

TECHNICAL SPECIFICATION

SPECIAL PURPOSE GEAR UNITS FOR PETROLEUM, CHEMICAL AND GAS INDUSTRY SERVICES (AMENDMENTS/SUPPLEMENTS TO API STD 613)

DEP 31.29.00.32-Gen.

December 1995

(DEP Circulars 23/97 and 22/99 have been incorporated)

DESIGN AND ENGINEERING PRACTICE



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NOTE: In addition to DEP publications there are Standard Specifications and Draft DEPs for Development (DDD's). DDD's 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 DDD's. Standard Specifications and DDD's will gradually be replaced by DEPs.

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PART I INTRODUCTION

1.1 SCOPE

This is a new DEP which specifies requirements and gives recommendations for special-purpose gear units for petroleum, chemical and gas industry services.

This DEP is based on API Std 613, fourth edition, June 1995. Part III of this specification amends, supplements and deletes various clauses of API Std 613.

1.2 DISTRIBUTION, INTENDED USE AND REGULATORY CONSIDERATIONS

Unless otherwise authorised by SIOP and SIEP, the distribution of this DEP is confined to companies forming part of the Royal Dutch/Shell Group or managed by a Group company, and to Contractors and Vendors/Manufacturers nominated by them (i.e. the distribution code is "F", as defined in DEP 00.00.05.05-Gen.).

This DEP is intended for use in oil refineries, chemical plants, gas plants, oil and gas production facilities, and supply/marketing installations.

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

1.3 DEFINITIONS

The **Contractor** is the party which carries out all or part of the design, engineering, procurement, installation, and commissioning or management of a project or operation of a facility. The Principal may sometimes undertake all or part of the duties of the Contractor.

The **Vendor** is the party which manufactures or supplies the gear unit to perform the duties specified by the Contractor and the Main Manufacturer.

The **Main Manufacturer** is the party who has the coordinating responsibility with the Vendor and the vendors of the various components for the sound engineering of the complete train.

The **Principal** is the party which initiates the project and ultimately pays for its design and construction. The Principal will generally specify the technical requirements. The Principal may also include an agent or consultant, authorised to act for the Principal.

The word **shall** indicates a requirement.

The word **should** indicates a recommendation.

1.4 CROSS-REFERENCES

Where cross-references are made, the number of the section or sub-section referred to is shown in brackets.

All publications referred to in this DEP are listed in (Part IV).

PART II GENERAL INFORMATION

Part III of this DEP gives amendments and supplements to API Std 613, fourth Edition, June 1995.

For ease of reference, the clause numbering of API Std 613 has been used throughout Part III of this specification.

Clauses in API Std 613 which are not mentioned shall remain valid as written.

A bullet (·) in the margin against certain clauses (paragraphs) in API Std 613 indicates that a decision is required by the Contractor and/or the Principal. 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.

PART III AMENDMENTS/SUPPLEMENTS TO API STD 613

SECTION 1 GENERAL

1.1 SCOPE

1.1.1 Modify the first sentence of this clause as follows:

Replace "refinery services" with "petroleum, chemical and gas industry services".

1.1.3 Add new clause:

Up to a gear ratio of 1:9, one-stage speed increasers or reducers shall be used; for higher gear ratios the use of two-stage speed or epicyclic gear increasers may be considered but shall be approved by the Principal.

1.1.4 Add new clause:

In mutual agreement between the Contractor, the Principal and the Main Manufacturer it shall be decided whether a single-or double-helical gear shall be applied for critical services. Where large cyclic torque variations are envisaged (such as with reciprocating compressors) gears should be double helical.

In offshore applications the selection of a double helical gear shall have preference in view of smaller "footprint" and lighter weight.

The gear selection for a power recovery train or for any other configuration where load reversals can occur requires the approval of the Principal as load reversals can occur for extended periods.

1.1.5 Add new clause:

Unless otherwise specified, the Vendor shall supply the gear unit to the Main Manufacturer for mounting the equipment on a common base plate. The Vendor shall supply all relevant information, including dynamic analysis, performance, dimensions and noise emission to the Main Manufacturer such that a fully integrated unit results.

1.1.6 Add new clause:

Special-purpose gear units shall be supplied by Vendors qualified by experience in manufacturing gear units with closely similar duties to those being proposed.

To qualify, the Vendor shall have manufactured at least two gear units of comparable power rating, pinion speed and pitch line velocity. These gears shall have acquired at least 16 000 hrs of trouble-free operation.

1.1.7 Add new clause:

The Vendor and his sub-suppliers shall have an implemented and effective quality system. This should comply with ISO 9001 requirements or an equivalent internationally recognised quality system that is acceptable to the Principal.

1.2 ALTERNATIVE DESIGNS

The Vendor's primary quotation shall be in accordance with this DEP. Alternative quotations may be submitted if they offer significant price, delivery, or technical advantage. Alternative proposals must be clearly defined as such.

1.3 CONFLICTING REQUIREMENTS

Replace this clause by:

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

upper level : purchase order and variations thereto;
second level : data/requisition sheets and drawings;
third level : this DEP.

1.5 REFERENCED PUBLICATIONS

1.5.1 Add to this clause:

All publications referenced by this DEP are listed in Part IV.

SECTION 2 BASIC DESIGN

2.1 GENERAL

2.1.2 Modify the first sentence of this clause as follows:

Replace "at least 3 years of uninterrupted operation" by "at least 4 years' of uninterrupted operation".

Add to this clause:

Units should be capable of completing 10 complete start cycles per year in the uninterrupted operation period without any adverse effect.

2.1.4 Replace this clause by:

The Contractor shall comply with DEP 31.10.00.31-Gen. and thereby communicate to the Main Manufacturer the specified noise limitations by using data sheets DEP 31.10.00.94-Gen. and DEP 31.10.00.96-Gen., which form part of the requisition. The Vendor is responsible for assuring that these equipment noise limitations have been specified.

The Vendor shall submit quaranteed sound power levels and sound pressure levels of the equipment, together with any relevant information as requested in the data sheet, DEP 31.10.00.94-Gen. The Main Manufacturer shall indicate what special silencing measures, if any, are proposed in order to meet the specified levels.

2.1.5 Add to this clause:

The gear unit shall be capable of handling maximum torque transmissions experienced during start-up, overload torques or any other transient condition as demanded by the driver or driven equipment under the anticipated operating conditions. For diesel and gas turbine drivers consideration should also be given to the maximum power that may be developed at the specified minimum ambient temperature. The Main Manufacturer shall be responsible for ensuring that the Vendor is made aware of such loads.

2.1.7 Replace this clause by:

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

2.1.10 Replace the second sentence of this clause by:

The Vendor shall review and comment on the base plate design proposed by the Main Manufacturer and also on the Contractor's foundation details.

2.1.15 Add to this clause:

Spare parts shall be available for purchase, and all manufacturing drawings shall be retained by the Vendor, for the specified service life or for 20 years, whichever is longer.

2.1.18 Add new clause:

The Vendor shall list in his proposal all changes which are not proven in similar machines produced for the last five years or which have not acquired at least 16 000 hours of trouble-free and satisfactory operation. These changes are specifically subject to the Principal's approval and proven alternatives may be requested.

2.1.19 Add new clause:

In the event of any design or manufacturing error, faulty material or damage the component in question shall be replaced unless otherwise agreed by Principal. Any proposal to recover the component rather than replace it, and the method of repair shall be submitted to the Principal for approval. Additional tests or calculations may be required to prove (a) the effectiveness of the repair, and (b) that there will be no detrimental effect on the

serviceability of the component.

2.2 RATING

2.2.2.1 Replace this clause by:

The minimum gear service factor (SF) shall be no less than that specified for in Table 2. The required service factor for gear units driven by a variable-frequency motor drive or a synchronous motor shall be the same as for internal combustion engines.

2.2.3.1 Add to this clause:

Calculations on the probability of scoring (including flash temperature index) shall be done as part of the gear design. These calculations shall be reviewed with the Contractor and the Principal, and it shall be demonstrated that the probability of scoring is no higher than that for which the Vendor has prior satisfactory experience.

The Vendor shall state the minimum FZG factor required for the gears.

2.2.5 Add to this clause:

If the Vendor considers that a more reliable gear can be quoted, the Vendor may also propose the alternative design. If pitch line velocities exceed 160 m/s, the design shall be subjected to an engineering review by the Vendor, the Contractor and the Principal, and requires approval by the Principal.

2.2.5.1 Add new clause:

The teeth quality and tolerances shall be equal to or better than quality IV according to DIN 3961, DIN 3962 and DIN 3963.

Tolerances for shaft position and distances shall comply with DIN 3964. Backlash, deviations and tolerances in teeth thickness shall comply with DIN 3967 class 25 or better. The Vendor shall state the actual standard of accuracy used in manufacture.

Tolerances for shaft positions, etc., shall be in accordance with the Vendor's design.

2.3 CASINGS

2.3.1.1 Replace this clause by:

Gear casings shall be stress relief annealed to promote dimensional stability. Wherever possible, preference shall be given to a cast construction.

2.3.1.7 Replace the third sentence of this clause by:

Threaded connections may only be applied if unavoidable, and then only with the approval of the Principal. If threaded piping and flange connections are so approved for use, they shall not be seal welded.

2.3.1.8 Replace this clause by:

All required piping and nozzles shall be AISI 316 stainless steel. If space limitations within the gear preclude the use of flanges, stainless steel tubing conforming to Table 4 with forged AISI 316 stainless steel compression fittings (Swagelok or equivalent). All nuts and fastening devices inside the gear shall be positively locked against becoming loose. Sealing tape shall not be used.

2.3.1.12 Add to this clause:

If specified by the Principal the filter breather outlet shall be flanged to enable it to be piped to a safe location or connected to a fully closed vent system.

2.3.4.2 Replace the fourth sentence of this clause by:

Any maintenance item having a mass greater than 20 kg shall be provided with lifting lugs or similar fixed lifting point(s). Screw-in eye bolts may be used only for internal components where other lifting arrangements are impractical. Lifting points intended for lifting the cover only and not for lifting the complete gearbox shall be permanently and clearly identified accordingly.

2.3.4.3 Add new clause:

If this option is available, a design in which the bearings are clamped in position by bearing caps which are independent of the casing cover should be used. Alternatively bearings may be clamped by the upper casing part by means of long stay bolts. The upper parts of the bearing halves shall be positively fixed to the lower halves of the bearings. The complete bearings shall be precisely fitted in the lower casing part and shall be secured against rotational and axial movement. Removal of the upper part of the casing shall in no way disturb the bearings, their clearances or the alignment.

2.3.4.4 Add new clause:

Junction boxes or auxiliaries shall not be mounted on top of the upper casing.

2.3.4.5 Add new clause:

Casings shall be provided with 2 diagonally located standard earthing bosses according to standard drawing S 68.004.

2.4 CASING CONNECTIONS

2.4.1 Replace this clause by:

There shall be a single lubricating oil supply connection.

2.4.5.1 Add new clause:

If a noise hood is to be used, all connections (including instrument connections) shall project to the outside of the enclosure.

2.4.6 Replace the second sentence of this clause by:

Where flanged, machined and studded openings are impractical on weldable casings, openings of DN 25 or larger shall be full penetration butt weld connections, not socket weld connections. Openings of less than DN 25 may be reinforced boss connections of the "weldolet" type, using only full penetration butt welds.

Threaded connections may only be applied if unavoidable, and then only with the approval of the Principal.

2.4.7 Replace this clause by:

**Amended per
Circular 23/97**

Flanges shall be welding neck, raised face, rating class 300 in accordance with ASME/ANSI B16.5.

2.4.7.1 Delete this clause.

2.4.7.2 Delete this clause.

2.4.7.3 Delete this clause.

2.4.9 Add to this clause:

Threaded connections may only be applied if unavoidable, and then only with the approval

of the Principal.

2.5 GEAR ELEMENTS

2.5.1.1 Add to this clause:

Unless otherwise approved by the Principal, all gear teeth shall be finished by grinding.

2.5.1.2 Delete this clause:

Lapping shall not be used as a method of achieving the required surface finish.

2.5.1.4 Replace this clause by:

Teeth may be plated only if approved by the Principal.

2.5.2.2 Add to this clause:

Each pair of mating gears shall be checked according to this clause. The results shall be preserved and a copy included in the maintenance manual. A thin coating of red dye (Dykem Red) or other color transfer material shall be applied to three or more adjacent teeth in three equidistant locations of each gear wheel and the gear run under load in order to check tooth contact.

2.5.3.2 Add to this clause:

Gears shall be integrally forged with their shafts unless otherwise approved by the Principal.

2.5.3.3 Add new clause:

Shrunk-on, forged rims shall not be used without the approval of the Principal. Whenever possible, the gear mesh of shrunk-on elements shall be finished after shrinking the gears onto the shaft.

2.5.4.1 Add to this clause:

All shafts shall be stress-relieved before machining.

2.5.4.3 Add to the clause:

If possible shafts shall be provided with integrally forged flanges to which couplings shall be bolted. If this is not possible, and subject to the approval of the Principal, hubs should be fitted using hydraulic expansion (see 3.2.2).

2.6 DYNAMICS

2.6.1.5 Add to this clause:

The lateral critical speed analyses report shall be submitted within four months of the date of order. The gear Vendor is responsible for the gear lateral analysis.

2.6.1.6 Add to this clause:

The report shall also include:

1. A graphic display of undamped critical speeds and operating speeds.
2. A graphic display of rotor response to unbalance weight, damped and undamped, at no load, 50% load and full load torque.

2.6.1.8 Add to this clause:

Unless otherwise specified in the purchase order or data sheet, the Main Manufacturer shall perform a torsional and lateral analysis of the complete train. The Vendor shall therefore predict the stiffness and inertia of the gear shafts and shall send his data within two months of the date of order to the Main Manufacturer, who may specify necessary modifications.

A torsional analysis of the entire train, independent of the above, shall be performed by the Vendor using the basic dimensions, stiffness data and sources of torsional excitation supplied by the vendors of the driver and driven equipment when specified.

The torsional analysis shall include at least:

- a. A complete description of the method used in completing the analyses.
- b. A graphic display of the mass elastic system.
- c. A tabulation identifying the mass moment of inertia and torsional stiffness for each component identified in the mass elastic system.
- d. A graphic display of exciting frequencies/sources versus natural frequencies.
- e. A tabulation of torsional critical speeds and related deflections.

2.6.3.1 Add to this clause:

The amplitude of any discrete non-synchronous vibration shall not exceed 20% of the allowable vibration.

The specified vibration limits include both mechanical and electrical run-out.

This acceptance criteria apply to both cold and hot running conditions.

2.6.3.4 Delete this clause.

2.6.3.5 Replace the second sentence of this clause by:

The overall unfiltered vibration readings on the bearing housing in any plane shall not exceed 3 mm/s RMS measured in the specified speed range.

2.7 BEARINGS AND BEARING HOUSINGS

2.7.1.3 Replace this clause by:

Platinum (100 Ohm, three-wire) RTDs shall be used for bearing metal temperature detection and shall be arranged as follows unless otherwise specified by the Principal:

- radial bearings shall have two RTDs within the expected load zone;
- thrust bearings shall have six RTDs, three on the active side and three on the inactive side.

Bearing metal temperatures shall not exceed 110 °C under any load condition with the maximum specified oil inlet temperature.

2.7.2.3 Add new clause:

Bearings shall be designed to provide stable performance over the full operating speed range with zero to 100% load. If specified by the Principal, the Vendor shall submit for approval a graphic display of speed against bearing maximum load capacity showing the boundaries of minimum oil thickness and the load to produce the maximum bearing lining metal temperature, taking any inherent misalignment into account.

2.7.3.2 Add to this clause:

Hydro-dynamic thrust bearings shall be of the self-equalizing, multi-segment type, e.g. Kingsbury type.

Wherever possible, thrust collars shall be integral with their shaft.

2.7.4.3 Add to this clause:

Probes and proximeters of the type specified shall be provided by the Vendor and the read-out instrumentation shall be provided by the Contractor. The probes shall be adjustable within the probe holders while the unit is in operation. All probes shall be provided with the same cable length. The wiring shall be in conduits. The proximeters shall be in a housing

suitable for the area classification.

2.8 LUBRICATION

2.8.5 Add to this clause:

"... as amended by DEP 31.29.60.32-Gen.

2.8.7 Add new clause:

The Vendor shall state in the operating manual the specifications, the supply temperature and pressure ranges and the required amount of the lubricating oil.

2.9 MATERIALS

2.9.1.1 Add to this clause:

and shall be in accordance with DEP 30.10.02.11-Gen. where possible.

2.9.1.2 Add to this clause:

If the Vendor's material specification (i.e., physical properties, chemical composition, and test requirements) deviates from the specified material it shall be included in the proposal for the approval of the Principal.

2.9.1.5 Add to this clause:

Toothings shall be carburized and case-hardened. If through-hardened gearing offers technical and/or commercial advantages, it may be offered as an alternative.

2.9.1.8 Add new clause:

All repairs shall meet the inspection requirements and acceptance standards of the original material specification. Approval of the Principal shall be obtained before a major weld repair is carried out. The definition of a major weld repair is to be taken as either the removal of more than 50% of the wall thickness, or a length of more than 150 mm in one or more direction(s), or if the total surface area of all repairs exceeds 10% of the original surface area.

SECTION 3 ACCESSORIES

3.2 COUPLINGS AND GUARDS

3.2.2 Add to this clause:

Gear and pinion shall be furnished with integrally forged coupling flanges unless otherwise agreed by the Principal.

3.2.6 Replace this clause by:

The coupling mounting design shall conform to API Std 671 and shall transmit the torque through friction, not by coupling bolts in shear. Unless otherwise approved by the Principal, the gear unit as well as the coupling connections shall be capable, when used in an electric power generator, of withstanding the torques resulting from the following conditions:

A) line-to-line short circuit.

B) mis-synchronisation to the grid.

The resulting torques shall be calculated by the driver vendor and the generator vendor. The Main Manufacturer shall coordinate the necessary flow of information between the parties involved. The calculation results of both vendors shall be presented to the Principal for approval.

3.2.8 Add new clause:

The Main Manufacturer shall provide the Vendor with certified prints of the selected coupling showing: type, rating, torque, weight, location of centre of gravity, mass moment of inertia (WR^2), torsional stiffness, axial thrust, balance, end play tolerance, shaft fits, etc.

3.2.9 Add new clause:

The coupling guards for oil-lubricated couplings shall be made of aluminium or any other suitable non-sparking material. They shall be fully enclosed and oil tight and shall employ a stainless steel bellows at one end to accommodate axial and lateral movements of the adjacent machines. The size of the coupling guard shall be adequate to limit the temperature rise of the coupling guard to 25 °C above ambient with a maximum of 70 °C. The guard shall be equipped with vent and drain connections, each at least DN 50 in size. Coupling guards shall be supplied by the Main Manufacturer.

Open type coupling guards of a suitable non-sparking material shall be the first option for those cases where dry type couplings are specified. Guards shall be designed in such a way that the axial and lateral movements of the adjacent machines can be accommodated.

3.3 MOUNTING PLATES

3.3.2.7 Replace the first sentence of this clause by:

The mounting pads on the bottom of the base plate shall be machined flat in one plane, within 0.05 mm over the total length of the base plate to permit the use of a single-level foundation.

3.3.2.9 Add to this clause:

Each machined gear mounting surface shall be parallel within 0.1mm/m.

3.4 CONTROLS AND INSTRUMENTATION

3.4.1.1 Replace this clause by:

**Amended per
Circular 22/99**

Instrumentation and connections for instruments shall be in accordance with

DEP 32.31.09.31-Gen. and DEP 32.31.00.32-Gen.

3.4.1.3 Replace this clause by:

Instrumentation and electrical equipment shall be suitable for use in the specified area classification.

3.5 PIPING AND APPURTENANCES

Add to this clause:

"... as amended by DEP 31.29.60.32-Gen."

Add new clause:

3.7 SPARES

To enable the Principal to make a proper selection, the Vendor's recommended spare parts list and pricing shall be included in the quotation.

The Contractor shall propose for the approval of the Principal which of the spares shall be supplied with the gear unit.

SECTION 4 INSPECTION TESTING AND PREPARATION FOR SHIPMENT

4.1 GENERAL

4.1.1 Replace this clause by:

Prior to manufacture, the Contractor and the Principal shall specify if, and to what extent, they will participate in the inspection and testing.

4.1.3 Modify the second sentence of this clause as follows:

Replace "sufficient" by "five working days".

4.2 INSPECTION

4.2.1.1 Add to this clause:

The Vendor shall supply to the Contractor a record of all "as built" final assembly and running clearances.

The acceptance criteria of any tests not already specified by API Std 613 as amended by this DEP shall be agreed with the Principal prior to testing.

4.2.1.2 Add to this clause:

The Contractor shall specify the extent of radiographic, ultrasonic, liquid penetrant and magnetic particle examination to be performed by the Vendor. This shall be subject to the approval of the Principal.

4.2.2.4.1 Replace this clause by:

Magnetic particle examination shall be performed in accordance with ASME VIII, Division 1, Appendix 6.

4.2.2.4.2 Replace this clause by:

The acceptance standard used for welded fabrications shall be ASME VIII, Division 1, Appendix 6.

The acceptance standard used for castings shall ASME VIII, Division 1, Appendix 7.

4.2.2.5.1 Replace this clause by:

Liquid penetrant examination shall be performed in accordance with ASME VIII, Division 1, Appendix 8.

4.2.2.5.2 Replace this clause by:

The acceptance standard used for welded fabrications shall be ASME VIII, Division 1, Appendix 8.

The acceptance standard used for castings shall ASME VIII, Division 1, Appendix 7.

Delete Table 8.

Retain the Note below Table 8.

4.2.2.7.2 Add to the last sentence of this clause:

"... and approved by the Principal."

4.3 TESTING

4.3.1.4 Add new clause:

Final test procedures and test agendas covering any running test specified shall be

submitted by the Vendor to the Contractor for agreement prior to testing. Such submittal shall be made at least 90 days prior to test.

4.3.2.1 Add to this clause:

In order that vibration measurements during the mechanical test are meaningful, sufficient load shall be imposed on the gear to ensure that the shaft journals adopt attitudes in the bearings similar to those they will adopt in service. The magnitude of this load shall be approved by the Principal unless another test arrangement has been agreed.

4.3.2.1.3 Modify this clause as follows:

Replace "API Standard 614" by "API Std 614 as amended by DEP 31.29.60.32-Gen."

4.3.2.2.12 Add to this clause:

During this test, the lubricating temperature shall be held for a minimum period of 30 minutes at the temperature corresponding to the minimum allowable viscosity, and for 30 minutes at the temperature corresponding to the maximum allowable viscosity. During these tests vibration levels and frequency spectra shall be recorded. The vibration levels and bearing temperatures shall be within the specified limits.

4.3.2.3.2. Add to this clause:

In addition, the Contractor may require dismantling for inspection if there is evidence of malfunction, excessive repairs, improper fabrication or other defects. The extent of dismantling would be as necessary to verify the integrity of the unit.

4.3.2.4 Add to this clause:

If a spare gear set is furnished, all testing is applicable to both gear sets.

4.3.2.5 Add new clause:

Any oil leakage during the "mechanical run" test is unacceptable and shall be cause for rejection of the equipment.

4.3.3.5 Sound-level test

Replace this clause by:

The Contractor shall comply with DEP 31.10.00.31-Gen. and thereby communicate to the Main Manufacturer the specified equipment noise limitations by using data sheet DEP 31.10.00.94-Gen. which forms part of the requisition. The Main Manufacturer is responsible for assuring that these equipment noise limitations have been specified.

4.4 PREPARATION FOR SHIPMENT

4.4.1 Modify the second sentence of this clause as follows:

Replace "6 months" by "12 months".

4.4.3.2 Add to this clause:

"... for 12 months' outdoor storage".

4.4.3.4 Add to this clause:

Equipment shall be completely free of water prior to any storage preparation. All internals shall be protected against the entry of water or dirt. Vapour phase inhibiting crystals shall be installed in large cavities such as bearing housings and attached to flange covers. A list detailing the quantity and location of all corrosion preventatives and drying agents shall be furnished to ensure removal during preparation for start-up.

- 4.4.3.9 Modify the first sentence of this clause as follows:
Replace "3 years" by "5 years."

SECTION 5 VENDOR'S DATA

5.2 PROPOSALS

5.2.3 Technical Data

Replace item (b) by:

- b. Noise levels with and without attenuation features as required by DEP 31.10.00.31-Gen.

Add to this clause:

- n. Full details of radial and thrust bearings data.
- o. Vendor's quality plan (based on Appendix I and amended in line with this DEP).
- p. Indicate the capability of full load (or partial load) testing and the cost and timing for such test.

5.3 CONTRACT DATA

5.3.3 Technical Data

Add to this clause:

The SI system of units shall be used throughout all data sheets and documentation.

5.3.6.3 Operation, Maintenance and Technical Manual

Add to this clause:

The manuals shall also contain the manufacturing reports including material certificates for casings, shafts and gears. The certificates shall include hardness results and records of heat treatment and non-destructive tests. The Vendor shall furnish:

- Records of rotating equipment balancing
- Records of shaft run-out checks
- Records of tooth contact and surface checks
- Records of the running test, e.g. vibration levels, bearing temperatures
- Records of "as-built" clearances.

PART IV REFERENCES

Amended per
Circular 23/97

In this DEP reference is made to the following publications.

NOTE: Unless specifically designated by date, the latest edition of each publication shall be used, together with any amendments/supplements/revisions thereto.

SHELL STANDARDS

Index to DEP publications and standard specifications	DEP 00.00.05.05-Gen.
Metallic materials - Selected standards	DEP 30.10.02.11-Gen.
Noise control	DEP 31.10.00.31-Gen.
Equipment noise limitation	DEP 31.10.00.94-Gen.
Rotating equipment acoustic enclosures	DEP 31.10.00.96-Gen.
Lubrication, shaft sealing and control oil systems for special-purpose application (Amendments/Supplements to API Std 614)	DEP 31.29.60.32-Gen.
Piping - General requirements	DEP 31.38.01.11-Gen.

Amended per
Circular 22/99

Instruments for measurement and control	DEP 32.31.00.32-Gen.
Instrumentation for equipment packages	DEP 32.31.09.31-Gen.

STANDARD DRAWINGS

Earth bosses	S 68.004
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AMERICAN STANDARDS

Information sheet-geometry factors for determining the strength of spur, helical herringbone and bevel gear teeth	AGMA 908
Gear classification and inspection handbook for un-assembled spur and helical gears	AGMA 2000
Fundamental rating factors and calculation methods for involute spur and helical gear teeth	AGMA 2001
Practice for enclosed speed reducers or increasers using spur, helical, herringbone and spiral bevel gear units	AGMA 6010
Practice for high speed helical and herringbone gear units	AGMA 6011
<i>Issued by:</i> American Gear Manufacturers Association 1901 North Fort Myer Drive, Suite 1000 Arlington, VA 22209, USA.	
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.*

Special purpose gear units for petroleum, chemical and gas industry services	API Std 613, 4th edition, June 1995
Lubrication, shaft sealing, and control oil systems for special service applications	API Std 614
Special-purpose couplings for refinery service	API Std 671

*Issued by:
American Petroleum Institute
Publications and Distribution Section
1220 L Street Northwest
Washington DC. 20005
USA.*

ASME Boiler and Pressure Vessel Code: Rules for construction of pressure vessels	ASME VIII, Div. 1
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*Issued by:
American Society of Mechanical Engineers
345 East 47th Street
New York, NY 10017, USA.*

GERMAN STANDARDS

Tolerances for cylindrical gear teeth; Bases	DIN 3961
Tolerances for cylindrical gear teeth	DIN 3962
Tolerances for cylindrical gear teeth; Tolerances for working deviations	DIN 3963
Deviations of shaft centre distances and shaft position; Tolerances of casings for cylindrical gears	DIN 3964
System of gear fits; Backlash; Tooth thickness allowances; Tooth thickness tolerances; Principles	DIN 3967

*Issued by:
Beuth Verlag GmbH
Burggrafenstrasse 4-10
D-1000 Berlin 30
Germany.*

INTERNATIONAL STANDARDS

Quality Systems - Model for quality assurance in design, development, production, installation and service	ISO 9001
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*Issued by:
International Organisation for Standardisation
1, Rue de Varembe
CH-1211 Geneva 20
Switzerland.*

Copies can also be obtained through the national standards organizations.