TECHNICAL SPECIFICATION

RECIPROCATING COMPRESSORS
(Amendments/supplements to API Std 618)

DEP 31.29.40.31-Gen.

May 1988
(DEP Circulars 15/91, 26/92, 20/97 and 24/99 have been incorporated)

DESIGN AND ENGINEERING PRACTICE

USED BY

COMPANIES OF THE ROYAL DUTCH/SHELL GROUP

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TABLE OF CONTENTS

APPENDICES

PART I. INTRODUCTION

This specification is a revision of DEP 31.29.40.31-Gen., dated September 1983, and contains the minimum technical requirements for reciprocating compressors handling air or gas, used in refineries, chemical plants, exploration and production facilities and new ventures.

This specification gives SIPM/SICM amendments and supplements to API Standard 618, Third edition, February 1986, 'Reciprocating Compressors for General Refinery Services'.

It shall be used in conjunction with data/requisition sheet DEP 31.29.43.93-Gen, latest edition.

As a rule the requirements of this specification shall be adhered to. However, national and/or local regulations may exist in which some requirements are more stringent. The contractor shall determine by careful scrutiny which requirements are more stringent and which combination of requirements will be acceptable regarding 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 to comply with national and/or local regulations. The principal may then negotiate with the authorities concerned in order to obtain agreement to follow this specification as closely as possible.

Unless otherwise authorized by SIPM, the distribution of this specification is confined to companies forming part of 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 gives the amendments and supplements to API Std. 618, Third edition, February 1986.

Problems stemming from the publication of revisions or amendments to the above standard by the American Petroleum Institute in 1987 or subsequent years shall be referred to the principal.

Reciprocating compressors handling air or other gases shall conform to API Std. 618 as amended/supplemented by this specification.

This specification does not cover portable air compressors, compressors with single-acting trunk-type pistons (automotive-type) that also serve as crossheads, and air-cooled utility air ('tool air') compressors that discharge at 8.6 bar gauge or below.

For ease of reference, the clause (or paragraph) numbering of API Std 618 has been used throughout Part III of this specification. Clauses (paragraphs) in API Std 618 which are not mentioned remain unaltered. Where cross-references are made, the number of the section/subsection/ clause of this specification referred to is shown in brackets.

A bullet (•) in the margin before certain clauses (paragraphs) in API Std 618 indicates that alternative requirements are possible and a decision by the principal is required. These decisions shall be indicated directly on the relevant data/requisition sheet if 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 specifies the technical requirements. The principal may also include an agent or consultant, authorized to act for the principal.

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 reciprocating compressor, its auxiliaries and, if applicable, all associated equipment 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 618

SECTION 1 GENERAL

1.1 SCOPE

Delete this clause and replace by:

This specification covers the minimum requirements for reciprocating compressors and their drivers handling air or gas with either lubricated or nonlubricated cylinders.

Included are related lubricating systems, controls, instrumentation, intercoolers, aftercoolers, pulsation suppression devices and all other auxiliary equipment.

1.3 CONFLICTING REQUIREMENTS

Delete this clause and replace by:

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

= first priority : purchase order (including attachments) and variations thereon.

= second priority : data/requisition sheets and drawings.

= third priority : this specification.

1.4 DEFINITIONS OF TERMS

1.4.4 and 1.4.5 Delete these clauses.

Add the following new clauses:

1.4.19 HAZARDOUS SERVICE for compressors, auxiliaries and package equipment is defined as a service for process streams containing one or more of the following substances:

= 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.), and in case of doubt the principal shall be consulted.

= hydrogen plus hydrocarbons, if the partial pressure of hydrogen is in excess of 0.7 MPa. (7 bar).

1.4.20 VARIABLE SPEED DRIVE SYSTEM (VSDS) for a compressor is defined as a variable speed Electric Motor drive, coupled either direct or via a gear unit to the compressor.

These drivers shall comply with DDD 33.66.05.33-Gen.: "Electrical Variable Speed Drive Systems".

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 additional to those listed in this clause and referred to in this specification are listed in Part IV.

1.5.2 Delete this clause and refer to Part I of this specification.

SECTION 2 BASIC DESIGN

2.1 GENERAL

2.1.1 Add to this clause:

Compressor ratings shall not exceed the limits of the manufacturer's design and shall be well within the manufacturer's actual experience. Only equipment which has proven its reliability in similar service is acceptable. A reference of at least 3 units of the same type and size and with an accumulated experience of 24,000 hours of operation each is required.

2.1.2 Delete this clause and replace by:

2.1.2 NOISE

2.1.2.1 General

EEMUA specification No. 140: "Noise, Procedure specification" (formerly OCMA specification NWG-1) shall be adhered to with regard to definitions, notations, measuring equipment, measuring procedures, test reporting, calculation methods and calculation procedures.

2.1.2.2 Noise limits

Applicable noise limits shall be indicated in the Equipment Noise Limitation sheet, DEP 31.10.00.94-Gen. which shall form part of the requisition. The requirements apply in the absence of reverberation and background noise from other sources, and for all operating conditions for which the equipment may normally be expected to be used.

2.1.2.3 Noise abatement

Excessive equipment noise should preferably be eliminated by low noise design. Where other noise control measures, such as acoustic insulation or acoustic enclosures, are required, they shall not in any case obstruct operational or routine maintenance activities. Where noise hoods are proposed, prior approval of the principal shall be obtained regarding construction, materials and safety requirements.

2.1.2.4 Information to be submitted with the tender

The supplier shall submit the guaranteed sound power levels and/or sound pressure levels of the equipment, together with any other relevant information as requested in the equipment noise limitation sheet, DEP 31.10.00.94-Gen.

2.1.3 Delete the first sentence of this clause and replace by:

Unless otherwise specified in the data/requisition sheets, liquid cooling systems for lube oil, cylinders and piston rod packing shall be designed for the following conditions on the coolant side:

Change in the clause:

Fouling factor on the coolant side: 0.25 m^2.K/kW.

2.1.5 Delete this clause and replace by:

All equipment shall be designed to run safely to the relief valve setting including accumulation. See also 3.6.4.4

2.1.7 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.

2.1.10 Replace the last sentence of this clause by:

The combined performance of the machine and its driver under all operating conditions shall be the responsibility of the vendor. The combined unit (or complete package, if applicable) shall perform substantially as well on its permanent foundation as it did on the manufacturer's test stand.

2.1.11 Add to this clause:

The conditions to be certified shall refer to the limits of the scope of supply of the vendor of the compressor and associated equipment (package).

2.1.12 Delete this clause and replace by:

The capacity at the performance point certified by the manufacturer is to have no negative tolerance. The compressor vendor shall submit the design tolerance between the compressor's rated capacity and the required capacity. (This tolerance should not be more than 3%).

2.1.13 Add to this clause:

NOTE: In accordance with Appendix B this power tolerance refers to the required power at manufacturer's rated capacity.

2.1.15 Add to this clause:

For compressors installed in unheated areas, entirely or partly exposed to the atmosphere, the following minimum requirements shall be provided for:

= dust and air-tight enclosure of the crankcase

= dust-tight distance pieces. When required, vented and purged in accordance with 2.11.8.

= If ambient conditions require winterizing, heating facilities should include crankcase, oil lines, lubricators and cooling water conduits, as necessary.

= complete drainage facilities of all cooling water spaces and lines.

2.1.16 Add to this clause:

The vendor shall use SI units in the data sheets in his proposal, as well as in written guarantees regarding performance of the equipment.

2.1.19 Insert new clause:

The complete compressor unit shall be able to withstand the effects of a fully loaded shutdown of the unit against safety relief valve set pressure.

In case of an electrical motor driver (either fixed or variable speed) the complete unit shall be able to withstand the effects of a 2 phase short circuit.

The complete unit shall be capable for a restart with full opposite residual voltage.

2.2 ALLOWABLE SPEEDS

Add to this clause:

Compressor speeds and corresponding average piston speeds shall be limited to the following maxima:

Installed power	Maximum compressor speed	Maximum average piston speed
25 kW and below	500 rpm	6 m/s
25 - 150 kW	400 rpm	5 m/s
150 kW and above	375 rpm	4 m/s

For special high pressure services, these maximum speeds could be considerably lower, based on the manufacturer's experience.

The average piston speed in compressors handling saturated hydrocarbon gases and in non-lubricated compressor cylinders shall not exceed 3.5 m/s.

The maximum speed of vertical labyrinth piston-type compressors shall be 400 rpm, irrespective of the installed driver power.

Only for non-critical "oil field" applications in production areas with a maximum discharge pressure of 80 bar (g), and where the drive system would have to include a gear unit in order to adhere to the above-mentioned speed limits, may a "high speed compressor" be applied. The maximum allowable speed of this unit is 1000 rpm with a maximum average piston speed of 4 m/s. The application of a "high speed compressor" is subject to the

explicit approval of the principal.

2.3 ALLOWABLE DISCHARGE TEMPERATURE

2.3.2 Replace the last sentence of this clause by:

The use of synthetic oils is recommended for additional safety; however, the application of these oils shall not be used as a reason to increase the maximum allowable discharge temperature.

Add to the clause:

The high discharge temperature trip signal, which will shut down the unit, shall be set at 20 °C above the maximum operating discharge temperature. Each cylinder shall have its own dedicated temperature measuring point for this purpose, which shall be located as close as possible to the cylinder discharge valves.

2.4 ROD LOADINGS

2.4.1 Delete this clause and replace by:

The actual maximum rod loading shall be calculated taking necessary account of part load operation by considering, for each stage of compression, the relevant relief valve set pressure. Minimum specified suction pressure shall be considered. The rod load so assessed shall not exceed 85% of the manufacturer's maximum allowable continuous rod load for the compressor. In the proposal the basis for the manufacturer's figure shall be provided, including details of related critical stress areas. (See for relief valve set pressures: 3.6.4.4).

2.4.2 Replace the second sentence of this clause by:

The duration of reversal shall be at least 20 crankshaft degrees and the magnitude of the peak combined reverse load shall be at least 5% of the actual peak combined load in the opposite direction. The manufacturer shall provide the purchaser with instructions regarding the restrictions in operational conditions due to above limits. This shall be presented in the form of a graph (per stage), which shows the minimum required discharge pressure as a function of the suction pressure (from 0 to max. specified suction pressure).

2.5 CRITICAL SPEEDS

2.5.2 Replace the first sentence of this clause by:

For compressor units involving either a VSDS or a geared motor driver or turbine driver, the vendor shall perform a torsional analysis of the complete compressor/(gear)/driver system.

Add to the clause:

If these separation margins cannot be met, the vendor shall perform an additional response analysis in order to prove that the stress levels at resonance conditions are within well proven limits of the manufacturer.

Additionally, for compressors with a VSDS or other variable speed driver, the vendor shall perform a response analysis of the rotating system during all possible resonance conditions which may occur during run-up and within the complete operating speed range. All possible excitation frequencies and consequent torques shall be considered.

In every response analysis the resulting stresses in the relevant components shall be calculated using a maximum modal damping of 1%. (Modal damping is defined as the damping ratio between the total combined structural and material damping and the critical damping of the system under consideration).

In strength calculations the manufacturer shall, amongst other things, give due consideration to the combined effect of static, alternating bending and torsional stresses as well as the effect of stress raisers, such as stress concentration factors and notch sensitivities. The manufacturer shall indicate the most highly stressed locations in the system and the safety factor applying at these locations. Safety factors shall be clearly defined.

2.6 COMPRESSOR CYLINDERS

2.6.1 GENERAL

2.6.1.2 Delete this clause and replace by:

Unless otherwise specified in the data/requisition sheet, horizontal cylinders shall be provided, which shall have top suction and bottom discharge.

When vertical cylinders are specifically allowed, these shall be designed such that complete drainage of the cylinder is possible.

2.6.2 CYLINDER APPURTENANCES

2.6.2.1 Add to this clause:

Piston rod run-out shall be measured directly adjacent to the cylinder packing case flange.

2.6.2.2 Delete from the first sentence of this clause:

"Unless otherwise specified,...."

2.6.2.5.4 Add to this clause:

Also adequate clearance shall be provided to permit the use of torque wrenches, including multipliers for torque values over 300 Nm. If hydraulically tensioned studs are provided, the extended threaded stud end shall be protected by a steel cover.

2.6.3 CYLINDER COOLING

2.6.3.4 Add to this clause:

Cooling water jackets of fabricated (welded) construction shall not be used for salt or brackish cooling water.

2.6.3.5 Delete this clause and replace by:

When specified in the data/requisition sheet, a self-contained, closed loop jacket coolant system shall be furnished. It shall meet the requirements of 2.6.3.5.1 through 2.6.3.5.4. The scope of supply shall be in accordance with, but not necessarily limited to, Figure G-1, Plan D, of Appendix G.

The coolant system shall be such that the temperature limits in 2.6.3.5.1 and 2.6.3.5.2 are met under all specified operating conditions, including start-up, shut-down and other transients. Coolant systems shall be designed in accordance with the limits in 2.1.3.

2.6.3.5.4 Add new clause:

Pumps in the cooling system shall be centrifugal type pumps and shall be of the vertical close coupled type, unless other types are approved in the data/requisition sheet. Pumps shall comply with DEP 31.29.02.30-Gen: "Centrifugal Pumps". Pumps shall have nodular cast iron or steel casings. The type of drivers shall be as indicated in the data/requisition sheet. Each pump shall have a suction strainer, which shall be provided with a 40 mesh SWG 32 stainless steel screen. Strainers shall be designed and constructed in accordance with standard drawings S 38.002 and S 38.005.

2.6.4 CYLINDER CONNECTIONS

2.6.4.1 Delete the last sentence of this clause and replace by:

Cap bolts are not allowed.

2.6.4.3 Delete this clause and replace by:

Amended per Circular 20/97

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

2.6.4.4 Delete the last sentence of this clause and replace by:

Threaded connections are not permitted.

2.7 VALVES AND UNLOADERS

2.7.1 Delete this clause and replace by:

Average inlet gas velocity shall be computed for each cylinder end as follows:

$$V = \frac{D}{A}$$

in which: V = average gas velocity in metres per second.
D = cylinder displacement in cubic metres per second
A = product of the actual lift, the valve-opening periphery in square metres and the number of inlet valves per cylinder.

Note: The valve lifts used in above equation shall be shown on the data sheets.
Average gas velocities of each head end and crank end shall be shown on the data sheets.
The manufacturer shall indicate his maximum allowable gas velocity for the proposed design.

2.7.3 Add to this clause:

The design of valves shall aim for maximum valve life by employing, for example, minimum valve lift and rigid plates or discs. If valves are required to operate with different gas compositions, the manufacturer shall clearly state in his proposal for which of the gas compositions the valve design has been optimized and what restrictions are to be applied during operation on other gases.

The final valve selection shall be coordinated between the valve supplier, the compressor manufacturer and the principal.

2.7.4 Add to this clause:

The proposed type and material of gaskets shall be subject to the principal's approval.

2.7.5 Add to this clause:

All valves located at the bottom side of a cylinder shall be provided with an arrangement to retain the complete valve assembly, including cage, in position while the cover plate is removed or installed.

2.7.8 Add to this clause:

Metal valve discs or plates and damper plates shall be fully milled; they shall not be punched.

2.7.10 Delete this clause and replace by:

Cylinder unloading shall be accomplished by either valve depressors or plug-type unloaders. The use of the latter needs the approval of the principal. Valve lifters shall not be used. When valve depressors are specified, all inlet valves of the cylinder ends involved shall be provided with unloaders.

Where plug-type unloaders are used, the number of unloaders is determined by the area per plug opening, the total of which must be equal to or greater than one half of the total free lift area (or at least flow area) of all suction valves on that end.

Unloaders shall be pneumatically operated, unless specifically stated otherwise on the data/requisition sheet. Manual overrides on pneumatically operated unloaders are not permitted. If "air to unload" actuators are specified, unloaders on valve depressors shall be capable of maintaining the suction valve fully depressed without any plate fluttering, while operating on the minimum specified instrument air pressure.

Pneumatically operated unloaders shall be piped by the manufacturer in such a way that incorrect selection between stages and cylinder ends shall not occur. The vendor shall provide the principal with a system of properly sequenced unloader operation. See 3.6.2.

2.7.11 Add to this clause:

If specified on the data/requisition sheet, the unloader stem packing shall be provided with a lantern ring and a purge connection for the injection of a buffer gas. All purge and vent connections shall be piped up to a single purge and vent connection. Unless otherwise specified, all lines to and from unloaders shall be AISI 316 L stainless steel.

2.8 PISTONS, PISTON RODS, AND PISTON RINGS

2.8.1 Replace the 5th sentence of this clause by:

Hydraulic tightening methods are strongly preferred for all piston rod diameters and, if applied, shall be positively locked. Thermal methods are not acceptable.

NOTE: The maximum allowable rod loading used in this clause shall be the manufacturer's maximum rod loading and not the 85% load allowed by (2.4.1) of this specification.

2.8.4 Add to this clause:

The rod finish in the packing area for lubricated and non-lubricated services shall be 0.2 µm Ra for maximum allowable working pressures above 414 bar(g).

Coated rods shall not be furnished unless specifically approved by the principal.

2.8.6 Delete this clause and replace by:

Tailrod constructions are not allowed.

2.8.7 Insert new clause:

Piston diameters larger than 500 mm shall only be furnished with the explicit approval of the principal.

2.9 CRANKSHAFTS, CONNECTING RODS, BEARINGS AND CROSSHEADS

2.9.1 Add to this clause:

Crankshafts shall have integrally forged coupling hubs.

2.9.2 Delete this clause and replace by:

Replaceable precision-bored shell (sleeve) crankpin bearings and main bearings shall be used. Anti-friction bearings are not acceptable. The application of aluminium or aluminium alloys in bearings is not allowed.

2.9.3 Delete this clause.

2.9.4 Delete this clause.

2.9.5 Add to this clause:

Big-end bolts shall be furnished with rolled threads and should be provided with hydraulically tightened nuts.

2.9.6 Add to this clause:

The application of aluminium or aluminium alloys in crosshead shoes is not allowed.

Designs in which the crosshead pin is clamped in the connecting rod or designs using forked connecting rods are not allowed.

2.9.7 Add to this clause:

Crankcase explosion relief valves shall have a minimum throat area of 70 mm^2 for each dm^3 of the gross crankcase contents.

2.10 DISTANCE PIECES

2.10.1 Add to this clause:

Unless stated otherwise in the data/requisition sheet, the following type of distance piece is required:

a) For air or pure nitrogen: Type B

b) For all other gases: Type C

2.10.3 Delete this clause and replace by:

Solid metal distance piece covers shall be provided.

The outer compartment of the distance piece adjacent to the cylinder, the partitions, the covers, the bolting, and the intermediate seal packing shall be designed for a minimum compartment pressure of 3.5 bar(g).

2.11 PACKING CASES AND PRESSURE PACKING

2.11.2 Replace the 1st and 2nd sentence of this clause by:

Packing case flanges shall be of steel and shall be bolted to the cylinder with at least four stud bolts. Cap bolts are not allowed.

Add to the clause:

The construction of the stuffing box/distance piece shall be such that the packing case assembly can be installed as a whole. If this is not possible, the packing case and flange may be separated in sub-assemblies, which shall be provided with separate tie bolts in order to maintain positive alignment during installation in the stuffing box.

Packing cases shall be designed to accommodate piston rod movements.

2.11.3 Add to this clause:

Vent and drain piping and fittings shall be of AISI 316 L stainless steel. Connections shall be minimum 3/4" NPT.

2.11.4.2 Add to this clause:

Cooling passages and their respective sealing between the cups shall be designed such that any entrainment of process gas into the coolant system is positively prevented. The application of lapped metal-to-metal surfaces as sole sealing method is not allowed.
O-ring sealing constructions shall be such that the O-ring is fully confined.

2.11.5 Add to this clause:

Direct cooling of the packing assembly by water is not acceptable. If the packing requires direct cooling, oil shall be used as coolant. If a selfcontained closed loop liquid coolant system is specified on the data/ requisition sheet, the scope of supply shall be in accordance with, but not necessarily limited to, Figure G-5 in Appendix G.

2.11.8 Delete this clause and replace by:

If specified on the data/requisition sheet, one of the following buffer gas and/or venting arrangements is required:

A) The cylinder packing case and the frame/distance piece partition of a type C double distance piece shall be purged with nitrogen. The cylinder packing case vent connection (G) shall be separately connected to the flare or disposal system via a steam traced line. The inboard distance piece compartment shall be plugged, the outboard compartment shall be vented to safe location (connection A). The nitrogen buffer pressure P2 shall be such that the accumulated pressure in the inboard compartment is between 30 and 50 mbar(g). The scope of supply shall be as indicated on Figure G-4 of Appendix G. Side loaded packing rings as indicated in Fig. G-4 shall be subject to the principal's approval with respect to number of rings, construction of the rings and applied side load. In addition the suction valve unloader stem packings of the compressor shall be provided with a nitrogen purge connection and vent piping in accordance with chapter 2.7.11 of this specification.

B) The cylinder packing case purge connection shall be plugged and the vent connection (G) shall be separately connected to the flare or disposal system via a steam traced line. The inboard distance piece compartment of a type C double distance piece compartment shall be plugged and pressurized with nitrogen to a pressure of 30-50 mbar(g). The outboard compartment shall be vented to safe location.

C) The cylinder packing case purge connection shall be plugged. The vent connection shall be separately connected to the flare or disposal system. The inboard compartment shall be vented to atmosphere via a breather. The outboard compartment shall be provided with a vacuum system as laid down in Appendix 1 of this publication. The outlet of the ejector is vented to safe location. The driving medium for the ejector

shall be as indicated on the data/requisition sheet.

D) The cylinder packing case is vented into the (single) distance piece, which is vented to atmosphere. This arrangement is only allowed in air or nitrogen service.

NOTE: For arrangement (A) or (B) the manufacturer shall provide a suitable pressure relieving device, which shall prevent the nitrogen pressure in the compartment from exceeding the maximum allowable compartment working pressure.

2.12 COMPRESSOR FRAME LUBRICATION

2.12.1 Delete this clause and replace by:

The frame lubrication system shall be a pressurized system. The crankcase oil sump temperature shall not exceed 70 °C. Cooling coils shall not be used in crankcases or oil reservoirs.

2.12.3 Delete this clause and replace by:

Forced lubrication systems shall consist of a separate oil pump with a suction strainer, a supply and return system (see par. 3.7.2 of API 618), a twin full-flow oil filter, a single oil cooler installed upstream of the oil filter and other necessary appurtenances.

2.12.3.1 Delete this clause and replace by:

Shaft-driven lube oil pumps are not permitted, unless explicitly approved by the principal.

The pump shall be a rotary internal screw- or gear-type pump and shall be driven by a separate electric motor. The electric motor driver shall be suitable for the area classification concerned and shall comply with DEP 33.66.05.31-Gen.
The pump shall be provided with a pressure relief valve not integral with the pump. The relief valve discharge line shall be provided with a sight glass.
Pumps, filters, valves and coolers shall be of low-carbon (not exceeding 0.23% carbon) steel, unless otherwise specified.

2.12.3.2 Delete this clause and replace by:

The compressor manufacturer shall state in his proposal whether the offered compressor can run down safely without mechanical damage in case of a lube oil pump failure. If not, alternative lubrication proposals are required.

2.12.3.3 Replace the last sentence of this clause by:

Relief valve materials shall be as required in (3.6.4.4.1).

2.12.4 Change in this clause:

The minimum tube wall thickness shall be 16 BWG (1.65 mm).

Replace the last two sentences of this clause by:

The vendor shall design the lubrication oil system such that the oil pressure at cooler outlet will be at least 1 bar higher than the maximum water pressure stated in the data/requisition sheet in order to prevent oil contamination in case of cooler failure.
The oil cooler shall be sized for the total cooling load taking into account the fouling factor specified in the data/requisition sheet. Coolers shall be equipped with vent and drain connections on the oil and water sides. Complete details of any proposed aircooled type cooler shall be included in the proposal.
Unless otherwise specified, the materials for shell-and-tube coolers shall be as follows:

a) for fresh treated water:

- the manufacturer's standard materials.

b) for brackish and salt water:

- shell : ASTM A 285 Grade C[1]) or ASTM A 106 Grade A[1]) or B[1]), or, alternatively, ASTM B 171 alloy C 63000.
- channel)
- flanges) : ASTM B 584 alloy C 90500 or B 148 alloy C 95800
- nozzles)

- tubes : BS 2871: Part 3: CZ 110, ASTM B 111 alloy C 68700, or DIN 1785 Cu Zn 20A1.
- fixed tube sheets : ASTM A 105[2]) with a layer of copper alloy to ASTM B 171 alloy C 63000 welded on to the water side.

1) C max. 0.23%

2) C max. 0.25% and normalized

2.12.6 Replace in the first sentence of this clause "When specified" by:

"If the specified minimum ambient temperature is lower than the minimum lube oil temperature required by the manufacturer for starting,...."

2.13 CYLINDER AND PACKING LUBRICATION

2.13.1 Add to this clause:

Unless otherwise specified, cylinder lubricators shall be driven by a separate electric motor. Lubricator reservoirs shall be equipped with a low level alarm.

Each compressor cylinder shall have a minimum of two lubricating points. Piston rod packing of cylinders with a rated discharge pressure of 100 bar(g) or more shall have a minimum of two lubricating points. Piston rod packing of cylinders with a rated discharge pressure above 250 bar(g). shall have a minimum of three lubricating points. Lubricating points shall be made on the upper side of the piston rod.

2.14 MATERIALS

2.14.1 GENERAL

2.14.1.1 Delete this clause and replace by:

The materials of construction shall be as specified on the data/ requisition sheet. The manufacturer may suggest alternative materials if, based on his experience, these would be a better solution.

2.14.1.5 Delete this clause and replace by:

All used materials shall be suitable for the (range of) process conditions and ambient conditions specified in the data/requisition sheet.

2.14.1.9 Delete this clause and refer to (2.14.1.1).

2.14.1.11 Add to this clause:

Gray cast iron shall not be used for compressor cylinders. Above 70 bar(g) cylinder relief valve pressure, nodular cast iron (also known as ductile iron) shall not be used. Cylinder liners shall be of Ni-resist ductile iron castings.

2.14.1.15 Delete this clause and replace by:

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

2.14.4 MATERIAL INSPECTION

Amended per Circular 15/91

2.14.4.2 Add to this clause:

Critical sections of cylinder castings shall be fully radiographed in accordance with ASME VIII, Division 1, Appendix 7. Where such sections cannot be radiographed, ultrasonic examination shall be substituted (also in accordance with ASME VIII, Division 1, App. 7).

The Manufacturer shall submit, for Purchacer's approval, details of the critical sections proposed to be radiographed/ultrasonically examined.

2.14.4.4 Insert "new" clause:

All casting and forging surfaces shall be examined visually by the manufacturer and shall meet the visual acceptance standards specified in MSS SP-55.

Following visual inspection, magnetic particle inspection in accordance with ASTM E 709 shall be carried out on all surfaces after final machining.

Dye-penetrant inspection shall be used only when magnetic particle inspection is not feasible. The 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 of 2.14.4.3.

2.15 NAMEPLATES AND ROTATION ARROWS

2.15.3 Add to this clause:

Unless otherwise specified, the text on the nameplates shall be in the English language. The information on the nameplates shall include the year of manufacture.
All data shall be in SI units.

SECTION 3 ACCESSORIES

3.1 DRIVERS

3.1.1 GENERAL

3.1.1.1 Replace the first sentence of this clause by:

The type of driver and drive system shall be as specified in the data/ requisition sheet.

Add to the clause:

The full flow relief condition at the discharge, see (3.6.4.4) of this specification, and normal conditions at the suction shall be taken into account when sizing the driver.

3.1.2 MOTOR DRIVERS

3.1.2.2 Delete this clause and replace by:

Electric motors for main drives as well as auxiliary drives shall be as specified in the data/requisition sheet DEP 33.66.05.93-Gen. and shall also comply with DEP 33.66.05.31-Gen.

Electric motor drivers for compressors over 150 kW shall be direct drive single bearing type, unless otherwise specified in the data/requisition sheets.

VSDS drivers shall comply with DDD 33.66.05.33-Gen.

3.1.2.3 Add to this clause:

For the required accelerating torque, see DEP 33.66.05.31-Gen.

3.1.2.4 Delete this clause.

3.1.2.5 Delete this clause and replace by:

The inertia of the rotating parts of the combined motor-compressor installation shall be such that the speed irregularity is less than 1.5% of rated speed at the most adverse cylinder loading combination. If the compressor is driven by a variable speed driver, this speed irregularity shall be less than 1.5% of operating speed throughout the speed range.

3.1.2.7 Delete this clause and replace by:

If the compressor is direct driven by a single bearing electric motor, the motor shall have the coupling hub integral with the shaft.

3.1.3 TURBINE DRIVERS

3.1.3.1 Add to this clause:

while operating under specified steam conditions.

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.

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 deviations between the above specification and the gas turbine proposed by the vendor shall be itemized in a separate section of the proposal.

3.1.4 INTERNAL COMBUSTION - SPARK IGNITED ENGINE DRIVERS

3.1.4.1 The type of engine drive (integral or separate) and the composition of the fuel to be used shall be as specified in the data/requisition sheet. The engine shall be sized to deliver continuously the rated compressor power plus any transmission losses.

The vendor shall state in his proposal the derating factors used. Engine ratings shall be based upon specified site ambient conditions as well as the given fuel gas composition. The vendor shall indicate the estimated octane number of the specified fuel gas as well as the

minimum acceptable octane number for the proposed engine type and rating.

3.1.4.2 Internal combustion spark-ignited engine drivers ("gas engines") shall comply with the requirements of DDD 31.29.90.30-Gen.

3.2 COUPLING AND GUARDS

3.2.2 GUARDS

3.2.2.1 Add to this clause:

Guards shall be made of one of the following spark-resisting materials or as specified on the data/requisition sheets:

1) Commercially pure aluminium
2) Aluminium alloys with a maximum content of 2% magnesium or 0.2% copper.
3) Copper or copper based alloys (e.g. brass, bronze)

3.5 SOLEPLATES, RAILS AND BASEPLATES

3.5.2 Delete from the last sentence of this clause:

"When specified,"

3.5.8 Add to this clause:

The design and method of installation in the foundation will be subject to the vendor's approval.

3.6 CONTROLS AND INSTRUMENTATION

3.6.1 GENERAL

3.6.1.1 Delete this clause and replace by:

If specified on the data/requisition sheet, the vendor shall provide for a compressor control system. The controls and instrumentation shall be adequate for controlling the compressor safely and efficiently at the operating conditions specified in data/requisition sheet DEP 31.29.43.93-Gen.

3.6.1.3 Delete this clause and replace by:

All instrumentation shall be as specified in data/requisition sheet DEP 31.29.43.93-Gen. and shall conform to DEP 32.31.09.31-Gen.

3.6.1.8 Delete from this clause:

...."other than shutdown sensing devices".....

3.6.1.9 Add the following new clause:

Each piston rod of a horizontal compressor shall be provided with a non-contacting probe for rod run-out measurement. The probe shall be located in the outer distance piece on the packing case flange and shall be wired to an outside junction box, where the proximitor is located. The junction box shall provide plug type connections for portable read-out equipment.

3.6.2 CONTROL SYSTEMS

3.6.2.4 Add to this clause:

Stepless capacity control by means of "Reverse flow regulation" on suction valve depressors is subject to the explicit approval of the Principal.

3.6.2.6 Delete this clause and replace by:

Variable type clearance pockets are not allowed for capacity control.

3.6.3 INSTRUMENT AND CONTROL PANELS

Delete this clause

3.6.4 INSTRUMENTATION

3.6.4.1 TACHOMETERS : Delete this clause

3.6.4.2 TEMPERATURE MEASUREMENT : Delete this clause

3.6.4.3 PRESSURE MEASUREMENT : Delete this clause

3.6.4.4 RELIEF VALVES

3.6.4.4.1 Add to this clause:

Brass or cast iron safety/relief valves and fittings are not allowed. All safety/relief valves shall have inlet and outlet connections flanged. The minimum flange rating shall be ANSI Class 300 RF unless the service requires a higher rating or different type of flange facing. Safety/relief valves shall also comply with any other national and/or local regulations.

3.6.4.4.2 Delete this clause and replace by:

Safety/relief valves shall not operate above the maximum allowable working pressure and shall be set as a minimum above maximum operating pressure (including peak of pulsation pressure) as follows:

Max. operating pressure (bar(g))	Safety/relief valve setting (bar(g))
0 - 10	M.O.P. + 1 bar
above 10	M.O.P. + 10%

3.6.5 ALARMS AND SHUTDOWNS

3.6.5.1 Add to this clause:

Direct switches in alarm and shutdowns are not allowed. A combination of signal transmitter with switch and/or trip amplifier shall always be used.

3.6.5.5 Delete from the 3rd sentence in this clause:

"(see Figure E-1 in Appendix E)"
Delete the 5th and 6th sentence of this clause.

3.6.5.6 Delete this clause and replace by:

Power supply for alarm, shutdown and control systems shall be in as specified by the principal and comply with DEP 32.31.09.31-Gen. Safeguarding systems shall be designed and constructed entirely independent of control systems.

3.6.5.8 Delete this clause and replace by:

Alarm and shutdown devices shall be energized at normal operating conditions of the system and be installed such that device failure, power supply failure, wire breakage etc. will cause alarm and/or shutdown.

3.6.6 ELECTRICAL SYSTEMS

3.6.6.1 Delete the second sentence of this clause and replace by:

Instrumentation and its installation shall comply with the requirements of DEP 32.31.09.31-Gen.

3.6.6.6 Delete this clause and replace by:

Electrical installation and wiring shall comply with the specifications in the data/requisition sheets.

Instrumentation installation and wiring shall comply with

DEP 32.31.09.31-Gen. and with the requirements in the data/requisition sheets.

3.6.6.7 Delete this clause.

3.7 PIPING AND APPURTENANCES

3.7.1 GENERAL

3.7.1.4 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 26/92

= DEP 31.38.01.11-Gen. Piping - general requirements

= DEP 31.38.01.12-Gen. Piping classes

= DEP 31.38.01.31-Gen. Shop fabrication of steel piping

3.7.1.5 Delete from the beginning of this clause:

"When specified,".....

3.7.1.9 Add to this clause:

Threaded connections are not allowed, except in the following cases:

= Cooling water piping (not cooling oil for packing cooling).

= Connections to the distance piece compartments for cooling, lubrication and venting purposes.

= Cylinder and packing lubrication connections

Seal welding of threaded connections is not allowed. If welded connections are required, only full penetration butt welded connections are permitted.

3.7.1.10 Add to this clause:

Suction and discharge flanges shall be designed to withstand the maximum allowable working pressure of the cylinder. Flange facings shall be as specified in the data/requisition sheet (for description of flange facings, see 2.6.4.3 of this specification)

3.7.1.11 Delete this clause.

3.7.1.14 Add to this clause:

Cast iron and malleable iron pipe, fittings, valves, strainers and/or other components shall not be used.

3.7.1.16 Add to this clause:

The application of hydraulic fastening tools, or similar, shall be possible for
= Class 1500 flanges of DN 150 (6") and larger.

= Class 2500 flanges of DN 100 (4") and larger.

3.7.2 FRAME LUBRICATING OIL PIPING REQUIREMENTS

3.7.2.2 Replace the first sentence of this clause by:

All lubricating oil lines shall be made of AISI 316L stainless steel and shall have flanged connections.

3.7.4 COOLANT PIPING REQUIREMENTS

3.7.4.6 Add to this clause:

For self-contained rod packing cooling systems (see 2.11.5) the following is required:

= All connections shall be flanged and/or welded.

= All lines shall be of AISI 316 L.

3.7.5 INSTRUMENT PIPING CONNECTIONS

3.7.5.1 Add to this clause:

Amended per

Circular 24/99

Connections for instruments shall comply with DEP 32.31.00.32-Gen. and DEP 32.37.10.11-Gen.

3.7.5.2 Delete this clause.

3.7.5.3 Delete this clause.

3.8 INTERCOOLERS AND AFTERCOOLERS

3.8.1 Delete this clause and replace by:

Water-cooled intercoolers and aftercoolers shall be designed and constructed in accordance with the codes specified in the data/ requisition sheet.

3.8.3 Add to this clause:

Rupture discs on the shell side to protect the shell in the case of tube failures are not allowed.

3.8.4 Delete this clause and replace by:

Coolers shall not be installed on top of the compressor.

3.8.7 Delete this clause and replace by:

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

3.8.8 Delete this clause.

3.9 PULSATION AND VIBRATION CONTROL REQUIREMENTS

3.9.1 GENERAL

Add to this clause:

The manufacturer shall provide pulsation suppression devices at the suction and discharge side of each cylinder. Cylinders operating in parallel may be connected to a common suction and a common discharge pulsation suppression device.

Volume bottles (defined as vessels without any internals, with a diameter of at least twice the line connection diameter, and having an internal volume of at least 12 times the piston displacement per revolution of all connected cylinders) shall be used as pulsation suppression devices.

The application of pulsation filters and attenuators, including proprietary commercial designs based on acoustical suppression techniques, choke tubes and orifices is subject to the explicit approval of the principal.

The use of intercoolers and/or aftercoolers as pulsation suppression device is not permitted.

3.9.2.1 Add to this clause:

Unless specifically stated otherwise, only Approach 1 or 3 are to be used.

Amended per Circular 15/91

3.9.2.4.1 Replace the Table in this clause by:

Number of Stages	Single Cylinder	Two Cylinders	Three or More Cylinders
One	1	1	3
Two or more	-	3	3

Amended per Circular 15/91

3.9.2.4.2 Replace the Table in this clause by:

Number of Stages	Single Cylinder	Two Cylinders	Three or More Cylinders
One	3	3	3
Two or more	-	3	3

3.9.2.6 Add to this clause:

If the results of an acoustical analysis and/or the results of a mechanical response analysis are such, that modifications to the piping and/or pulsation suppression devices are necessary, the following descending order of priority shall be used by the manufacturer in making proposals for modifications:

1) Increase of volume bottle and/or pipe volume.

2) The application of orifices. The restriction orifice plates shall be tagged as instrument flow orifice plates.

3) The application of other types of pulsation suppression devices.

Each modification is subject to the principal's approval.

3.9.3 PULSATION SUPPRESSION DEVICES

3.9.3.1 Delete this clause and replace by:

Pulsation damping equipment shall be designed and constructed in accordance with the codes specified in the data/requisition sheet, see also 2.14.1.15 of this specification.

3.9.3.9 Add to this clause:

The suction and discharge piping connections of cylindrical volume bottles shall be located at the longitudinal centre or at the end of the volume bottle in such a way that optimal symmetry is obtained to eliminate free gas forces.

3.9.3.10 Add to this clause:

Inlet and outlet nozzles of suction pulsation suppressing equipment shall be flush with the inner wall and arranged such that no liquid can accumulate inside the vessel, thus preventing liquid slugs entering the compressor. Volume bottles shall not be provided with instrument connections.

3.9.3.14 Delete this clause and replace by:

All connections to a pulsation suppressor shall be butt welded flanged connections.

3.9.3.15 Delete this clause and replace by:

Flanges shall be in accordance with ANSI B 16.5, except that lap-joint flanges shall not be used. Flange facings shall be in accordance with 2.6.4.3 of this specification.

SECTION 4 INSPECTION, TESTING, AND PREPARATION FOR SHIPMENT

4.1 GENERAL

4.1.5 Add the following new clause:

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

The requirements for material certificates giving the chemical composition and the mechanical properties 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.

4.1.5.1 The following types of certificates shall be used by the manufacturer to verify that the requirements of the specification and contract are met.

TYPE A

Certificates by which the manufacturer confirms that the supplied product 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 manufacturer method as the delivery concerned.

TYPE B

Certificates by which the manufacturer's inspector confirms that the supplied product 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 an independent testing centre which shall not form part of the production department in the manufacturing works. It shall report directly to the management of the company. It shall have the necessary facilities at its disposal.

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. Type C certificates shall only be valid when stamped and signed by this independent inspector.

4.1.5.2 All certificates shall contain the following information as a minimum:

- name of purchaser
- 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 approved
- material charge number, batch number or heat lot number
- mechanical properties recorded from test results
- chemical composition recorded from results of chemical analysis
- NDT methods and results, when and where applicable
- heat treatment procedures, furnace charge number and heat treatment records, where applicable
- any supplementary or additional information as may be required

4.1.5.3 As a minimum, material certificates in accordance with Type A are required for pressure-containing parts in non-hazardous and non-hydrocarbon services, for non-ferrous materials in non-hazardous and non-hydrocarbon services, and for crankcases.

4.1.5.4 As a minimum, Material certificates in accordance with Type B are required for pressure-containing parts in hydrocarbon services and for crankshafts, connecting rods, crossheads, piston rods, cylinder liners, and main bolts and nuts.

4.1.5.6 If specified on the data/requistion sheet, Type C material certificates are required for the parts indicated under 4.1.5.4.

4.1.6 MARKING

4.1.6.1 Marking is required for components parts certified under a Type B or C certificate (see 4.1.5.4)

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 attack or harmfully affect the material.

4.1.6.2 The stamping/marking shall include:

- manufacturer's symbol; the stamp shall be identical to the symbol on the 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 identification stamp or mark shall be identical to the stamp/mark on the certificate.

NOTE: Where the size of the part does not permit complete marking, the identification marks may be omitted or another form of identification may be used with the prior agreement of the principal.

4.3 TESTING

4.3.1 HYDROSTATIC AND PRESSURE TESTS

4.3.1.2 Add to this clause:

Air may be used instead of helium in the leakage test. The minimum required test pressure for the leakage test is 7 bar(g).

4.3.2 MECHANICAL RUNNING TESTS

4.3.2.1 Add to this clause:

A mechanical running test shall be carried out with at least one suction valve assembly and one discharge valve assembly removed from each cylinder side.

The compressor shall be run at rated speed for at least four hours. After completion of this run, the temperature of the main bearings, crank bearings and crosshead bearings shall be checked. This temperature shall not exceed 70 °C. Furthermore the compressor shall be dismantled for inspection as specified below:

To be dismantled for inspection				
Number of throws of compressor	Piston and piston rod	Main bearing	Crank pin bearing	Crosshead
1 or 2	1	1	1	1
3 or more	2	2	2	2

Inspection shall be carried out as follows:

- internal surface of cylinder liners to be checked for roundness, required surface finish and material imperfections
- piston rings and rider rings to be checked for gap clearance, groove clearance and bearing surface
- piston rod to be checked on packing area surface and run-out, which shall be in accordance with the limits of (2.6.2.1)
- all valve assemblies to be checked for correct lifting height of valve plates and leakage (leakage test of valves to be done either with air or with low viscosity solvent; water is not allowed)
- main bearings, crank bearings and crosshead to be checked for correct bonding of babbit material to the base metal and for correct bearing surface
- crankshaft journal, crank pin and crosshead pin to be checked for the bearing contact area
- crankcase to be internally inspected to check:
  - locking device of all bearing bolt nuts
  - correct fitting of lubricating oil piping to main bearings
    correct securing of lubricating oil piping in the crankcase

4.3.3 OTHER TESTS

Add the following NEW clauses:

4.3.3.3 When specified, the compressor shall be performance-tested in accordance with ISO 1217.

4.3.3.4 "Packaged unit test":

When specified, such components as gears, the driver and all auxiliaries that make up the complete compressor unit shall be tested together with the compressor during the mechanical running test. This will include, but not necessarily be limited to, coolers, vessels, piping, all instrumentation and all electrical equipment in the scope of supply of the vendor.

Details of the extent and the procedure of the test shall be included in the proposal. The final version of the test procedure shall be subject to the principal's approval.

4.4 PREPARATION FOR SHIPMENT

4.4.1 Add to this clause:

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

SECTION 5 VENDOR'S DATA

5.1 PROPOSALS

Add to this clause under b):

The relevant data/requisition sheet(s) and API data sheets (SI units) shall be completed to the furthest extent possible.

5.2 CONTRACT DATA

5.2.1.1 Add to this clause:

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

5.2.2.2 Delete in the 2nd and 3rd sentence: "When specified,"...

APPENDIX D REPAIRS TO GRAY AND NODULAR IRON CASTINGS

Delete this appendix and replace by:

Any repair and/or repair method is subject to the explicit approval of the principal.

APPENDIX G FIGURES AND SCHEMATICS

Add to Figure G-4:

Notes: 6) The packing flare connection line between connection G and the liquid collection pot in "type B" and "type C" arrangements shall be provided with a pressure and a temperature indicator, which shall be located as close as practical to the distance piece connection G.

APPENDIX H MATERIAL SPECIFICATIONS FOR MAJOR COMPONENT PARTS

Delete from Table H-1 the following:

- Cylinders gray iron
- Compressor cylinder heads gray iron
- Valve seats and guards cast iron
- Packing cases cast iron

Add to the Appendix:

For reference the following materials are listed with their respective ASTM and DIN specifications. If used, materials shall be in accordance with these specifications or with similar internationally accepted specifications.

Material	ASTM	DIN
Nodular cast iron	- A 395	- 1694: GGG 40
Ni-resist ductile iron	- A 439-D2	- 1694: GGG NiCr20 2
Cast steel	- A 216 WCA or WCC	- 17245: GS-C25

PART IV. REFERENCES

Amended per Circular 20/97

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.

DEPs

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 26/92

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.
Centrifugal pumps (Amendments/supplements to API Std 610)	DEP 31.29.02.30-Gen.
Data/requisition sheet for reciprocating compressors	DEP 31.29.43.93-Gen.
General-purpose steam turbines	DEP 31.29.60.30-Gen.
Special-purpose steam turbines	DEP 31.29.60.31-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.
Internal combustion spark ignited engines (In preparation)	DDD 31.29.90.30-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 24/99

Instruments for measurement and control	DEP 32.31.00.32-Gen.
Instrumentation for equipment packages	DEP 32.31.09.31-Gen.
Instrument impulse lines	DEP 32.37.10.11-Gen.
Electric motors	DEP 33.66.05.31-Gen.

Electrical variable speed drive systems	DDD 33.66.05.33-Gen.
Requisition sheet for electric motors	DEP 33.66.05.93-Gen.

STANDARD DRAWINGS

Y-type pump suction strainers	S 38.002
Sieve for Y-type pump suction strainers	S 38.005

AMERICAN STANDARDS

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.

Forgings, Carbon Steel, for Piping Components	ASTM A 105
Pressure Vessel Plates, Carbon Steel Low- and Intermediate-Tensile Strength	ASTM A 285
Ultrasonic Examination of Carbon and Low-Alloy Steel Castings	ASTM A 609
Copper and Copper-Alloy Seamless Condenser Tubes and Ferrule Stock	ASTM B 111
Aluminium Bronze Sand Castings	ASTM B 148
Copper-Alloy Condenser Tube Plates	ASTM B 171
Copper-Alloy Sand Castings for General Applications	ASTM B 584
Radiographic Testing	ASTM E 94
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

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

Standards, codes and specifications	TEMA C

Issued by
Tubular Exchange Manufacturers Association Inc.
53 Park Place,

New York, NY 10007, USA

BRITISH STANDARDS

Copper and copper alloys. Tubes	BS 2871: Part 3 Tubes for heat exchangers
Endless wedge belt drives and endless V-belt drives	BS 3790

Issued by
British Standards Institution,
2 Park Street, London, W1A2BS,
England

Engineering equipment and materials users association	
Noise Procedure Specification	EEMUA publication No. 140

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England

GERMAN STANDARD

Rohre aus Kupfer und Kupfer-Knetlegierungen fur Kondensatoren und Wärmeüberträger (Copper and copper alloy tubes for condensers and heat exchangers)	DIN 1785

Issued by
Beuth Verlag GmbH,
Burggrafenstrasse 4 10,
D 1000 Berlin 30,
W. Germany

INTERNATIONAL STANDARD

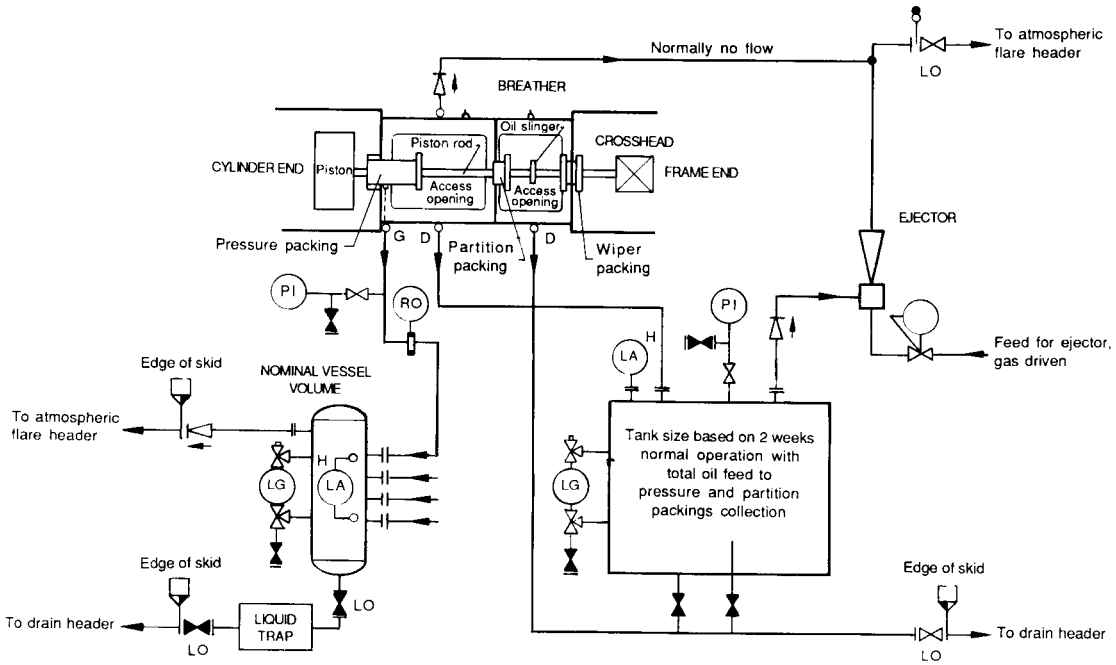
Displacement compressors -Acceptance tests	ISO 1217

Issued by
Central Secretariat of ISO,
1, rue de Varembé,
1211 Geneva 20, Switzerland

Copies can be obtained through the national standards organizations

PART V. APPENDIX

APPENDIX 1 DISTANCE PIECE VENTING AND DRAINING, ARRANGEMENT C



Note : Instrumentation as indicated shall be subject to approval by the principal.