MANUAL

INSTALLATION OF ROTATING EQUIPMENT

DEP 31.29.00.10-Gen.

July 1996

DESIGN AND ENGINEERING PRACTICE

PREFACE

DEP (Design and Engineering Practice) publications reflect the views, at the time of publication, of:

Shell International Oil Products B.V. (SIOP)
and
Shell International Exploration and Production B.V. (SIEP)
and
Shell International Chemicals B.V. (SIC)

The Hague, The Netherlands,

and other Service Companies.

They are based on the experience acquired during their involvement with the design, construction, operation and maintenance of processing units and facilities, and they are supplemented with the experience of Group Operating companies. Where appropriate they are based on, or reference is made to, national and international standards and codes of practice.

The objective is to set the recommended standard for good design and engineering practice applied by Group companies operating an oil refinery, gas handling installation, chemical plant, oil and gas production facility, or any other such facility, and thereby to achieve maximum technical and economic benefit from standardization.

The information set forth in these publications is provided to users for their consideration and decision to implement. This is of particular importance where DEPs may not cover every requirement or diversity of condition at each locality. The system of DEPs is expected to be sufficiently flexible to allow individual operating companies to adapt the information set forth in DEPs to their own environment and requirements.

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

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

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

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

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

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

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

All administrative queries should be directed to the DEP Administrator in SIOP.

NOTE: In addition to DEP publications there are Standard Specifications and Draft DEPs for Development (DDDs). DDDs generally introduce new procedures or techniques that will probably need updating as further experience develops during their use. The above requirements for distribution and use of DEPs are also applicable to Standard Specifications and DDDs. Standard Specifications and DDDs will gradually be replaced by DEPs.

TABLE OF CONTENTS

1. **INTRODUCTION** 4
1.1 SCOPE 4
1.2 DISTRIBUTION, INTENDED USE AND REGULATORY CONSIDERATIONS 4
1.3 DEFINITIONS 4
1.4 CROSS-REFERENCES 4

2. **GENERAL REQUIREMENTS** 5
2.1 QUALITY PLAN 5
2.2 CONSTRUCTION TOOLS / SPECIAL TOOLS 5
2.3 INSTALLATION AND OPERATING MANUALS 5
2.4 SPARE PARTS 6

3. **STORAGE OF EQUIPMENT PRIOR TO INSTALLATION** 7

4. **FOUNDATIONS** 8
4.1 GENERAL 8
4.2 FOUNDATION BOLTS 8
4.3 LEVELLING 8
4.4 GROUTING 9

5. **PIPING ASSOCIATED WITH ROTATING EQUIPMENT** 11

6. **SHAFT ALIGNMENT** 13
6.1 GENERAL 13
6.2 REQUIREMENTS 13
6.3 DOWELLING 14

7. **COUPLINGS** 15

8. **CLEANING OF PIPING SYSTEMS** 16
8.1 CLEANING OF EQUIPMENT AND RELATED SYSTEMS 16
8.2 FLUSHING OF LUBOIL AND SEAL OIL SYSTEMS 16
8.3 CHEMICAL CLEANING 16
8.4 FILTERS 16

9. **FINAL INSPECTION AND CHECKS BEFORE START-UP** 18

10. **FIRST START, RUN-IN, INITIAL OPERATION** 19

11. **REFERENCES** 20

APPENDICES

APPENDIX 1a STANDARD FOUNDATION DIMENSIONS FOR THE INSTALLATION OF VERTICAL CLOSE COUPLED PUMPS 22

APPENDIX 1b SETTING PLATE FOR VERTICAL CLOSE COUPLED PUMPS, BS 4082 - CODE 20 AND 60 23

APPENDIX 1c SETTING PLATE FOR VERTICAL CLOSE COUPLED PUMPS, BS 4082 - CODE 10, 30, 40 AND 50 24

APPENDIX 2 TYPICAL ARRANGEMENT OF SOLE PLATES, LEVELLING SPINDLES AND SHIMS AS USED FOR RECIPROCATING EQUIPMENT 25

APPENDIX 3 DIMENSIONS AND TYPICAL ARRANGEMENT OF JACKING BOLTS 26

1. INTRODUCTION

1.1 SCOPE

This DEP specifies requirements and gives recommendations for the mechanical installation of rotating equipment. This DEP shall supplement and, in those cases where it is more stringent, shall replace the Manufacturer's recommendations.

This DEP shall be used by the Contractor to prepare checklists to ensure proper installation of rotating equipment.

This DEP is a revision of an earlier DEP of the same number dated October 1984.

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 nominated by them (i.e. the distribution code is "C" as defined in DEP 00.00.05.05-Gen.).

This DEP is intended for use in oil refineries, chemical plants, gas plants and, where applicable, in exploration and 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, construction, commissioning or management of a project or operation of a facility. The Principal may undertake all or some of the duties of the Contractor.

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

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

The word **shall** indicates a requirement.

The word **should** indicates a recommendation.

1.4 CROSS-REFERENCES

Where cross-references to other parts of this DEP are made, the referenced section number is shown in brackets. Other documents referenced in this DEP are listed in (11).

2. GENERAL REQUIREMENTS

2.1 QUALITY PLAN

At an early stage of the project the Contractor shall propose for the approval of the Principal a quality plan covering all aspects of installation, inspection and pre-commissioning of rotating equipment

Each individual item of equipment shall have its own checklist covering all aspects of installation, inspection and pre-commissioning.

Such a checklist shall ultimately be signed by the rotating equipment department of the Principal or its representative and shall act as a key document in the hand-over procedure.

A copy of the completed checklist shall be added to the Equipment Record Card (including installation records, level and alignment data, run-in record, vibration data etc.). Reference is made to DEP 61.10.08.11-Gen.

2.2 CONSTRUCTION TOOLS / SPECIAL TOOLS

It is the Contractor's responsibility to ensure that the correct tools are available and are used for the proper installation of rotating equipment (i.e. stainless steel shims, correct-size spanners and keys, certified slings and chain hoists, torque wrenches, metric alignment dial gauges and calibrated engineering spirit levels, vibration meters, analysers, etc.). Generally, adjustable spanners shall not be used on rotating equipment.

Abnormal wear and tear of parts of equipment through the use of improper tools during installation is not acceptable. At hand-over, equipment shall be in 'as-new' condition.

At an early stage during construction a check should be made on the availability of special tools that shall be supplied by the equipment manufacturer.

These special tools shall be used by the Contractor when required, but the Contractor remains responsible for the care of these tools and their hand-over to the Principal in an "as-new" condition.

2.3 INSTALLATION AND OPERATING MANUALS

The Manufacturer's installation and operating manuals shall be available at site at least one month prior to installation of the equipment. The instructions contained therein shall be followed unless superseded by more stringent requirements in this DEP.

Shop test and inspection records and records of all "as built" clearances shall be collected and made available at site when the installation commences.

At the time installation starts, completed Equipment Record Cards of all equipment supplied shall be available at site. In the Project Specification it shall be specified whether Record Cards are required in electronic form or as hard copies.

During installation and commissioning, the Contractor shall add any relevant information to the Equipment Record Cards.

The Contractor is responsible for ensuring that lubricants comply with the latest Shell grade designation or equivalent, as approved by the Principal.

The Contractor should minimise the number of grades by a grade rationalisation exercise in consultation with the Principal and the equipment manufacturer. However, this grade rationalisation shall not violate the individual equipment manufacturer's guarantees.

The Contractor shall furnish lubricant recommendations for all rotating equipment of the project in the form of a lubrication manual, which shall contain the required grade and quantity of lubricant as well as the lubrication intervals for each individual rotating equipment item. This information shall be available six months prior to the start-up of the installation.

2.4 SPARE PARTS

DEP 70.10.90.11-Gen. shall apply. The Contractor shall ensure that initial and insurance

spare parts are available during the construction and commissioning period. Normal operating spare parts shall be ordered to arrive at site prior to hand-over of the equipment to the Principal.

Spare rotors for major rotating equipment are usually furnished with watertight metal transport/storage containers suitable for vertical storage and able to withstand an internal pressure of 0.20 bar (ga). These containers shall be checked on arrival at site for any signs of damage and for absence of moisture and shall be stored according to the Manufacturer's instructions. Vertical storage is recommended if allowed by the Manufacturer's instructions. Special attention is required to ensure that a proper inert environment is maintained in this container e.g. by nitrogen under a slight overpressure.

All spare rotors shall be properly supported, preserved in accordance with DEP 70.10.70.11-Gen., and supplied with clear instructions for long term storage.

The Contractor is responsible for the preparation of separate equipment record cards for major capital spares such as rotors, blade carriers, electric motors, gearboxes, etc. This record card shall correspond to the unique identification number of each item.

3. STORAGE OF EQUIPMENT PRIOR TO INSTALLATION

DEP 70.10.70.11-Gen. shall apply.

At an early stage of the project it should be ensured that there will be adequate quantities of rust preventatives at site by the time equipment is received. Stocks of Shell Ensis Fluid G, H, K, Ensis Oil N and Shell Ensis Engine Oil, Ensis Compound CB, VPI-crystals in bags, VSI 8235 additive and sufficient desiccant in bags shall be available. Other equivalent protective fluids may be used if approved by the Principal.

If the equipment is received at site and cannnot be installed immediately it shall be stored in a dry location.

On receipt the equipment shall be checked against the shipping manifest and inspected for any damage.

Shop preservation shall be checked. Where necessary, damage to preservation shall be rectified without delay. Shop-applied protection is usually sufficient only for the shipment period or 6 months. The Contractor shall take all necessary actions to restore the preservation, where relevant.

Provided equipment design permits, shafts of selected equipment shall be turned at least once per month and a check list shall be used to record that this is done. Locking devices used for equipment transport shall be removed and kept for any future transport.

It is the Contractor's responsibility to ensure that at all times the Manufacturer's recommendations on prolonged storage (indoor and outdoor) are followed and that damage due to dust or moisture is prevented.

4. FOUNDATIONS

4.1 GENERAL

Allowance shall be made for grouting between the rough surface of the concrete and the underside of the baseplate (4.4).

Whereas most pump units and small compressors are mounted on baseplates, some equipment may be mounted directly on the foundations. In these cases, sole plates shall be provided, which are grouted on the foundation to facilitate easy removal and re-installation of the equipment during maintenance.

Vertical close-coupled pumps shall be mounted on sole plates. A foundation layout and a sole plate should be applied as shown in Appendices 1a, 1b and 1c.

Lifting of the baseplate during installation shall be done in accordance with the Manufacturer's instructions to prevent permanent distortion.

4.2 FOUNDATION BOLTS

To allow for slight differences in dimensions between the holes in the frame or bed plate and the bolts in the foundation, foundation bolts shall be installed according to Standard Drawing S 10.045.

4.3 LEVELLING

Any special levelling instructions of the Manufacturer shall be followed if more stringent than this DEP.

All mounting pads on the base plate receiving the equipment should already have been fully machined flat and level by the Manufacturer. It shall be verified that each mounting pad on the baseplate is level in both the X and Y directions, within a tolerance of 0.05 mm/m. This shall be checked with a calibrated engineer's spirit level (1 division = 0.02 mm/m).

For equipment which is delivered already installed on its baseplate where the machined pads are not sufficiently accessible for proper use of a spirit level, the equipment shall be removed to facilitate levelling.

Levelling spindles, not vertical jackscrews, shall be used for levelling base plates if provided. Levelling spindles shall be removed or loosened after grouting. Removal of levelling spindles after grouting is mandatory for reciprocating machinery or any other installation where impact and/or pounding action are to be expected during normal operation.

For reciprocating equipment, sole plates and shims should be installed (provided the construction allows). See Appendix 2 for a typical arrangement.

Instead of individually fitted stainless steel sole plates and shim plates, the use of epoxy resin compound chocks may be considered. These resin chocks minimize heat build-up on foundations, assure precise and intimate contact with bedplates and provide a high coefficient of friction to help maintain equipment alignment.

Jacking screws should be used whenever levelling spindles have not been provided by the equipment manufacturer. Jacking screws shall be of a type and size according to Appendix 3. Removal after grouting is not necessary except for reciprocating equipment, where removal is required. For each machine sufficient jacking screws shall be used (as a minimum one jacking screw per anchor bolt shall be installed).

For equipment levelling, stainless steel shims which straddle the holding-down bolts shall be used. The total number of shims shall be minimized by using shims of adequate thickness. In any shim pack no more than three shims shall be used. The minimum shim pack thickness shall be 3 mm (after alignment).

4.4 GROUTING

For precision cement grouting and epoxy grouting reference is made to API 610. API 610

shall be followed as well as this DEP unless the Principal agrees to deviate, for example if the equipment manufacturer's requirements are more stringent.

Grout material may be either: cement-based non-shrink grout or epoxy grout. Epoxy grout shall be used for the following installations, provided that surface temperatures local to the grout are less than 60 °C:

- reciprocating machinery (not skid-mounted) and other installations where impact and/or pounding action are to be expected during normal operation;
- all internal combustion engines;
- all sole plate mounted equipment, except vertical close coupled pumps.

For rotating equipment installations not covered by the above categories, cement-based non-shrink grout shall be used.

It shall be ensured that the foundation under the baseplate is free of dirt, dust, oil or grease. Approximately 15 - 20 mm of the top of the concrete foundation shall be roughened/chipped to remove the weak upper layer of concrete, damaged concrete and any oil-soaked areas. At least 25 mm between the baseplate and the top of the foundation should be allowed for grouting. For levelling spindles or jacking screws (4.3), the clearance shall be at least 50 mm.

For proper bonding, the baseplate shall be clean and free of rust, oil and/or grease. If epoxy resin is used, the baseplate underside may have to be specially treated in which case the resin supplier's instructions shall be followed.

Foundation bolt sleeves or pockets shall be filled prior to grouting the baseplate. See Standard Drawing S 10.045 for the filling procedure.

Metal parts that should not bond to the grout (e.g. jacking screws of reciprocating machinery and parts of the foundation bolts) shall be sealed with tape or grease prior to grouting. On reciprocating machinery, foundation bolts should be sealed over a length of 10 times the diameter, to prevent bonding with the grout when sleeves or pockets are filled and in order to retain elasticity.

If cement-based non-shrink grout is used, the foundation top shall be saturated with fresh water for at least 24 hours prior to grouting. There shall be no free water on the foundation top during grouting. Necessary steps shall be taken to prevent grouting from drying too quickly (in accordance with the grout manufacturer's instructions).

The foundation shall be sized such that grouting can be extended 50 mm beyond the base/soleplate or the shims.

If large areas need to be grouted the use of expansion joints shall be considered, and if found necessary they shall be engineered in consultation with the grout manufacturer.

Those parts of the foundation top that do not require grouting material for structural reasons shall be surface finished by other means.

After structural grouting of the baseplate beams has been executed, the space between the concrete foundation and the baseplate assembly shall be filled, if necessary, to obtain the required stiffness of the baseplate assembly.

At no place on the foundation shall liquids be able to accumulate.

The filling shall be ordinary construction concrete of the same grade as the foundation up to 20 mm under the drip pan/drain rim. The rest of the space shall be filled with cement-based non-shrink grout.

After curing of the grout the foundation bolts shall be tightened and the level of the machined pads shall again be checked. A change in level requires a decision of the Principal, who may reject the baseplate installation or have the pads re-machined in situ.

After grouting, the base plates shall be checked for the presence of any voids. Epoxy pressure grouting techniques shall be used to fill any voids.

Grout openings and vent holes shall be sealed and/or covered, where necessary, to prevent contamination of the grout by oil or other products. In chemical plants it may be necessary

to protect the grout and foundation from chemicals (e.g. by tiles).

5. PIPING ASSOCIATED WITH ROTATING EQUIPMENT

The Contractor shall ensure that the piping associated with the rotating equipment complies with the Manufacturer's requirements and with DEP 31.38.01.11-Gen.

After levelling and grouting the equipment is normally available for the installation of piping (including piping related to instruments and electrical connections).

During this period the equipment shall remain preserved and protected in accordance with DEP 70.10.70.11-Gen.

To prevent ingress of dirt and foreign matter it shall be ensured that all routes and openings are properly blinded off and sealed and that temporary suction strainers are correctly installed in accordance with DEP 31.38.01.11-Gen. Dust blinds shall remain installed until final alignment.

Piping shall not be rigidly connected to the equipment before the final pipe supports have been installed.

To avoid the undue stressing of rotating equipment, the installation of piping shall never start from rotating equipment nozzles. Piping upstream and downstream of the equipment shall be fitted from the nearest anchor.

Welding shall not be done on piping connected to the equipment foundation, base plates or the equipment itself, without proper direct earthing-back to the welding transformer. In order to prevent damage to equipment bearings by stray currents, earth cables shall not be connected to any part (base plate, pedestal, drive, etc.) of rotating equipment.

Before the equipment is offered for the final alignment inspection (see 5.2) all work on piping systems shall be completed. This includes pressure tests, cleaning or air blowing and installation of permanent supports (fixed, sliding and spring supports). During these activities the piping shall be disconnected from the equipment. The lock pins of any spring supports immediately adjacent to rotating equipment shall be kept in place until systems have had their initial run on the actual product and the corresponding temperature(s) have been reached.

Tolerances on flange connections between rotating equipment and associated piping:

a) Parallelism

Before bolting up, flange faces shall be aligned parallel within 0.05 degrees in all directions, i.e:

Flange diameter (mm)	Maximum deviation from parallel across flange diameter (mm)
< 300	0.2
300 to 600	0.3
> 600	0.5

Flange bolt holes shall be aligned within 3 mm maximum offset.

b) Clearance

The gasket type, material and size shall be checked. The gap between the flanges shall be just sufficient to slide in the gasket without damaging the gasket or the flange faces.

c) Concentricity

The flange bolt dimensions and material shall be checked. Galvanised bolts shall not be used in stainless steel flanges. Studbolts shall extend beyond the nut, but not by more than the height of one nut. To check flange concentricity the flange bolts shall slide freely through the bolt holes of mating flanges without interference.

6. SHAFT ALIGNMENT

6.1 GENERAL

Prior to alignment checking of rotating equipment, and after completion of the checks described in (5), the following shall be considered:

- Alignment shall allow for potential movements such as thermal expansion, hydraulic loading, gears with rising pinions, etc. The Manufacturer's instructions shall be followed.
- Check that coupling hubs are correctly installed before making alignment checks.
- Check and record the distance between shaft ends and/or distance between hubs (axial float, pre-stress etc.).
- Confirm that the equipment is correctly supported, e.g.:
- no "soft foot" (maximum dial movement 0.03 mm);

  NOTE: A 'soft foot' is one which does not have solid flat contact with the mating support pads when the equipment is in place.

  - shims are of stainless steel;
  - shims straddle foundation bolts and are fully bearing;
  - axial and transverse keys are properly located and secured;
  - level and alignment adjustment screws are loose.

6.2 REQUIREMENTS

Final misalignment shall not exceed the Manufacturer's recommendations or the following, whichever are the more stringent:

Equipment condition	Radial (parallel) misalignment Total Indicator Reading	Axial (angular) misalignment
All speeds and coupling spacer lengths $\leq$ 250 mm	0.05 mm	0.05 mm (based on a diameter of 150 mm)
All speeds and coupling spacer lengths > 250 mm	0.02 mm per 100 mm of spacer length	0.05 mm (based on a diameter of 150 mm)
Speeds lower than 1500 r/min, low power (< 10 kW) with elastomeric flexible couplings	0.10 mm	0.05 mm (based on a diameter of 150 mm)

The following methods of shaft alignment are acceptable in the following order of preference:

1) optical alignment method (with laser optics);
2) the reverse periphery method with dial indicators;
3) the face and rim method with 2 axial dial gauges and 1 radial dial gauge.

NOTE: Method 3) should be applied only for those cases where the measuring diameter for the face reading is equal to or larger than half the DBSE (distance between shaft ends) to ensure reliable angular shaft alignment readings.

Both the driver and driven shafts are turned simultaneously to take alignment readings.

Readings shall be demonstrated to be repeatable. Dial bracket sag shall be taken into account and shall not be more than 0.05 mm (which should be checked, e.g. on a lathe).

Alignment checks include:

- a preliminary check to ensure that alignment is possible with regard to shim limitations, bolt and bolt hole positions, etc.;

- an alignment check without piping connected to the equipment;
- an alignment check with the bearing bracket support loose (for overhung pumps);
- final alignment check. For this check the optical instruments or dial indicators should be on the equipment before and during the tightening of the piping and brackets, to detect any distortion. The relative movement of shaft centre lines shall not exceed 0.025 mm (= 0.05 mm TIR). The final shaft alignment reading shall be taken with all process piping and auxiliary piping connected with proper gaskets in place and shall be within the tolerances of (6.2).

Hot alignment checks shall be agreed with the Principal on a case-by-case basis, taking into account the operating temperature and/or the Manufacturer's recommendations. For the final hot alignment, the tolerances of (6.2) shall apply.

Final alignment data shall be recorded, filed and handed over together with the Equipment Record Card of the equipment.

6.3 DOWELLING

Dowelling of equipment and its driver shall be executed when required by the Manufacturer. Diagonal dowelling shall not be applied.

7. COUPLINGS

The following shall be checked to ensure that couplings are properly installed:

(a) any special instructions of the Manufacturer;

(b) for couplings installed in the field, the installation records of hydraulic pressure, area of contact, applied axial travel, final position;

(c) the recorded distance between shaft ends and/or distance between hubs (axial float, pre-stress);

(d) the correct angular position of spacers in relation to the hubs;

(e) the correct tightening torque of the coupling bolts as applied and recorded;

(f) the axial float of the spacer (measured and recorded);

(g) the luboil spray nozzles. They shall be effective in both extreme positions of the coupling spacer and shall not rub the spacer or hub;

(h) the oil pressure and flow, and absence of oil leakage;

(i) the correct installation of the coupling guard.

The above checks also apply to dry-type couplings, except (f), (g) and (h).
After installation of the coupling there shall be no distortion or damage of the flexible elements.

NOTE: Grease-filled couplings shall be filled with the proper grade and quantity of grease as soon as possible after installation at site.

8. CLEANING OF PIPING SYSTEMS

Piping systems shall be cleaned in accordance with DEP 70.10.80.11-Gen.

8.1 CLEANING OF EQUIPMENT AND RELATED SYSTEMS

For cleaning of systems, rotating equipment parts, bearing housings, etc., a suitable non-flammable cleaning agent shall be used. Paint thinner, gasoline and similar liquids shall not be used because of their adverse effects on internal painting, '0' rings, liquid gasket material, etc.

After cleaning, parts shall be preserved in accordance with DEP 70.10.70.11-Gen.

8.2 FLUSHING OF LUBOIL AND SEAL OIL SYSTEMS

Luboil and seal oil systems shall be cleaned and flushed in accordance with the Manufacturer's instructions.

Forced feed lubricating and seal oil systems shall be demonstrated to be clean by installing 120 mesh SWG 42 screens upstream of each bearing and seal, and circulating oil for at least 12 hours at the highest possible temperature and flow, but in any case not lower than 45 °C. During this period pumps shall be repeatedly stopped and started.

Each filter shall be inspected after this procedure to verify system cleanliness. After completion of this flushing/cleaning operation, the oil system shall be drained, the fine mesh screens removed, the tanks/vessels cleaned and inspected and a fresh charge of oil supplied.

Cleaning of piping associated to or serving gas seals shall be carried out according to the requirements of the seal manufacturer. Piping already installed and cleaned prior to shipment to site should be sealed off.

Piping between filters and seals should not be disturbed without the consent of the equipment manufacturer, in order not to violate the warranty.

8.3 CHEMICAL CLEANING

Oil and process piping associated with rotating equipment may require chemical cleaning. This requirement should be reviewed and defined for each installation in consultation with the Principal. If more stringent, the Manufacturer's recommendations shall be followed. For further recommendations reference is made to DEP 70.10.80.11-Gen. A leak test shall be carried out before recommissioning of the equipment.

8.4 FILTERS

For the precommissioning and start-up period fine mesh screens shall be temporarily installed in the rotating equipment suction strainers as indicated below.

a) Pumps

Reference is made to Standard Drawings S 38.004 and S 38.005. During the precommissioning period a 40 mesh, SWG 32 wire cloth with an open area of approximately 32% shall be fixed on the upstream side of the perforated plate. This applies for both Y-type and conical strainers.

b) Reciprocating compressors

On top of the perforated plate a primary screen of stainless steel wire cloth (22 mesh SWG 33) with an open area of approximately 61% shall be attached. On top of this wire cloth a secondary screen of stainless steel woven cloth (200 mesh SWG 47) with an open area of approximately 34% shall be attached. The fixation method described on Standard Drawing S 38.041 shall be followed.

After 1 hour of successful operation the 200 mesh screen shall be replaced by a stainless steel wire cloth (100 mesh SWG 39) with an open area of approximately 23%.

Operation shall continue for a further 5 hours, after which the cloth shall be checked and cleaned. Eventually this secondary screen shall be removed if no increase in pressure differential is observed and no foreign matter such as welding rod, nuts and scale is found to be present.

c) Centrifugal compressors

On top of the perforated plate a stainless steel woven wire cloth (22 mesh SWG 33) with an open area of approximately 61% shall be attached as described on Standard Drawing S 38.041. This screen shall be removed when no increase in pressure differential is observed over a continuous operating period of 24 hours and no foreign matter is found present. This pressure differential shall be measured using a differential pressure gauge.

Temporary strainers for line sizes greater than DN-600 shall follow the same requirements but may be of alternative design in view of the required strength.

Location of these filters shall be chosen with the agreement of the Principal, such that equipment alignment is not disturbed by filter handling.

9. FINAL INSPECTION AND CHECKS BEFORE START-UP

The Contractor and Principal shall agree a hand-over procedure. DEP 61.10.08.11-Gen., lists the final checks which should be made before start-up of the various types of mechanical equipment.

10. FIRST START, RUN-IN, INITIAL OPERATION

The Principal shall specify the responsible party for equipment installation, commissioning and performance testing (including hot alignment, overspeed tests and operational records) up to the agreed hand-over of the equipment.

11. REFERENCES

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.
Piping - General requirements	DEP 31.38.01.11-Gen.
Field inspection prior to commissioning of mechanical equipment	DEP 61.10.08.11-Gen.
The preservation of old and new equipment and piping standing idle	DEP 70.10.70.11-Gen.
Cleaning of equipment	DEP 70.10.80.11-Gen

EQUIPMENT RECORD CARDS

Gear box	DEP 31.29.00.80-Gen.
Centrifugal pump	DEP 31.29.02.80-Gen.
Reciprocating pump	DEP 31.29.12.80-Gen.
Rotary displacement pump	DEP 31.29.22.80-Gen.
Axial pump	DEP 31.29.32.80-Gen.
Centrifugal compressor/blower	DEP 31.29.40.80-Gen.
Reciprocating compressor	DEP 31.29.43.80-Gen.
Fan	DEP 31.29.47.80-Gen.
Reciprocating vacuum pump	DEP 31.29.53.80-Gen.
Rotary vacuum pump	DEP 31.29.56.80-Gen.
Steam turbine	DEP 31.29.60.80-Gen.
Gas turbine	DEP 31.29.70.80-Gen.
Internal combustion engine	DEP 31.29.80.80-Gen.
Steam engine	DEP 31.29.85.80-Gen.
Spare parts	DEP 70.10.90.11-Gen.

STANDARD DRAWINGS

Anchor bolts with sleeves for concrete foundations and structures	S 10.045
Bucket-type suction strainers	S 38.004
Sieve for Y-type strainer	S 38.005
Temporary strainer for compressors	S 38.041

BRITISH STANDARDS

External dimensions for vertical in-line centrifugal pumps	BS 4082: Part 1

Issued by:
British Standards Institution
389 Chiswick High Road

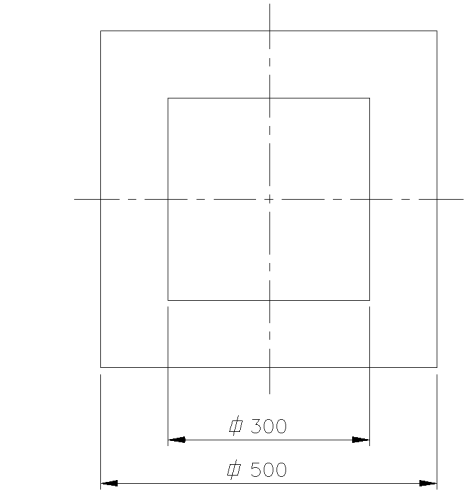
London W4 4AL
England, United Kingdom

AMERICAN STANDARDS

Centrifugal Pumps for general Refinery Service	API Std 610
Special-purpose Couplings for Refinery Services	API Std 671

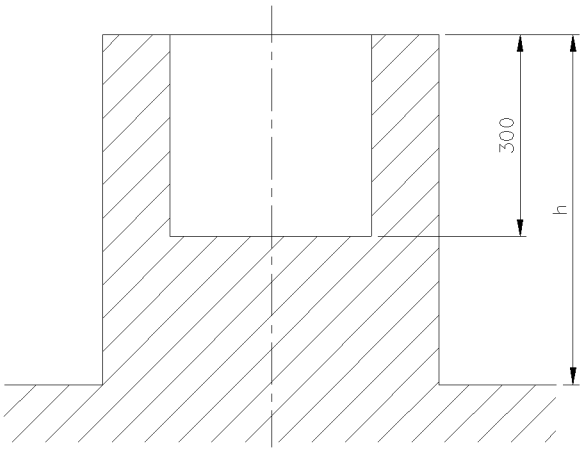
Issued by:
American Petroleum Institute
Publications and Distribution Section
1220 L Street Northwest
Washington DC. 20005
USA.

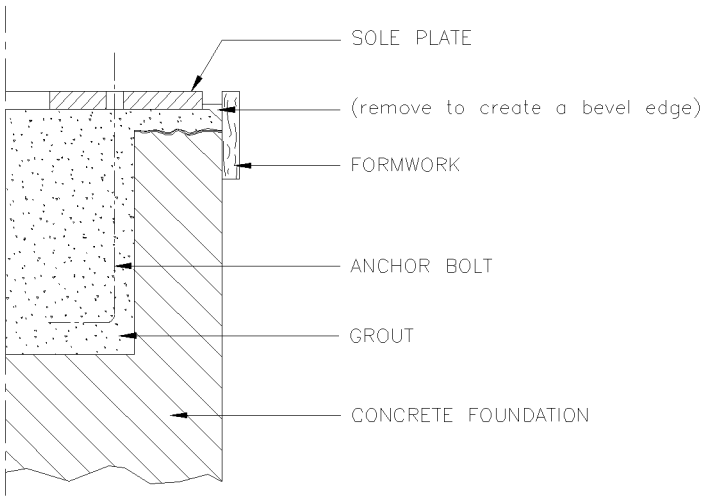
APPENDIX 1a STANDARD FOUNDATION DIMENSIONS FOR THE INSTALLATION OF VERTICAL CLOSE COUPLED PUMPS



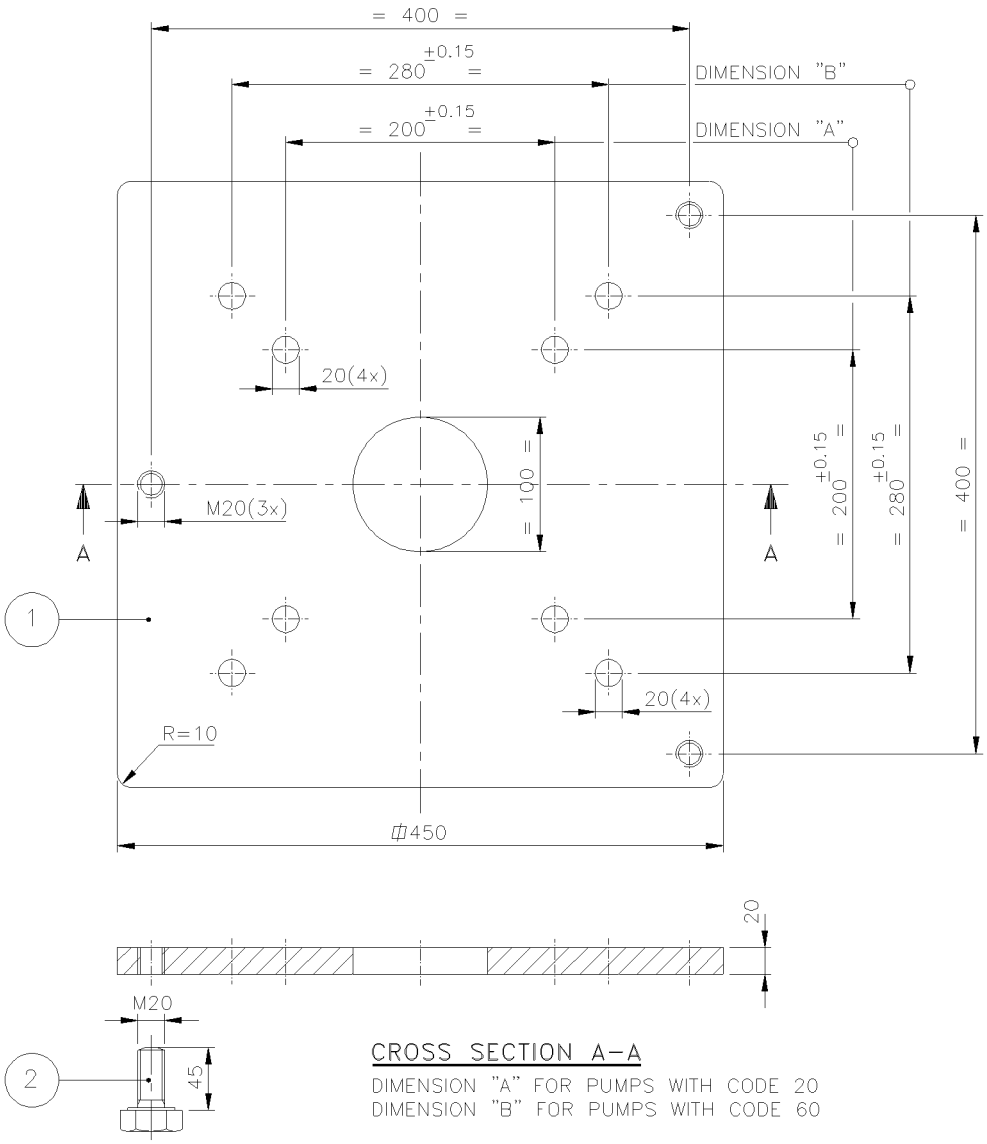
REMARKS:

* The concrete has to be sufficiently cured and shall be free of any dust, oil or grease. The upper layer shall be roughened/chipped.
* Required reinforcement of foundation is not shown in this schematic drawing.
* Dimensions in mm; dimension h depends on actual situation at site.



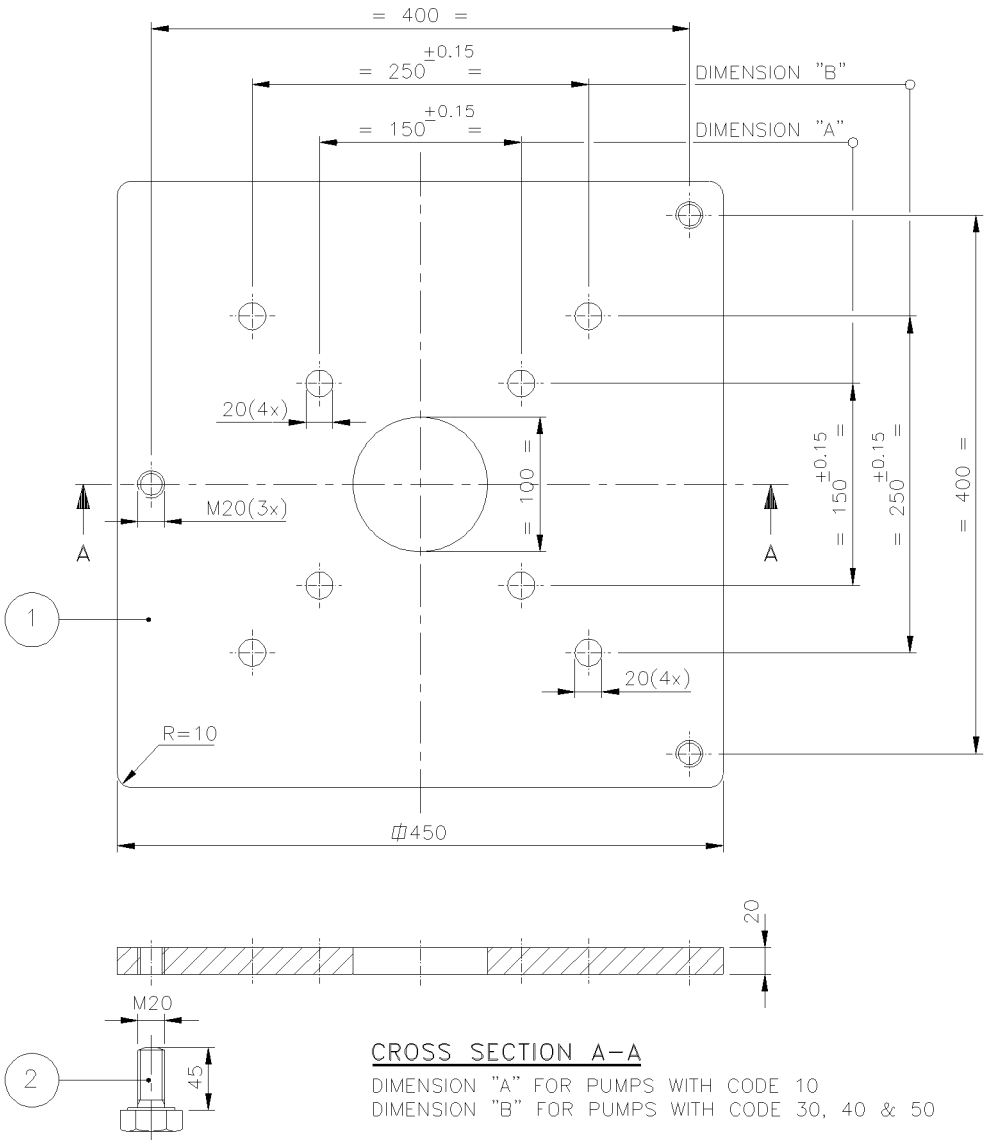


APPENDIX 1b SETTING PLATE FOR VERTICAL CLOSE COUPLED PUMPS, BS 4082 - CODE 20 AND 60



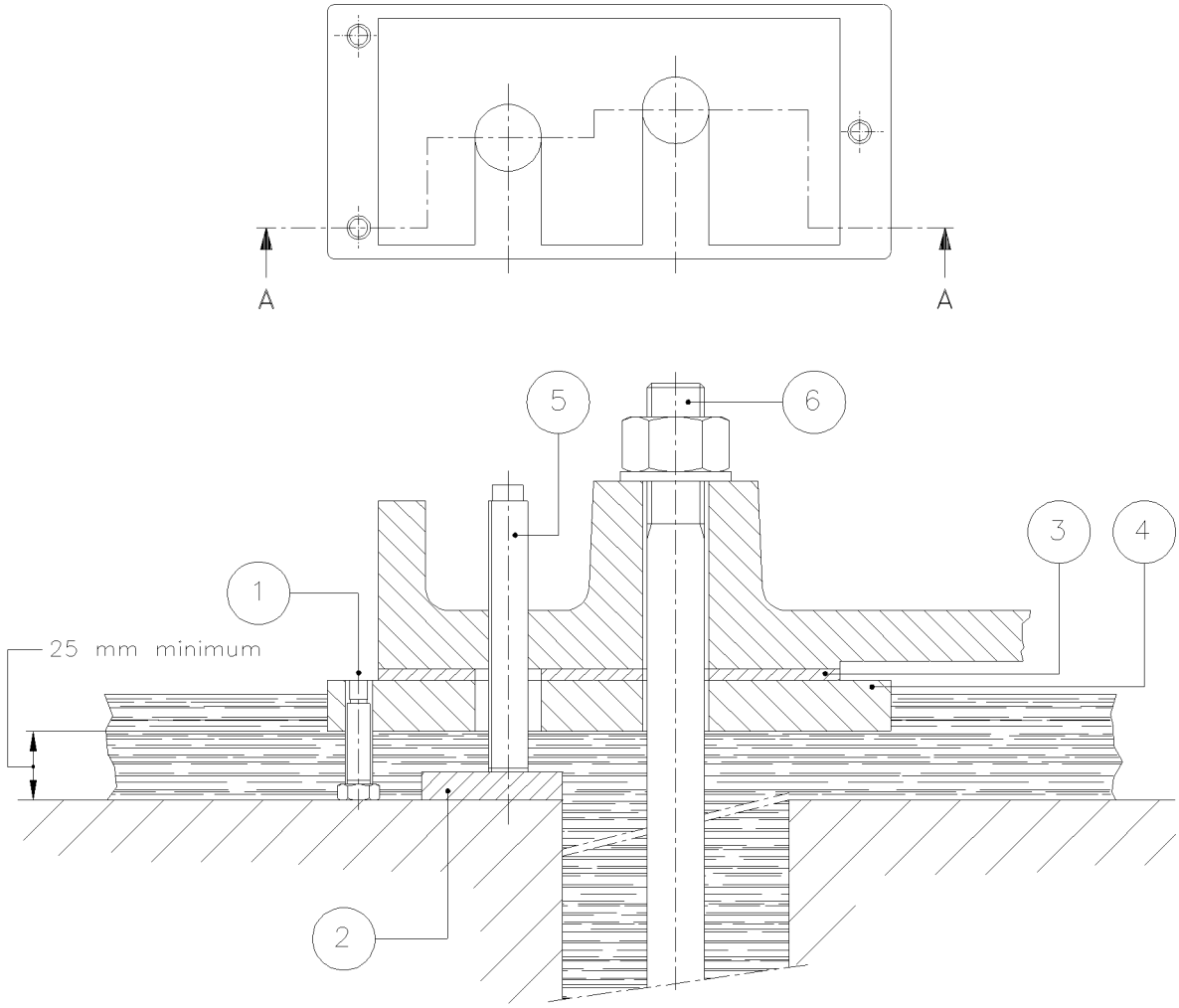
2	3	SETTING BOLT	ST. 8.8	M20 x 45
1	–	SETTING PLATE	ST. 37	⌀450 x 20
POSITION	QUANTITY	DESCRIPTION	MATERIAL	REMARKS

APPENDIX 1c SETTING PLATE FOR VERTICAL CLOSE COUPLED PUMPS, BS 4082 - CODE 10, 30, 40 AND 50



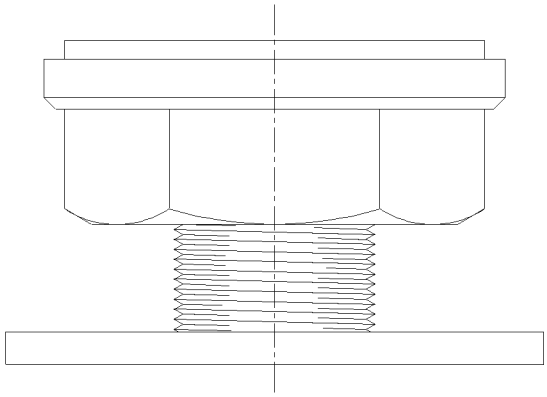
2	3	SETTING BOLT	ST. 8.8	M20 x 45
1	–	SETTING PLATE	ST. 37	⌀450 x 20
POSITION	QUANTITY	DESCRIPTION	MATERIAL	REMARKS

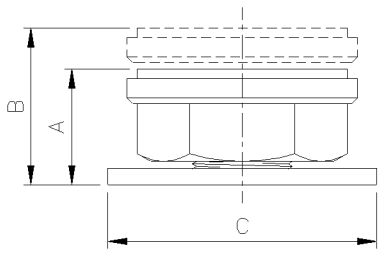
APPENDIX 2 TYPICAL ARRANGEMENT OF SOLE PLATES, LEVELLING SPINDLES AND SHIMS AS USED FOR RECIPROCATING EQUIPMENT

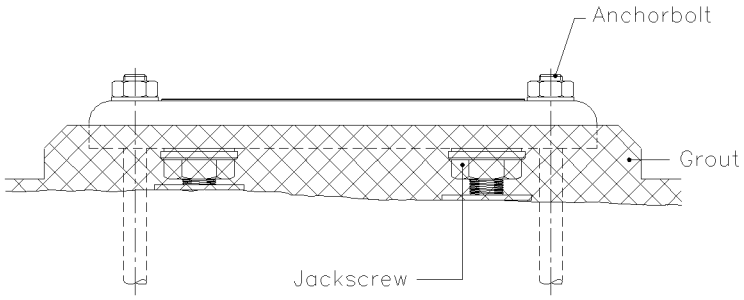


1. Sole plate positioning bolt
2. Steel plate
3. Shims
4. Sole plate
5. Machine levelling spindle
6. Anchor bolt

APPENDIX 3 DIMENSIONS AND TYPICAL ARRANGEMENT OF JACKING BOLTS







Dimensions:
A .. 45 mm
B .. 67 mm
C .. 80 x 80 mm

Approx. weight: 1.05 kg
Maximum load: 2000 kg per jackscrew