not exceed the limits in the following table:

Thickness mm	**Gas and blow holes**	**Sand spots and inclusions**	**Internal shrinkage**	**Cracks and hot tears**
			Types, 1, 2, 3, and 4	
Below 25	2	2	2	Not allowed
25-50	3	3	2	Not allowed
51-114	3	3	2	Not allowed
Over 114	3	3	2	Not allowed

Ultrasonic inspection shall be used where radiography is not possible.

Ultrasonic inspection shall be in accordance with ASTM A 609. For each range of wall thickness, the level of acceptance shall be in accordance with the following table:

Thickness mm	Acceptance level
Below 50	2
50-100	3
Over 100	4

2.11.4.2 Delete this clause and replace by:

All accessible areas of welds on built-up rotors shall be inspected by magnetic particle examination. Dye-penetrant inspection shall be used only when magnetic particle inspection is not feasible.

2.11.4.4 Insert new clause:

The inspection requirements specified in (2.11.4.1) of this specification can be relaxed at the discretion of the principal if the manufacturer can establish proven good experience with the same casing material and same casting technique. The principal and manufacturer shall then agree the revised extent of inspection.

2.12 NAMEPLATE AND ROTATION ARROW

Add to this clause:

The text on nameplates shall be in the English language and the data shall be in SI units unless otherwise specified.

The information on nameplates shall include the year of manufacture and the built-in compression ratio.

SECTION 3 ACCESSORIES

3.1 DRIVERS

3.1.2 Delete this clause and replace by:

Electric motors for auxiliary equipment shall comply with DEP 33.66.05.31-Gen.

3.1.3 Delete this clause and replace by:

Steam turbine drivers shall conform to API Std 611 as amended/supplemented by DEP 31.29.60.30-Gen. or to API Std 612 as amended/supplemented by DEP 31.29.60.31-Gen. and data/requisition sheet DEP 31.29.61.95-Gen. or DEP 31.29.61.93-Gen. whichever is applicable.

Steam turbine drivers shall be sized to continuously deliver 110% of the power required for any of the purchasers specified operating conditions (including gear and coupling losses), while operating under specified steam conditions.

3.1.4 Add to this clause:

Electric motor drivers shall be as specified in data/requisition sheet DEP 33.66.05.93-Gen. and shall comply also with DEP 33.66.05.31-Gen.

3.1.5 Delete this clause and replace by:

Gas turbine drivers shall comply with API Std 616 as amended/supplemented by DEP 31.29.70.31-Gen. and data/requisition sheet DEP 31.29.70.93-Gen. and shall be sized by mutual agreement between the purchaser and the vendor.

All discrepancies between the above specifications and the gas turbine proposed by the vendor shall be itemized in a separate section of the proposal.

3.1.7 Add to this clause:

The vendor shall state how many seconds after complete power failure the motor may still reaccelerate the fully loaded compressor at 80% of nominal voltage.

3.4 CONTROLS AND INSTRUMENTATION

3.4.2 Control systems

3.4.2.1 Add to this clause:

Instrumentation for measurement and control shall be as specified in data/requisition sheet DEP 31.29.41.93-Gen. and shall comply with DEP 32.31.09.31-Gen.

3.4.3 Alarms and shutdowns

3.4.3.1 Delete this clause and replace by:

Amended per Circular 25/99

The manufacturer shall provide pressure and temperature connections as specified in data/requisition sheet DEP 31.29.41.93-Gen. and in accordance with DEP 32.31.09.31-Gen. and DEP 32.31.00.32-Gen.

3.4.3.2 Delete this clause

3.5 PIPING AND APPURTENANCES

3.5.1 General

3.5.1.1 Add to this clause:

Flanged connections shall conform to the requirements of (2.3.7) of this specification.

3.5.3 Utility piping

Add to this clause:

Where interconnecting process piping is included within the scope of supply, it shall conform to the requirements of the following publications:

Amended per Circular 27/92

- DEP 31.38.01.11-Gen.
- DEP 31.38.01.12-Gen.
- DEP 31.38.01.31-Gen.

3.5.4 Instrument piping

Delete this clause and replace by:

Each pressure connection for instrumentation shall be provided

with a shut-off valve with straight-through trim and terminating in an ANS Class 150 or ANS Class 300 ½-in. threaded flange.

3.5.5 Intercoolers and aftercoolers

3.5.5.1 Delete this clause and replace by:

Shell-and-tube heat exchangers, when specified, shall conform to the specification(s) indicated on the data/requisition sheet.

3.5.5.2 Delete this clause

3.5.5.3 Delete this clause

3.5.5.4 Delete this clause and replace by:

Air coolers, when specified, shall conform to API Std 661 as amended/supplemented by DEP 31.21.70.31-Gen.

3.5.5.5 Delete this clause

SECTION 4 INSPECTION AND TESTING

4.1 INSPECTION

4.1.2 Delete item 1 of this clause and replace by:

The manufacturer shall provide the purchaser with assurance that materials of construction are in accordance with the purchase order.

The requirements for material certificates giving the chemical composition and the mechanical and test data for the materials used for the pressure-containing parts and for the main components of the compressor set out in the following supplementary clauses shall be adhered to.

4.1.2.1 The different types of certificate which shall be used by the manufacturer for verifying that the requirements of the specification and the contract are met are distinguished below.

Type A

Certificates by which the manufacturer confirms that the product supplied corresponds to what was specified, on the basis of test results taken from the in-production testing of products of the same material and the same manufacturing method as the delivery concerned.

Type B

Certificates by which the manufacturer's inspector confirms that the product supplied corresponds to what was specified, on the basis of tests carried out on the delivery itself or on standards-specified test specimens related to the delivery.

The necessary testing shall have been carried out by a testing centre which is independent of production in the manufacturing works and which has the necessary facilities at its disposal. When the independence of the testing centre cannot be established, a Type C certificate shall be submitted.

Type C

Certificates as described under Type B with the additional requirement that the tests shall be witnessed by an independent inspector who shall be approved by the principal. Certificates shall be valid only when stamped and signed by this independent inspector.

4.1.2.2 All certificates shall contain the following information:

- name of manufacturer
- purchase order number and date
- manufacturer's order number
- identification number of certificate and its date of issue material specification(s)
- dimensions in SI units, unless otherwise specified or applicable
- material charge number, batch number or heat-lot number
- mechanical properties recorded from test results
- chemical composition recorded from results of chemical analyses
- NDT methods and results, where applicable
- heat treatment procedures, furnace charge number and heat treatment records, where applicable
- such supplementary or additional information as may be required.

Additionally, all Type C certificates shall state:

- name of independent inspector who has witnessed the test(s)
- this independent inspector's identification symbol.

Unless otherwise specified, the material concerned shall be stamped with an identical symbol using low-stress dies.

4.1.2.3 As a minimum, material certificates in accordance with Type A are required for pressure-containing parts in non-hazardous and non-hydrocarbon services with an operating temperature above 0°C, and for gear- and bearing housings.

4.1.2.4 As a minimum, material certificates in accordance with Type B are required for carbon steel pressure-containing parts in hydrocarbon services with an operating temperature above 0°C, and for rotors.

4.1.2.5 Material certificates in accordance with Type C are required for carbon steel pressure-containing parts in services with an operating temperature of 0°C and below, for pressure-containing parts in hazardous services, and for alloy steel pressure-containing parts.

4.1.6 Insert new clause:

Marking

4.1.6.1 Marking is required for component parts certified under material certificates Type B and Type C, see (4.1.2.4) and (4.1.2.5) of this specification.

Parts with a wall thickness in excess of 5 mm, except those items manufactured from austenitic stainless steel or from nickel alloys, shall be legibly marked by hard-die stamping on to a painted background, and at a point clearly visible later. Pipes should be marked at a point approximately 250 mm from one end.

Only low-stress stamps shall be used for hard-die stamping, and the stamps shall be round-nosed with a minimum radius of 0.25 mm.

For items manufactured from austenitic stainless steel or from nickel alloys, and for items with a wall thickness of 5 mm or less, the marking shall be applied by stencil using a water insoluble ink which contains no injurious substances such as metallic pigments, sulphur, sulphides or chlorides which could attack or harmfully affect the material.

4.1.6.2 The stamping/marking shall include:

- manufacturer's symbol; the stamp shall be identical to symbol on certificate*
- material and product identification
- charge or batch number
- heat treatment chart or furnace charge reference number, where applicable
- heat treatment symbol or code, where applicable
- NDT symbol or code, where applicable
- size and schedule
- hydrostatic test pressure in bar, where applicable.

* Where applicable, the third-party agency identification stamp or mark shall be identical to the stamp/mark on the certificate.

NOTE: Where the size of the fitting does not permit complete marking, the identification marks may be omitted in the reverse order presented above, or another form of identification may be used with the prior agreement of the principal.

4.2 TESTING

4.2.2 Hydrostatic test

4.2.2.1 Delete last item and replace by:

Item	Minimum test pressure
Jackets	1½ times the maximum working pressure of the cooling medium but not less than 8 bar ga.

4.2.2.2 Delete this clause and replace by:

Pressure-containing parts for compressors handling gases with a molecular weight of 12 or less, or gases containing more than 0.1% mol. hydrogen sulphide, shall be tested for leakage after the hydrostatic test.

Parts shall first be thoroughly dried and cleaned, then pressurized with dry air up to a pressure of 7 bar minimum.

Leak detection shall be carried out by applying a soap solution to the part under test and watching for bubbles to form. There shall be zero leakage.

Testing gasketing shall be the same as specified for the service condition.

4.2.3 Mechanical running test

4.2.3.1 Insert at the beginning of this clause:

Each compressor shall be subjected to a mechanical running test at the manufacturer's works unless the compressor absorbs less than 10 kW and testing is not specifically required and specified in the purchase order.

The mechanical running test shall be carried out on air unless otherwise stated in the purchase order.

Amend items 1, 2 and 4 as follows:

1. Delete `two hours' in last sentence and substitute `three hours'.
2. Delete `20 degrees Fahrenheit for a minimum of 30 minutes' and substitute `20 °C for a minimum of one hour'.
4. Delete `250 degrees Fahrenheit' and substitute `120 °C'.

4.2.3.4 Delete this clause and replace by:

The vendor shall maintain a detailed log of all final tests and shall submit to the purchaser the required number of copies.

The following shall be observed and recorded at regular intervals:

- lubricating oil temperatures and pressures
- bearing temperatures
- external timing gear temperature
- seal oil leakage (if oil-buffered seal units are applied)
- seal oil temperature (if oil-bufferred seal units are applied)
- vibration measurements in accordance with (2.7.3) of this specification.

4.3 PREPARATION FOR SHIPMENT

4.3.1 General

4.3.1.1 Add to this clause:

Preparation for shipment shall be in accordance with the requirements of the inquiry and of the purchase order(s) and supplements appertaining thereto.

SECTION 6 VENDOR'S DATA

6.1 PROPOSALS

6.1.1 General

6.1.1.1 Delete item 1 and replace by:

1. All the relevant data/requisition sheets completed to the furthest extent possible.

6.2 CONTRACT DATA

6.2.1 Drawings

6.2.1.1 Add to this clause:

The information shall include the documents for controls and instrumentation as specified in DEP 32.31.09.31-Gen.

PART IV. REFERENCES

In this specification, reference is made to the following publications.

NOTE: The latest issue of each publication shall be used together with any amendments/supplements/revisions to such publications.

It is particularly important that the effect of revisions to international, national or other standards shall be considered when they are used in conjunction with DEPs, unless the standard referred to has been prescribed by date.

Metallic materials - Requirements for equipment for low-temperature service and for equipment containing liquefied gas or lethal substances	DEP 30.10.02.31-Gen.

Amended per Circular 27/92

Data/requisition sheet for equipment noise limitation	DEP 31.10.00.94-Gen.
Air-cooled heat exchange equipment (Amendments/supplements to API 661)	DEP 31.21.70.31-Gen.
Data/requisition sheet for rotary compressors	DEP 31.29.41.93-Gen.
General-purpose steam turbines	DEP 31.29.60.30-Gen.
Special-purpose steam turbines	DEP 31.29.60.31-Gen.
Lubrication, shaft-sealing and control oil systems for special-purpose application	DEP 31.29.60.32-Gen.
Data/requisition sheet for special-purpose steam turbines	DEP 31.29.61.93-Gen.
Data/requisition sheet for general-purpose steam turbines	DEP 31.29.61.95-Gen.
Combustion gas turbines	DEP 31.29.70.31-Gen.
Data/requisition sheet for gas turbines	DEP 31.29.70.93-Gen.
Piping - General requirements	DEP 31.38.01.11-Gen.
Piping classes	DEP 31.38.01.12-Gen.
Shop fabrication of steel piping	DEP 31.38.01.31-Gen.

Amended per Circular 25/99

Instruments for measurement and control	DEP 32.31.00.32-Gen.
Instrumentation for equipment packages	DEP 32.31.09.31-Gen.
Electric motors	DEP 33.66.05.31-Gen.
Requisition sheet for electric motors	DEP 33.66.05.93-Gen.

AMERICAN STANDARDS

General-Purpose Steam Turbines for Refinery Services	API Std 611 Second Edition, january 1982
Special-Purpose Steam Turbines for Refinery	API Std 612

Services	Second Edition, June 1979
Lubrication, Shaft-Sealing, and Control Oil Systems for Special-Purpose Applications	API Std 614 First Edition, 1973
Type H Industrial Combustion Gas Turbines for Refinery Services	API Std 616 Second Edition, 1982
Rotary-Type Positive Displacement Compressors for General Refinery Services	API Std 619 First Edition, September 1975
Air-Cooled Heat Exchangers for General Refinery Services	API Std 661
Noncontacting Vibration and Axial Position Monitoring Systems	API Std 670 First Edition,1976

Issued by
American Petroleum Institute,
Publications and Distribution Section,
2101 L Street Northwest,
Washington, DC 20037, USA

Amended per Circular 21/97

Pipe flanges and flanged fittings, NPS $^1/_2$ through NPS 24	ASME/ANSI B16.5

Issued by:
American Society of Mechanical Engineers
345 East 47th Street
New York NY 10017
USA.

Gray Iron Castings for Pressure-Containing Parts for Temperatures up to 650 °F (345 °C)	ASTM A 278
Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures	ASTM A 395
Qualification for Procedures and Personnel for the Welding of Steel Castings	ASTM A 488
Ductile Iron Castings	ASTM A 536
Ultrasonic Examination of Carbon and Low-Alloy Steel Castings	ASTM A 609
Radiographic Testing	ASTM E 94
Magnetic Particle Indications on Ferrous Castings	ASTM E 125
Liquid Penetrant Inspection	ASTM E 165
Heavy-Walled (51 to 114 mm) Steel Castings	ASTM E 186
Heavy-Walled (114 to 305 mm) Steel Castings	ASTM E 280
Steel Castings up to 51 mm in Thickness	ASTM E 446
Magnetic Particle Examination	ASTM E 709

Issued by
American Society for Testing
and Materials,
1916 Race St., Philadelphia,
Pa. 19103, USA

Quality Standard for Steel Castings Visual Method — MSS SP-55

Issued by
Manufacturers Standardization Society,
5203 Leesburg Pike, Suite 502,
Falls Church, Virginia 22041, USA

Sulfide stress cracking resistant metallic material for oil field equipment — NACE Standard MR-01-75 (1980 Revision)

Issued by
National Association of Corrosion
Engineers,
1440 South Creek, Houston,
Texas 77084, USA

OIL COMPANIES MATERIALS ASSOCIATION

Noise Procedure Specification — OCMA publication NWG-1, Revision 2

Issued by
Heyden & Son Ltd.,
Hillview Gardens,
London NW4 2JQ,
England